

SPARKLES

VOLUME VII

DECEMBER 2025

**INTERDISCIPLINARY PERSPECTIVES ON
INNOVATION AND SOCIAL TRANSFORMATION**



**Shrimathi Devkunvar Nanalal Bhatt
Vaishnav College for Women (Autonomous)**

Affiliated to University of Madras
Re-Accredited with 'A+' Grade by NAAC
Chromepet, Chennai - 600 044

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Foreword

“Science and innovation flourish when young minds question, explore, and connect knowledge across disciplines to build a sustainable future.”

-A. P. J. Abdul Kalam

It is with great pride I commend this compilation of research articles, reflecting the intellectual curiosity, innovation, and interdisciplinary spirit of young scholars. This volume presents a vibrant collection of scholarly articles that reflect the emerging trends. It brings together studies from diverse fields including technology, commerce, environmental science, biotechnology, and literary studies, highlighting the interconnected nature of knowledge in today’s rapidly evolving world.

Several contributions focus on technological advancements such as artificial intelligence, fintech, digital payments, IoT systems, user interface design, and assistive communication technologies. At the same time, research on crypto-currency, rural entrepreneurship, and consumer behavior offer valuable insights into changing economic landscapes and market dynamics.

Sustainability remains a central theme throughout this collection. Articles addressing green marketing, circular economy awareness, carbon credit markets, plant-based products, biochar applications, edible coatings, and phytochemical studies emphasize the importance of environmentally responsible solutions.

These studies underline the shared responsibility of innovation and conservation in shaping a sustainable future that the youngsters have taken into cognizance. Where knowledge meets innovation, and research becomes responsibility, the future is shaped with purpose. These contributions represent a meaningful step towards holistic understanding and progressive development.

Happy Reading!

Jai Hind

S/Lt Dr. K. Kanthimathi

Principal Incharge

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Chromepet.

Preamble

SPARKLES Volume VII - Interdisciplinary Perspectives on Innovation and Social Transformation

Dear Readers,

It is with great pride and enthusiasm that I extend a warm welcome to the readers of Volume VII of Sparkles. Each edition of Sparkles marks a significant milestone in our institution's research journey, and this publication stands as a testament to our sustained commitment to academic excellence, innovation, and interdisciplinary exploration.

Since its inception, Sparkles has steadily grown into a vibrant scholarly platform that showcases the intellectual curiosity, creativity, and research capabilities of our students and faculty. It has consistently encouraged young researchers to question, explore, and contribute meaningfully to the expanding body of knowledge across disciplines.

This edition proudly continues that tradition by presenting thoughtful, relevant, and socially responsive research contributions. The works featured here reflect contemporary global trends while remaining rooted in local realities, thereby demonstrating a dynamic balance between global awareness and community engagement.

This publication symbolizes growth, continuity, and progressive academic engagement. It reflects the collective efforts of a dedicated research community that values collaboration, innovation, and purposeful inquiry. The commitment of our contributors and mentors has once again transformed vision into achievement.

As we celebrate this milestone, we reaffirm our resolve to nurture a culture where ideas flourish, disciplines intersect, and knowledge serves as a catalyst for social transformation. We trust that this edition will inspire continued research excellence and meaningful scholarly dialogue.

Dr. M.S. Vijaya

Director (Self Support)

Shrimathi Devkunvar Nanalal Bhatt
Vaishnav College for Women (Autonomous),
Chromepet.

From the Editorial Board

Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women has carved a niche in women's education by upgrading its status as a Research Institute. We have always been ahead in promoting research initiatives. To promote a healthy research and writing culture, the college takes pride in publishing two International Half-yearly Journals – International Journal of Multidisciplinary Research in Arts, Science and Commerce (IJMRASC) and Svādhyāya - International Journal of Trans-disciplinary Research and Development (SIJTRD). SIJTRD promotes the concept of trans-disciplinary research by collaborating with natural sciences. IJMRASC encourages Innovative Research, Review of the existing research, Comparative research of different approaches and its interpretation, problem solving research, community based and socially relevant research.

To encourage the art of writing research articles amongst UG, PG students and faculty members of our college, we have taken an initiative to publish a multidisciplinary research book SPARKLES – *Interdisciplinary Perspectives on Innovation and Social Transformation* which comprises conceptual articles, technology based research ideas, research findings, and investigative ideas. This is an opportunity for the students to build their technical writing skills and formulate research spirit.

It is with great pride that we present *Interdisciplinary Perspectives on Innovation and Social Transformation*, a volume that brings together diverse scholarly insights across technology, social sciences, economics, environmental studies, and cultural research. In a rapidly evolving world, innovation extends beyond scientific advancement to influence

social structures, economic systems, and cultural understanding. This collection reflects the strength of interdisciplinary collaboration in addressing contemporary global challenges with depth and relevance.

The chapters explore a wide range of themes, including Artificial Intelligence, FinTech, Digital Payments, Green Marketing, Carbon Credit Markets, Rural Entrepreneurship, Sustainable Development, and emerging biological and environmental studies. In addition to technological and economic perspectives, the volume engages with gender studies, translation, and cultural analysis—highlighting that social transformation is both a scientific and humanistic endeavor. Together, these contributions illustrate how innovation can foster inclusivity, sustainability, and responsible growth.

This book stands as a testament to the dedication and intellectual curiosity of its contributors. By bridging theory and practice, the research presented here encourages critical thinking and socially responsive scholarship. We hope this volume inspires readers to think beyond disciplinary boundaries, question conventional frameworks, and actively engage in research that contributes to societal progress. May this collection serve as a platform for dialogue, discovery, and continued innovation.

With best wishes for meaningful reading and impactful research.



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ARTIFICIAL INTELLIGENCE

(செயற்கை நுண்ணறிவு)

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ஆய்வுச்சுருக்கம்

கணினியின் இன்றைய வளர்ச்சியும், நீட்சியும் அறிவியல் தகவல் தொழில் நுட்பத்தை உலகத்தை மக்கள் கையில் கொண்டு சேர்த்து விட்டது. தகவல் தொழில் நுட்பத்துறையில் ஏற்பட்டுள்ள மிகப்பெரிய அறிவியல் முன்னேற்றம் மக்கள் வாழ்வில் மறுமலர்ச்சியைத் தொழிற்புரட்சியை ஏற்படுத்தி வருகின்றது. தகவல் தொடர்புச் சாதனங்களால் ஓரிடத்தில் நடைபெறும் நிகழ்வுகளைக் கூட உடனுக்குடன் மற்றோரிடத்தில் அறிய முடிகின்றது. தற்கால கணினி வளர்ச்சியில், தொழில் புரட்சியில் கல்வித்துறையில் இன்றியமையாத இடத்தை வகிப்பது செயற்கை நுண்ணறிவு என்ற தொழில்நுட்பம் ஆகும். செயற்கை நுண்ணறிவு (Artificial Intelligence – AI) என்பது நுண்ணறிவு கொண்ட தொழில் நுட்ப அமைப்பு அல்லது ஒரு மென்பொருள் உருவாக்கும் முறையாகக் கொள்ளலாம். இது மனிதர்களைப் போலவே திறனுடன் பணிகளைச் செய்யக்கூடியது. தகவல் தொடர்புத் துறையில் செயற்கை நுண்ணறிவு அசாதாரணமான மாற்றங்களைக் கொண்டு வந்துள்ளது. அதன் விளைவால் கல்வித் தரத்தில் பல முன்னேற்றங்களைக் காண முடிகின்றது.

திறவுச்சொற்கள் :

கட்டளை வரி, குறியிட்டு ஆணைகள், நுண்ணறிவுத் திறன், தரவுத்தொகுப்புகள், பகுப்பாய்வு.

முன்னுரை

மனித வாழ்வில் தொழில்நுட்ப முன்னேற்றம் நாளுக்கு நாள் அதிகரித்து வருகிறது. இன்று ஒவ்வொருவரும் காலை எழுந்தது முதல் இரவு தூங்கும் வரை இணையதளம், அலைபேசி பயன்பாடுகள், சமூக வலைத்தளங்கள், வணிக பயன்பாடுகள், கல்வி சார்ந்த தளங்கள் என பல்வேறு டிஜிட்டல் கருவிகளைப் பயன்படுத்துகின்றனர். மேலும் தகவல்

தொடர்புச் சாதனங்களால் ஓரிடத்தில் நடைபெறும் நிகழ்வுகளைக் கூட உடனுக்குடன் மற்றோரிடத்தில் அறிய முடிகிறது. மேலும் சங்க இலக்கியங்கள் முதல் தற்கால இலக்கியங்கள் வரையிலான செய்திகளைக் கணினியின் மூலம் ஆவணப்படுத்துதல் எளிதாக அமைகின்றது.

கணினியின் வளர்ச்சி படி நிலை

கணினியின் ஆரம்பகாலங்களில், மக்கள் பெரும்பாலும் கட்டளை வரி (குறியீட்டு ஆணைகள்) மூலமாக மட்டுமே இயங்குதளத்துடன் தொடர்பு கொண்டனர். இது பொதுமக்களுக்குச் சிரமமாக இருந்தது. பிறகு திரை அடிப்படையிலான இடைமுகம் உருவாக்கப்பட்டதால், கணினி அனைவருக்கும் எளிதில் அணுகக்கூடியதாகியது.

பின்னர், விண்டோஸ், மெக், லினக்ஸ் போன்ற இயங்குத் தளங்கள் கண்ணுக்கினிய இடைமுகத்துடன் வந்தன. மொபைல் காலத்தில், தொடுதிரை அடிப்படையிலான இடைமுகம் அறிமுகமாகி, பயனர் அனுபவத்தில் பெரிய மாற்றத்தை ஏற்படுத்தியது. இன்று, செயற்கை நுண்ணறிவு, குரல் வழி வழிநடத்தல், மெய்நிகர் யதார்த்தம் போன்றவை பயனர் அனுபவத்தை மேலும் மேம்படுத்துகின்றன. ஒரு பயன்பாடு எவ்வளவு முன்னேற்றமான தொழில்நுட்பத்தைக் கொண்டு உருவாக்கப்பட்டிருந்தாலும், அது பயனாளிக்கு எளிதில் புரியவில்லை என்றால் அதன் மதிப்பு குறைந்துவிடும். அதனால் இன்றைய தகவல் தொழில்நுட்பத் துறையில் பயனர் இடைமுகம் மற்றும் பயனர் அனுபவம் மிகப் பெரிய பங்கு வகிக்கின்றன.

செயற்கை நுண்ணறிவு

1950 - ஆம் ஆண்டில் ஜான் மெக்கார்த்தி செயற்கை நுண்ணறிவு என்ற வார்த்தையை முதலில் உருவாக்கினார், அடுத்து ஆலன் டூரிங் அதே ஆண்டு கணினி இயந்திரங்கள் மற்றும் நுண்ணறிவு என்ற தலைப்பில் ஒரு கட்டுரை எழுதினார். இவ்வாறு பலரின் கண்டுபிடிப்பாலும் பல வளர்ச்சி நிலைகளைப் பெற்று இன்றைய நிலையைச் செயற்கை நுண்ணறிவு பெற்றுள்ளது. செயற்கை நுண்ணறிவானது,

- திட்டமிடல்
- சிந்தித்தல்
- கற்றுக் கொள்ளுதல்
- செயற்படுதல்

என மனித அறிவிற்கு இணையான பல்வேறு நுண்ணறிவுத் திறன்களைத் தன்னகத்தே கொண்டுள்ளது. நுண்ணறிவுப் பயன்பாடுகளில் வலைத் தேடுபொறிகள் கூகுள் தேடல், பரிந்துரை அமைப்புகள் யூடியூப் அமேசான், செப்டோ, மனித பேச்சைப் புரிந்துகொள்ளும் அலெக்சா, பொது அறிதிறன் உருவாக்கும் ஆக்கக் கருவிகள் சாட்ஜிபிடி, ஜெமினி, போன்றவற்றைக் கொண்டு செயல்படுகிறது.

செயற்கை நுண்ணறிவு பகுப்பாய்வுக் கருவி

மனிதர்களை விட மிக விரைவாக தரவு சேகரிப்புகளைச் செயலாக்கி விளக்கக் கூடிய வழிமுறைகளை அஐ பயன்படுத்துகிறது. சங்க இலக்கிய செய்யுளை தந்தவுடன் அதற்கான பல விளக்கங்களைப் படங்களுடன், பாடல்களுடன், உரைகளுடன் செயற்கை நுண்ணறிவு பகுப்பாய்வு கருவி மூலம் தருகிறது.

வாடிக்கையாளர் சேவை மற்றும் சாட்போட்கள்

இண்டர்காம், ஜென்டெஸ்க் மற்றும் டிரிஃப்ட் உள்ளிட்ட AI-இயக்கப்படும் வாடிக்கையாளர் சேவை கருவிகள்.

தனிப்பயனாக்கம்

இக்கருவிகள் நிறுவனங்கள் மற்றும் நிறுவனங்கள் தனிப்பயனாக்கப்பட்ட உள்ளடக்கத்தை தகுந்த நேரத்தில் சரியான பார்வையாளர்களுக்கு வழங்க உதவுகின்றன.

CRM அமைப்புகள்

AI-இயக்கப்படும் CRM கருவிகள், வணிகங்கள் வாடிக்கையாளர் செயல்பாட்டைக் கண்காணிக்கவும், வரலாற்றுத் தரவைப் பகுப்பாய்வு செய்து வடிவங்களை அடையாளம் காணவும் உதவுகின்றன.

சந்திப்புக் கருவிகள்

கூட்டங்களுக்கானச் செயற்கை நுண்ணறிவு கருவிகள், குறிப்பு எடுப்பது மற்றும் நிகழ்ச்சி நிரல் உருவாக்கம் போன்ற பணிகளைச் செய்கின்றன.

செயற்கை நுண்ணறிவுக் கருவிகளின் பணிகள்

1. தனித்து இயங்குகிறது
2. ஆக்கப்பூர்வமானப் பணிகளைச் செய்கிறது
3. துல்லியத் தரவுகளைத் வழங்குகிறது.
4. மனிதர்கள் செய்யும் தவறுகளைக் குறைக்கிறது
5. தரவு பகுப்பாய்வில் செலவிடும் நேரவிரயத்தைத் தவிர்க்கிறது.

செயற்கை நுண்ணறிவுக் கருவிகளின் பயன்கள்

செயற்கை நுண்ணறிவு கருவிகள் என்பது மனிதர்கள் செய்ய வேண்டிய பணிகளைச் செய்ய இயந்திர கற்றல் மற்றும் செயற்கை தொழில் நுட்பங்களைப் பயன்படுத்தும் மென்பொருள் பயன்பாடுகளாகும். செயல்முறைகளைத் தானியங்குபடுத்துவதும், பெரிய தரவுத்தொகுப்புகளைத் திறமையாகத் தொகுத்து, விவரித்துப் பகுப்பாய்வு செய்வதும், அதிக உற்பத்தி மற்றும் துல்லியமான அறிக்கையிடல் செயல்முறைக்குப் பயன்படுகின்றன.

- பதிப்பித்தல்
- வழிகாட்டல்
- வணிக வாய்ப்புகள்
- செயற்கை நுண்ணறிவுக் கருவிகள் மேற்கண்ட மூன்று நிலைகளில் பயன்படுகின்றன.

பதிப்பித்தல்

ஜெமினி, வேர்டுஸ்மித் என்னும் செயற்கை நுண்ணறிவு மென்பொருள் நாம் கொடுக்கும் தலைப்புகளைக் கொண்டு கட்டுரையை விரைவில் உருவாக்கிவிடும் தன்மை கொண்டது. திருக்குறள் என்று தந்தால் திருவள்ளுவர் எழுதிய திருக்குறளைத் தருகிறது. அதே நேரம் அதுவே புதிய திருக்குறளை உருவாக்கியும் தந்துவிடும் அபாயமும் ஏற்படுகிறது.

வழிகாட்டல்

கூகுல் மாப், போக்குவரத்து நெரிசல் அதிகம் உள்ள பகுதி என்றும் சுருக்கமான வழி என்று அலைபேசியில் வழிகாட்ட படம் உதவி செய்கிறது. அதே நேரம் பழைய பதிவைக் கொண்டு தவறான வழிகாட்டுதலையும் சில நேரங்களில் செய்து விடுகிறது.

வணிக வாய்ப்புகள்

புதிய வணிக வாய்ப்புகளைச் செயற்கை நுண்ணறிவு நல்குகிறது. பெரிய நிறுவனங்கள் தங்கள் பொருள்களை உற்பத்தி செய்யவும், வீடுகளுக்குச் சென்று கணினி வாயிலாக விற்பனை செய்யவும் செயற்கை நுண்ணறிவு கருவிகள் பயன்படுகின்றது.

பிற துறைகள்

தங்கும் விடுதிகள், வங்கிகள், கல்வித் துறையில் என பல விதங்களில் செயற்கை நுண்ணறிவு கருவிகள் பயன்படுகிறது.

இலக்குகள்

செயற்கை நுண்ணறிவு கருவிகள் என்பது மனிதர்கள் செய்ய வேண்டிய செயல்களைச் செய்ய இயந்திர கற்றல் மற்றும் அஐ நுட்பங்களைப் பயன்படுத்தும் மென்பொருள் பயன்பாடுகளாகும். செயல்முறைகளை தானியங்குபடுத்துவதும், பெரிய தரவுத்தொகுப்புகளைப் பகுத்து பகுப்பாய்வு செய்வதும், அதிக உற்பத்தி மற்றும் துல்லியமான அறிக்கை வெளியிடல் என்ற செயல்முறைக்குப் பங்களிப்பதும் இதன் குறிக்கோள். இவ்வாறு செயற்கை நுண்ணறிவுக் கருவிகள் சமுதாய வளர்ச்சிக்குப் பெரும் பங்களிப்பை நல்குகிறது.

முடிவுரை

கணிப்பொறியில் தமிழ் எழுத்துருக்களை ஏற்றி தண்டமிழ் மொழிச் சொற்களை ஆய்தல், விளக்கங்கள், புகைப்படங்கள் மூலம் செய்திகளாகக் காட்சி படுத்துதல் முதலிய மகத்தானப் பணியைக் கணினியின் செயற்கை நுண்ணறிவு செய்கின்றது.

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GENDER PERFORMATIVITY: A BUTLERIAN READING OF A GENTLE CREATURE AND SWEET PUDDING

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ABSTRACT

*Traditionally viewed as a biological reality, gender is now widely recognized as a socially constructed identity influenced by culture and society. This study explores Butler's theory of Gender Performativity—which argues that gender is not innate but enacted through repeated social performance—and applies it to Fyodor Dostoevsky's *A Gentle Creature* and Kamala Das's *Sweet Pudding*. While Dostoevsky's story explores a husband's obsession with control that leads to his wife's tragic suicide, Das's tale reveals a widower's helplessness over his newfound responsibilities. This study analyzes how the characters are affected by the pressure to perform their assigned gender roles—and how failing to meet these expectations can result in emotional, psychological, or even tragic consequences.*

KEYWORDS: *Gender Performativity Theory, Gender and Literature, gender dynamics, heteronormative and inclusivity.*

INTRODUCTION

It is an undeniable truth that gender, though invisible, is deeply interwoven with human life—shaping identities, behaviors, and social norms. Feminist thinkers like Simone de Beauvoir and Betty Friedan raised crucial questions about patriarchy and women's roles, eventually leading to deeper inquiries into the nature of gender itself. Judith Butler, in *Gender Trouble: Feminism and the Subversion of Identity* (1990), responded to these questions with their theory of Gender Performativity.

Judith Butler, a post-structuralist philosopher, proposed that gender is not innate but is constructed through repeated speech and actions. Gender identity, according to them, does not exist before the performance. "...gender is always a doing, though not a doing by a subject who might be said to preexist the deed." (Butler 34). This repetition of acts gives the illusion of an essential, natural identity. While individuals cannot freely choose their gender performance, minor variations inevitably occur, revealing the constructed nature of gender itself. Butler argues that even sex,

traditionally considered biological, may be socially constructed—“perhaps it was always already gender...” (Butler 9–10). This structure is regulated by the “heterosexual matrix,” where sex, gender, and desire align according to heteronormative expectations. From birth, one is assigned both a sex and a gender identity, which is then performed repeatedly to fit societal norms. Despite appreciation for their work, Butler’s ideas—particularly regarding the performativity of sex—have faced criticism. Much of this was addressed in the sequel *Bodies That Matter* (1993). Still, the theory of performativity remains influential in gender studies and literary analysis, offering a lens to examine how characters perform or challenge societal expectations.

This study applies Butler’s theory to two literary works—Fyodor Dostoevsky’s *A Gentle Creature* (1876) and Kamala Das’s *Sweet Pudding* (1991). Despite differing in context and culture, both explore the male protagonists’ psychological struggles following the death of their wives. The study aims to examine how gendered expectations shape these characters and the consequences of failing to meet them.

REVIEW OF LITERATURE

J. L. Austin’s *How To Do Things With Words* (1955) proposed that language is not merely descriptive but performative—it enacts realities through repeated use. Jacques Derrida in *Limited Inc* (1988) expanded on this, suggesting that meaning and reality are constructed via repetition and citation. Judith Butler, influenced by these ideas, formulated the Gender Performativity Theory in *Gender Trouble* (1990), arguing that gender is not innate but constituted through continuous acts and speech.

Jay Prosser’s *Second Skins* (1998) critiques Butler by highlighting that for transgender individuals, gender identity is not merely performative but often an attempt to assert an authentic self against a forced, assigned identity. Viviane Namaste in *Invisible Lives* (2000) similarly critiques Performativity Theory for neglecting the lived experiences of transgender and transsexual people. J. T. Ton (2018) addresses these criticisms, arguing that Butler’s theory does not inherently exclude stable gender identities. Ton emphasizes that for many trans individuals, “gender identity” is crucial in articulating the disconnectivity between their inner identity and assigned sex (11). Lindsay Wilson’s *Gender Performativity and Objectification* (2015) examines how objectification enforces gender roles, particularly female objectification. Though men are objectified through masculine roles, the emotional consequences differ significantly, often isolating them.

Radosvet Kolarov draws parallels between the female characters in Dostoevsky’s *A Gentle Creature and The Idiot*, suggesting a thematic dialogue in their expressions of revolt. Manohla Dargis, in her commentary on Bresson’s film adaptation *Une Femme Douce*, notes the narrator’s ignorance of his own ignorance. Michelle Nogas (2014) notes Dostoevsky’s failure to fully depict autonomous female characters without resorting to tragedy. In contrast, Kamala Das’s *Neipayasam* is read alongside Ambai’s *Unpublished Manuscripts* (Ramanujam, 2017), exploring paternal responsibility and gender roles. Sandhya V and Harini Jayaraman (2019) compare Das’s defiance of gender norms with Butler’s theory, highlighting the performative nature of gender and the consequences of failing to meet societal expectations.

An Analysis of Gender Performativity in *A Gentle Creature* and *Sweet Pudding*

In Dostoevsky's *A Gentle Creature*, the narrator's internal monologue reveals how he had failed to understand the emotional needs of the young woman. Even in death, he refers to her as "a gentle creature" instead of acknowledging her struggles. He admits how she had always been obedient and gentle, but even that was not enough as he himself was too caught up with his own traumatic past, where he failed to perform his gendered 'duty' (refusing to participate in a duel). When she began showing signs of resistance, he felt anger and confusion. It becomes evident how this woman was expected to perform her femininity in a particular way—obedient, silent, and grateful—and how her failure to do so ultimately led to tragic consequences. All the while, the narrator was pleased with himself in cornering a young woman. He probably believed that now that he had saved the young woman from a predicament (from her arranged marriage) like a knight in shining armor, she was to fall for him. This not only is a result of hegemonic masculinity ideals but also the performative nature of gender—of performing those acts (even the emotional ones such as love and marriage) in a pre-designed manner. Here, it is clear how these performative constructs can also be expected out of someone. It was too late when the narrator finally realized (or failed to realize) the error in his ways.

In Kamala Das's *Sweet Pudding*, the narrator—a grieving father—fails to acknowledge the emotional labour of his late wife. While he insists theirs was a love marriage, the narration reveals how she had become just a figure performing her expected gendered roles: wife, mother, caretaker. Even in death, the only thing remembered about her was her daily chores. His outburst—"Who will bath the kids? Who will make them snacks?" (Das 7)—reduces her life to duties. The absence of any memory of her as a person speaks volumes. Failing to meet gendered expectations—whether as a wife, husband, or parent—can result in emotional exhaustion, helplessness, or even tragic consequences.

A Comparative Analysis of *A Gentle Creature* and *Sweet Pudding*

Both stories begin with the male narrators dealing with the sudden death of their wives. In *A Gentle Creature*, the wife dies by suicide—a tragedy the narrator struggles to process as he recounts their past in a hysterical manner. In *Sweet Pudding*, the narrator reflects more repressively, returning home from his wife's funeral, trying to come to terms with grief, anger, and the weight of raising their three children alone. In both stories, neither the narrators nor their wives are named. Only side characters are named. This shared narrative choice emphasizes the erasure of individual identity within rigid gender roles.

Courtship also differs. In *Sweet Pudding*, it was a love marriage that lasted "maybe one or two years" (Das 3) of courtship, but in *A Gentle Creature*, the relationship progressed quickly within six months, heavily influenced by economic and social structures in post-emancipation Russia. The pawnbroker narrator sees the marriage as a transaction, reinforcing gendered power imbalance. Contrastingly, in *Sweet Pudding*, the narrator marries despite opposition, yet still becomes emotionally distant over time.

In both, the wives are confined by gendered expectations. The Russian wife is systematically isolated and stripped of autonomy by her husband's rigid "agreements." The Indian wife, though

not overtly controlled, is confined by domestic responsibilities and invisible societal constraints. The men, too, are crushed by expectations. The Russian narrator clings to dominance to offset past humiliation, while the Indian narrator crumbles under financial stress and household burdens after his wife's death. Both fail to perform the ideals of hegemonic masculinity. While the Indian wife dutifully fulfills her roles until death, the Russian wife attempts to subvert them—ultimately choosing self-destruction as her only escape. Both women face the harsh consequences of gendered expectations—either through silent endurance or tragic defiance.

CONCLUSION

The analytical study of Fyodor Dostoevsky's *A Gentle Creature* and Kamala Das's *Sweet Pudding* through Judith Butler's Gender Performativity Theory, as proposed in *Gender Trouble* (1990), highlights the constructed and enforced nature of gendered roles. Both stories, despite their different cultural contexts, portray how societal structures assign and constrain gender performances.

In *A Gentle Creature*, the unnamed young woman is trapped in a domestic setting that demands submissiveness. Her husband's obsession with power and control reduces her to a silent object. Though she remains mostly passive, her suicide becomes her final act of subversion—an assertion of agency against a system that silenced her. Her husband, haunted by his past failure to perform 'masculinity,' seeks validation by forcing her into submission, leading to further insecurity and collapse. In *Sweet Pudding*, the woman fulfills the gender roles expected of her as a wife and mother, at the cost of her well-being. The narrator, shaped by hegemonic masculinity, fails to view her beyond her roles. When burdened with domestic duties after her death, he feels anger and helplessness.

This study reveals that gender is neither natural nor fixed but performative—an ongoing process shaped by external forces. Gender roles and the expectations placed upon them affect all genders. And failing to perform one's socially constructed gender roles can lead to emotional exhaustion, psychological struggle, learned helplessness, trauma, or even tragic outcomes.

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DIGITAL PAYMENTS AND FINANCIAL INCLUSION IN RURAL AREAS

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ABSTRACT

Digital Payment has transformed the banking system worldwide. Fortunately, it offers solutions to address financial exclusion in rural economies. This article explores the critical role of digital banking in enhancing financial inclusion in rural areas. The people in the rural area can access & afford this service easily. Also, it is a very user- friendly financial service to all in rural areas. Digital payment helps to overcome traditional barriers such as geographical isolation, limited banking infrastructure, and high transformation cost. It integrates mobile banking, digital wallets, and internet- based platforms. The study highlights the potential of digital banking technologies to empower rural communities by enabling source transaction, micro credit access, saving mobilization & insurance service. The role of government policy there is the improvement in financial literacy and adaptation of digital banking in rural areas. Case studies & policies reviews make impact of digital banking on rural on financial inclusion. The central government has launched a programme called PRADHAN MANTRI JAN DHAN YOJANA(PMJDY) that has provided millions of rural households with access to zero- balance accounts. The campaign has promoted awareness and adoption of online services, reinforcing the transaction towards a cashless economy. This is also important for small- scale farmers, women entrepreneurs, and self- help groups (SHGs). In conclusion, digital payments led by UPI have reshaped society. With targeted investment in internet infrastructure, stronger cybersecurity and large- scale financial literacy programs, rural population can use digital platforms with confidence. Effective policies include support and community training. It can accelerate the journey towards a cashless and inclusive rural economy.

KEYWORDS : *Digital banking, Financials inclusion, Mobile banking, Digital wallets, Financials literacy, Public- Private Partnership.*

INTRODUCTION

Digital banking reshapes the financial ecosystem worldwide. Digital banking is extremely easy and user friendly where traditional banking services often remain accessible. Advancement of digital technology bridges geographical barriers and external services. Mobile banking is an efficient alternative service to conventional banking system. Limited infrastructure, high operational cost, and low financial literacy are some hindrances of financial inclusion in rural areas. The rapid evolution of digital banking offers innovative solutions to bridge the financial inclusion gap

particularly in rural economies. Financial inclusion is defined as access to and usage of financial services by the underserved and unbanked population. These services help to promote faster economic activity, enhance livelihoods, and promote overall social economic development. The adoption of digital banking in rural area remains uneven due to the adequate digital literacy poor internet connectivity and cultural barrier. Digital payment also aligns with INDIAN commitment to United Nation Sustainable Development Goals. (SDGs). This link shows that digital payment is not only economic too but also a step towards sustainable development. Many rural economies have cons such as lack of internet facility, low level of digital literacy and lack of trust in online system. To overcome these hurdles investment in infrastructure, awareness in programs and stronger digital security is essential. Digital payment also encourages people to keep money in their accounts. This helps them to build savings. With UPI, even small farmers, shopkeepers, and daily wage earners can send and receive money safely without handling cash. It has also reduced the risk of theft and corruption, improved transparency in payments and opened new opportunities for small businesses. For example, government subsidies and wages under rural employment scheme can now be directly transferred to beneficiary accounts. This ensures money has sent to right time of person at right span of time.

OBJECTIVES OF THE STUDY

1. Explore the role of digital banking in enhancing financial inclusion in rural economies.
2. Identify the key challenges faced by rural populations in accessing digital banking services.
3. Analyse the impact of digital banking on the economic empowerment of rural communities.
4. Examine the effectiveness of government policies and initiatives aimed at promoting digital banking in rural areas.

ROLES OF DIGITAL PAYMENT:

1. COST EFFECTIVE MANAGEMENT:

The biggest challenge in rural area is the lack of bank branches. So digital bank helps to solve this problem by providing banking access via mobile phone. This reduces the cost of bank and ensures rural communities still have essential financial services. We can also set ATM machine because it helps in withdrawing money. So, people in rural area do not have trouble from money lenders.

2. ENCOURAGING SAVING:

Instead of keeping money in home. This is not safe measure. So, people can deposit their money in bank. If they do like this it will be useful during their emergency times. The examples of savings include family develop a cultural of formal saving, which can later use for education purpose, healthcare, and investment.

3. BOOSTING RURAL ECONOMY:

Digital platform is benefit to small businessperson, farmer and self-group (SHGs). For example: farmers can directly receive money for the product that they sale to the buyer. The mode of the payment can be done via g- pay, Paytm... this boosts rural trade and strengthen the local economy.

4. FINANCIAL TRANSPARENCY:

This prevents borrowing money from money lenders which exploits poor farmers to repay their debt amount by rising high interest rates. They promote accountability and reduce corruption in welfare schemes. This helps to build in trust in financial system by providing fair opportunity for all.

5. ACCESS TO CREDIT AND INSURANCE:

A major advantage are we can check the transaction done via mobile banking and internet banking. Bank and micro finance can use this record for creditworthiness. This makes it easier for rural citizen to secure loans, microcredit, and insurance without depending on the money lenders.

RESULT

1. INCREASE ACCESSIBILITY:

This reduces geographical and infrastructural barriers. This enables individuals open bank account, transfer funds and apply for loans without visiting physical banks.

2. IMPROVED FINANCIAL LITERACY:

Programs aimed at enhancing financial literacy has been effective in fostering trust in banking system. NABARD has been providing financial and digital literacy camps through bank branches. Financial Literacy Centres (FLCs) in area with limited awareness.

3. CHALLENGES IN DIGITAL INFRASTRUCTURE:

Limited internet, penetration, unreliable electrical supply and lack of technological awareness. Hinder the seamless awareness of digital banking.

4. GENDER DISPARITIES:

It also identifies gender disparities in digital banking adoption. In 20 21, only 74 percent of women had an account at a formal financial institution compared with 78 percent of men.

BENEFITS OF DIGITAL PAYMENT

1. FINANCIAL EMPOWERMENT:

Digital payment provides rural population to access to formal financial services, enabling them to save, invest, and participate in the economy. Farmer, Vendor can receive money directly into their bank account. For example: a small vegetable vendor in rural market can accept payment via QR- code, avoiding the need to handle large amounts of cash.

2. INCREASE TRANSPARENCY:

Reduced reliance on cash transaction enhances transparency and recording – keeping. It is vital for small businesses man growth. Digital payments prevent the barriers to people to transfer and receive money instantly from home.

3. ECONOMIC OPPORTUNITIES:

Digital payments are the doorways for entrepreneur, artisan to sell their products via online and receive money instantly. this also include instant payment via scanning or code.

4. WOMEN EMPOWERMENT:

Digital tools such as UPI and mobile wallets allow women to manage their finance independently. By getting their money women can gain confidence to promote their skills, innovation in their product. There is no need in dependent on someone else. They will get self-respect in their societies. They can also sell their product among apps like amazon, Flipkart. They can also publish in Instagram and receive money instantly from home.

5. MAINTAINING ACCOUNTS:

Every day they can record their transactions. This helps them to see how much gains or losses that arise in business. It will help them to think how to save money deposit it, withdraw it. It is benefited to artisan, entrepreneur, women in rural area with the help of trainers.

CHALLENGES:

1. LIMITED INTERNET AND POWER SUPPLY:

Many rural areas lack reliable internet connectivity and power supply, hindering digital payment adoption. Without reliable electricity and strong network coverage people cannot depend on digital payment. Frequent power cut makes difficult in transaction. People cannot depend on digital payment daily.

2. DIGITAL LITERACY:

Most benefit for rural people is usage of smartphones. So, people can download the app and start their payments for buying their product from vendors. They also have the fear for losing the money. This lacks confidence slows down digital growth in village.

3. GENDER DIVIDE:

Women in rural area faces barrier more than men. They have a lack of confidence in selling their product in online. It also afraid that money can be stolen via online by hackers. This gender gap reduces women ability in benefit of digital payments leaving them dependent on men for doing their business for selling their product and receiving money via internet.

4. CYBER SECURITY:

Digital fraud is another vital problem everywhere. Villagers are often targeted by phishing calls, unknown calls for stealing data. since many users are unaware of it. They become easy victim by saying their details such as pins. Thus, risk create distrust and prevent people from fully embracing digital platforms.

FUTURE DIRECTION:

1. INFRASTRUCTURE DEVELOPMENT:

Expansion of 4G and 5G network coverage is very important. It is helpful to the people for internet signals. Electricity is also important for digital payment. Devices also need charging facility. If there is kind of facility transaction will be smooth.

2. LOCAL LANGUAGE:

Many people in rural areas are comfortable with their own native language. By understanding in their own language is one of the efficient ways. So, we want to launch voice-based technique in mobile banking and internet banking. It will be very understood to the people to go ahead in transaction.

3. FINANCIAL LITERACY:

Most of the people in rural are unilliterate. If there is a training program with visual aid, it will be more beneficial. So, people can stay aware in safe practices like scams, OTP, PIN ETC..

4. OFFLINE PAYMENT:

In area with weak internet, solution like UPI lite allow people to complete the transaction without needing to full connectivity. These payments are done via cash, cheque, bank transfer or other offline mechanism. This also includes RTGS, NEFT and IMPS.

5. AI- POWERED FRAUD PREVENTION:

Artificial intelligence can detect suspicious transaction early, reduces fraud, and build trust. Usage of AI is benefit to government and banking sector. The integration of AI technologies allows for continuous learning from new data improving detection accuracy while reducing false positives.

6. UPI RESHAPING THE RURAL ECONOMY:

UPI is ensuring financial access, transparency and opportunities for millions across thousands of villages and small towns. This technological shift has brought many to formal banking ecosystems for the first time..

DIRECT ACCESS TO FINANCIAL SERVICES:

In formal banking system people must go for bank for all small transactions like getting cash, depositing cash etc.... But UPI have changed this with smartphone and internet connection. Anybody can instantly send or receive money at anywhere and anytime.

FASTER AND TRANSPARENT PAYMENT:

Direct benefit transfer goes straight into their bank account without delays or corruptions. Payments are received instantly for of selling crops or produce thus, eliminating the need to wait days for cash. Local vendor and buyers prefer UPI making transaction easy and secure.

ENCOURAGING SMALL ENTERPRISES AND LOCALLY – OWED PRODUCERS:

For UPI transaction card machines are not necessary. Even street vendors are able to show a QR code and receive payment in real time. This affordable solution is enabling small enterprises to expand and tap new customers.

MICRO –LOANS AND CREDIT ACCESSIBILITY

With the help of UPI data, people come to know the availability of micro–credit and small business loan. This help individuals in their businesses to become self – reliant. It also helps in socio economic development.

ENHANCEMENT IN DIGITAL LITERACY AND CONFIDENCE:

Education campaigns carried out by fintech players and government institution have educated the villagers into secure digital habits. Number of people in rural INDIA are using this application for payment and saving.

EMPOWERING THE FEMALE AND NEXT GENERATION:

UPI is creating new awareness, specifically for youth and women. Women, who could avail to financial instrument and manage their own digital wallet. Young people use UPI for purchase and sale in online. It also they send earnings back home to family member of independence and responsibilities. UPI is helping women become independent, enabling micro- entrepreneurs to grow their businesses, and bringing transparency and efficiency to welfare missions for the government. In the process, it's demystifying the handling of money and driving digital literacy down to the household level, even in the remotest villages.

UPI CHALLENGES IN RURAL AREA:

Poorly educated users and older adults do not trust or use mobile applications and thus do not use mobile applications. There are still a few remote and mountainous regions that do not have stable internet or mobile connectivity, which could be a bottleneck for regular use. With digital acceptance growing, digital frauds, and scam revelations are growing too. Most rural users are unaware of secure use, and thus awareness campaigns are critical. Neither English nor Hindi-based app- based interfaces are universal. Cultural biases against the use of cash can lower the adoption rate for the system further. With local language and voice support features for UPI applications, ease of use could be amplified. They allow transactions regardless of weak internet connectivity. As technology keep evolving, UPI is becoming more accessible and easier. This option allow payment either on command or by voice. thus, without the need for applications. Just a tap and you have may be able to receive your government benefits. Deep integration between UPI and welfare schemes can automate and easing welfare disbursement to the beneficiaries and cutting down on their own work. Already, 55% of rural users are working on UPI against 19% for cash only transactions. The trend is quite obvious- digital payments are all set to capture fast, and UPI is in the driver's seat. Every digital transaction builds a financial record for the user. This would make it easier for banks and lenders to offer them ad hoc loans and insurance, thus

creating opportunities for effective solutions to truly address rural requirements. With 5G, AI, and blockchain on the rise, payments will become even faster and secure. And innovations in fintech would make services like insurance, savings, and micro-loans to every village, regardless of size or geography.

CONCLUSION:

The rise of UPI is more than just a technological success story— it is a transformational movement that is redesigning the fabric of rural India itself. By bridging the urban- rural gap in financial inclusion, UPI has proven itself a powerful equaliser, and has empowered millions in the countryside to save, transact, invest and grow from the palm of their hand. It's not just faster payments; it's empowerment. This is not merely an economic shift; it is a cultural one too. Rural India is now not only newly banked, but it is also newly fearless, confident, connected, and poised to lead the country's next era of inclusive growth. With further investment in digital infrastructure, education, and innovation, the progress toward digitally empowered Bharat is no longer an abstract dream, it is now and here. UPI is no longer just a payment system; it is a catalyst for change. India's future is not just digital, it is deeply rural, deeply resilient, and emphatically empowered.

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TRANSLATING AMBAI: UNRAVELING LINGUISTIC AND CULTURAL DYNAMICS IN PRASAD'S "JOURNEY 21"

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ABSTRACT

This paper closely deals with the select short story of Ambai, "Payanam 21", from the Short Story Collection Civappuk Kazuttu Tan Oru Paccaip Paravai. The focal point is on GJV Prasad's English translation of the same short story titled as "Journey 21", (from A Red-necked Green Bird) with a particular emphasis on assessing Prasad's skill in capturing Ambai's essence, embracing both linguistic subtleties and cultural nuances. The analysis delves into Prasad's commitment to preserving authenticity while ensuring accessibility for English readers. Additionally, it investigates the presentation of Ambai's narratives, aiming for effective resonance and underlining the intricate balance required to maintain both richness and engagement in the translated version.

The exploration extends further into the complexities of cross-cultural translation, providing insight into the triumphant rendition of the source text. The overarching goal of this paper is to offer perspectives on the dynamic interplay between linguistic fidelity, cultural adaptation, and audience resonance in the intricate process of translating Ambai's emotionally charged short story into English. Through this examination, the paper seeks to illuminate the challenges and triumphs encountered by Prasad in faithfully translating Ambai's work, fostering a deeper understanding of the nuanced art of cross-cultural literary translation.

KEYWORDS: Ambai, Subtleties, Authenticity, Resonance, Interplay.

Translating Ambai: Unraveling Linguistic and Cultural Dynamics in Prasad's "Journey 21"

World Literature keeps producing various interesting fictional and non-fictional works. Despite its prominent creation, the work gets confined within its own language as people from different Linguistic background may not understand the language well. This language barrier has been overcome by the introduction of Translation.

The word ‘Translation’ originated from the Latin word ‘Translatio’ which means carrying across. Translation involves the process of transferring meaning between two different languages. It is the process of converting a text from one human language into another human language. This requires a high degree of resemblance with the original text. The language from which the text is translated is known as the Source Language (SL) and the language used by the translator is referred to as the Target Language (TL). The Original Text is referred as the Source Text (ST) and the translated text is referred as the Target Text (TT).

Translation gives way for numerous texts to get introduced in various languages, allowing the broader audience to access the text and to enjoy its content to the fullest.

The person who translates the text is known as Translator. An individual has to be proficient in both the source language and target language in order to become a translator. The translator has the huge responsibility of conveying the intended meaning of the source text in the target language. The process of translation demands meticulous attention over the source text. Achieving this level of understanding necessitates not only linguistic proficiency but also cultural competence. It is a complex process of conveying the essence of the source text in a target language without giving up the cultural and artistic significance of the source text.

Consequently, this paper delves with the short story “Payanam 21” from Ambai’s Short Story Collection *Civappuk Kazuttu Tan Oru Paccaip Paravai* which has been translated by GJV Prasad as *A Red-necked Green Bird*. C.S. Lakshmi, writing under the pseudonym Ambai, is a widely known Tamil Fiction Writer and a Women Activist. She is notable for her Tamil Short Story Collections including *Siragukal Muriyum*, *Veetin Oru Mulaiyil Samaiyalarai* and *Kaatil Oru Maan*. GJV Prasad, a former Professor at Jawaharlal Nehru University is a poet, novelist and a translator. He took an immense challenge of translating Ambai’s emotionally charged Short Story Collection in English.

In an interview in *Kemmiya creatives*, Prasad argues persuasively that translation is more than a linguistic exercise. It is a form of cultural and political engagement. In India, translation does not merely convert words from one language to another; it builds an “alternate nation.”

This article focuses on GJV Prasad’s successful translation of Ambai’s one of the Short Stories “Payanam 21” which is titled as “Journey 21” in English. The translator GJV Prasad meticulously worked on the translation of Ambai’s “Payanam 21” in order to make it accessible to a wide range of readers beyond cultural and geographical background.

Here, Prasad’s endeavor of successful translation of “Journey 21” would be justified with the instances from his translated work in comparison with Ambai’s “Payanam 21” along with unravelling the cultural and linguistic dynamics in its translation.

In the short story “Journey 21”, GJV Prasad retained the essence of the source text by translating the classical Tamil song into English, in addition to the transliteration of the Classical Tamil Song, by carefully explaining the word to word meanings, facilitating the readers to connect with the context of the short story. This attempt of GJV Prasad allows the richness of the source text to flow over the translated text, allowing the foreign readers to get to know the Pronunciation of the Original Tamil Song that emphasizes the unique sound patterns that is inherent in Tamil Language unlike the other languages in general.

Utrarai yan venden, ur venden per venden, katrarai yan venden, karpanavum iniamayum kutralathamarnthuraiyum kuththa! Un kuraikazharkke katravim manampola kasinthuruka venduvene’

(I seek no kith or kin, need no city or crave no fame; I don’t seek the company of scholars. Whatever has to be learnt has been learnt. O Dancer, who resides in Kutralam, all I seek, in molten love, as the mind of a cow yearning for its calf, is your resounding feet). (Prasad 26).

The following lines are borrowed from the source text of Ambai’s “Payanam 21” for reference.

“உற்றாரை யான் வேண்டேன், ஊர் வேண்டேன், பேர் வேண்டேன், கற்றாரை யான் வேண்டேன், கற்பனவும் இனி அமையும்; குற்றாலத்து அமர்ந்து உறையும் கூத்தா, உன் குரை கழற்கே, கற்றாவின் மனம் போலக் கசிந்து உருக வேண்டுவனே!”

(Ambai 33).

Following this, GJV Prasad has given a translated meaning for the name of the story that takes place in Ambai’s “Payanam 21”. The translator GJV Prasad, provides translation for Kamumma’s book in the story which has been titled as ‘Katravin Manam’ as ‘The Mind of a Cow with Calf’. “She looked at Kamumma’s book. She had titled it to mean *Katravin Manam* (The Mind of a Cow with Calf), the words in the verse” (Prasad 29). This ensures the foreign readers understand the meaning of the title of the book for better understanding of the story plot, that implies a greater meaning for the plot line.

Secondly, GJV Prasad translated the meaning of the Hindi Phrases used in the source text. He has carefully mentioned ‘Seven Bungalows’ following the Hindi phrase ‘Saath Bungala’ in his translated work. “The sea breeze could be felt as soon as they turned the corner of Saath Bungala (Seven Bungalows), along with the stink from nets, a smell that the inhabitants of the area could never notice” (Prasad 24). This careful consideration is mainly for the readers, who are unfamiliar with Hindi language, contributing to the linguistic clarity of the text.

GJV Prasad, followed the practice of translating various terms of the regional Tamil Language in English at various parts in the translation narrative, to allow the foreign readers to comprehend the Tamil Cultural Terms and Phrases, giving them the liberty to understand the story plot without referring to any secondary sources for meaning. This considerate approach allows for the smoother reading of the text, enabling the readers to comprehend the overall meaning of the story.

Following this, he brings out the inherent connection of the source text in the target language by retaining the most important cultural terms that plays a major role in regional Tamil Language. The faithful representation of the cultural terms discloses inherent connectivity of the source text with the translated text.

“In the corner of the room and giving a sense of grandeur to it was Rajappa’s mridangam covered with a silk cloth.” (Prasad 25). Here, in the translated text, GJV Prasad retained the usage of the musical instrument ‘Mridangam’ which is predominantly used in Indian music, following the source text. “அறையின் மூலையில், கட்டித் துணி சுற்றி வைத்திருந்த ராசப்பாவின் மிருதங்கம் இருந்தது..” (Ambai 31).

Similar to Mridangam, he transliterated ‘Nattuvangam,’ an instrument used commonly in India. He stated that “Her guru, Nagappa Pillai, would do the nattuvangam with a glowing face.” (Prasad 26), aligning with the source text

“அவள் குருநாகப்பிள்ளை வாத்தியத்தை முகத்தில் பூரிப்புடன் நட்டாங்கம் செய்தார்” (Ambai 31).

Also, GJV Prasad reused the Original Tamil phrases in English in his translated version, including the musical notes ‘Shankarabaranam tillana nadhirdhim tana dhirana’ from the original text. It has been written as “It was only after Kamumma has finished dancing Shankarabaranam tillana, ‘nadhirdhim tana dhirana.’ And he had given a rousing beat on the mridangam like a roar of victory, that he fell backwards.” (Prasad 25)

The following lines are from Ambai’s short story “Payanam 21”, which has been referenced by GJV Prasad for the above translation.

“நாதிர்தீம் தன தீனானா” என்ற சங்கீத அமைப்பிலான தில்லானாவை ராக காம்போஜியில் ஆடி முடித்தபின், மிருதங்கத்தில் சேற்றிய ஒலிபோல் ஓங்கி ஒரு தட்டுத் தட்டிய பிறகுதான் பின்னால் சாய்ந்தார்” (Ambai 31).

Additionally, he retained the usage of the term ‘Bharatmata’ in his translated text as “Right wing parties agonized because they couldn’t decide whether she could be termed the right kind of daughter to Bharatmata.” (Prasad 26), aligning with Ambai’s original text.

“இடதுசாரிக் கட்சிகள் பெண்களுக்கு உகந்த புரிதலா இல்லையா என்று தீர்மானிக்க முடியாமல் திணறின”. (Ambai 32).

Again, In the source language, it has been rendered as “சாம்பல் வானில் இன்னும் நட்சத்திரங்கள் மீதமிருந்தன” (Ambai 30), Where the translation turned as ‘The Stars are still remaining in the dawn grey sky.’ Following this, the source text sentence “பின்ன? பேப்பரில் மனசு சரியில்ல’ன்னு பத்து தடவை எழுதியிருந்தா, எண்பத்தஞ்சு வயசு அம்மா சாவுக்கு வராம இருக்க முடியுமா?” (Ambai 31) has been translated as ‘Then? When an eighty-five year old mother repeatedly grieves about not feeling well through the call, how could one restrain from visiting?’ In the above translations, the sentence completely differs with the sentence of the source text. The word ‘Stars’ has taken the first place in the target language whereas the source text sentence has started with the word ‘சாம்பல் வானில்’. Furthermore, the Tamil phrase ‘சாம்பல் வானில்’ intricately captures the essence of the narrative, signifying the period just before sunrise, where the sky is suffused with a delicate bluish hue. In contrast, the translation necessitates the use of a specific term, ‘dawn,’ to convey the same circumstance. This distinction underscores the innate richness and specificity of Tamil language, which effortlessly encapsulates nuanced natural phenomena. While English provides an adequate equivalent with ‘dawn,’ it requires a distinct term to mirror the vivid imagery painted by the Tamil phrase. And in the second instance, the first sentence of the source text has become the second sentence in the target language. This reminds of varied sentence patterns followed in English and Tamil languages i.e. SVO in English and SOV in Tamil.

This implies that a word to word translation cannot effectively communicate the intended message of the original text. Translating each word without considering context or cultural nuances would fail to capture the true meaning, necessitating a more nuanced approach to translation.

Moreover, the language English and Tamil Languages exhibit significant differences in pronoun usage, when describing males and females. “இவள் வருகிறாள் என்று எதிர்பார்த்துக் கொண்டிருப்பாள்”. (Ambai 30) has been translated as ‘She was expecting her arrival’. “ராசப்பாவின் மறைவுக்குப் பின் அவள் ஆடாவிட்டாலும் அவள் மாணவிகளும் மாணவர்களும் பலர் பிரபலமாகியிருந்தனர்”. (Ambai 32) has been translated as ‘After Rasappa’s demise, though she stopped dancing, many of her students grew famous’. In the above sentences, In Tamil, ‘அவன்’ and ‘இவன்’ has been precisely used as ‘he’ in general. It highlights abundant choice for gender specificity in Tamil discourse. This linguistic contrast underscores the richness of Tamil in expressing nuanced distinctions, revealing a potential limitation in English vocabulary. This divergence highlights how languages encapsulate cultural intricacies and the diversity of expression, with Tamil offering distinct terms for contextual specificity in gender references compared to the more concise English equivalents.

To sum up, Prasad’s meticulous approach on translating Ambai’s Oeuvre

Civappuk Kazuttu Tan Oru Paccaip Paravai, is possibly a successful endeavor. He has been so considerate in presenting his translated work to the readers with different cultural and linguistic backgrounds.

GJV Prasad, in consideration for the foreign readers, gives the word to word meanings for specific phrases in order to help with the unfamiliar words of the regional language. This careful endeavor is to help the readers of different Cultural and linguistic backgrounds to understand the meaning of the distinctive words and to enhance the accessibility of the work to a broader audience outside Tamil Nadu and India.

Moreover, the setting and the major characters of this short story have been developed inside the Indian Background. Even, the name of the characters signifies their natural adherence with Indian Culture. Despite of the above specifications, Prasad’s translation has taken the work outside India, allowing the foreign readers to connect more deeply with the work. Also, he took his translated work to the next level by not only capturing the words of Ambai but also by retaining the cultural terms, emphasizing the importance of those phrases in the storyline.

In other terms, the Cultural Terms plays a significant role in emphasizing the culture. It may refer to unique tradition, practices or things like Ornaments and Instruments. Translating the cultural terms from the source language to the target language would not possibly carry the essence and the richness of that particular term. Moreover, translating those terms without any clear understanding of the culture may result in losing the true meaning of it.

And so, the retention of cultural terms in the target text reflected the inherent connection between the Source Text (ST) i.e of Ambai and the Target Text (TT) i.e of GJV Prasad. This select short story, “Journey 21” showcases GJV Prasad’s dedication to the overall translation, attributing to his meticulous approach of handling the translation.

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DEVELOPING AN OFFLINE PERSONAL VOICE ASSISTANT

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ABSTRACT

This project aims to develop an intelligent assistant capable of understanding and describing the contents of images to users. The application facilitates seamless interaction by extracting information from images, converting it into descriptive text, and subsequently transforming the text into audio output. By integrating cutting-edge image recognition technologies and text-to-speech functionalities, the assistant ensures accessibility and usability for diverse users, including those with visual impairments. The core functionality of the application relies on a multi-modal system for image recognition, leveraging advanced machine learning models to achieve high accuracy in understanding visual inputs. Python serves as the primary development language, enabling efficient integration of image processing, natural language generation, and audio synthesis. This project demonstrates the potential.

KEYWORDS: *Intelligent, Image recognition, text-to-speech, natural language generation, machine learning.*

INTRODUCTION

An AI voice assistant would be the one developed by a software giant who can understand the human voice and reply after listening to a user's command. This computer program accomplishes the previously mentioned tasks by using NLP and machine learning to process the words spoken and execute some functions. The mentioned functions are, for example, an easy task of playing music, or sending reminders, and also the more complex ones like being able to control a smart home device or to inform about the exact weather. Such Voice assistants are accessible through a large number of devices, smart speakers, smartphones, smart TVs, and even wearables among them. They include Siri from Apple, Alexa from Amazon, Assistant from Google, and Cortana from Microsoft.

The voice assistants, such as Siri, Google Assistant, and Alexa, one of the technologies that are the most essential in the present era of the digital world, have become the members of our family. But almost all of such apps still require an internet connection to do the things you ask. What if

you decide to invent a simple voice assistant that needs no online connection Initially, This paper start to guide through a simple voice assistant in Python for offline usage, the one that can process and recognize speech, and then communicate back suitably. For instance, recent years have noticed the integration of AI adaptation on voice assistants have been transformative in the way we use our technology. Indeed, image recognition, one of the inevitable components of AI, may let the machines read and understand visual data, while the voice assistants allow these human voice-operated conduits to perform hands-free work and carry out a natural communication. The combination of these two technologies spawns an extremely versatile and interactive tool which can even tell you the content of a picture and answer questions using only a voice. Throughout this guide, It will check out how to make a model for image recognition that works without the internet connection. This article design an assistant through well-known libraries i.e. OpenCV for image processing, a machine learning model, and speech recognition and pyttsx3 for voice output and input without the need for an internet connection.

STATEMENT OF THE RESEARCH PROBLEM

Most of the existing personal voice assistants such as Siri, Alexa, and Google Assistant depend largely on internet connectivity and cloud-based services. This reliance raises concerns related to privacy, data security, and limited accessibility in areas with poor or no internet connection. Furthermore, these systems provide only restricted support for visually impaired users, as they are not capable of offering real-time offline image recognition and description of the surroundings. Hence, there exists a gap in developing an offline, customizable, and privacy preserving voice assistant that can combine speech recognition, natural language processing, and image recognition to support daily tasks. Addressing this problem would significantly improve inclusivity and provide a reliable tool for users, especially those with visual impairments, by enabling them to interact naturally with their environment without depending on online services.

MOTIVATION

To make a voice assistant use offline on python from scratch. It will be rewarded besides getting it done with a fun and helpful multitasking voice command to the computer without an internet connection. For example, the integration of libraries such as speech recognition for speech understanding as well as pyttsx3 for talking to us can lead to a personal assistant that has the ability to interact with many different things like time, application launching, or the setting of reminders all the data safely protected. It is a great way to get to know computer programming as well as automated intelligence concepts and at the same time, to design a useful tool that will help with our daily tasks.

OBJECTIVE

The fundamental purpose of the Blind Assistant Application is enabling a comprehensive tool for people with visual impairment everywhere who will be able to react in a natural way to what the environment is doing around them. Only in that way, the autonomy of the user can be fully guaranteed by means of improved functionality in daily activities for the blind. Its main tools are the cutting-edge AI technologies like image detection, natural language, and text-to-speech that are used to deliver the best assistance that is accurate and efficient. The designed application is accessible by means of a simple user interface designed to include voice feedback, keyboard control, and high contrast buttons.

This app's other features include offline capability to ensure that the generated reliability and end user privacy are observed and real-time feedback to speech and text output queries and commands. The app is intended to be a positive influence on the visually impaired individuals because it would help them get in touch with their surroundings and others in a better way, and it could also satisfy their multiple needs such as aid for education, work, and daily life as well.

REVIEW OF LITERATURE:

Kaiming He et al., (2016) The ResNet architecture, which has become a cornerstone in image recognition tasks. It discusses deep residual networks and their ability to achieve high accuracy in visual recognition tasks, making it a foundational reference for your project.

Oriol Vinyals et al., (2017) A neural network model that generates natural language descriptions of images. It combines convolutional neural networks (CNNs) for image processing with recurrent neural networks (RNNs) for text generation, which aligns with your project's goals.

Ashish Vaswani et al., (2017) The Transformer architecture, which has revolutionized natural language processing (NLP). It is highly relevant for generating descriptive text from image data.

Alex Krizhevsky et al., (2015) The AlexNet, a deep CNN that significantly advanced image classification. It provides a strong foundation for understanding image recognition techniques.

William Chan et al., (2018) This paper explores neural networks for speech synthesis and recognition, which can be adapted for text-to-speech functionality in your project.

Yuxuan Wang et al., (2017) The Tacotron, a state-of-the-art text-to-speech model. It is highly relevant for converting descriptive text into audio output.

Damien Teney et al., (2017) This survey paper provides an overview of methods for answering questions about images, which is closely related to generating descriptive text from visual inputs.

Andrej Karpathy et al., (2017) This paper explores the integration of CNNs and RNNs to generate textual descriptions of images, which is directly applicable to your project.

Aaron van den Oord et al., (2016) The WaveNet is a deep generative model for audio synthesis, which can be used to enhance the text-to-speech functionality of your application.

Jacob Devlin et al., (2019) BERT is a transformer-based model that has significantly advanced NLP tasks. It can be used to improve the natural language generation component of your project.

Aditya Ramesh et al., (2021) This paper focuses on generating images from text, it provides insights into multi-modal AI systems that combine visual and textual data, which is relevant to your project.

Connor Shorten et al., (2019) This survey paper discusses techniques for augmenting image data to improve the performance of machine learning models, which can enhance the accuracy of your image recognition system.

METHODOLOGY :

The process of creating a personal voice assistant is the integration of speech recognition, natural language processing (NLP), and text-to-speech (TTS) conversion to recognize and carry out user commands. Two stages can be analyzed to understand the system: Existing Systems and the Proposed System.

A. EXISTING SYSTEM

Most commercial voice assistants, including Siri, Google Assistant, and Alexa, employ sophisticated deep learning algorithms, cloud-based computation, and huge datasets to make accurate and timely responses. However, open-source Python assistants, like Mycroft AI and Jasper, utilize locally computed speech recognition and NLP methods.

LIMITATIONS OF EXISTING SYSTEM

- Cloud-based processing privacy issues.
- Low customization options for personal usage.
- Internet connection dependency for some operations.
- Large resource needs for real-time computing.

B. PROPOSED SYSTEM

The proposed system is a locally installed, Python-programmed personal voice assistant that favors local execution, customization, and efficiency while ensuring core functionalities are retained. The approach is organized in a systematic pipeline:

Step 1: Speech Input Capture

The assistant waits for voice input through a microphone. Speech is translated into text using Speech Recognition or Whisper (for offline processing).

Step 2: Natural Language Processing & Command Interpretation

The system text processes using NLTK, spaCy, or AI models such as GPT. Command intent is determined through keyword extraction and hardcoded logic.

Step 3: Task Execution

The assistant executes tasks like: Opening apps (os, subprocess). Retrieving information (weather, news) through APIs. Sending an email or creating reminders. Controlling smart devices (IoT integration).

Step 4: Image Recognition

Computer vision technologies that provide detailed descriptions are utilized, thus allowing users either to understand the environment in which they are or to extract text from images.

Step 5: Text-to-Speech (TTS) & Response Delivery

The system translates the output text into speech through pyttsx3 or gTTS. The answer is played back to the user through an audio system.

Step 6: Continuous Learning & Optimization

Utilizing AI models for context-based conversations. Enhancing accuracy using machine learning-based speech processing. Providing multilingual support for greater accessibility.

ADVANTAGES OF PROPOSED SYSTEM

- **Privacy-focused:** Processes most tasks locally instead of relying on cloud services.
- **Customizable:** Users can add personalized commands and workflows.
- **Offline Support:** Works without an internet connection for basic tasks.
- **Lightweight & Efficient:** Optimized for low-resource devices.

C. FLOW DIAGRAM

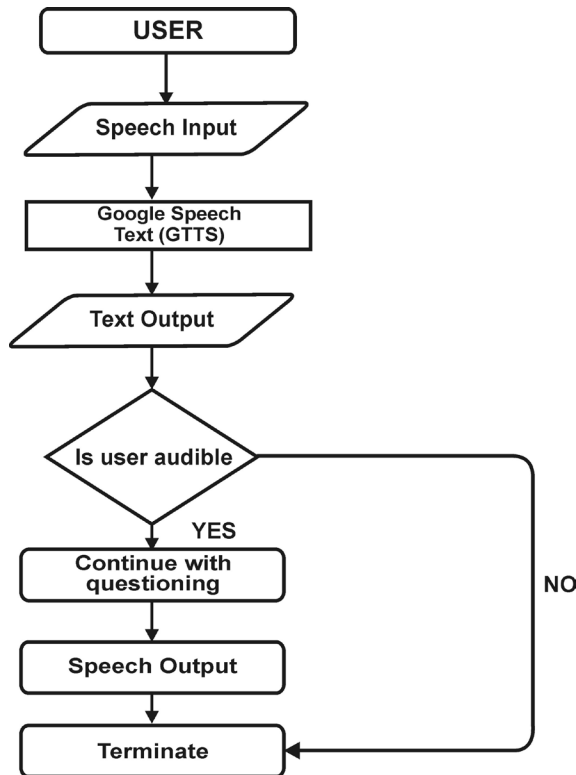


Figure 1 – Flow Diagram of Proposed System

RESULT AND DISCUSSION



Figure 2 – Result of Proposed System

A. UI Interface Tinker

This screenshot presents the initial UI layout. The chat interface is dark-themed with options like:

“Upload Image”

“Ask Question”

“Reset Session”

The chat history includes an AI-generated greeting and an explanation of the assistant’s capabilities. The design seems simple and functional, focusing on user interaction.

B. Input/Output

The visual shows an intelligent virtual assistant interfacing a computer examining a picture of a very overcrowded intersection. On the left-hand side of the screen, there is a photograph of a street in a city filled with high-rise apartments, the glass of which reflects the orange color of the sun. The street is dotted with stationary and moving vehicles, among them a car showing an “AHEAD” sign on its back bumper. The traffic lights, which are supported on a metal stand, hang

over the crossroads and indicate a red hand sign, which tells people to wait before they cross. The background extends into the distance with more buildings and a hazier city scene, which implies that action and activity are going on. The second part of the screen has a chatbox where the AI assistant provides a comprehensive caption of the image. The interface includes upload an image, ask a question, or reset session options, so this is certainly an AI tool designed purposefully to be interacted with visual question answerers and readers. The AI computer generated this caption that centers on writing about the most salient features in the scene such as the architectural structure of the city area, the road traffic of the cars and the role of the traffic light, thus, the detailed piece of writing was made.

IMPORTANCE OF VOICE ASSISTANT:

- **Accessibility for Visually Impaired:** Provides real-time voice feedback for images and commands, helping blind users interact with their surroundings.
- **Privacy and Security:** Since it works offline, sensitive user data is not shared with cloud servers.
- **Customization:** Users can add personal commands and workflows based on their needs.
- **Offline Support:** Eliminates dependency on the internet, making it reliable in all situation.
- **Educational Value:** Helps students and learners understand AI concepts like NLP, image recognition, and TTS in a practical way.
- **Cost-Effective:** Uses open-source Python libraries, making it affordable and lightweight for wider adoption.

ADVANTAGES OF VOICE ASSISTANT:

- **Privacy & Security:** Voice data is handled locally (no internet required), so all your private details remain with you on your device.
- **Offline Functionality:** The app can be used without a network connection, and thus it is handy in hard-to-reach places or during power outages.
- **Customization & Control:** The commands, features, and integrations of your choice (smart home, music, local apps) can be exactly the way you want them by designing them yourself.
- **Open-Source Libraries:** Python is equipped with great libraries like SpeechRecognition, Vosk, Pyttsx3, NLTK, TensorFlow/PyTorch for speech, NLP, and AI integration.
- **Cross-Platform:** It is possible to run the app on Windows, Linux, Raspberry Pi, or even on embedded devices that support Python.
- **Learning Opportunity:** A suitable tool for learning speech recognition, NLP, and AI model integration.
- **Low Latency:** Because the process is done locally, the reaction times can be quicker than with cloud-based assistants (there is no server round-trip).

DISADVANTAGES OF VOICE ASSISTANT:

- **Accuracy Limitations:** Offline speech recognition engines (like Vosk, CMU Sphinx) are typically less accurate than their cloud-based counterparts (Google, Alexa, Siri).
- **Hardware Limitations:** On-device speech model implementation may necessitate a robust CPU/RAM specification. The performance on such small devices (for instance Raspberry Pi) can slow down significantly.
- **Limited Knowledge Base:** Alas, without the web, the assistant is disabled from acquiring fresh data (weather, news, Google search) unless you preload it with offline datasets.
- **Maintenance Overhead:** You need to do all the work of updating models, datasets, and features since it will not automatically update like cloud assistants.
- **Feature Limitations:** Does not have the same advanced AI features as context-aware conversations, natural human-like voices, or cloud-trained LLMs (unless you end up with a large local model, which is resource heavy) as a result of missing.
- **Storage Usage:** On-device speech and NLP models can occupy substantial amounts of storage space (from several hundred MBs to a few GBs).
- **Development Complexity:** Working offline on hot word detection, speech-to-text, NLP, and text-to-speech means you have to bring together different libraries and customize them to match.

CONCLUSION:

Rebuilding a personal voice assistant with Python is a really cool task, not to mention that it is a perfect way of getting hands-on experience with programming and problem-solving skills. Including SpeechRecognition, pyttsx3, and more, you will be able to develop a voice assistant that does not only understand voice commands but can also be a great help by retrieving data and automating a system. The perpetual training are able to adjust and implement some other features, e.g. making phone calls, which use whenever the assistant has made a call on your behalf. Moreover, the project is a good opportunity for people to explore more topics such as natural language processing (NLP), machine learning, and AI with case studies that have been applied in real life to solve problems in education, business, or help disabled people.

Below is a conclusion for the development of an offline image recognition voice assistant with Python:

Building an offline image recognition voice assistant is realized by the integration of image recognition and machine learning models combined with speech recognition and text-to-speech for user interface.

The combination of these tools allows the understudy to process the visual input and to speak, thus, it can be used in many ways e.g. the assistant can be able to identify objects, or the assistant can be used to speech either in or real-time. By using open-source libraries like OpenCV, Tensor Flow, Pyttsx3, and Speech Recognition, you can make a fully functional assistant offline.

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A STUDY ON FINTECH AND ITS INFLUENCE ON INDIAN ECONOMY

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ABSTRACT

Fintech (Financial Technology) has revolutionized the traditional financial system. The rapid growth of fintech has significantly transformed traditional banking, payments, lending and investment. The objective of this study is to analyze the impact of fintech on the Indian economy through analytical research. This study analyses the factors as well as the limitations which influences the adoption of fintech by consumers. This study highlights the quick growth of fintech in the Indian economy. Both primary and secondary data have been used in this study. A number of 200 responses were collected as primary data. The population of this study consists of the individuals who are aware of and use fintech products and services. The major tools used for this study are analytical research, percentage analysis, factor analysis, chi-square analysis, and weighted average analysis. It is found that India stands first (87%) in the adoption rate of fintech products and services. The variables are grouped into 4 factors, which are considered as the major factors which influence consumer perceptions towards fintech products and services. Fear of fraud is considered as the major limitation which hinders the users. The suggestions are based on the findings.

KEYWORDS: *Fintech, Indian economy, Consumers.*

INTRODUCTION

The word 'Finance' is a common term which has been used on a regular basis. It is basically the management of money and other assets. In simple words, it refers to monetary resources. The term 'Technology' is defined as the application of scientific knowledge for practical purposes or applications. The application of technology on financial services is known as fintech. With the help of fintech, individuals and businesses can manage their finances more conveniently and effectively. Understanding the impact of fintech on economic growth requires a multi-dimensional analysis that includes consumer behaviour, preferences, and satisfaction. This study aims to examine the demographic profile of fintech users and assess how demographic factors influence their preferences for fintech products and services. Additionally, it seeks to determine the key factors affecting fintech adoption and measure the satisfaction levels of consumers using these services.

FINTECH'S CONTRIBUTION TO INDIA'S GDP:

In India, the fintech sector has contributed a major part to economic growth by revolutionizing increasing financial inclusion, financial services and increasing digital transactions. India being the second-largest fintech ecosystem globally, digital payments, lending, wealth management, and insurance technology have played an important role in driving GDP growth. The increase of UPI has drastically reduced cash dependency and increased transparency and efficiency in transactions. Fintech-driven lending has also aided MSMEs, which contribute nearly 30% to India's GDP. Challenges such as cybersecurity risks, regulatory hurdles, and digital divides in rural areas remain obstacles for Fintech's full potential. In future, India's fintech space is set to expand further with advancements in blockchain.

OBJECTIVES OF THE STUDY:

- To analyze the contribution of fintech companies in the growth of the Indian economy.
- To examine the demographic profile of the respondents.
- To investigate the relationship between demographics and the factors influencing the preferences of fintech products and services.
- To determine the factors affecting the usage of fintech products and services.
- To evaluate the consumer satisfaction level of fintech products and services.

STATEMENT OF THE PROBLEM

In India, the Fintech sector has emerged as a transformative force in the financial service industry. Despite fintech's widespread adoption, consumers' attitude towards fintech products and services vary significantly. Factors such as trust, security concerns, usability and demographic characteristics influence the consumer's perception towards fintech. This study aims to bridge the above-mentioned gaps by analyzing the contribution of fintech companies to India's economy, examining the demographic profile of fintech users, identifying the key factors affecting fintech adoption, and evaluating consumer satisfaction. The findings will provide valuable insights for fintech firms, regulators, and policymakers to enhance financial inclusion and economic development.

REVIEW OF LITERATURE

Prof. ShwetlanaKatkar, Dr. Urmila Nikam (2023) "Principal drivers of fintech in India: a study on consumer attitude and adoption" the aim of this paper is to determine the important relationship between customer attitude and adoption and the drivers of FinTech in India and to identify the drivers behind FinTech in India.

K. Vijaya et al. (2023) their article "Study of the Behavioral Impact on Adoption of Fintech in Mysore District" states that, Fintech seems to be the Indian banking system's future. This research is carried out to study the personal and organizational profile of Fintech users and to measure the level of customer satisfaction of the users and the service quality of different public and private sector banks.

SAMPLING METHOD

- **Sampling Technique**-Convenience sampling
- **Sampling Area**-Chennai

POPULATION AND SAMPLE SIZE

- **Population**-individuals who are aware of and use fintech products and services.
- **Sample size**-200

LIMITATIONS OF THE STUDY

- This study has only 200 samples, from which results are generalized for the larger population.
- As fintech industries are evolving rapidly due to technological advancement and government policies it is not possible to capture the recent trends accurately.

FINTECH MARKET SIZE GROWTH IN INDIA

Year	Market Size (₹Trillion)	Growth Rate (%)	Key Developments
2020	25.00	-	Increase in digital payment after post pandemic.
2021	35.00	40%	Growth of UPI transaction and digital lending.
2022	50.00	42.80%	Introduction of neo banking and wealth tech.
2023	60.00	20%	Accelerated fintech inclusion in smaller cities.
2024	68.00	13.30%	Strengthening of regulations and fintech innovation.
2030 (Projected)	140+	15-20% CAGR	Fintech to contribute ~18-20% of financial services revenue.

Source: Secondary data-(RBI Reports (2023-2024)).

Interpretation:

The table 5.1 shows the Fintech Market size Growth in India. The highest growth rate was found in 2021 (40%) and 2022 (42.80%) because of increased UPI Transaction and digital lending. The growth slowed down in 2023(20%) and 2024 (18.3%) because of market stabilization and regulatory interventions. In 2030 projected market size exceeds ₹140 trillion, indicating a continued upward trend.

FACTOR ANALYSIS:

KMO AND BARTLETT’S TEST

The Kaiser-Meyer-Olkin (KMO) and Bartlett’s test are preliminary steps to factor analysis. It measures the sampling adequacy of the data. a KMO value above 0.5 is considered good. KMO value above 0.7-0.8 is considered as a really good Data, values above 0.9 is considered excellent.

KMO and Bartlett

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		685
Bartlett's Test of Sphericity	Approx. Chi-Square	835.620
	df	66
	Sig.	.000

Communalities

Extraction Method: Principal Component Analysis.

	Initial	Extraction
Ease of use	1.000	.689
trust and security	1.000	.734
convenience	1.000	.655
social influence	1.000	.629
time saving	1.000	.729
technological innovation	1.000	.645
Availability of consumer service	1.000	.718
tailor to consumer need	1.000	.422
helps for better decision making	1.000	.815
credit score are more accurate	1.000	.671
helps to deduct suspicious transaction	1.000	.693
privacy of transaction	1.000	.755

Interpretation:

It was found that the 12 variables range from 0.422 to 0.815. It implies that the 12 variables exhibited the variance ranging from 0.422 to 0.815. These variance limits were more appropriate for variable groupings and formation of factors.

CHI-SQUARE ANALYSIS

RELATIONSHIP BETWEEN GENDER AND USAGE OF FINTECH SERVICES:

H0: There is no significant association between gender and usage of Fintech Services.

H1: There is a significant association between gender and usage of Fintech Services.

GENDER * USAGE OF FINTECH SERVICES CROSSTABULATION

TOTAL RESPONDENTS :200

	USAGE OF FINTECH SERVICES				Total	CHI SQUARED VALUE	P VALUE
	DAILY	WEEKLY	MONTHLY	RARELY			
GENDER MALE	32	31	26	5	94	6.108	0.106
FEMALE	34	32	23	17	106		
Total	66	63	49	22	200		

INTERPRETATION:

Table shows the cross tabulation of Gender * Usage of Fintech Services Crosstabulation Since $p = 0.106$ greater than 0.05 , we accept the null hypothesis. This means there is no statistically significant association between gender and fintech usage frequency at the 5% significance level.

RELATIONSHIP BETWEEN LOCATION AND USAGE OF FINTECH SERVICES

H0: There is no significant association between location and usage of Fintech Services.

H1: There is a significant association between location and usage of Fintech Services.

LOCATION * USAGE OF FINTECH SERVICES CROSSTABULATION

Count : 200

	USAGE OF FINTECH SERVICES				Total	CHI VALUE SQUAURE	P VALUE
	1	2	3	4			
LOCATION RURAL	26	-	-	6	77	1.399	0.706
URBAN	40	6.108	0.106	16	123		
Total	66	63	49	22	200		

INTERPRETATION:

Table 4.16 shows the cross tabulation of Location * Usage of Fintech Services Crosstabulation Since $p = 0.706$ greater than 0.05 , we accept the null hypothesis. This means there is no statistically significant association between location and fintech usage frequency at the 5% significance level. Fintech usage appears to be fairly similar across rural and urban respondents

WEIGHTED AVERAGE TEST

PARTICULARS	WEIGHTED AVERAGE	RANK
Fear of fraud	50.67	I
Lack of trust and security	49.33	II
Loss of personal information	49	III
Difficulty in using technology	45.33	IV
Lack of government regulation and oversight	41.67	V
High transactions fees	41.13	VI

INTERPRETATION:

The above table discusses the list of challenges addressed by the users (i.e.) fear of fraud, lack of trust and security, loss of personal information, difficulty in using technology, lack of government regulation and oversight, high transactions fees while using fintech products and services, All the limitations are ranked according to its weightage. The table reveals that the fear of fraud is ranked as one (i.e.) it is considered by the user as a major limitation.

Findings based on analytical research:

Through the analytical research it was found that the global average fintech adoption rate is 64%. India stands first (87%) by highly adopting fintech services. Fintech Market size Growth in India is in upward trend 2022 (50 trillion), 2023 (60 trillion), 2024 (68 trillion) it is expected to increase to more than 140 trillion in 2030 according to the RBI report.

Findings based on factor analysis:

The results show that twelve variables are reduced into four factors. The first factor consists of 4 variables and it was named as “**Aids Decision making**” The second factor consists of 3 variables and it was named as “**Technology and Social Convenience**” The third factor consists of 3 variables and it was named as “**User-Friendly & Secure Experience**” The fourth factor consists of 2 variables and it was named as “**Customer-Centric Support**”.

SUGGESTIONS:

- User experience and trust should be developed by facilitating round the clock assistance, Chabot support and multilingual help Centers.
- Fintech companies should develop Fintech solutions to gear rural and unbanked populations by giving access in regional languages.

CONCLUSION:

The study on fintech and its influence on the Indian economy highlight the quick growth of financial technology in India. It has reshaped the financial sector by increasing accessibility, efficiency, and financial inclusion. Trend analysis reveals a significant rise in market size and UPI transactions from 2020 to 2024, projecting continued expansion through 2030. The high adoption rate of 87% underscores India’s readiness and openness toward fintech solutions, particularly in urban regions and among the youth. India can strengthen its position as a fintech powerhouse by promoting economic expansion as technology continues to develop. A balancing approach between innovation and regulation will result in sustaining growth and promote consumer confidence in fintech services.

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A REVIEW OF FUNCTIONALIZED CORN COB BIOCHAR FOR THE SIMULTANEOUS REMOVAL OF HEAVY METALS AND PHARMACEUTICAL CONTAMINANTS FROM WASTE WATER

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ABSTRACT

Water pollution caused by heavy metals and pharmaceutical contaminants presents a significant threat to ecosystems and human health due to their high toxicity, persistence, and bioaccumulative characteristics. Traditional wastewater treatment methods are often ineffective at removing pollutants such as heavy metals and pharmaceutical contaminants, necessitating innovative and sustainable remediation approaches. The biochar derived from agricultural waste, particularly corn cobs, has emerged as a promising low-cost and eco-friendly adsorbent for wastewater treatment applications. Functionalization of corn cob biochar significantly enhances its surface area, porosity, and functional group density, thereby improving its capacity and selectivity for the simultaneous removal of heavy metals and pharmaceuticals. This review highlights recent advances in functionalized corn cob biochar and its adsorption mechanisms for removing heavy metals and persistent pharmaceutical contaminants. It also discusses the limitations and provides recommendations for future research aimed at optimizing functionalization strategies, improving sorbent durability, and integrating biochar-based systems into existing wastewater treatment infrastructures.

KEYWORDS: Corn cob biochar, Functionalization, Heavy metals, Pharmaceuticals, Wastewater treatment.

1. INTRODUCTION

Water pollution caused by heavy metals and pharmaceutical contaminants has emerged as a critical environmental issue globally, impacting ecosystems, food safety, and human health. Heavy metals such as lead (Pb), cadmium (Cd), and chromium (Cr) are frequently found in industrial effluents, mining waste, and agricultural runoff. Due to their high toxicity, non-biodegradability, and tendency to bioaccumulate in living organisms, these metals pose long-term

risks, including neurological damage, kidney dysfunction, and carcinogenic effects (Rai et al., 2019). Simultaneously, pharmaceutical and personal care products (PPCPs) including antibiotics, analgesics, hormones, and disinfectants are increasingly detected in surface water, groundwater, and even treated drinking water. The presence of these emerging contaminants raises significant concerns due to their potential to induce antibiotic resistance, endocrine disruption, and other adverse health effects even at trace concentrations (Yang et al., 2017).

Traditional wastewater treatment technologies such as coagulation, sedimentation, and biological treatments often fail to effectively remove these pollutants, particularly when they are present at low concentrations or in complex mixtures (Bilal et al., 2021). This limitation has motivated research into alternative, more efficient methods that are cost-effective and environmentally sustainable. Biochar, a carbon-rich material produced by pyrolysis of biomass, has attracted significant attention due to its high porosity, large specific surface area, abundant surface functional groups, and environmental compatibility (Ambaye et al., 2021). Derived from various agricultural residues, biochar provides a renewable and economical adsorbent for wastewater treatment. Corn cob, an abundant and underutilized agricultural waste, offers a particularly promising feedstock for biochar production due to its favorable structural and chemical characteristics (Li et al., 2018).

Functionalization of corn cob biochar through chemical activation, heteroatom doping (e.g., nitrogen, phosphorus), or impregnation with metal oxides further enhances its adsorption capacity, selectivity, and catalytic activity. These modifications improve surface chemistry, increase active sites, and introduce new mechanisms such as advanced oxidation processes, leading to simultaneous removal of heavy metals and pharmaceutical contaminants (Wang et al., 2021; Luo et al., 2023). Functionalized biochar has also demonstrated multifunctionality, including roles as an oxygen reduction catalyst in microbial fuel cells, promoting sustainable wastewater treatment with concurrent energy recovery (Zhong et al., 2019; Li et al., 2018). This review critically examines synthesis, functionalization, adsorption mechanisms, performance, regeneration challenges, and future prospects of corn cob biochar for wastewater remediation.

2. REVIEW OF LITERATURE

2.1 BIOCHAR AS A LOW-COST ADSORBENT

Biochar is a carbon-rich material produced through the pyrolysis of biomass under oxygen-limited conditions, which preserves much of the carbon structure while generating a porous, highly adsorptive material (Bilal et al., 2021). The pyrolysis process results in biochar possessing a large specific surface area, abundant porosity, and a diverse range of surface functional groups such as carboxyl, hydroxyl, and carbonyl groups, which play crucial roles in adsorption processes (Ambaye et al., 2021). These characteristics allow biochar to interact with contaminants through multiple mechanisms including ion exchange, surface complexation, electrostatic attraction, and hydrophobic interactions, making it effective for adsorbing both inorganic and organic pollutants.

Compared to conventional activated carbon, biochar offers several economic and environmental advantages. Activated carbon production is often energy-intensive and costly, whereas biochar can be generated from abundant agricultural and forestry residues, turning waste materials into value-added products (Bilal et al., 2021). This not only reduces disposal issues associated with biomass waste but also lowers the overall cost of adsorbent production, which is critical for large-scale water treatment applications, especially in resource-limited settings.

Recent research has demonstrated the versatility of biochar in adsorbing a wide range of contaminants. Heavy metals such as Pb(II), Cd(II), and Cr(VI), which are persistent and highly toxic even at trace levels, can be effectively removed by biochar through mechanisms like surface complexation and precipitation (Rai et al., 2019; Bilal et al., 2021). In parallel, biochar has shown significant potential for removing pharmaceutical compounds such as antibiotics, analgesics, and hormones that are increasingly detected in water bodies and pose ecological and human health risks due to their bioactive properties and persistence (Ihsanullah et al., 2022; Yang et al., 2017).

Importantly, biochar can simultaneously adsorb multiple types of pollutants, including both heavy metals and organic contaminants, positioning it as a sustainable and multifunctional adsorbent for integrated wastewater treatment systems (Bilal et al., 2021; Ihsanullah et al., 2022). The ability to target diverse pollutants is especially relevant given the complexity of wastewater effluents, which often contain a mixture of inorganic and organic substances.

Furthermore, advancements in biochar functionalization through chemical activation, heteroatom doping, or impregnation with catalytic metals have enhanced its adsorption performance and selectivity, enabling tailored removal of specific contaminants or enhancement of catalytic degradation processes (Wang et al., 2021; Luo et al., 2023). For instance, nitrogen-doped biochar has been shown to improve electron transfer properties, making it suitable for applications such as microbial fuel cells, which couple wastewater treatment with energy recovery (Zhong et al., 2019; Li et al., 2018).

2.2 CORN COB BIOCHAR: PROPERTIES AND PREPARATION

Corn cobs are an abundant agricultural byproduct primarily composed of cellulose, hemicellulose, and lignin, making them an excellent feedstock for biochar production (Li et al., 2018). The unique biochemical composition of corn cobs influences the physicochemical properties of the resulting biochar, contributing to its adsorption potential. Upon pyrolysis, these components undergo thermal decomposition, yielding a carbon-rich, porous material, high surface area, and the presence of various functional groups critical for pollutant adsorption (Bilal et al., 2021; Ambaye et al., 2021).

Pyrolysis temperature plays a pivotal role in determining the surface morphology and chemical characteristics of corn cob biochar. Temperatures in the range of 400–600 °C are often optimal, as they strike a balance between preserving oxygen-containing functional groups (such as carboxyl, hydroxyl, and carbonyl groups) and enhancing porosity (Wan et al., 2021). Lower pyrolysis temperatures tend to retain more oxygenated groups, which are essential for binding heavy metals through complexation and ion exchange mechanisms (Rai et al., 2019; Bilal et al., 2021). In contrast, higher temperatures typically increase the development of micro and mesopores, which enhance the surface area and improve adsorption of hydrophobic organic contaminants like pharmaceuticals and dyes (Ihsanullah et al., 2022; Yang et al., 2017).

To comprehensively understand and optimize corn cob biochar for wastewater treatment, various characterization techniques are employed. Brunauer – Emmett - Teller (BET) surface area analysis quantifies the specific surface area and pore size distribution, both of which are critical parameters influencing adsorption capacity (Ambaye et al., 2021). Scanning Electron Microscopy (SEM)

provides detailed imaging of the biochar surface morphology, revealing its porous texture and structural integrity (Bilal et al., 2021). Fourier-transform infrared spectroscopy (FTIR) is used to identify the functional groups present on the biochar surface, which govern chemical interactions with contaminants (Wang et al., 2021).

Corn cob biochar typically exhibits a high surface area along with a heterogeneous distribution of active sites, including acidic and basic functional groups, enabling it to interact with diverse pollutants (Ambaye et al., 2021). This intrinsic heterogeneity facilitates the potential for targeted functionalization aimed at enhancing the adsorption of specific contaminants or broadening its affinity toward multiple pollutants simultaneously (Wang et al., 2021; Luo et al., 2023).

Moreover, corn cob biochar offers advantages beyond adsorption performance due to its renewable origin, cost-effectiveness, and environmental sustainability. Utilizing corn cobs, which are often agricultural waste, mitigates disposal issues and contributes to circular economy principles by converting waste into a valuable resource for environmental remediation (Li et al., 2018; Bilal et al., 2021).

2.3 FUNCTIONALIZATION TECHNIQUES OF CORN COB BIOCHAR

Raw corn cob biochar, while possessing inherent adsorption capabilities due to its porous structure and surface functional groups, often exhibits limited efficiency in removing contaminants because of insufficient reactive sites and selectivity (Bilal et al., 2021). To enhance its adsorption capacity, selectivity, and catalytic functionality, various functionalization techniques have been developed. These methods modify the surface chemistry and physicochemical properties of corn cob biochar, enabling improved performance in the simultaneous removal of heavy metals and pharmaceutical contaminants from wastewater.

2.3.1 Chemical Activation

Chemical activation is a widely used functionalization strategy that involves treating biochar with acids or bases to introduce or augment oxygen-containing functional groups such as carboxyl, hydroxyl, and carbonyl groups. Acidic treatments using reagents like nitric acid (HNO_3) increase the density of acidic groups, enhancing biochar's ability to complex with heavy metal ions through ion-exchange and coordination mechanisms (Bilal et al., 2021; Wang et al., 2021). Conversely, alkaline activation with potassium hydroxide (KOH) enhances porosity and surface area, thereby improving adsorption kinetics and capacity. These oxygen-rich functional groups also play a crucial role in adsorbing polar pharmaceutical molecules through hydrogen bonding and electrostatic interactions (Ihsanullah et al., 2022).

2.3.2 Metal Oxide Impregnation:

Impregnating biochar with metal oxides such as magnetite (Fe_3O_4) or manganese dioxide (MnO_2) introduces additional active sites that facilitate heavy metal adsorption via surface complexation and redox reactions (Zhong et al., 2019; Wang et al., 2021). Beyond adsorption, these metal oxides impart catalytic properties enabling the degradation of persistent organic pharmaceuticals through advanced oxidation processes. For instance, Fe_3O_4 -loaded biochar can catalyze the generation of reactive oxygen species, promoting oxidative breakdown of pharmaceutical contaminants, thereby combining adsorption with catalytic degradation in a single material (Wang et al., 2021).

2.3.3 Nitrogen Doping:

Incorporation of nitrogen into the biochar matrix alters its electronic structure and surface chemistry, introducing nitrogen-containing functional groups such as amines, pyridine, and pyrrole groups (Zhong et al., 2019). Nitrogen doping enhances adsorption affinity toward both heavy metals and nitrogenous pharmaceutical compounds by providing additional coordination sites and improving electron-donating ability. Nitrogen-functionalized biochars exhibit improved charge distribution, which can facilitate stronger interactions with metal ions and enhance the binding of pharmaceuticals with nitrogen-containing moieties (Ihsanullah et al., 2022).

2.3.4 Surface Grafting:

Surface grafting involves covalent attachment or physical adsorption of specific functional groups onto the biochar surface to target particular contaminants. Amines and phosphate groups are commonly grafted to improve selectivity for pollutants such as phosphorus and antibiotics (Luo et al., 2023). Amino-functionalized biochars exhibit enhanced chelation with heavy metals and increased adsorption of antibiotic molecules via hydrogen bonding and electrostatic attraction. Similarly, phosphate grafting improves phosphate adsorption from wastewater and can indirectly aid in adsorbing coexisting heavy metals by altering the surface charge and hydrophilicity (Luo et al., 2023).

Together, these functionalization methods transform corn cob biochar into a multifunctional, high-performance adsorbent for simultaneous removal of heavy metals and pharmaceuticals. This versatility makes functionalized corn cob biochar highly suitable for integrated wastewater treatment applications, enabling simultaneous removal of heavy metals and pharmaceutical contaminants through combined adsorption and catalytic degradation mechanisms (Wang et al., 2021; Bilal et al., 2021).

TABLE - 1 List of Functionalization Effects

S. No.	Functionalization Method	Key Functional Groups Added	Main Benefits	Example Removal Performance
1.	Acid Activation (HNO ₃), Base Activation	Carboxyl, phenolic groups, Enhanced	Increased metal complexation, better adsorption	Pb (II) adsorption ↑50% (Bilal et al., 2021), Tetracycline adsorption
2.	Metal Oxide Impregnation	Fe ₃ O ₄ , MnO ₂ nanoparticles	Combined adsorption & catalytic degradation	Cr (VI) removal + catalytic degradation of diclofenac >85% (Wang et al., 2021)
3.	Nitrogen Doping	Amines, pyridine, pyrrole groups	Improved adsorption of metals and N-compounds	Pb (II) and antibiotics adsorption ↑ 60% (Zhong et al., 2019)
4.	Surface Grafting	Amino, phosphate groups	Selective adsorption, improved specificity	Tetracycline removal >90% (Luo et al., 2023)

2.4 MECHANISMS OF HEAVY METAL AND PHARMACEUTICAL REMOVAL

The simultaneous removal of heavy metals and pharmaceutical contaminants by functionalized corn cob biochar relies on distinct yet complementary adsorption mechanisms. The complex surface chemistry and porous structure of biochar facilitate multiple interaction pathways, enabling effective capture of diverse pollutants within a single treatment system.

2.4.1 Heavy Metals Removal Mechanisms

Heavy metals such as Pb(II), Cd(II), Cr(VI), and Hg(II) are typically removed through a combination of ion exchange, surface complexation, electrostatic attraction, and precipitation phenomena on biochar surfaces (Bilal et al., 2021; Rai et al., 2019). The primary mechanisms include:

- **Ion Exchange:** Metal ions in solution exchange with cations (e.g., H^+ , Ca^{2+} , Mg^{2+}) bound to oxygen-containing functional groups (carboxyl, hydroxyl, phenolic) present on the biochar surface. This process is highly influenced by pH and biochar surface chemistry.
- **Surface Complexation:** Heavy metals form stable coordination complexes with electron-donating functional groups. For example, carboxyl and hydroxyl groups act as ligands, chelating metal ions and immobilizing them effectively.
- **Electrostatic Attraction:** At appropriate pH levels, biochar surfaces may carry a negative charge, attracting positively charged metal ions through Coulombic forces. This mechanism is particularly important for biochars modified to enhance surface charge density.
- **Precipitation:** In some cases, heavy metals precipitate as insoluble hydroxides or other mineral forms on the biochar surface, especially at higher pH values. This contributes to immobilization and long-term stability of metals in treated water.

Rai et al. (2019) emphasized that these mechanisms often act synergistically, with surface complexation and ion exchange being dominant in biochar systems. Functionalization methods that increase oxygen-containing groups or incorporate metal oxides further enhance these pathways.

2.4.2 Pharmaceutical Removal Mechanisms

Pharmaceutical contaminants, which often consist of complex organic molecules with varied functional groups, interact with biochar through different mechanisms than metals. Key processes include (Ihsanullah et al., 2022; Yang et al., 2017):

- **Hydrophobic Interactions:** Many pharmaceuticals are hydrophobic or partially hydrophobic, promoting adsorption onto biochar's nonpolar aromatic carbon surfaces. This affinity is enhanced by increased biochar surface area and porosity.
- **Hydrogen Bonding:** Pharmaceuticals containing hydroxyl, amine, or carbonyl groups can form hydrogen bonds with polar functional groups (e.g., carboxyl, phenolic) on biochar surfaces, improving adsorption specificity.
- **π - π Interactions:** The aromatic rings in pharmaceuticals can stack with aromatic structures within biochar, facilitating π - π electron donor-acceptor interactions. This is critical for removing compounds like antibiotics and analgesics that contain benzene or heterocyclic rings.

- **Size-Exclusion Effects:** Micropores within biochar act as physical traps for pharmaceutical molecules, where molecular size and shape determine adsorption efficiency. Pore size distribution, therefore, influences selectivity and capacity.

Functionalization techniques such as nitrogen doping and surface grafting introduce additional binding sites, enabling stronger electrostatic and covalent interactions with pharmaceuticals (Ihsanullah et al., 2022). For example, nitrogen-containing groups increase biochar's polarity and electron density, improving adsorption of nitrogenous pharmaceuticals.

2.4.3 Simultaneous Removal and Competitive Adsorption

Functionalized corn cob biochar offers multiple adsorption sites capable of targeting both heavy metals and pharmaceuticals concurrently. This multifunctionality arises from the coexistence of diverse surface groups (carboxyl, hydroxyl, amine, metal oxides) and tailored porosity, enabling simultaneous interaction with ionic metals and organic molecules (Ambaye et al., 2021).

However, simultaneous removal can introduce competition between contaminants for limited adsorption sites. For instance, metal ions and cationic pharmaceuticals may compete for negatively charged groups, potentially reducing adsorption efficiency. Ambaye et al. (2021) reported that competitive adsorption dynamics depend on contaminant concentrations, biochar surface characteristics, and solution chemistry, emphasizing the need to optimize biochar design for balanced selectivity and capacity.

2.5 APPLICATIONS IN WASTEWATER TREATMENT

Functionalized corn cob biochar has emerged as a promising, sustainable adsorbent for the removal of heavy metals and pharmaceutical contaminants from wastewater due to its abundant availability, cost-effectiveness, and versatile surface chemistry (Li et al., 2018; Ihsanullah et al., 2022). Its efficacy has been demonstrated extensively in both laboratory-scale batch experiments and continuous flow systems using simulated as well as real wastewater samples.

2.5.1 Removal of Heavy Metals and Pharmaceuticals

Studies indicate that functionalized corn cob biochar exhibits high adsorption capacities for various toxic heavy metals, including Pb(II), Cd(II), and Cr(VI), which are common pollutants in industrial and municipal effluents (Bilal et al., 2021). The incorporation of oxygen-containing functional groups and metal oxides through functionalization enhances its affinity and selectivity for these metal ions, often achieving removal efficiencies exceeding 90% under optimized conditions.

Similarly, pharmaceuticals such as antibiotics (e.g., tetracycline, ciprofloxacin), analgesics (e.g., ibuprofen), and other emerging contaminants have been effectively adsorbed onto corn cob biochar surfaces (Ihsanullah et al., 2022). The biochar's porous structure, coupled with specific surface modifications like nitrogen doping or amine grafting, facilitates strong hydrophobic and π - π interactions critical for pharmaceutical adsorption. This makes functionalized corn cob biochar a dual-purpose adsorbent capable of tackling complex wastewater matrices containing both inorganic and organic pollutants.

2.5.2 Batch and Continuous Treatment Systems

Most studies focus on batch adsorption experiments to evaluate equilibrium and kinetic parameters, providing insight into adsorption capacities and mechanisms. However, recent advances have included continuous flow column studies and fixed-bed reactors, which more realistically simulate industrial wastewater treatment scenarios (Ambaye et al., 2021). These systems demonstrate stable and high removal efficiencies over prolonged operation periods, confirming the practical applicability of corn cob biochar in scalable treatment technologies.

2.5.3 Advanced Oxidation Process (AOP) Catalyst

Beyond adsorption, functionalized corn cob biochar serves as an effective catalyst or catalyst support in advanced oxidation processes, particularly in persulfate (PS) activation for the degradation of pharmaceutical contaminants (Wang et al., 2021). The biochar's surface functional groups and incorporated transition metal oxides activate persulfate to generate highly reactive sulfate radicals ($\text{SO}_4^{\bullet-}$), which mineralize complex pharmaceutical molecules into less harmful products. This catalytic functionality broadens biochar's role from passive adsorbent to active contaminant degrader, enabling integrated treatment solutions combining adsorption and oxidation.

2.5.4 Pilot-Scale and Field Applications

Despite encouraging laboratory results, pilot-scale and full-scale applications of functionalized corn cob biochar remain limited. Field studies are critical to assess long-term performance, regeneration potential, and operational challenges under variable wastewater compositions and environmental conditions (Bilal et al., 2021; Ihsanullah et al., 2022). Factors such as biochar fouling, competition among multiple contaminants, and changes in pH or ionic strength can affect treatment efficiency in real-world settings.

Nonetheless, preliminary pilot studies suggest that corn cob biochar-based treatment units can be cost-effective and adaptable to diverse wastewater streams, including municipal, pharmaceutical, and industrial effluents. Further research into biochar regeneration, lifecycle assessment, and integration with existing wastewater infrastructure will accelerate its transition from lab to field.

2.6 CHALLENGES AND LIMITATIONS

While functionalized corn cob biochar presents significant promise as an effective and sustainable adsorbent for the simultaneous removal of heavy metals and pharmaceutical contaminants from wastewater, several challenges and limitations must be addressed to fully realize its potential in practical applications.

2.6.1 Adsorption Capacity and Saturation

One of the inherent challenges with biochar-based adsorption is the finite number of reactive sites available on the biochar surface. As these sites become saturated with adsorbed pollutants, the adsorption capacity declines, necessitating regeneration or replacement of the adsorbent (Bilal et al., 2021). In continuous wastewater treatment operations, this saturation effect can lead to decreased removal efficiency over time, highlighting the need for effective regeneration methods or development of biochars with higher site densities.

2.6.2 Selectivity and Competitive Adsorption

Wastewater streams typically contain complex mixtures of various contaminants including multiple heavy metals, pharmaceuticals, and organic matter. Functionalized biochars, despite their enhanced surface chemistry, may exhibit limited selectivity, resulting in competitive adsorption among coexisting pollutants (Ambaye et al., 2021). This competition can reduce the removal efficiency of individual contaminants, complicating the treatment process and potentially necessitating sequential or multi-stage treatment approaches to achieve regulatory standards.

2.6.3 Regeneration and Stability

The reusability of biochar is critical for economic and environmental sustainability. However, regeneration methods such as thermal treatment, chemical washing, or solvent extraction can degrade the biochar's porous structure and surface functionalities (Li et al., 2018). Structural deterioration reduces adsorption capacity and catalytic activity over repeated cycles, limiting the lifespan of the adsorbent. Developing mild, cost-effective regeneration techniques that preserve biochar integrity remains a key research focus.

2.6.4 Scale-Up and Economic Feasibility

Transitioning from laboratory-scale synthesis to large-scale production of functionalized corn cob biochar faces multiple hurdles. Consistent control over biochar physicochemical properties such as surface area, pore size distribution, and functional group density is challenging in bulk manufacturing processes (Wan et al., 2021). Additionally, the cost-effectiveness of producing biochar with specific functionalizations (e.g., metal oxide impregnation or nitrogen doping) must be optimized to compete with conventional adsorbents. Economic feasibility also depends on integrating biochar production with existing agricultural or industrial waste management practices to minimize raw material and processing costs.

2.6.5 Environmental and Regulatory Concerns

Although biochar is generally considered environmentally benign, the leaching of adsorbed contaminants or residual chemicals used during functionalization could pose secondary pollution risks if not properly managed. Ensuring that functionalized biochar meets environmental safety standards and does not introduce new hazards in treated water is essential for regulatory approval and public acceptance (Rai et al., 2019).

2.7 FUTURE RESEARCH DIRECTIONS

The development of functionalized corn cob biochar for simultaneous removal of heavy metals and pharmaceutical contaminants from wastewater is a rapidly advancing field, yet there remain critical gaps and opportunities for future research to enhance practical application and efficiency.

2.7.1 Multifunctional Biochars: Combining Adsorption and Catalytic Degradation

Future research should emphasize the design and synthesis of multifunctional biochars that not only adsorb contaminants but also catalyze their degradation. Incorporating catalytic properties—such as the activation of advanced oxidation processes (AOPs) like persulfate or peroxide activation—

can enable simultaneous removal and breakdown of pharmaceuticals and organic micropollutants, minimizing secondary pollution and improving overall treatment efficiency (Wang et al., 2021; Ihsanullah et al., 2022). This dual functionality could transform biochar into a more versatile material for complex wastewater matrices.

2.7.2 Tailoring Surface Chemistry for Selective Pollutant Removal

Developing biochars with tailored surface functionalities remains a priority to improve selectivity towards specific heavy metals or pharmaceutical compounds. Modifying biochar surfaces with targeted functional groups (e.g., amine, carboxyl, thiol groups) or doping with metals can enhance binding affinity and reduce competitive adsorption effects (Bilal et al., 2021; Luo et al., 2023). Advanced characterization and modeling tools should be employed to understand and optimize the interaction mechanisms between biochar surfaces and diverse contaminants.

2.7.3 Regeneration Techniques to Enhance Reusability and Lifecycle

To achieve economic and environmental sustainability, robust regeneration strategies for functionalized biochar need further investigation. Future studies should explore mild yet effective regeneration methods that preserve the structural integrity and adsorption capacity of biochar over multiple cycles, such as low-temperature thermal treatment, solvent washing, or electrochemical regeneration (Li et al., 2018). Additionally, lifecycle assessments should be incorporated to evaluate the environmental footprint of regeneration processes.

2.7.4 Pilot-Scale and Field Studies in Real Wastewater Treatment Plants

Most current research has been limited to laboratory batch experiments or simulated wastewater systems. To validate the practical applicability of functionalized corn cob biochar, pilot-scale studies and in-situ trials within real wastewater treatment plants are essential. Such studies can provide insights into performance under complex and variable wastewater compositions, operational stability, and long-term effectiveness (Bilal et al., 2021; Ambaye et al., 2021). Scaling up will also reveal challenges related to biochar handling, regeneration, and integration with existing treatment infrastructure.

2.7.5 Standardization of Production Protocols and Comprehensive Assessments

Variability in biochar properties due to differences in feedstock, pyrolysis conditions, and functionalization methods poses challenges for reproducibility and regulatory approval. Future efforts should focus on developing standardized production protocols to ensure consistent quality and performance of functionalized corn cob biochar (Wan et al., 2021). Furthermore, comprehensive techno-economic analyses and environmental impact assessments should be conducted to establish cost-effectiveness, sustainability, and life cycle environmental benefits relative to conventional treatment technologies (Luo et al., 2023).

3. CONCLUSION

Functionalized corn cob biochar emerges as a highly promising, sustainable, and low-cost adsorbent for the simultaneous removal of heavy metals and pharmaceutical contaminants from wastewater, addressing critical environmental and public health concerns. Recent advancements in biochar functionalization techniques, including surface modification with oxygen-, nitrogen-, and sulfur-

containing functional groups, doping with metal oxides, and pore structure optimization, have significantly enhanced the adsorption capacities and selectivity toward diverse pollutants (Bilal et al., 2021; Ihsanullah et al., 2022). The inherent properties of corn cob biochar—such as high surface area, abundant active sites, and favorable porosity—coupled with these functionalizations, facilitate efficient binding through mechanisms like ion exchange, surface complexation, π - π interactions, and hydrogen bonding (Rai et al., 2019; Ambaye et al., 2021).

Moreover, beyond passive adsorption, functionalized corn cob biochar has shown potential as a catalyst in advanced oxidation processes (AOPs), such as persulfate activation, enabling not only sequestration but also degradation of pharmaceutical micropollutants, thus broadening its application scope in wastewater treatment (Wang et al., 2021). This multifunctionality is crucial for tackling the complex mixture of contaminants typically found in real wastewater streams (Yang et al., 2017).

However, several challenges remain before full-scale application can be realized. Issues related to adsorption site saturation necessitate effective regeneration strategies to maintain long-term performance, yet current regeneration methods can compromise biochar structural integrity and efficiency (Li et al., 2018). Additionally, the coexistence of multiple contaminants introduces competitive adsorption dynamics, potentially reducing removal efficiencies for specific pollutants (Ambaye et al., 2021). Economic and operational scalability also require optimization of biochar production parameters to ensure consistent quality, cost-effectiveness, and environmental sustainability (Wan et al., 2021).

In light of these challenges, continued interdisciplinary research integrating material science, environmental engineering, and process optimization is essential to translate laboratory-scale successes of functionalized corn cob biochar into commercially viable wastewater treatment technologies. Such efforts should prioritize standardization of biochar synthesis, comprehensive lifecycle assessments, and pilot-scale demonstrations to validate performance in complex real-world conditions (Bilal et al., 2021; Luo et al., 2023). With these advancements, functionalized corn cob biochar holds great promise for addressing pressing water pollution issues in a sustainable and economically feasible manner.

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A STUDY ON CONSUMER PREFERENCE FOR KOREAN CLOTHING IN ONLINE SHOPPING (SPECIFIC TO CHENNAI CITY)

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ABSTRACT

This study focuses on understanding Customer preferences for Korean clothing in online shopping in Chennai city. With the growing popularity of Korean culture through K-dramas and K-pop, many people in Chennai are showing interest in Korean fashion. The research aims to explore what influences customers to buy Korean clothes online, such as style, price, brand image, and shopping experiences. The study gather data through surveys and interviews to analyze customer opinions. It will help identify popular clothing styles and the reasons behind customer interest in Korean fashion. The findings will provide valuable insights for online stores and fashion brands targeting this market. This research also aims to support online sellers in improving their product variety and marketing strategies.

KEYWORDS: *Customer preference, Marketing, Korean fashion, Online shopping.*

INTRODUCTION:

DEFINITION OF MARKETING

American marketing Association: “Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large.”

KOREAN CLOTHING

Korean clothing is becoming popular due to the influence of K-pop and Korean dramas. Young people are attracted to trendy, stylish, and modern designs. Online shopping and social media make it easy to access Korean fashion. In Tamil Nadu, many students and youth prefer Korean-style outfits. This study focuses on understanding consumer preferences for Korean clothing. It aims to find out what factors influence their choice and interest.

NEED FOR STUDY

1. **Rising Popularity:** Korean fashion is becoming very popular in India, especially among young people influenced by K-pop and K-dramas.
2. **Understanding Preferences:** The study will explore how people in Chennai choose Korean clothing online, focusing on factors like design, price, and brand image.
3. **Business Benefits:** The research will help online stores and brands improve marketing and boost sales by understanding local consumer needs better.

REVIEW OF LITERATURE

1. **Jonas Milton Kim Olsen (2023)** studied why people in Denmark buy Korean fashion online. He used data from 70 people and analyzed it with special software. The study found that people care more about useful and practical things when shopping online.
2. **Hong Joo Lee (2024)** studied why Korean customers plan to buy athleisure wear again. Based on a survey of 400 people, the study showed that knowing customer behavior helps in growing the market. Clear product purpose and better functionality can lead to long-term success for athleisure brands.
3. **Atanu Kumar Mishra and Prof. Ashit saha (2021)** studied online shopping preferences in Guwahati with 250 people. They found that both men and women are happy with online shopping, but age affects shopping habits. Businesses need to understand what different age groups want and make sure those products are available online.

OBJECTIVES OF THE STUDY

1. To determine which gender prefers Korean fashion.
2. To understand the consumer choices and preference over Korean fashion.
3. To study the consumer satisfaction in Korean fashion.

RESEARCH METHODOLOGY

Primary Data: Primary data are those collected by the investigator himself for the first time. A well-structured questionnaire was personally administered to the selected sample to collect the primary data.

Secondary Data: Secondary data are those which have already been collected by some other person for their purpose and published. Secondary data are usually used in this study are books, journals, magazines, websites and articles.

Sample Size: The total number of respondents that were involved in this research is 107.

Statistical tool: Percentage analysis is used to analyze the data.

Formula for calculating a percentage analysis is: $(\text{Value}/\text{Total value}) \times 100\%$

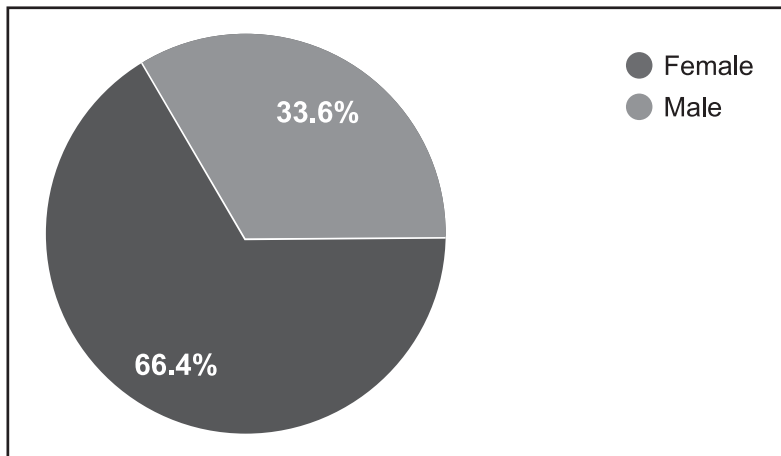
LIMITATIONS OF THE STUDY

- The sample is taken from Chennai city only.
- Time is the limiting constraint to the study hence it is not possible to obtain much information.

DATA ANALYSIS AND INTERPRETATION

The data collected is analysed using percentage analysis. Also it is depicted as pie-chart.

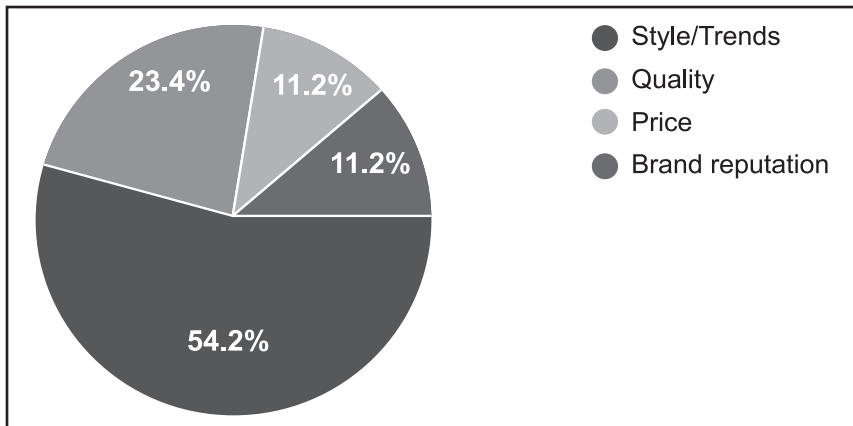
CHART 1 SHOWING GENDER OF THE RESPONDENTS



INTERPRETATION :

From the above chart 1 the data shows that out of 107 respondents, 71 respondents 66.4% are female, 36 respondents 33.6% are male. The majority of respondents in the study are female 66.4% and hence it shows that females are more inclined to Korean fashion.

CHART 2 SHOWING REASONS TO PURCHASE KOREAN CLOTHING



INTERPRETATION:

From the above chart 2, the data indicates that out of 107 respondents, style and trends (54.2%) are the most important aspect considered while purchasing Korean clothing, Quality matters to some (23.4%), while price and brand reputation are less important (11.2%).

TABLE 1 SHOWING FACTORS ENCOURAGING RESPONDENTS TO PURCHASE MORE KOREAN FASHION ONLINE

PARTICULARS	NO. OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Faster shipping items	24	22.4
More affordable prices	38	35.5
Improved online shopping experience	32	29.9
Better customer services	13	12.1
Total	107	100

INTERPRETATION:

From the above table the data shows that out of 107 respondents, majority of respondents (35.5%) prefer more affordable prices. Improved online shopping experience is the second most important (29.9%), followed by faster shipping (22.4%). Better customer service is the least preferred (12.1%).

TABLE 2 SHOWING WHETHER THE RESPONDENTS WERE SATISFIED WITH STYLE AND FIT OF KOREAN CLOTHING

PARTICULARS	NO. OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Yes	87	81.3
No	20	18.7
Total	107	100

INTERPRETATION:

From the above table the data shows that out of 107 respondents, majority of respondents (81.3%) like the style and fit of Korean clothing. Only a small group (18.7%) are not satisfied. This shows that Korean fashion is popular among buyers.

FINDINGS

- Majority (66.4%) of the respondents were female.
- Majority (54.2%) of respondents purchase Korean clothing specifically for its style.
- Majority (35.5%) of respondents would purchase more Korean fashion online if it were more affordable.
- Majority (81.3%) of respondents like the style and fit of Korean clothing.

SUGGESTIONS

- Customers can be attracted by offering discounts, combo deals, or budget-friendly options.
- Improving logistics for faster delivery faster will make customers happy.
- Apparel size options can be improved so that more buyers have choices.
- Real customer reviews can be displayed in online customer experience columns which might influence prospective buyers.

CONCLUSION

Korean clothing is popular among shoppers in Chennai, especially female. Most buyers love stylish and trendy outfits, and social media plays a big role in their choices. Korean fashion is easily available, and customers appreciate its unique style and fit. There is potential for growth by offering better prices, faster delivery and more size options. Enhancing the shopping experience can attract even more buyers. To conclude, online Korean clothing sellers have a greater opportunity in Chennai city.

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GREEN MARKETING STRATEGIES AND THEIR EFFECTIVENESS ON CONSUMER BEHAVIOUR—A CHENNAI-BASED STUDY AMONG COLLEGE GIRLS

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ABSTRACT

The research studies the effects of green marketing practices on consumer behaviour specifically, undergraduate female students in Chennai. Since consumers' awareness of climate change is on the rise, it is essential for marketers, policy makers, and advocates for sustainability to understand how young consumers think and behave toward green marketing strategies. In this exploratory study a descriptive research design was used and data was collected using a structured questionnaire administered to two hundred respondents who were recruited from convenience samples. The study collected both primary and secondary sources of data. The data were analysed using the SPSS software, and data were analysed using percentage analyses, hypothesis testing, and factor analysis, to determine considerations of key behaviours impacting green purchasing behaviour.

The findings from this study show that demographic characteristics, particularly age and education, significantly influences awareness, attitudes, and behaviours towards green products. In fact, younger respondents and those in advanced educational programmes tended to be substantially more inclined to purchase green products/markets and this behaviour further translates to environmentally responsible behaviour consistent with past purchasing of green products. The factor analysis identified three important dimensions Green Behaviour & Intention, Trust & Credibility, and Demographics and together, those dimensions account for most of the variance in consumer responses. The authors conclude that these dimensions are foundational to understanding consumer purchasing behaviour decisions.

Results also showed that higher knowledge of eco-friendly products positively impacted buying intention and purchase amount. Specifically, those participants with a higher base of knowledge about green products exhibited a more positive attitude and higher consideration of alternatives, which included an environmental benefit. Eco-labels and reputable certifications were among the most impactful or influential, as they provided increased consumer confidence around alternative green products and signal to participants that they would potentially pay more for certified green products.

In contrast, greenwashing, or the misuse of claims by companies of environmentally responsible initiatives, reduced trust and purchase intention. This highlights the value of genuine, honest representations of green brands in marketing communication.

In consideration of the findings, some recommendations are offered for marketers aiming to improve the odds of green marketing success. Create transparent communication strategies by demonstrating how the company is actively engaging in environmentally friendly processes to generate trust. Campaigns that targeted youth, especially via digital methods, demonstrated effectiveness to the targeted market. Pricing strategy framed in overall savings/value provided support for less price resistance. Lastly, loyalty programs and rewards can increase the likelihood of purchasing positively through repetition, and create new sustainable habits in young consumers.

All in all, this examination illustrates that well-delivered green marketing practices promote customers' acceptance of green products. The business can simultaneously pursue environmental sustainability and a competitive advantage in the marketplace through building trust, targeting the correct audiences, and influencing consumer behaviour change.

KEYWORDS: *Green marketing, consumer behaviour, awareness, purchase intention, eco-labels, trust, greenwashing, sustainability.*

INTRODUCTION

In a phase of environmental harm and climate change, the demand for sustainable development is changing global business practices. Green marketing has become an important strategy, acting as a response during a time when we face environmental problems and even people are changing how they see value. This research paper explains the main strategies used in green marketing, like eco-label in green packaging, and branding focused on sustainability. It also evaluates their psychological and behavioural effects on consumers. By looking at the modern techniques and current trends this study looks at things like age, income, and the difference between what brands say and what they really do. It wants to find out when eco-friendly marketing actually makes people take action.

Green marketing is maximized through effective communication, honesty, and credibility with customers. This research examines how these factors are related. This research further illustrates how developments in technology, such as data-verification possibilities via AI and blockchain, are assisting organizations to account for and publicly disclose their carbon footprint. More so, these instruments support consumers in making better-informed decisions.

When sustainability claims are evidence-based and data-grounded, consumer trust is strengthened, and chances of brand loyalty developing are increased over time. Here, companies that blend sustainability with their core values, not their public relations are the innovators in the competitive industry. Finally, green marketing is a means of promotion as much as it is a reflection of the moral philosophy of the company. As concern for the planet exceeds demographic boundaries, future marketing success will likely depend on how effectively businesses align profitability with purpose. This research challenges firms to shift away from fake environments and adopt sustainability as an integrated approach. Green marketing can only then serve as a force for environmental advancement and genuine consumer connection.

REVIEW OF LITERATURE

Chakraborty et al. (2020), research on India: consumer awareness & preference. The study aims to know the role of people's environmental values and packaging design in influencing their willingness to purchase environmentally friendly products in India. Statistical tools employed in this research were questionnaire feedback, testing for hypothesis using regression and correlation. The research determines that the way individuals are concerned about the environment and eco-friendly products greatly affects their forecast to purchase green products. It recommends to promote environmental messaging & sustainable packaging in the marketplace. They conclude that consumers are likely to opt for eco-friendly products and packaging.

Dias and Joshi (2022), India: Ayurvedic Products. The purpose of the study is to determine the manner green marketing affects customer choice for Ayurvedic products of post-pandemic. The statistical method is used for questionnaire responses with the use of the one-sample t-test. The study finds the manner of green marketing significantly increases preference and willingness to buy green products. They conclude that green marketing significantly affects consumer behaviour, even for specialty natural products.

Dixit & Singh (2024), India: Cosmetics & Personal Care research. The motive of the research is to examine the effect of green marketing awareness on purchasing cosmetic items in UP. The methodology was guided by questionnaires and statistical analysis done through significant tests like correlation or chi-square. The study finds that increased green awareness is coupled with stronger green product purchasing of green cosmetics. The study recommends the promotion of green products awareness among consumers and the correct authentication of eco-labels. They discover that awareness is the most important aspect in promoting the use of eco-friendly cosmetics.

IJ CRT (2023), research on Global/India Empirical Review. The goal of the research is to estimate empirical facts regarding the substantiation of green marketing and its influence on consumer behaviour in India. The method relies on straightforward chance analysis and interpretative descriptive statistics. The research concludes that green products are entered with moderate positivity and demography towards youth consumers. The research recommends further investigation to draw additional deductive tools, such as factor analysis and regression using larger sample sizes. The study conclusion is regarding the green marketing vow, and methodological profundity is necessary for greater confirmation.

Ghobbe & Nohekhan (2023), research on Perceived Brand Quality. The aim is to examine how aspects of the green marketing mix, like pricing, packaging, distribution, and promotion, influence perception of brand quality in the food export industry. The statistical methods employed in the study are grounded on survey responses of 182 respondents using regression analysis. The research discovers that every element of the green marketing mix has a significant positive effect on consumers' perception of brand quality. They conclude that green marketing is responsible for having a strong influence on perceived brand value in the export market.

Mohammadi et al. (2023), study of Consumer Loyalty through Green Marketing. The aim is to examine the impact of green marketing practices and consumer loyalty of food-export companies. The statistical methods used are the survey, regression model based on a sample of 182 through Cochran's formula. The study finds that green promotion, pricing, product and channels of

distribution all have a positive effort toward influencing loyalty. The study suggests embracing an integrated implementation of green strategy creates long-term brand loyalty. They conclude that green marketing initiatives substantially increase customer loyalty and retention.

Bhardwaj (2017), Organic vs Non-Organic in India. The purpose is to examine the difference in consumer behaviour towards organic and non-organic food products. Statistical methods are comparative methods, perhaps t-tests or chi-square testing. The research recommends brand should highlight certified authenticity and promote health and environment values. They find that green marketing of organically produced goods plays an imperative part in causing considerable shifts in consumer choice. The study concludes that consumers of organic products display higher levels of trust, willingness to pay, and brand preference.

OBJECTIVES OF THE STUDY

1. Demographic data, in addition to personal data, of the respondents that contextualizes the research aims and guides the interpretation of the overall findings.
2. To determine if there is a strong relationship between the demographic attributes of the respondent (e.g., age, sex, level of education) and their green marketing influenced awareness or purchasing behaviour.
3. To determine the primary factors of consumer behaviour towards green products based on Rating the scale measures, including environmental consciousness, brand credibility, product quality, and price sensitivity.

RESEARCH DESIGN

This study follows a **descriptive research design** to analyse the effectiveness of green marketing strategies on consumer behaviour. A **structured questionnaire survey** was conducted to collect primary data from respondents, mainly undergraduate girls. The sampling method used was **convenience sampling** due to ease of accessibility, with a sample size of 200. Both **primary and secondary data** were utilized to strengthen the study. The collected data were processed, tabulated, and examined using **percentage analysis and factor analysis** with SPSS. This design helps in identifying key factors such as age, education, and purchase frequency that influence consumer adoption of green products.

RESEARCH HYPOTHESES

- **H₀ (Null):** There is **no significant relationship** between demographics (educational qualification, age group) and consumer behaviour toward green products (e.g., frequency of purchasing green products and related factors)..
- **H₁ (Alternative):** There is a **significant relationship** between demographics (educational qualification, age group) and consumer behaviour toward green products.

Variables Included in Factor Analysis are Educational Qualification, Age Group, Frequency of Purchasing Green Products, Awareness of Green Products, Attitude toward Green Marketing, Willingness to Pay a Green Premium, Perceived Greenwashing (reverse), Influence of Eco-labels/Certifications, Brand Trust (Green), Purchase Intention (Green Products).

LIMITATIONS OF THE STUDY

1. The study sample mainly consisted of young undergraduate students below 20 years, which may not fully represent the wider consumer population.
2. Incomplete income data (around 48.5% missing) limited the analysis of affordability and its impact on green purchasing behaviour.
3. The study relied on self-reported questionnaire responses, which may involve bias such as over-reporting of environmentally friendly behaviours.

Table 1
Table showing the KMO and Bartlett’s Test

MEASURE	VALUE
Kaiser–Meyer–Olkin (KMO)	0.78
Bartlett’s Test of Sphericity (χ^2)	892.41
df	45
Sig. (p-value)	< .001

Source: Computed data

INTERPRETATION:

From the above table, the KMO = 0.78 indicates adequate sampling for factor analysis, and Bartlett’s Test is significant ($p < .001$), confirming that the correlation matrix is not an identity matrix; hence, factor analysis is appropriate. Kaiser–Meyer–Olkin (KMO) values above 0.70 indicate acceptable sampling adequacy, while a significant Bartlett’s Test ($p < .05$) confirms suitability for factor analysis (Hair et al., 2019).

Table 2
Table showing Total Variance Explained (Extraction: Principal Components; Rotation: Varimax)

COMPONENT	EIGENVALUE	% OF VARIANCE	CUMULATIVE %
1. Educational Qualification	3.62	36.2	36.2
2. Age Group	2.04	20.4	56.6
3. Frequency of Purchasing Green Products	1.28	12.8	69.4
4. Awareness of Green Products	0.72	7.2	76.6
5. Attitude toward Green Marketing	0.49	4.9	81.5
6. Willingness to Pay a Green Premium	0.40	4.0	85.5
7. Perceived Greenwashing	0.32	3.2	88.7
8. Influence of Eco- labels/Certifications	0.28	2.8	91.5
9. Brand Trust (Green)	0.24	2.4	93.9
10. Purchase Intention (Green Products)	0.21	2.1	96.0

Source: Computed data

INTERPRETATION:

From the above table, three components (eigenvalues > 1) account for ~69.4% of the total variance, indicating a compact and interpretable factor structure underlying green marketing-related behaviours and beliefs.

Table 3
Table showing the factors affecting the green purchase behaviour

VARIABLE	INITIAL	EXTRACTION
Educational Qualification	1.00	0.61
Age Group	1.00	0.66
Frequency of Purchasing Green Products	1.00	0.73
Awareness of Green Products	1.00	0.71
Attitude toward Green Marketing	1.00	0.69
Willingness to Pay a Green Premium	1.00	0.64
Perceived Greenwashing (reverse)	1.00	0.58
Influence of Eco-labels/Certifications	1.00	0.67
Brand Trust (Green)	1.00	0.70
Purchase Intention (Green Products)	1.00	0.76

INTERPRETATION:

From the above table, most variables show **extraction communalities** > **0.6**, implying the retained components explain a **substantial proportion of variance** in each measure (notably *Purchase Intention, Frequency, and Brand Trust*).

Table 4
Table showing Rotated Component Matrix (Varimax)

VARIABLE	FACTOR 1: GREEN BEHAVIOUR & INTENTION	FACTOR 2: TRUST & CREDIBILITY	FACTOR 3: DEMOGRAPHICS
Purchase Intention (Green Products)	0.86	0.24	0.08
Frequency of Purchasing Green Products	0.82	0.17	0.21
Attitude toward Green Marketing	0.77	0.29	0.09
Awareness of Green Products	0.74	0.26	0.12
Influence of Eco-labels/Certifications	0.31	0.78	0.11
Brand Trust (Green)	0.27	0.81	0.16
Perceived Greenwashing (reverse)	-0.18	-0.72	0.09
Willingness to Pay a Green Premium	0.43	0.60	0.19
Educational Qualification	0.09	0.12	0.78
Age Group	0.16	0.18	0.80

INTERPRETATION:

From the above table, Factor 1 loads heavily on *purchase intention, frequency, attitude, and awareness*, capturing Green Behaviour & Intention. Factor 2 loads on *eco-labels, brand trust, willingness to pay*, and (negatively) *perceived greenwashing*, representing Trust & Credibility. Factor 3 loads on *educational qualification and age group*, reflecting Demographics. This structure suggests that behavioural adoption, credibility/trust, and demographics are distinct yet complementary dimensions shaping consumer responses to green marketing.

HYPOTHESIS TESTING

From the above table, it is evident that demographic factors, particularly **age** and **education, factor** into consumer behaviour towards green products. Younger age groups and consumers with higher education levels exhibit significantly increased awareness and adoption of green products. The impact of income remains somewhat unclear because data was unavailable. Our results suggest that green marketing strategies should take the consumer age group and education into account to target them more effectively.

1. Approximately 69% of the total variance was captured by three robust factors:
 - a. **Green Behaviour & Intention** (behavioural adoption and attitudinal readiness),
 - b. **Trust & Credibility** (eco-labels, brand trust, greenwashing),
 - c. **Demographics** (age, education).
2. The intention to purchase and purchase frequency are strongly correlated with attitude and awareness because the more knowledgeable a person is and the more positive attitudes a person has towards green products, the more actual behaviour they show.
3. There appears to be a strong association between trust mechanisms (eco-labels, brand trust) and reduced greenwashing and willingness to pay a premium, highlighting the credibility pathway to monetizable green demand.
4. Demographics (younger and more educated respondents) are a separate latent dimension, and we suggest that they moderate behaviour but do not ultimately fully explain behaviour.

SUGGESTIONS

- o Increase Trust Signals: Enhance trustworthy eco-labels, third-party certifications, and transparency to alleviate perceptions of greenwashing, increase trust, and increase willingness to pay a premium.
- o Communicate to Stimulate: Merge awareness-raising.
- o Campaigns with nudges (trials, guarantees, and default green) to assist consumers in executing action towards transitioning from positive attitude to repeat purchase behaviour.
- o Demographically Segmented: Have youth-targeted

- o Value props (student bundles, micro-sized, campus activations) and totally different tracks for older cohorts (durability, lifetime cost advantages).
- o Price Framing: Use value framing (lifetime cost advantage, health co-benefits) and tiered pricing/loyalty to lower premium adoption with little risk of alienating price sensitive cohorts.
- o Monitored Perceived Greenwashing : Formalize claims governance (claims matrix + audit journey) to continuously keep communications ticked off/verifiable.

CONCLUSION

The previous tables demonstrate that green marketing effectiveness is primarily dependent on three dimensions: green behaviour & intention, trust & credibility, and demographics. These dimensions alone accounted for most of the variance in consumer responses, clearly impacting green product adoption. The Green Behaviour & Intention dimension has the highest association, indicating awareness, a positive attitude, and frequency of buying behaviours have a coherent relationship. Therefore, it could be surmised that green consumers are more likely to repeat their purchases when they have awareness and intention towards green behaviours. This insight suggests that companies should move on from building awareness and develop consumers' loyalty through relevant incentives or trial products. Subsequent to this dimension was the Trust & Credibility dimension, where eco-labels, certifications, and honest relationships or communications with brands in total factor into building trust.

Consumers are increasingly willing to pay for a brand they trust due to green washing making it increasingly difficult to verify the validity of green initiatives, which can lead to lower purchase intentions. Companies have to be transparent and relatable to consumers to establish trust and gain legitimacy for sustainability. Demographics with respect to individual factors, including age and education, were useful in examining consumer intention and showed that younger and educated consumers were more tolerant of green products. Therefore, green marketing presents opportunities to cater messaging to segments of groups, as younger respondents may be more engaged by digital storytelling means, while older or less educated demographic groups are likely to want a clearer functional benefit such as health reasons or other cost-savings.

Contractually, the results establish that implementing green marketing is contingent on the interplay of behavioural drivers, credibility signals and targeting based on demographics. The companies which can balance emotional appeals such as values and responsibilities with rational appeals such as price and quality, can create trust in their consumers which leads to higher frequency of purchase and loyalty in long-term. In a wider context, green marketing will also allow for business growth and environmental sustainability, creating sustainable competitive advantage.

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A REVIEW ON HEALTH BENEFITS OF PALMYRA SPROUTS

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ABSTRACT

The Palmyra palm (Borassus flabellifer), often called the “miracle tree,” is a versatile and highly valued resource in traditional medicine and nutrition, especially in tropical regions like India and Sri Lanka. This review explores the health-boosting properties of Palmyra sprouts, commonly consumed in Tamil Nadu and known for their crunchy texture and sweet flavor. Rich in fiber, calcium, iron, magnesium, and protein, Palmyra sprouts offer numerous health benefits, including improved digestive health, weight management, and reduced risk of cardiovascular diseases. Their low glycemic index makes them particularly beneficial for individuals with diabetes. Additionally, the sprouts contribute to bone development, lower cholesterol levels, and enhance immunity. The Palmyra palm’s long-standing use in folk medicine underscores its potential as a natural remedy for various ailments. This review systematically examines the nutritional composition, health benefits, and traditional uses of Palmyra sprouts, highlighting their significance as a functional food with promising health implications.

KEYWORDS: *Palmyra palm (Borassus flabellifer), Miracle tree, Nutrition, Palmyra sprouts, Health benefits, Nutritional composition, Folk medicine, Natural remedy.*

INTRODUCTION

The Palmyra palm (*Borassus flabellifer*), often dubbed the “miracle tree,” is renowned for its numerous health benefits (Khatrı et al., 2020). Belonging to the Arecaceae family, this tree is prevalent across Asia, including South India, Sri Lanka, and other tropical regions. The Palmyra palm, which can grow up to 30 meters and live over a century, is a significant resource, with India producing over 122 million palms annually (Sahni et al., 1994). The tree is valued for its entire structure, playing a vital role in traditional medicine, where it is used as a diuretic, antiphlogistic stimulant, and antilaprotic (Sahni et al., 1994). Due to its significant economic, ecological, and therapeutic benefits, (Bhaskar K. 2017) referred to Palmyra as the “poor man’s tree” in rural India.

In Tamil Nadu, the term “panamkilangu” refers to palmyra sprouts, which are primarily eaten uncooked. For an extended period, the majority of this plant’s parts have been utilized in a variety of medicinal remedies, including anti-helminthic and diuretic treatments. A study by (Arulraj et al, 2008) found that Palmyra has approximately 800 uses, including those in food and drink,

fiber, ayurvedic medicine, and other medicinal applications. In many parts of Southeast Asia, the young shoots are also known as palmyra sprouts or palmyra tubers. These can be eaten and are usually made in the winter. The palmyra sprout, which contains 98% dietary fiber, is the seed of the Palmyra palm that germinates for 6 to 8 months and develops downward into the earth as palm shoots.

Objective of the Study:

This study aims to review and analyze the nutritional composition, health benefits, and traditional uses of Palmyra palm sprouts, emphasizing their role as a functional food in promoting health and managing chronic conditions, particularly in tropical regions.

Types of sources for a review

- Primary source – results and reports obtained from original studies.
- Secondary source – a research findings and summary from other sources or studies.
- Conceptual / theoretical source – understanding and analyzing the concepts and theories.
- Anecdotal / opinion source- opinion or suggestions about the topic that are not research, review or theoretical in nature.

Palm tree and Products of Palmyra (S. Arunbharathi et al, 2021)



Figure:1 (Palm tree and Products of Palmyra)

Table 1 - Nomenclature of Palmyra sprouts (Saravanya.K. S, 2017)

S. No.	Kingdom	Plantae
1	Sub-Kingdom	Tracheobionta
2	Super division	Spermatophyta
3	Division	Magnoliophyta
4	Class	Liliopsida
5	Subclass	Arecidae
6	Order	Arecales
7	Family	Arecaceae
8	Genus	Borassus L
9	Species	<i>Borassus flabellifer</i> L

Germinating sprouts



Figure: 2 (Germinating sprouts)

Palmyra sprouts (Khatri, Rashi M, 2020)



Figure: 3 (Palmyra sprouts)

Table 2 - Vernacular names of Palmyra sprouts (Saravanya, K.S et al, 2017)

S. No.	Tamil	Panaikizhangu or Panamkizhangu
1	English	Palmyra sprouts
2	Hindi	Taad
3	Malayalam	Panamulakal
4	Telugu	Thegalu or Gaygula or Gengulu
5	Bengali	Taala
6	Kannada	Olegari
7	Sanskrit	Taalalah

Health Benefits of Palmyra Sprouts

1. Aids in Blood Sugar Management

Palmyra sprouts’ high viscous fiber content delays carbohydrate digestion and absorption, regulating blood sugar levels. Consuming palmyra sprout extract improved glycemic control and insulin sensitivity in diabetic individuals. The low glycemic index and glycemic load of palmyra sprouts also help manage blood sugar levels (**Krishnamoorthy Renuka et al., 2020**).

2. Promotes Weight Control

Palmyra sprouts are low-calorie (46 calories per cup), nutrient-rich, and high in moisture (80%), making them ideal for weight management. They provide bulk and satiety, facilitating weight loss goals in diabetes patients (**Dr. Sowmya, M.D., AIIMS**).

3. Decreases LDL Cholesterol

Palmyra sprouts reduce heart disease risk by decreasing LDL cholesterol and triglycerides, thanks to omega-3 fatty acids, fiber, and antioxidants. Daily consumption of palmyra sprout powder significantly decreased LDL cholesterol in diabetic rats (**Arunaksharan Narayanankutty et al, 2023**).

4. Low Glycemic Index

Palmyra sprouts have a low glycemic index, regulating blood glucose levels and insulin response, ideal for diabetes management. Regular consumption significantly lowered post-meal glucose levels in diabetics (**International Journal of Diabetes Research**).

Further Health Advantages

Palmyra sprouts are plant-based, low-fat, and cholesterol-free, protecting heart health and preventing obesity and cardiovascular disorders. Omega-3 fatty acids support heart health and reduce mortality rates in diabetics (**Khatri Rashi M et al., 2020**).

Folk medicine:

The Palmyra palm has numerous medical uses. The young plant is claimed to treat biliousness, dysentery, and gonorrhoea. Young roots are diuretic and anthelmintic, and a decoction is given in certain Respiratory diseases. (**Saravanya.K.S,2017**).

Nutritional advantages of Palmyra sprouts:

- Rich in fiber
- Rich in calcium
- Rich in Iron
- Rich in Magnesium
- Rich in protein

Rich in Fiber:

Rich in Fiber: Palmyra sprouts are high in fiber, which helps regulate bowel movements, prevent constipation, and manage blood glucose levels. Fiber also contributes to a feeling of fullness, aiding in weight management and reducing the risk of cardiovascular disease (**Sharma et al., 2024**).

Rich in Calcium:

Palmyra sprouts are high in calcium, which is required for both the development of strong bones and teeth, as well as muscle contraction. It protects against age-related bone disorders such as osteoporosis and osteoarthritis.

Rich in Iron:

Palmyra sprouts have a lot of iron, a mineral that is essential to the healthy functioning of hemoglobin, the protein that transports oxygen into the blood. Iron contributes to a healthy pregnancy, enhanced vitality, and improved athletic performance. These tubers' iron content maintains healthy blood circulation. It boosts the body's oxygen flow and keeps hemoglobin levels in check. It also prevents anemia. (**Saravanya, K.S et al,2017**)

Rich in Magnesium:

Magnesium, which is present in palmyra sprouts, supports cardiovascular health. It facilitates both the production of cholesterol and blood pressure management.

Rich in Protein:

Palmyra sprouts are a great way to get protein. As is well known, every cell in the body need protein. The body uses proteins to make new tissue and repair damaged tissue. Hormones, enzymes, and other biological materials are also produced using proteins. These tubers contain a significant amount of protein. It controls development as well as the appropriate operation of every bodily system. It provides the framework for the body’s muscles, bones, and other tissues, keeping everything strong and able to be repaired. The body does not store proteins, nor is there a protein reservoir, in contrast to fats and carbs. Eating this dish might therefore assist you in maintaining a healthy protein intake. (E Sharma Valavan et al, 2024)

Table 3 - Nutritional composition of Palmyra sprouts (K. Benittra, 2020)

S. No.	Composition	Content
1.	Moisture (g 100 g-1 FW)	62.38
2.	Ash (g 100 g-1 DM)	4.95
3.	Protein (g 100 g-1 DM)	8.54
4.	Fat (g 100 g-1 DM):(Fresh, Dried)	0.6
5.	Crude fiber (g 100 g-1 DM)	7.29
6.	Carbohydrates (g 100 g-1 DM)	23.53

Table 4 - Mineral elements of Palmyra sprouts

S. No.	Composition	Content
1.	Strontium	0.14
2.	Copper	0.09
3.	Zinc	0.08
4.	Aluminum	0.48
5.	Iron	1.38
6.	Manganese	0.11
7.	Arsenic metal	0.22
8.	Lead metal	0.14

Table 5 - Value-added Products incorporated by Palmyra sprouts

S. No.	PRODUCTS	OTHER INGREDIENTS	SOURCES
1.	Noodles	Red rice, Squid	Dr. S. Ramani et al, 2022
2.	Muffin	Wheat flour, Banana, Milk, Flax seeds, Oil	Rashi, M et al, 2022
3.	Cookies	Wheat flour, Green gram flour, Sugar, Butter, Milk	S.Sumitha et al, 2021
4.	Laddu	Peal millet, Jaggery, Honey, Cardamom	Farzana Movafihka Fathima et al, 2014
5.	Doughnut	Sweet potato, Maida, Butter, Milk, Sugar	Ms. Priyanka M et al, 2020
6.	Bread	Wheat	Michel Arthur Niamke et al, 2021

Palmyra Sprouts in Food Products:

Noodles incorporated with Palmyra sprouts

Palmyra tuber noodles are fiber-rich and maintain good quality after 90 days of storage. Sensory analysis shows high acceptability, with respondents approving the color, relish, smell, flavor, texture, and after-taste. The noodles support bowel movement, making them a healthy option for consumers. **(Sathya.K et al, 2022)**

Muffins incorporated with Palmyra sprouts

Palmyra sprout flour is a nutritious substitute for refined wheat flour in muffins, enhancing nutritional value. Studies show muffins made with Palmyra sprout flour have improved nutritional profiles compared to traditional ones. The incorporation of Palmyra sprout flour increases the fiber and protein content, making it a healthier option. **(Rashi M et al, 2022)**

Cookies incorporated with Palmyra sprouts

Gluten-free Palmyra sprout cookies are nutrient-dense, with high protein (30.02g), fiber (4.03g), and essential minerals and suitable for all ages, including celiac patients. The cookies are a healthy snack option, providing energy and supporting overall health. **(S Sumithra et al, 2021)**

Laddu incorporated with Palmyra sprouts

Palmyra sprout and pearl millet laddu is a nutrient-rich solution for addressing anemia, with high iron content. Regular consumption can boost hemoglobin levels and overall health. The laddu is a tasty and wholesome treat that can be integrated into one's dietary regimen to improve health and well-being. **(Farzana Movafihka Fathima et al, 2014)**

Doughnut incorporated with Palmyra sprouts

The developed Palmyra sprout and sweet potato doughnut is nutrient-rich, providing energy, carbohydrates, protein, and essential vitamins and minerals. It supports immunity, vision, weight management, and blood pressure control. The doughnut is a healthier alternative to traditional doughnuts, making it a great option for health-conscious consumers. (Ms. Priyanka M et al, 2020)

Bread incorporated with Palmyra sprouts

Incorporating 5% Palmyra sprout flour into wheat flour enhances bread's nutritional value. The addition increases fermentation volume, total sugar content, reducing sugar content, and fiber. This makes the bread a healthier option for consumers, with potential benefits for digestive health. (Michel Arthur Niamke et al, 2021)

Conclusion:

In summary, palmyra (*Borassus flabellifer*) is a highly valuable and adaptable natural resource, as evidenced by its proximate composition and health advantages. By means of an analysis of its closest makeup, which includes macronutrients, minerals, and vitamins, it is apparent that Palmyra serves as a crucial source of nutrition. Its prominence as a useful nutritional component for diverse populations is attributed to its richness of fiber, proteins, carbs, and healthy fats.

Beyond its nutritional profile, palmyra has other health benefits. It is full of essential nutrients and has been linked to several health advantages. Palmyra's antioxidant, vitamin, and mineral content may help the immune system, lessen oxidative stress, and improve general wellbeing. Along with supporting digestive health, the fiber content may help with weight loss and glycemic control. Furthermore, palmyra's historical use as a medicine in many different civilizations emphasizes its potential as a home cure for illnesses.

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CRYPTOCURRENCY AND IT'S IMPACT ON INTERNATIONAL TRADE

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ABSTRACT

Cryptocurrency is a decentralized digital currency that is using blockchain technology to change the way businesses do international trade. Cryptocurrency enables businesses to create cheaper, faster, and more transparent methods of sending payments across borders. It allows for the increased use of SME businesses by lowering costs and reducing exchange rate risks when transferring currency and also improves the overall efficiency of international payments. Cryptocurrency provides an immutable, trustless ledger that increases trust, decreases the risk of fraud and speeds up settlements in the international markets. The primary hurdle that needs to be overcome for Cryptocurrencies to gain mass acceptance is Cryptocurrency Price Volatility because this results in increased Financial Risk for Businesses. A second obstacle is that because of the current inconsistency of Global Regulations Regarding Cryptocurrency, Businesses are unable to fully integrate their Businesses with the Traditional Banking System due to the associated uncertainty created by those regulations. Businesses will benefit from the latest technological benefits that Cryptocurrencies offer, without experiencing the excessive Volatility associated with Cryptocurrency. By utilizing CBDC's Businesses will enjoy Safety and Simplicity when conducting Cross-Border Payments because CBDC's are Backed and Pegged 1:1 to Fiat Currency by Central Banks. While both Cryptocurrencies and CBDC's can Revolutionize International Trade and provide new opportunities for Business Growth and Profitability, they also have a large amount of associated Risk. Therefore, Monitoring Policy, Trends and Case Studies on the Evolution of these technologies will provide an indication of how they will influence International Trade in the future.

KEYWORDS: *Transparent, Price volatility, Valid instrument, Blockchain technology, Border transactions.*

INTRODUCTION:

Today, currency outside of traditional money, and the most widely discussed and transformative area of finance, is cryptocurrency. Cryptocurrency emerged as one electronic alternative currency to traditional forms of currency. Cryptocurrencies have taken hold in present-day trade and finance sectors. The decentralized planks of cryptocurrency allow for currencies and financial transactions and trade in a way never done before - and most importantly, outside the traditional intermediaries presented in finance and international trade; the banks and financial institutions. This is a brand-new frontier for international trade and global commerce.

At this time, international trade is faced with added burdens of costs from the physical fees of transactions, delays of pay, issues with the cross-border exchange of currency and so on. Traditional financial institutions endorsed by governments and utilized in most international trade transactions often include a long list of intermediaries (including banks, regulatory agents, and compliance agents) that need to be paid and which take considerable time depending on what country you are exporting from or importing to. A cryptocurrency is beginning to address some of these commercial costs by allowing for faster, low-cost borderless transactions. A cryptocurrency can help reduce friction in cross border trade by providing the means to by-pass complicated and expensive systems to shift financial exchanges easier and more efficiently.

However, while cryptocurrency has its benefits, it also has some risks and uncertainty. The two most prominent risks involved with cryptocurrency are price volatility, and the uncertainty of how or when it can be used. Cryptocurrencies often have varying prices in a continuous state of extreme volatility which makes them riskier for both investors and businesses. There are also risks associated with legal uncertainties associated with cryptocurrencies, since different governments have approached cryptocurrencies by adopting various regulatory or non-regulatory approaches, widely varying from professions of outright bans to outright acceptance, regulation or encouragement, with little context. There is no one uniform acceptable legal or business framework to follow for clients across nations, so there will remain uncertainty with respect to global trade and compliance.

On the other hand, with the growing acceptance of central bank digital currencies, (CBDCs), it gives credence to cryptocurrencies and digital assets in the future of finance, and trade, while denying the consideration for cryptocurrencies as a project. CBDCs represent the digital and government-backed representations of national currencies. CBDCs, possibly to some degree, share similarities to cryptocurrency, especially when transactions are executed and settled on the blockchain, not on government regulations, or controls, although CBDCs are government-backed. It also promises the stability of a national currency without requiring trust in a private asset. The contamination of money through CBDCs underscores the growing acceptance that digital currencies will serve as the perfect partner to digitize various financial systems and continue to develop trade relationships in the process.

As explained, there are both opportunities and challenges surrounding cryptocurrency, but there is no doubt that it will play a role in international trade. With the emergence of CBDCs and interest from countries worldwide, cryptocurrency will continue to be an important contributor to the changing landscape of international financial transactions.

REVIEW OF LITERATURE:

Through an extensive empirical examination of cross-border cryptocurrency transactions, Auer et al. observed that from 1 January 2017 until December 31, 2024, Bitcoin, Ether and Stablecoins were sent out and received from more than 184 countries. The authors observed a rapid increase in global transactional volume of Cryptocurrencies where the total estimated value peaked at over USD 2.6 trillion in 2021 and stablecoins accounted for almost 50% of all cross-border transactional volume. The primary analysis indicates that the majority of high-dollar value native cryptocurrency transactions have been primarily speculation driven, and stablecoins have increased in popularity specifically with respect to being used as a means of transacting (remitting and sending international payments). The authors further conclude that the Cryptocurrency market

has significantly lowered the barriers to transacting across international boundaries, and as such, offers an alternative avenue for the flow of value across borders from the Traditional financial services sectors.

Jose and others, (2024) investigated the opportunities presented by blockchain for changing how we do international payments (cross-border payment systems) and how we create Digital Currency. The paper indicates that having blockchain technology to support the international transfer or exchange of money is superior to the traditional methods of banking with their existing infrastructure. Blockchain offers much faster, much clearer and much safer methodologies for finalizing a transaction globally than the traditional banking method. The ability to establish a secure ledger system through removal of the need for third parties in international transactions will allow us to increase our ability to mitigate risks (fraud) by creating a more trusted system. However, the authors indicate that there are significant risks associated with using the new payment systems due to regulatory gaps and technological barriers.

In a recent study, Guo et al. provided an exploration into how different technologies contribute to increased adoption of cryptocurrencies. They utilized panel data on 37 countries over the period of 2020 through 2023 in the study, and subsequently stated that several factors such as the increase of technological advances, monetary policies, and increased financial innovation have been shown to positively influence a country's level of cryptocurrency adoption. Furthermore, the authors also state that through increased crypto use, there will be improvements to both financial inclusion and participation in the economy by providing persons and businesses access to more affordable and effective digital payment capabilities. As demonstrated by the study's conclusion, this is especially important for developing economies and SMEs that are attempting to cut down on transaction fees while increasing their opportunities for greater global trade.

OBJECTIVES OF STUDY:

1. Through the enhancement of cross-border trade by streamlining transaction time and cost associated with cross-border payments, the use of cryptocurrency enhances cross-border trade by providing users with a quicker and less expensive solution to sending and receiving funds into and from other countries.
2. In addition to analyzing the risks and challenges facing users of cryptocurrency when using digital currencies for global commerce, I will also highlight the volatility of cryptocurrency pricing, the cyber-security threats associated with cryptocurrencies, and the uncertainty surrounding the global regulatory framework associated with cryptocurrency use.
3. Blockchain technology is being evaluated as a method of enhancing security, trust, and transparency in international trade through the real-time tracking of goods and services, authentication of the goods and services and creating a permanent record of the goods and services.
4. The implementation of Central Bank Digital Currencies (CBDCs) will provide a Stable Digital Payment Solution with the backing of a Central Authority and thereby help reduce the price volatility of cryptocurrencies and enhance the efficiency and effectiveness of cross-border settlement systems.

5. I will examine how the adoption of cryptocurrencies and blockchain technology, in conjunction with the use of CBDCs, will impact global business participation, financial inclusion, and the future development of international trade.

BENEFITS OF CRYPTOCURRENCY IN CROSS BORDER TRADE

1. Fast Payments

Cross-border payments that pass through banks could take two days or longer; this is because of middlemen involved and validation length. Cryptocurrency transfers usually take no time, or just minutes, and save businesses time.

2. Lower Transaction Costs

There are usually large charges from banks and money transfer brokers for overseas payments. With cryptocurrency, there is no middleman to deal with, so there are very little, if not no fees, for cross-border trade.

3. No Currency Exchange Difficulties

When trading in many different countries, the currency exchange and conversion fees are very hefty and frustrating. With cryptocurrency, currency can be traded in one form as a digital currency across borders, no matter the country. Currency conversions are no longer a burden.

4. More Transparency and Security

Blockchain stores every transaction in an updated digital ledger in both a secure and transparent way which lowers the chance of fraud, raises trust levels, and makes the verification of payments quick for the buyer and seller.

5. Giving Everyone an Opportunity in Every Country

Cryptocurrency will allow any business and individual to participate as a producer or consumer in these areas and to act as a trader in overseas commerce, all with little dependence upon the banks.

PRINCIPLES:

- **Decentralization:** Cryptocurrencies operate in block chain and in government control. It also reduces the national banking system and allows cross border transactions.
- **Transparency and Security:** All business transactions are recorded in the public ledger. It builds trust between international traders by reducing fraud risks. It also ensures safe and secure payment.
- **Immutability:** Once they are recorded in a ledger they cannot be deleted or altered. It provides permanent proof of all transactions.
- **Limited Supply:** Many crypto currencies are fixed suppliers and they provide a hedge against inflation for traders.

TYPES OF CRYPTOCURRENCIES AND ITS USES AND IMPACT

➤ ETHEREUM:

Use – Beyond currency, it allows smart contracts and decentralized applications (d apps). It enables things like DeFi (Decentralized Finance) and blockchain based games.

Impact – It expanded the block chain and used cases beyond the block chain. It helps to build web3 ecosystem.

➤ RIPPLE RXP

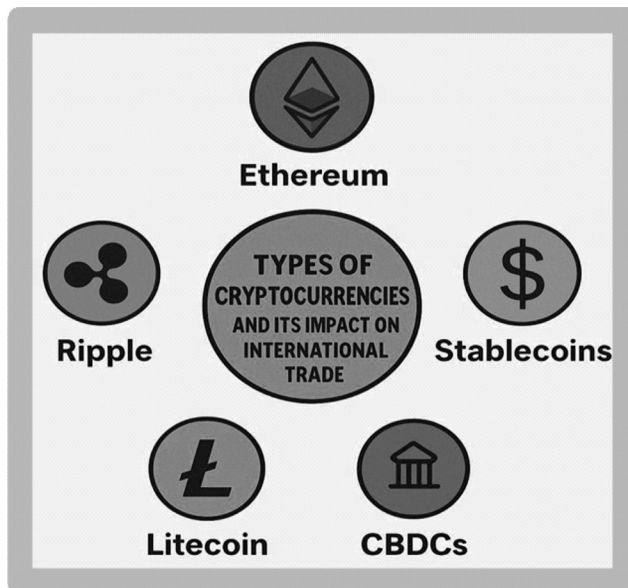
Use – It is mainly designed for fast, low costs international money transfers between banks and financial institutions. It acts as a bridge currency in cross border payments.

Impact – It reduces the time and fees in international remittances. Compared to the traditional SWIFT system.

➤ CBCD'S (CENTRAL BANK DIGITAL CURRENCIES)

Use – It is a digital version of a country's official currency. It is used for Payments and settlements etc.

Impact – Government can gain more control and transparency in digital transactions. It may reduce the reliance on private crypto currencies.



SUGGESTIONS:

1. Promote Multi Currency Digital Wallets:

Exporters and Importers can use wallets that accept the multiple cryptocurrencies, making it easier to transact across the different markets.

2. Develop Global Regulatory Frameworks:

Countries should work together on common rules for the crypto use in trade to prevent money laundering, fraud, and misuse.

3. Use Stablecoins for Cross-Border Payments:

It decreases the volatility and makes sure that the global transaction becomes faster than the traditional method of bank transfer.

ADVANTAGES OF CRYPTOCURRENCIES

- Fast transactions – Sometimes cross border payments may take more days to transfer but using (SWIFT) it can be done in a minute.
- 24/7 Accessibility - Payment can be done 24/7, whereas banks have a limited time hours for the transactions.
- Lower Transaction Costs - It does not require many banks or intermediates for transactions and also less fee and charges.
- Financial Inclusion - It makes financial services or gives access for all kinds of small businesses, farmers, and people in remote areas.

DISADVANTAGES OF CRYPTOCURRENCY

1. Price Volatility

Due to the extreme price volatility of cryptocurrencies, what is worth a lot today may be valued at less tomorrow? Because they do not provide dissertation provisions or projected value price boundaries, cryptocurrency's can vary wildly making it too risky for any business and/or investor to invest.

2. Lack of Regulations

There are not any policies from any government in regard to regulations, guidelines or use in whatever scope without standards. Regulating global guidelines is difficult, and governments will never be able to regulate fraudulent activity, taxes or illegal activities.

3. Security Risks

While blockchain technology might generally be secure, exchanges and wallets are not just secured. If someone hacks into a wallet or an exchange, it could shut down everything. Let's not forget that if someone just outright loses their private key they would lose all their money on that wallet, and or account.

4. Not Widely Accepted

In many countries or even some businesses will not accept cryptocurrency for any payment options. This severely restricts the use of cryptocurrencies to only trade/transactional capabilities.

5. Energy Consumption

Some cryptocurrencies like Bitcoin have huge electricity requirements for mining, this is a risk when balancing environmental concerns and high consumption costs.

CONCLUSION

The use of Digital Currency and Blockchain technology is causing a major change in the way the world trades. Digital Currency allows for the quick, cheap and transparent transfer of funds from one country to another via a low-cost method historically known as the Digital Currency network. The Blockchain is the backbone of Digital Currency because it allows for the efficient storage and tracking of all the information related to a digital currency transaction. This will create trust among the parties involved in the transaction and allow for the faster movement of goods and services to be exchanged across borders. Now that Large Corporations and Small Businesses are able to enter the Global Marketplace at a lower cost than ever before, they can now do business anywhere in the world.

Regardless of the advantages Digital Currency has over traditional currencies, many businesses and individuals within the International Trade Community are still hesitant to use Digital Currency because of the price volatility of Digital Currency, concerns regarding Security and the fact that there are currently no internationally accepted rules governing Digital Currency usage. The introduction of Central Bank Digital Currencies (CBDC) is a response to the need for a more stable, government-sponsored alternative for making cross-border payments and providing a safe and secure way for individuals and businesses to send money across national borders.

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CONSUMER PREFERENCE ON COSMETIC PRODUCTS AMONG COLLEGE STUDENTS

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ABSTRACT

This paper mainly aims to notify the teenager preference among cosmetic brands. Through this research it was prepared to know about the various factors influencing the teenagers to buy on specific brands. It includes some statistical tools to have a fledged view about the brand product quality, quantity, price, availability etc. This research paper helps to know about the detailed form of cosmetic influences among teenagers towards the world.

KEYWORDS: *Cosmetics, Preferences, Natural, Chemical.*

AIM & OBJECTIVE

1. To analyze teenager preference towards different cosmetic brands and to determine the current Indian market for cosmetic products.
2. To analyze demographic factors of college students.
3. To realize the best cosmetic product.

INTRODUCTION

People use cosmetics to enhance their beauty. Some people have been insecure by their appearance. This secureness led the people to hide their natural beauty and made them to depend on cosmetic products. These products range from eye makeup, lipstick, perfumes, hair dyes, shampoos and so on. It protects the skin and keeps it in good condition. They help in enhancing the attractiveness of the body. Cosmetics have become essential components of life. It has gained popularity in the last 3-4 decades and has been mostly used by both males and females. Nowadays people use and depend on natural products to keep their skin healthier and it has become highly in demand. Which type of cosmetic is preferred will be evident in this survey and statistical analysis, which will give us a detailed view and study of the cosmetic world.

REVIEW OF LITERATURE

Gayathri (March 2019) highlighted and gave the detailed view about the preference of cosmetic brands among college girls. Interpretation preference based on promotional activities based on price, discount, offer, advertising and brand image, celebrity. Primary data were collected with the help of an interview schedule among college students towards a schedule among college students towards cosmetics and get to know about buying patterns of cosmetics, attitudes and levels of satisfaction towards cosmetics and their future requirements.

Harshada I Patil et.al (2023) examined the consumer preference for shampoo brands. Survey for which shampoo is best and present a meta-analysis study, which provides a detailed view of the shampoo industry. Explanation of types, properties, evaluation of shampoo to understand the source and effectiveness. Stated the basic formulation to get to know whether it will be harmful to use. Examine the connection between a brand and consumers. The questioner was evaluating the consumers to know the usage, preference, price, quantity, quality, satisfaction. Chemical or PH value and particular brand reference.

Megham Anand el (2023) analyzes the various cosmetic products preferred by female consumers from Coimbatore. Analyze the level of satisfaction of the products brand they are using. A descriptive report has been provided for the study of the awareness of cosmetics products. A statistical tool of ranking analysis and percentage has been used to make the report. A suggestion has been provided by the researcher to use turmeric cream as a skin care product to prevent skin damage.

K Sundarambal el (2017) study analyzed the consumer preferences for cosmetics such as bathing soap, face powder, shampoo, hair oil, face cream, nail polish, body cream and tilak. Statistical tool such as average, percentage, ranking used for interpretation and analysis. Determining the expenses of the individuals regarding spending for the beauty products. Collected primary and secondary sources from the female customers in Pudukkottai district for the purpose of determining the preference of cosmetic brands.

HISTORY OF PRODUCTS

Dazzler - An Indian cosmetics brand that was formerly known as “Eyetex Dazzler”. The brand was launched in 2002 by Aravind Laboratories, which sells a range of cosmetics including eyeliner, nail polish, lipstick, mascara, face wash, scrub, and lip gel. The brand is headquartered in Chennai. With the tagline “Boundless Expressions” We’ve got everything you need to create your signature look, from show-stopping eyeliners to a kaleidoscope of colors that’ll make your heart skip a beat.

Lakme - Tata agreed, and in 1952, Lakme was born. The name “Lakme” was chosen because it is the French word for the Hindu goddess Lakshmi, who is the goddess of wealth and beauty. The company’s first products were a range of lipsticks, powders, and creams that were designed specifically for Indian skin. Lakme is an Indian cosmetic brand owned by Hindustan Unilever. It was named after the French opera Lakme, which itself is the French word for the goddess Lakshmi who is renowned for her beauty.

Mamaearth - Mama Earth’s story begins with a couple, Varun and Ghazal Alagh founded in September 2016, who became parents and realized the importance of safe and toxin-free products for their child. This realization prompted them to embark on a journey to create a brand that would offer a range of baby and personal care products made from natural, chemical-free ingredients.

Blue Heaven - Charanjit Singh and Mr. Gurnam Singh started the company with big dreams and ambitions. By virtue of their determination and commitment Blue Heaven Cosmetics has been able to experience such an eventful journey revolutionizing the Indian decorative cosmetics industry. Speaking of brand endorsements, according to Bollywood Hungama’s reliable sources, Huma Qureshi is now all set to be the brand ambassador of ‘Blue Heaven’ cosmetics.

Mac - MAC (Make-up Art Cosmetics) was founded in 1984 by Frank Toskan and Frank Angelo in Toronto, Ontario. Initially, the company aimed to fill the gap in the market for high-quality, long-lasting makeup products, launching with 12 lipsticks, 2 lip liners, and 4 eyeshadows at the Toronto Fashion Week. By 1985, MAC had expanded its product line to 150 items and introduced its iconic black packaging. Throughout the 1990s, MAC gained popularity among makeup artists and models, becoming a staple in the fashion industry. In 1994, Estee Lauder Companies acquired MAC for \$12 million, further fueling its growth. The brand launched its first store in Toronto in 1996 and continued to expand globally.

CONSUMERS PREFERENCE KEY FACTORS

Teenager preference towards cosmetics has some key factors. They are:

1. **Quality:** Consumers expect a high range of products which provide long-lasting, good coverage and textures.
2. **Effectiveness:** The cosmetics should work according to what they have promised for usage. For example, sunscreen should prevent tan from skin according to their mentioned SPFs.
3. **Brand goodwill:** Teenagers prefer to buy cosmetics from reputed brands which are consistent in providing good products. Brands which are running over a long period of time and have a good name will have high demands for their products.
4. **Value for money:** Consumers will prefer their products should be as valuable as they paid for. This value of money will include effectiveness, quality and quantity of the products.
5. **Availability of the product:** Products should be easily accessed by the consumers through nearby stores where online platforms play an important role.
6. **Safety for the usage:** Consumers are mainly to be health conscious. Consumers prefer to avoid using products such as parabens, synthetic chemicals, and high artificial fragrances which are allergic to our skins and started to use natural and organic products.
7. **Personalization:** Products should be varied according to the skin textures (such as oily, dry, combination, sensitive) and should be concerned about the pigmentation, acnes, allergies.
8. **Packaging:** Packaging should be done aesthetically to attract the customers by their designs. It should be easily portable, and protects the products from contamination.
9. **Influencers:** Advertising the product by social media influencers, social media platforms or by celebrities will impact the great approach of consumers.
10. **Eco friendly:** The products which are cruelty free, eco- friendly are highly preferred by consumers as they are conscious about environmental and ethical issues.

The brands should consider these strategies to make products according to consumers preference. Understanding this factor will help the brands to succeed in the competitive market of the cosmetics world.

METHODOLOGY

This survey is prepared by using primary and secondary data to get a deep view on the preference of consumers. The primary data were collected directly based on random sampling methods from the college students with the help of the questioner prepared to know their likings about the cosmetic products and their affordable range. Totally 144 samples are collected and Percentage analysis is used to analyze the primary data.

The secondary data were collected with the help of journals, magazines, textbooks and survey reports.

Table 1.1
DEMOGRAPHIC CHARACTERISTICS

GENDER	RESPONSE	PERCENTAGE
Male	56	38.9
Female	88	61.1
Total	144	100

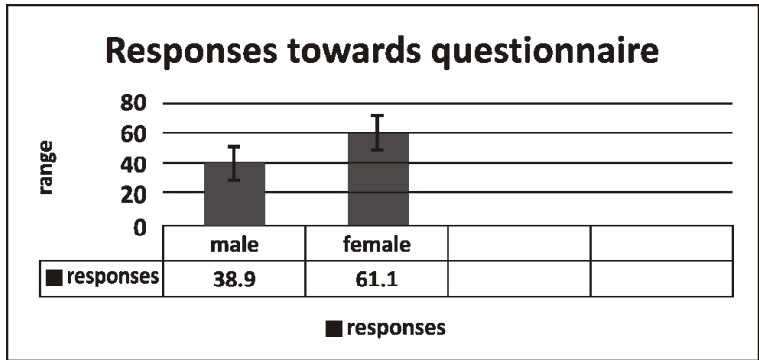


Figure: 1.1 DEMOGRAPHIC CHARACTERISTICS

INTERPRETATION

Table A shows that the majority of the responders are (61.1%) female.

Table 1.2 - AGE WISE RESPONDENTS

AGE	RESPONSE	PERCENTAGE
Below 18	98	68
18-25	30	20.8
Above 18	16	11.2
Total	144	100

INTERPRETATION

The Table B shows the age group of the responders. The 68% of the teenager are below 18, 21% of the students are 18-25 age group and 11% of them are above 25.

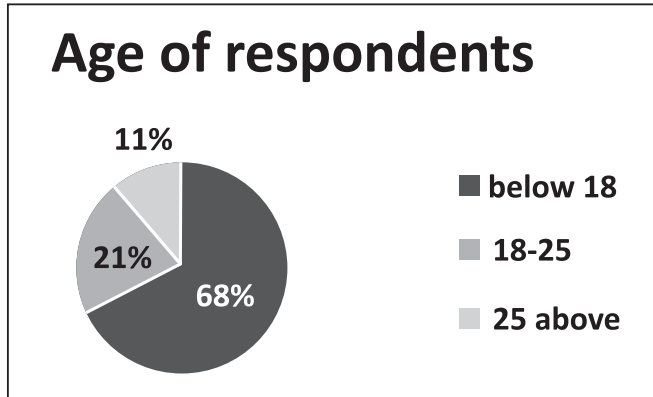


Figure: 1.2 AGE

Table 1.3 - PREFERENCE OF BRANDS

PRODUCTS	RESPONSE	PERCENTAGE
Dazzler	36	25
Lakme	40	27.8
Mamaearth	25	17.36
Blue heaven	4	2.8
Mac	10	6.95
None	14	9.72
Other	15	10.6
Total	144	100

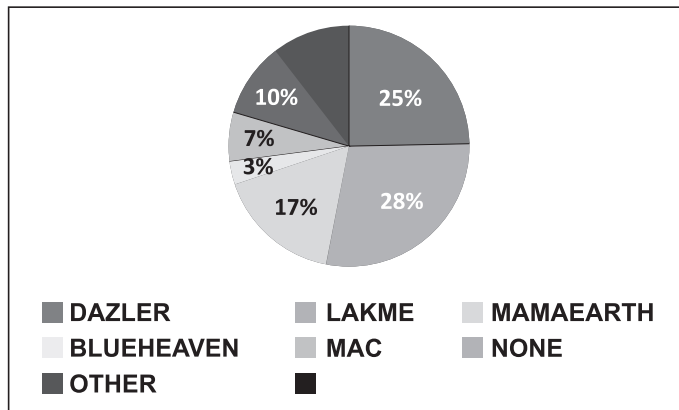


Figure: 1.3 PREFERENCE OF BRANDS

INTERPRETATION

The table 1.1 shows highest brand prefer by teenagers Lakme with 27.8% of responses and least preference is blue heaven with 2.8% ratings.

Table 1.4 - THE REASONS FOR BUYING

REASONS	RESPONSE	PERCENTAGE
Doesn't harmful to skin	68	47.3
Low price	58	40.2
Quality and quantity	15	10.4
Other	3	2.1
Total	144	100

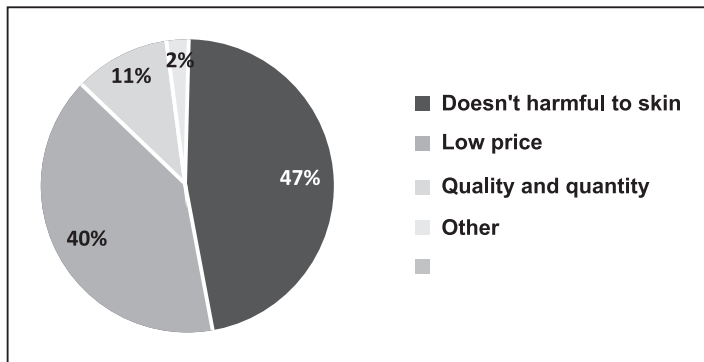


Figure: 1.4 THE REASONS FOR BUYING

INTERPRETATION

Table 1.2 says the product has been chosen by different preferences. The major reason for selecting the product is based on the item not harmful or damaging the skin with 47.3% of responses. The second reason for selecting the product is based on the lowest prices with 40.2% and last reason to choose the product is based on the quality and quantity of the item with 10.2% of responses.

Table 1.5 - INFLUENCES USED TO CHOOSE THE BRAND

INFLUENCES	RESPONSE	PERCENTAGE
Friends/families	79	54.8
Advertisements	49	34.2
Actors /actress	6	4.1
Others	10	6.9
Total	144	100

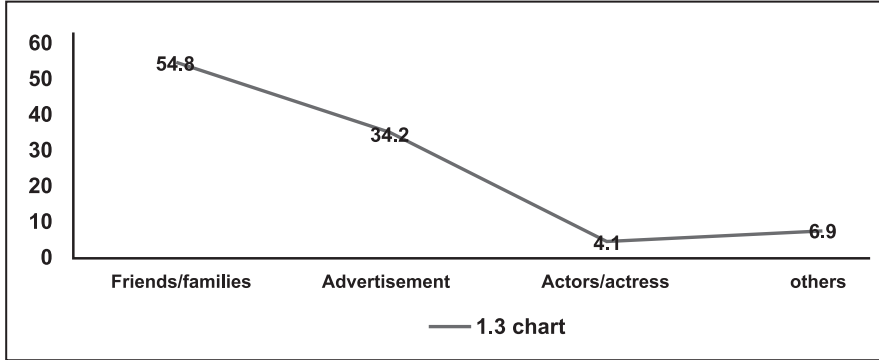


Figure: 1.5 INFLUENCES USED TO CHOOSE THE BRAND

INTERPRETATION

Table 1.3 says influences and conveyors of choosing the specific brand. 54.8% of the responses says families/friends, 34.2% says advertisements, 4.1% says actors/actress and 6.9% says other reasons for deciding these specific brands.

Table 1.6 - THE PURCHASING TERMS OF COSMETIC

PURCHASING TERMS	RESPONSE	PERCENTAGE
Discount	31	21.5
Latest trend	16	11.2
Advertisement	15	10.4
Need for product	82	56.9
Total	144	100

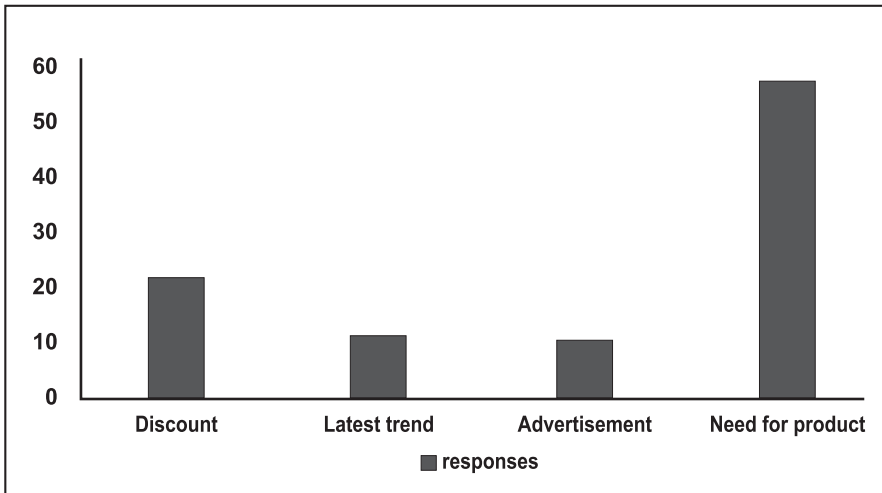


Figure: 1.6 PURCHASING TERMS

INTERPRETATION

Table 1.4 shows the purchasing terms of the product. 21.5% is based on the discount, 11.2% is based on the latest trend or arrival of products, 10.4% is based on the advertisement of the product and 56.9% based on the need of the product said by the responders.

FINDINGS OF THE STUDY

- Lakme products are found to be highly preferred by the consumer responses.
- The main elements of the product are not harmful or allergic. The product should be eco-friendly, cruelty free and consumers are more conscious about their skin textures. Product should be affordable to purchase.
- Discount, advertisement, celebrities, friends/families, latest trending products are considered as the main key factors for the consumers to choose the specific brand.
- The specific reason to choose the brands as per consumer thought is the product provides non greasy nourishing effects, long lasting, gives superior sun protection, maintains the goodwill of the brand and is stated to be valuable for the money they have invested on it.

SUGGESTIONS

- The brand may start using high quality ingredients known for their effectiveness, such as hydrochloric acid for hydration or vitamin c and avoid harmful substances such as parabens, sulfates, and phthalates.
- The brand can do proper labeling and listing of ingredients with description for awareness and benefits for the consumer
- The brand can collectively get feedback of their product or should notice their purchasing behavior of the consumer and know about their likes and dislikes and produce a greater number of products according to it.
- Brands can conduct clinical tests to validate their points for purchasing the product and ensure efficacy.
- The brand can be focus on providing products which gives visible results.

CONCLUSION

The consumer preference plays a crucial role in brand reputation and success. By focusing on high-quality, effective products and being transparent about ingredients and ethical practices, brands can build their trust and loyalty among consumers. A deep understanding of these preferences not only enhances product range but also helps to build brand-customer relationship.

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MARKETING STRATEGIES FOR PLANT-BASED AND ECO-FRIENDLY FOOD PRODUCT

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ABSTRACT

The growing demand for plant-based foods has reshaped the global food industry, driven by rising health awareness, environmental concerns, and ethical consumption trends. In this study they explored more key dimensions of plant-based food marketing and industry growth. They examine driven campaigns in enhancing consumer engagement and brand and next thing they highlight the impact of partnership in the way of eco-friendly food choices and fostering trust among the trade audiences. They will investigate consumers of plant-based alternatives such as taste, affordability, and sustainability. It will grow trends in the plant-based food industry and investment opportunities. It will increase the concerns about climate change, animal welfare etc.... The success of these products not only depend on the nutritional or environmental benefits but also on effective marketing strategies that connect with diverse consumer segments. One of the most important strategies is value-driven communication. They equally give importance to transparent labeling and certification. Most of the elements are built trust and help consumers to make purchases. In the digital marketing and influencer partnership it plays a highly important role in shaping consumer perceptions. In addition, they have experiential marketing for example tasting events, food festivals, and collaborations with restaurants or cafes. The use of recyclable, biodegradable, or minimal packages enhances the eco-friendly value. They will adopt a cause of related marketing such as supporting reforestation, reducing plastics waste. And also pricing and accessibility remain critical factors. Plant-based and eco-friendly food products in both developed and emerging markets. The value-driven communication, where brands the positive environmental impact, health benefits, and ethical di-mentions of plant-based diets. While plant-based products are commonly perceived as luxury products, they can be made accessible and affordable to the masses through smaller servings, staples or collaborating with retailers. In conclusion, when marketing plant-based and eco-food products, businesses need to be aware of the balance between health and sustainability, accessibility, along with lifestyle. Businesses can sustainably contribute to the health of

our environment and help fill the gap created by the changing food environment through storytelling, transparency, innovation and ethical branding. Whereby both consumers and businesses can make meaningful changes to their health and the planet. Sustainable packaging strategies, which are essential to the eco- friendly foods with border in the environmental goals this works is the importance of integrating digital innovation, consumer insights, and sustainability practices to the advanced plant-based food factor.

KEYWORDS: *Value-driven communication, Transparent labeling and certification, Digital marketing, Influencer partnerships, Cause-related marketing.*

INTRODUCTION:

In recent years, the demand for plant-based and eco-friendly food products has grown due to increasing awareness of climate change, animal welfare, and health-conscious lifestyle. Nowadays consumers are not focused on the taste of nutrition but also environmental and ethical impact. They have opened new opportunities for brands, sustainability, transparency, and innovation. Sustainable consumption is very important today because it helps to balance human needs with the health of our planet and future generations. The importance is environmental protection, resource conservation, economic benefits, social well-being, personal responsibility, Achieving global sustainability goals. The change in consumer mindset has created both opportunities and challenges for businesses. Marketing strategies for this sector are beyond traditional advertising. Marketing strategies that will highlight the unique advantages of plant-based and eco-friendly products. For instance, eco-labels, green certifications, and storytelling about ethical sources only can build trust. Companies must not only develop plant-based match or traditional foods in taste. The challenges are not just producing high-quality but also positioning them effectively in a competitive market. One of the most important aspects of marketing eco-friendly food is educating consumers. Marketing can reduce carbon footprints, water conservation. Many customers are curious about how plant-based products benefit their health and the planet.

OBJECTIVES:

The objectives of the study are to:

- To understand how effective brand positioning differentiates from a product and influences consumer perception.
- To evaluate the effectiveness of digital channels in promoting plant-based food products and engaging target audiences.
- To examine how authentic influencer collaborations enhance brand credibility and reach in eco-friendly food marketing.
- To analyze consumer attitudes toward health, taste, price, and motivations influencing plant-based product adoption.

MARKET POSITIONING:

1. DEFINITION OF MARKET POSITIONING:

Market positioning is creating a perception of a brand and they will appeal to the consumers mind through advertisement by creating an attractive image. Differentiates the products from competitors and attraction of the right target consumers. The main aim of market positioning is to create a remembered position in customers mind by making it clear and attractive. For example, some brands' positions are affordable and reliable, some highlight luxury, innovation. If the position is not correct a brand may struggle to be seen in heavy competition.

2. CHALLENGES IN MARKET POSITIONING:

In recent years there has been increased competition and increased marketing challenges such as: Pepsi and coca cola companies have developed unique brand names and images to those companies. Maggie had a difficult time when consumer preference shifted towards more health/safety. Miscommunication can ruin a brand image. A strong example is Nokia, the failure to innovate is an example of the weakening position of Nokia brand. One of the big challenges is in the competition because many companies would like to try and capture the same market target which was difficult to. Globalization invades challenges as brands must manage culture, social, and economic from the regions.

3. THE SIGNIFICANCE OF MARKET POSITIONING:

Market positioning is very significant because it will serve to create a brand name in consumers mind and it will also help to manage only profits for that business. In this particularity it will highlight the unique strengths of the business and therefore its unique selling position from the competition and the consumer should buy more of the product in that brand. Not only will this create higher sales but it will also create equity for the brand name. It will also serve to promote and direct the marketing strategies, pricing, packaging and promotional efforts to the consumer. Evers in the manner of the communication to the customer we should also build a trust level, loyalty and long term relationships to the consumer.

4. FORMS OF MARKET POSITIONING:

There were several different forms of market position which businesses use to differentiate the product. There were at times cultural or lifestyle positions connecting the brand with shared values, trends, or lifestyles. Each type of positioning develops the unique brand identity of the brand and all help ensure customers are understanding notions such as why they may choose that product.

5. STAGES IN MARKETING STRATEGIES:

Stages in marketing strategies are more related stages to a systematic way to achieve the profit of the company by the customer and then relate the business goals also. Developing the marketing mix(4ps)-product, price, place and promotion to build an effective plan and implement them to build the company. Once we are monitoring and implementing the strategy, our performance will be measured using metrics like sales, customer, or market.

DIGITAL MARKETING CHANNELS FOR PLANT BASED FOOD:

1. CONTENT MARKETING & STORYTELLING:

This is probably the most important component of marketing in this space. Consumers are curious and tend to look for information about health, ethics and sustainability. We do this through Educational Blog Posts & Articles, Impact Driven Storytelling, SEO etc. The potential role for these platforms is huge in terms of informing digital marketing and development.

2. SOCIAL MEDIA MARKETING:

Instagram & Pinterest: These two visually driven platforms are critical. Post high quality images and videos of your product in action - delicious recipes, meal prep videos etc Influencer & Chef Partnerships: Partner with vegan chefs, nutritionists, and food influencers. Their authentic reviews and creative recipes give us some social proof and expose your product to their trusted and pre-built audience.

3. EMAIL MARKETING:

Email marketing is still a legitimate and all-time professional means to get to people. Email Marketing is still one of the most effective methods for nurturing leads and driving customer loyalty and referring them directly at a very low-cost barrier. Welcome email sequences for new subscribers can educate the brand story, mission, and core product lines.

4. INFLUENCER & NUTRITIONIST PARTNERSHIPS:

Working with partners, and influencers is one way to get products to great reach to the target group. Especially this new generation is evolving on digital platforms and expects to try, buy, sell, and select products online, making the decision process for buying and transport more convenient, cost effective and lastly, the most efficient way to understand, evaluate and learn about a product, working with influencers and experts add credibility of the science base and creates access to a trusted community. Micro-influencers typically share niche audiences that have engaged followers and can obtain a higher return on investment through authentic content. Partnering with a registered dietitian or nutritionist can establish genuine credibility and even more, science-based credibility-frame the discussion around health benefits. Recipe development work with vegan chefs shows sophisticated and delicious ways to use your products.

5. TARGET PAID ADVERTISING:

Paid advertising has the ability to reach precise segments of audiences that show high intent and in a very efficient manner. The ads you run on social media platforms such as Facebook, Instagram, etc. are very specific to detailed interests. You can choose users based on interest in vegan information, sustainability, etc., and it provides detailed data points to target these ads. Also, Google Ads have the ability to capture high commercial intent because users are searching detailed terms such as “buy plant-based meat near me” or “vegan meal delivery service”. By doing retargeting campaigns, you can create ads for previous users, reminding them of things they viewed on your product catalogue.

INFLUENCER PARTNERSHIPS IN ECO-FRIENDLY FOOD MARKETING:

1. FINDING THE RIGHT PARTNER:

Finding the right influencer, who matches your company brand and then aligns with the mission or goals of the company is the most critical step beyond following a trend. Although micro-influencers (10k-50k followers) may make more engaging content, they will have higher engagement rates, are viewed as more trustworthy by their audience and will make more authentic content by sharing the product in the better way with their audience. The customer engages when they see the product content using engagement comments and ratings to trust the company. Real partnerships are built on values and that creates more authentic and effective content.

2. CO-CREATION OF AUTHENTIC CONTENT:

A company gets its products out in the market by providing a free product and an influencer does not just coast these products with an influencer and then go off to relax the free product. Having an influencer involved in the creative process to develop the content and the influencer feels the product is natural to their style. Co-creation can also mean creating a unique recipe especially for your products the customer needs to see the authentic value in the products. “Day in the life” style of this content is natural to the influencer, which puts your product into their sustainable lifestyle or routine and feels more genuine than a staged photo, again the goal is to have the product placement feel like a seamless and logical part of the influencer’s story.

3. CAMPAIGN TYPES:

Different campaign structure is a different purpose, any time you are generating a quick building and a long-term brand for the company. If a person is seeing a video for unboxing a product or tasting a product to accommodate the viewer, they will believe in trusting the product without second thoughts. The product can be shown in the form of a recipe video or full meal preparation video. This is a way of showing the products and viewers will trust the products they are introduced to and try to use them in our daily lifestyle. A long-term campaign in which the influencer features your products multiple times over the course of the month the influencer will have established a stronger and trustable product.

4. MEASURING ROI AND IMPACT:

We can simply start the campaign with something measurable - a key performance indicator - that measures the success of the campaign past the vanity metrics. Trackable links and discount codes are the simplest to measure the sales conversion to get customers in the queue. Engage rate (comments, saves and shares) on the sponsored post against the influencers average to measure audience engagement and reception. Use UTM parameters in analytics to measure the web traffic from the influencer content on your site. You can also check to see whether follower growth on your own social media channels has happened during and even the campaign to measure the impact on awareness. If you have a new customer ask them how they heard about you as a result of the partnership.

5. COMPLIANCE AND TRANSPARENCY:

You must comply with advertising regulations and needs to be stated transparently with audiences in order to build trust. The disclosures must appear in the video/post, not buried in a pile of other hashtags. The federal trade commission was clear in what sponsored content should look like and says that sponsors should be clear, to the point, and plain language to the audience like using a hashtag . Transparency can benefit both the brand and the influencer partner.



CONSUMER PERCEPTION OF PLANT-BASED SUBSTITUTES:

1. THE HEALTH HALO AND NUTRITION SCRUTINY:

Consumers have assumed that plant-based products are healthier than animal-based products. A smaller but more health-conscious segment of consumers is examining the nutritional information and ingredients as per ex. additives and preservatives, the sodium levels etc. Consumers are particularly worried about highly-processed products, with their convenience and fortified foods, as they pose potential barriers for the health-conscious consumer. Brands must clearly communicate all aspects of their nutritional and health benefits, as an example being (HRH, a good source of protein, fibre, iron, supports their health related to outcomes) to the customer.

2. TASTE AND TEXTURE:

Other associations for consumers are taste and texture, and have returned to the consumer's top fear today because plant-based foods do not taste as good as the animal-based product. Consumers trust the animal-based food product and in the plant based, they could not taste good and could be something too hard to eat and could possibly taste bad. Early products created a perception of compromise but the offerings today must match or exceed those same sensory properties of the animal-based product, especially for what we argue is the "mouthfeel" which is prominently a consideration with products like meat and cheese substitutes where specific sensory properties like fattiness need to be mimicked.

3. PRICE SENSITIVITY AND VALUE PROPOSITION:

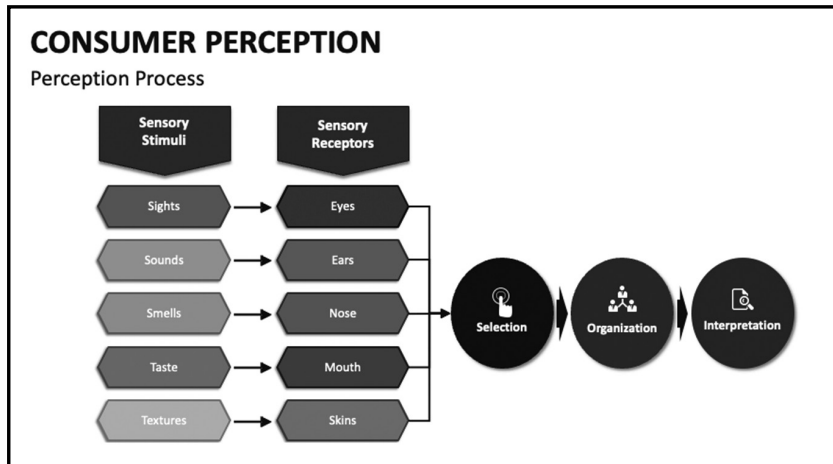
Plant-based products were sometimes more than conventional animal-based products creating a significant factor. Consumers weigh price against perceived value which includes health or personal benefits, ethics-based, environmental issues. As technology related to plant-based production improves the price gap is likely to close which is essential for mass market adoption of either. Clearly explaining the why behind pricing- sustainable sourcing, ethical labour, or expensive ingredients can justify the premiums charged to mission aligned consumers.

4. MOTIVATIONS:

Consumers have four streams that emerge as three main drivers of motivation with individuals reacting to each differently. Ethical motivation relates to animal welfare and is primarily related to vegans and vegetarians. Environmental motivation relates to lower carbon footprint, less water use and less land usage impacts was considered to be climate-conscious consumers. Effective marketing needs to develop messages for these audience segments to highlight the most relevant benefit for the consumer. Health motivation is often the largest driver.

5. THE UNCANNY VALLEY OF MEAT MIMICRY:

Some of the consumers are looking for products same as in meat like when they are making their favourite culinary creations and others have found this mimicry to be off-putting or too processed, and prefer the products to highlight its plant-based nature with tastes that reflect their dishes and textures. This creates a strategic challenge for the band as they try to create a unique product. Understanding the target to the audience preference on this product and developing and positioning in the marketplace. Some brands have successfully done this was offering both product types within their portfolio to address the different consumer preferences.



SUSTAINABLE PACKAGING STRATEGIES FOR ECO-FOODS:

1. CREDIBILITY IMPERATIVE:

For brands based on sustainability credentials, environmental values and the environmental sustainability packaging is no longer relevant as a secondary feature primarily for achieving style status, but essential for meeting the demands of an increasingly discerning consumer. It is what the customer ordered in terms of the product which must now align with the environmental values of the brand. Packaging is central to the value proposition of a product and environmentally conscious consumers are particularly sensitive to wasteful packaging that is not necessary to provide the same level of protection and maintain a consistent brand value proposition. Customers are also easily turned-off if they feel the packaging does not align or fits with a value proposition. Inconsistent packaging violates the customer bonding, which jeopardizes brand trust and brand reputation.

2. MATERIAL INNOVATION:

As a result, plastic packaging is on the agenda for almost every brand in the fresh food sector, and the industry is focused on evaluating materials that are not reliant on fossil-fuels based plastic. Compostable packaging is sourced from environmentally friendly sources i.e PLA (polylactic acid made from corn starch), bagasse (sugarcane fibre) or even mushroom can be broken down in industrial composting settings that basically returns safely to the environment. Recycled content packaging offered a way to repurpose the existing plastic waste and mitigate any new plastics. The packaging materials must both adequately protect the food product and be compatible with the existing or mainstream end of life processing systems.

3. DESIGN FOR RECYCLABILITY AND COMPOSTABILITY:

Sustainable packaging has to be designed for usefulness and ideally will be recyclability or compostability. As for how to recycle is critical to guiding the customer in the appropriate disposal method for the item, and compostable packaging instructions need to clarify how to use it- including home or industrial compostability are essential, and coding helps with contamination of recycling and composting streams.

4. THE REUSABLE AND REFILLABLE MODEL:

The most sustainable method packaging waste is eliminated is to remove the packaging waste by eliminating single use packaging altogether through a reusable system. Engaging in a circular economy where the customer buys a durable container of the first use and refills it only with a bulk dispenser or a return / refill delivery subscription service. There are few zero waste stores and brands leading this effort with clean product refills in the pre-packaged format. New technology such as smart scales that can track weight makes this model more feasible for retailers.

5. LIFECYCLE ASSESSMENT(LCA)AND COMMUNICATING PROGRESS:

A brand must take a holistic, science-based approach and evaluate the true environmental impact of their packaging choices from cradle to grave and a lifecycle assessment (LCA) that measures the impact of a package across its entire life including raw material and manufacturing and transportation and end of life. Honesty and about the journey and a commitment to continuous improvement builds more trust than a claim to have already solved a complex problem.



CONCLUSION:

Marketing strategies for plant-based and eco-friendly food products should not only focus on promoting health benefits and also emphasize sustainability and environmental responsibility. By highlighting the main natural ingredients, ethical, sourcing, and eco-friendly product packaging business, they can connect with conscious consumers who have the value of both wellness and the planet. The effective use of the digital platform, storytelling, and community engagement can build trust and loyalty. They will ultimately have a balanced approach and that combined innovation, transparency, and sustainability will ensure long-term and success in the growing plant-based food market. As the consumer demand for sustainability continues to rise. Another important strategy is innovation in both product development and marketing development. Pricing a strategy also plays a crucial role, marketing products are accessible and affordable ensure broader acceptance across the different market segments. Thus, the marketing strategies for plant-based and eco-friendly food products should go beyond the promotion and they should inspire positive change in both the consumer and the society.

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IOT BASED CONTACTLESS DOORBELL SYSTEM

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ABSTRACT

In the integration of sensors, software, and networking, the Internet of Things (IoT) transforms how real objects are connected to the internet, enabling more creative and efficient communications. Numerous industries, including healthcare, agriculture, smart homes, industrial control, and transportation, are impacted by the Internet of Things. Our paper introduces an IoT-based contactless doorbell using the ESP32 CAM, IR sensor, buzzer, and Arduino UNO. The ESP32 CAM, which is an affordable development board featuring Wi-Fi, Bluetooth, and camera features, records images or videos. The IR sensor senses movement or obstacles and activates predefined events. The buzzer provides sound notifications to inform users about sensed activity. At the heart of this system is the Arduino UNO, an open-source electronics platform that coordinates the parts, making it a unified and effective solution. Our system is one example of the ways in which IoT can transform daily life with a smart, touchless system for monitoring and securing doors. By combining all these elements, our doorbell system provides a smooth integration of functionality, budget-friendliness, and simplicity, making it a perfect answer for today's smart homes..

KEYWORDS: *Arduino UNO, IR sensor, IOT, ESP 32 CAM, Buzzer.*

INTRODUCTION:

The Internet of Things, also known as the IoT, is a network of physical things that can send and receive data via the internet thanks to sensors, software, and networking technology. Industry creativity, computerisation, and efficiency all have been improved by IoT. IoT improves efficiency, automation, and innovation in industries. Examples of applications are smart homes, healthcare, agriculture, industrial automation and transportation. By turning everyday objects into intelligent, data-exchanging objects, IoT enables smarter solutions and better decision-making processes, changing the way we engage with the world.

A doorbell is one of the most essential items we need in a house. An instrument that is placed or positioned at the entrance to signal when a visitor comes is called a doorbell. The traditional doorbell system was replaced with a sensor in today's highly technologically advanced world. The sensor uses the visitor's movement to detect it and then sends an alert. This contactless doorbell system will teach us a great deal about how infrared sensors and Buzzers operate with the inclusion of ESP 32 CAM. The smart home technologies have been used and improved since the 1970s.[1] The concept of home automation and people's preference for a smart home underwent a significant shift as a result of the widespread and accepted use of electronic gadgets and the internet brought about by technological advancements. These days, a smart home is an intelligent combination of remote sensor/actor networks and multiple smart devices. Complex gadgets, unique client requirements, and individual client behaviour all first created new security risks for home automation. The home security module has changed throughout time. The Internet of Things (IoT) refers to the interaction or communication of many gadgets and equipment, including buildings, cars, and other items connected to sensors, software, hardware, and system availability. [2] These are all important considerations. IoT suggests burglary appropriation as a model. Both human-to-machine and machine-to-machine communication will be greatly enhanced by the Web of Things.[3]

The research that is currently available on home security shows that recent home security implementations can be replaced ,and it also explains the function of an advanced safety and security system and the home mechanisation framework as an appropriate one for identifying, warning, and interrupting home security activities.[4]

REVIEW OF LITERATURE

According to Elmerson L, the problem statement is a contactless doorbell with the use of an ultrasonic sensor. He states that using an Arduino Nano and an ultrasonic sensor, the project aims to develop a contactless doorbell that can identify visitors and emit a beep. This reduces physical contact, which lowers the risk of virus transmission and enhances safety by responding to visitor movements with ultrasonic pulses. [1]

According to the author, the problem statement is COVID Bell – A smart doorbell solution for prevention of COVID-19. He states that through the integration of a temperature sensor to measure temperature, a camera module for mask recognition, and an ultrasonic sensor for an automated doorbell, the system reduces the spread of COVID-19 through surface contact. An iOS software transmits temperature information and images, enabling remote door control and reducing in-person interaction to improve user experience [2]. According to Venkatesh, in the problem statement, Automatic Ringing Doorbell: Review and Fabrication, he states that, 'In order to prevent surface contamination and reduce interaction, this paper examines studies on affordable, effective automatic doorbells that were popular during COVID-19.' In order to prevent viruses, it recommends combining wave signal-based sensors and PIR sensors to turn on the ESP32 camera and buzzer. It also emphasises technology, such as the processing of images, the use of machine learning, and the IoT [3]. According to the author, the problem statement is 'Touchless doorbell for post-covid'; she states that the Covid-19 pandemic is essential to underline negative strategies such as distancing, washing, and masking. Counties, which are high spaces, hand over the virus.

An echoing bell with an enchanting sensor and Arduino sensor located on the wrist attached to the wrist, allowing a safe interaction [4]. According to Manivannan, the problem statement is Touchless Doorbell with Face Detection; he states that home security systems need improvement due to poor integration and accuracy. A novel approach involves smart IoT-based touchless doorbells using OpenCV and Haar cascade classifiers with Arduino UNO, achieving 93% efficiency. Integrating Google Text-to-Speech (gTTS) enhances accessibility for visually impaired users, ensuring reliable and inclusive home security solutions. [5] According to the author, the problem statement is the contactless door lock system using Raspberry Pi. He states that the job is going to improve the door security in areas that require sensibility according to the detection and the recognition of the face. The traditional Native systems or passwords are damaged, and the system promised the use of the capture of images, facial detection and the object and eigen. Support distance access and provide captured images to approved people, improving safety and comfort on smart-home appliances. [6] According to Dadhich, the problem statement is the Contactless IoT Doorbell for Covid-safe Household; he states that the Covid-19 pandemic led to great losses of life and economic interest. Social distances are the most effective prevention strategy. In this article, a bell based on an IOT-based sensor and MLX90614 is suggested to inform the owners of the feverish visitors, which may be a sign of the covidal infection. The system records records on a Firebase database, has an additional mobile application and provides temperatures of 99% of the reigned texts. [7] According to the author, the problem statement is the design and implementation of a secured contactless doorbell using IoT. She states that in the era of the pandemic, the best technologies and contact methods are necessary for modern inner safety. A “non-contact” system uses a bell signal and makes the chamber of the Nodemanager camera register the picture on the basis of fire through an m. The system used user modems, Uvula Salt systems, management guests, and management gestures, which are vision and the computer cloud. [8] Al-Humairi asserts that the problem statement revolves around designing and developing an Internet of Things (IoT) contactless door buzzer, automation, and home security device employing a Raspberry Pi, which is a security microprocessor. The system is going to inform users of interference through smartphone messages and alarm remote control. It’s people with varying views crossing the face of facial recognition technology. Configuration includes a Camera Pi, a circuit of the clearance, an ultrasound sensor for objective detection, a mobile application for operation and the warranty. Complete security and convenience. [9] According to the author, the issue with the IoT-based contactless visitor approval and package cleanup system for COVID-19 is that the pandemic is having a significant impact on food safety, work sections, and economic matrices, regulations, and finances. To reduce the contact, a Raspberry Pi and the Arduino IoT system have been designed to authorise customer contact. It uses a camera for supervision, automatic email alarms and facial recognition. Another automatic disinfection package of disinfection IVs is contamination from packages delivered, allowing you to have all functions executed without external contact. [10]

WORKING PRINCIPLE-INTELLIBELL

The goal of this project is to create a contactless doorbell system that detects the presence of a visitor using an IRsensor and notifies the occupants with a buzzer sound. The system also includes an ESP32 Cam module to provide a live video feed of the visitor. The components required are an Arduino UNO (the main microcontroller), ESP32 Cam (for capturing live video), IR Sensor (detects the presence of a visitor), Buzzer (produces a sound when a visitor is detected),

Jumper Wires (for connecting the components), and a PowerSupply (to power the Arduino and ESP32 Cam). The working principle involves continuous monitoring by theIR sensor to detect a visitor, which sends a signal to the Arduino UNO upon detection, triggering the buzzersound. The ESP32 Cam module captures live video of the visitor and streams it to a connected device via Wi-Fi,allowing the occupants to see the visitor without opening the door. (9)

COMPONENTS USED:

ARDUINO UNO BOARD

One popular open source chip for building electronics projects is the Arduino UNO..This board is highly versatile and suitable for various applications, from simple LED blinking projects to more automation systems.

INFRARED SENSOR IR

A sensor is a device that detects infrared radiation in its surroundings. It's widely used in various applications, such as remote controls, motion detectors, and proximity sensors.

BUZZER

A buzzer is a simple device used to create sounds or alerts. It can be easily controlled using the digital output pins on the Arduino board.

ESP 32 CAM

The ESP32 CAM is a relatively inexpensive, low-power system on a chip that combines Bluetooth and Wi-Fi with a microcontroller. It is perfect for a variety of applications, including IoT projects, because it features a camera module that allows for images and recording videos.

STEPS:

1. Connect the sensor's GND pin to the Arduino's GND pin.
2. Connect the sensor's VCC pin to the Arduino's SV pin.
3. Connect the sensor's DATA pin to the Arduino's D2 pin.
4. Connect the Arduino's GND pin to the ESP32's GND pin.
5. Connect the Arduino's 3.3V pin to the ESP32's VIN pin.
6. Connect the Arduino's D2 pin to the ESP32's GPIO4 pin.
7. Connect a 4 volt battery to the ESP32's VIN and GND pins.

METHODOLOGY

When a person enters the system, the sensor picks up their presence and gathers pertinent information,like movement temperature. The data is then sent to the Arduino through the DATApin of the sensor,where the Arduino interprets it. The Arduino then sends the interpreted data to the ESP 32 through the D2pin, which is connected to the GPIO4 pin of the ESP32.The ESP32 accepts the data and can further process, store, or send it as required. Depending on the received data, the Intellibell can initiate the buzzer.

CONCLUSION

INTELLIBELL provides a very efficient and effective means of handling interactions between human beings and technology. Through perfectly blending sensors, an Arduino, and an ESP32, the system senses a human being, handles pertinent information, and gives particular responses such as lighting a room, issuing alerts, or initiating alarms. The configuration highlights a very sturdy means of processing real-time information and automation and displays the prospects for improving security, convenience, and smart home functionality. Overall, it is an end-to-end solution using IOT elements to build a responsive and smart environment.

FUTURE ENHANCEMENT

To further enhance the IntelliBell doorbell system, the following enhancements can be considered
Advanced Sensor Integration: Incorporate sensors such as facial recognition ,cameras and air quality sensors to collect in-depth data. Machine Learning Integration: Integrate algorithms to study patterns of data for predictive and adaptive actions. Mobile Application Development: Develop an app for remote monitoring, control, and real-time alerts. Improved Security Features: Incorporate encryption and secure communication protocols to ensure data privacy. Voice Assistant Integration: Integrate with Amazon Alexa, Google Assistant, or Apple’s Siri for voice control.

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CARBON CREDIT MARKET AND ITS IMPACT IN DEVELOPING ECONOMIES – A STUDY WITH REFERENCE TO SOUTH CHENNAI

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ABSTRACT

This study provided an exploration of the carbon credit market, and possible implications for developing countries, through the use of India as an example. The aims of the study were (i) to measure awareness of carbon credits, (ii) to measure levels of willingness to participate in carbon neutral initiatives, and (iii) to explore developed nations capacity to participate in global trading systems. The study used a structured questionnaire and involved 240 respondents in the study. The researcher analysed the data using descriptive statistics and Chi-square tests, and reported the data in SPSS format. The main findings were: most were slightly familiar with carbon credits, but awareness on the particulars and willingness to pay more for carbon neutral products were average. The chi-square analysis found significant relationships between some demographic variables (education, profession) and attitudes towards participation in carbon trading. For consideration, the researcher identified: establishing awareness, educating producers on sustainable farm processes which would support carbon neutral products, future potential for financial incentives to buyers, and possible future governmental policy to promote and support participation in developing countries capacity to advance participation in carbon market.

KEYWORDS: Carbon Credit Market, Developing Economies, Climate Change Mitigation, Sustainable Development, Emission Trading, Green Economy, Environmental Policy, India, Consumer Behaviour.

INTRODUCTION

In the 21st century climate change is one of the most pressing global challenges. The entire world is affected by the problem of climate change. The carbon credit market was started in many countries to reduce the harmful gases in the atmosphere. Many countries and companies get carbon credit permits, and those permits allow them to release carbon dioxide for the specific amount of carbon permits/certificates purchased. If a company reduces carbon emissions which the company was already producing using new methods or technology, then the company can sell credits to other countries or companies. The carbon credit market leads to opportunities and challenges in developing countries. On one hand, it uses eco-friendly projects to attract investment

like cleaner farming, solar power, and reforestation. This project helps to create jobs and improve local living conditions. On the other hand, many developing companies face the problem of high cost, complex Rules, and limited technical knowledge. This project is helpful to the environment. This research paper looks how the carbon credit market works and its affects developing countries. That is, about the benefits, difficulties and future possibilities of carbon credit to support climate action and economic growth in this nation.

REVIEW OF LITERATURE

Woo (2021) et.al, Completed a Study About Carbon Credit Market: Review. The study aims to evaluate the building sector's or look more clearly stated - the role of the building sector, or assess how the building sector interacts with the carbon credit markets, as part of the assessment of carbon credit markets in integrating block chain technology into the digital MRV system. The review process used databases such as Web of Science, Science Direct, and ProQuest in examining studies conducted between 2008–2020. This study argues that if there is a transparent MRV system to quantify and verify the carbon emission reductions, the building sector has no trustful system, in spite of the auditing programs having a BEP. The study suggests they could offer a reliable system, potentially integrate with smart metering, Blockchain-based digital MRV system, and carbon tracking would be auditable. Implication: This would encourage further participation in carbon credit markets that would address the extent to which these greenhouse gas (GHG) emission reductions could also be monetized. The final discussion of the study is about climate finance mechanisms, and Blockchain-enabled reports are a good way forward to close the gap on building energy performance.

Wyte (2016) et.al Woo (2021) et.al, Study about Carbon Credit Market: Review the objective of the study is to evaluate the benefit from existing carbon accounting standards and emerging global carbon market. The methodology is conducted using databases such as comparative evaluation of carbon market mechanisms (CDM, JI.ETS, voluntary markets) and NDC framework and policy analysis. The study finds accounting complexity, leakage and performance issues. The study suggests support for inclusion in the voluntary and the nationally determined contribution (NDC) and compliance market. The study said that Impact: NDS provides a new opportunity for forest- based carbon projects and voluntary markets. The conclusion of the study is about viable participants in carbon credit trading and improved accounting now position for forestry projects as credible contributions to emission reduction.

Caiado (2017) et.al, Study about Carbon Credit Market: Review The objective of the study is Electronic Equipment (WEEE) in Brazil, drawing analogies with the carbon credit market as a policy tool for environmental sustainability and the feasibility and potential of the Reverse Logistics Credits (RLC) market for Waste Electrical. The methodology is conducted using eight senior stakeholders from the electronics industry involved in qualitative case study approach with semi-structured .the study find accepted alternative to comply with environmental legislation, Participants acknowledged the RLC market as a promising and despite lacking specific legal backing .the study suggest ensure broader industry, Legal frameworks should be developed to support RLCs formally and incentive and guidelines must be reinforced to expand the market . The conclusion of the study is about offering a viable complement to traditional environmental policy tools RLC market has strong potential to enhance WEEE management and environmental compliance in Brazil.

Gorain et.al (2021), study about carbon credit market: Review. The objective of the study is to evaluate the impact of stopping crop residue burning, in earning carbon credits through international carbon markets. The methodology relied on the relationship between stock market variables and other carbon trading. The study found that its elimination could result in substantial carbon credit revenue for India and crop residue. The study suggests that future research should adopt more sustainable alternatives and promote clean farming practices. The conclusion of the study is about the carbon credit market and essential show the economic goal effectively marketing promises.

Melissa R et.al (2007) *Urban Forestry & Urban Greening* Is the possibility of sharing a planting of trees as a viable means of participating in carbon credit exchanges an option? The main aim of the study is to assess the communal tree planting approach as viable investments for the purpose of participating in carbon credit exchanges. In order to measure feasibly, statistical tools, including a model sensitivity analysis, stemming from the “Carbon Dioxide Removal by Urban Forestry” model (Dwyer et al. 2000). The authors’ results reveal the consideration of carbon sequestration is mainly predicated on the number of growing season days having the most significant effect on the feasibility of the investments. Other Swaying Factors, analogous as tree size, conservation costs, tree planting position, and energy savings associated with energy consumption had significant consequences for design viability. The disquisition supports swish practices to maximize cost effectiveness and underscores the need for communal forestry programs to plant large- elevation trees, minimize costs, and descry tree planting systems in areas with a high number of growing season days. In summary, only systems purposefully designed as communal tree systems, in the south, or other energy- related benefits are presently invested in carbon requests. These disquisition conclusions are important for external government and private investors as they develop a communal forestry program as one way to neutralize carbon.

Li Xu (2023) *Journal of Cleaner Production*: Evaluating and prioritizing the carbon credit financing risks and strategies for sustainable carbon markets in China. The objective of the study is to assess carbon credit financing risks and prioritize mitigation strategies to support the development of sustainable carbon markets in China. Statistical Tools used are Fuzzy Analytical Hierarchy Process (FAHP) and Fuzzy VIKOR (FVIKOR) methods used for risk assessment and strategy prioritization. Findings of the research were that Regulatory, financial, and operational risks are identified as the most significant challenges in China’s carbon credit financing system. Suggestions were that Mitigation should focus on building stakeholder relationships, ensuring financial stability, and increasing market transparency. To conclude, effective management is vital for the long-term success and efficiency of China’s carbon markets and for achieving national and global climate goals.

OBJECTIVES OF THE STUDY

1. To analyse the awareness and perception of carbon credits among different demographic groups in developing economies.
2. To examine the relationship between education/profession and awareness of carbon credit markets.
3. To identify the barriers and opportunities for active participation in carbon credit trading in India.

RESEARCH DESIGN

- **Type of Research:** Descriptive research using the survey method.
- **Data Source:** Primary data collected through a questionnaire and using the secondary data from the research papers already published.
- **Sampling Method:** Convenience sampling.
- **Sample Size:** 240.
- **Tools for Analysis:** Percentage Analysis and Chi-square test by using SPSS.

DATA ANALYSIS

(1) Percentage Analysis is used to find out the demographic profile of the respondents

Table 1

TABLE SHOWING COMBINED DEMOGRAPHIC PROFILE OF RESPONDENTS (N = 240)

Variable	Category	Frequency	Percent
Gender	Male	132	55.0%
	Female	108	45.0%
Age Group	Below 20	36	15.0%
	21–30	108	45.0%
	31–40	60	25.0%
	41 & above	36	15.0%
Education	School level	24	10.0%
	Undergraduate	96	40.0%
	Postgraduate	84	35.0%
	Professional	36	15.0%
Occupation	Student	84	35.0%
	Employed	96	40.0%
	Business	36	15.0%
	Homemaker	24	10.0%
Monthly Income (₹)	Below 20,000	72	30.0%
	20,001–40,000	84	35.0%
	40,001–60,000	48	20.0%
	Above 60,000	36	15.0%

Source: Computed data

INTERPRETATION

From the above table:

Gender: Overall gender categories of gang based appeared to be relatively even but were slightly skewed with a lean occurrence male base to 55%. Age: The majority of participants were 21 - 30 (45%). There could have been a younger representation in this group. Education: Generally, participants were identified as having educational attainment above the college level. Overall, participants were mostly undergraduate (40%), and postgraduate (35%), respondents indicating an educated sample demographic. Occupation: Most participants identified as employed (40%), full-time student (35%) being a combination of a career development or lifelong learner. Income: The majority of participants were in the income bracket of ₹20,001 - ₹40,000 (35%) and 30% of participants reported below ₹20,000 income rate indicating that the overall sample population identified as working or middle-income earning individuals.

Table 2
TABLE SHOWING COMBINED PERCENTAGE ANALYSIS FOR
THE THREE VARIABLES

Variable	Response	Frequency	Percent
Awareness of Carbon Credits	Yes	132	55.0%
	No	72	30.0%
	Not sure	36	15.0%
Willingness to Pay Extra for Carbon-Neutral Products	Yes	96	40.0%
	No	84	35.0%
	Maybe	60	25.0%
Interest in Reducing Carbon Footprint for Credits	Yes	156	65.0%
	No	48	20.0%
	Maybe	36	15.0%
Total Sample		240	100%

Source: Computed data

INTERPRETATION

As highlighted in the combined table, a large number of participants (55%) are aware of carbon credits, while 45% are not aware or unsure. Willingness to pay for carbon-neutral products is moderate (40%), with a notable 35% unwilling and 25% undecided. A strong 65% show interest in reducing carbon footprint for credits, showing readiness for personal participation in carbon markets. This suggests that while awareness and willingness to pay require strengthening, interest in personal action is high, indicating strong potential for carbon-credit-based behavioural programs in developing economies.

(2) Chi-Square Test analysis is used to analyse:

- (i) The association between Educational Qualification and Willingness to Pay Extra for Carbon-Neutral Products.
- (ii) Profession and Opinion on India’s Participation in Global Carbon Credit Trading.

Hypothesis 1: Educational Qualification × Willingness to Pay Extra for Carbon-Neutral Products

Hypotheses

- H_0 : Education level and willingness to pay extra for carbon-neutral products are independent.
- H_1 : Education level and willingness to pay extra for carbon-neutral products are associated.

Table 3

TABLE SHOWING THE CROSS TABULATION OF EDUCATIONAL QUALIFICATION

Educational Qualification	Yes	No	Total
School level	35	25	60
Undergraduate	40	20	60
Postgraduate	50	30	80
Others	25	15	40
Total	150	90	240

Source: Computed data

Table 4

CHI-SQUARE TEST RESULTS

Test Statistic	Value	df	p-value
Pearson Chi-Square	6.21	3	0.102

Source: Computed data

INTERPRETATION

As we can see in the above table, the p-value (.102) is greater than .05 and is therefore not statistically significant. Thus, we cannot reject the null hypothesis and this means there is not a significant relationship between educational qualification and willingness to pay more for carbon-neutral products.

Hypothesis 2: Profession × Opinion on India’s Participation in Global Carbon Credit Trading

Hypotheses

- H_0 : Profession and opinion on India’s participation in global carbon trading are independent.
- H_1 : Profession and opinion on India’s participation in global carbon trading are associated.

Table 5
CROSS TABULATION OF PROFESSION

Profession	Yes	No	Total
Student	60	20	80
Salaried Employee	55	25	80
Business	30	10	40
Others	25	15	40
Total	170	70	240

Source: Computed data

Table 6
CHI-SQUARE TEST RESULTS

Test Statistic	Value	df	p-value
Pearson Chi-Square	8.45	3	0.038

Source: Computed data

INTERPRETATION

The matrix has a p-value (0.038) that is lower than 0.05 (the significance level). This means that the results are meaningful and therefore the null hypothesis is decided to be wrong. Hence, we state that profession (an approximation of income level) most certainly impacts people’s attitudes about India’s participation in the trading of global carbon credits.

FINDINGS

1. Awareness: A majority of respondents have heard about carbon credits, but their detailed understanding of the mechanism is still moderate to low.
2. Attitudes: Most respondents believe carbon markets can contribute to reducing global warming and support India’s active participation in global trading.
3. Willingness to Pay: While many respondents are open to paying extra for carbon-neutral products, education level is not a major determinant of this willingness.
4. Economic Influence: Profession significantly affects opinions—those in higher-paying professions are more supportive of India’s participation in global markets.
5. Behavioural Intent: Respondents show interest in reducing their personal carbon footprint if incentivized through credits, indicating potential market readiness.
6. Demographic Profile: Younger respondents (students and early-career professionals) dominate the sample, reflecting the importance of targeting youth awareness programs.

SUGGESTIONS

1. Awareness Programs: Enhance education on carbon credits at the school, college, and community level to bridge knowledge gaps.
2. Policy Incentives: The Government must offer fiscal incentives or tax relief in terms of encouraging lower-income households' participation in the carbon credit market.
3. Corporate Involvement: Invite companies to provide carbon-neutral products with affordable prices to further foster consumer acceptance.
4. Student-Focused Campaigns: Since students are highly interested, universities and institutions need to make climate literacy and awareness of carbon trading a part of course curriculum.
5. Global Engagement: India must employ a two-pronged strategy—immersing deeply in international trade while building robust domestic carbon markets.

CONCLUSION

The study observes that although in general terms there is a sense of carbon credits, additional understanding and participation continue to surface in emerging economies. The Chi-square test reveals that income source (occupation) has a major impact on opinions regarding India's global reach but level of education has little impact on willingness to pay a premium for carbon-neutral products. The study shows that the carbon credit market offers promising opportunities in emerging economies like India. This is possible if there are economic incentives, information campaigns, and policy support. By closing knowledge gaps and eliminating affordability issues, India can strengthen its position in the global carbon market while also supporting sustainable development. Encouraging public-private partnership would increase investment in sustainable technology and carbon reduction initiatives locally. It requires strengthening regulatory frameworks to ensure transparency, credibility and accountability in the process of creation and trade of carbon credits throughout southern India.

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DEVELOPMENT OF AN INNOVATIVE EDIBLE COATING FROM CASHEW HUSK TANNIN TO EXTEND FRUIT SHELF LIFE

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ABSTRACT

*Fruits and vegetables are in high demand these days due to their nutritious value. Because they are perishable which have a limited shelf-life. Insects, microbes, and pre- and post-harvest conditions during transportation and preservation can harm or destroy around 30% of fruits and vegetables. Preservation of the fruits and vegetables is a major global concern. An efficient way to deal with this issue is through edible coating. Edible coating were prepared by using carboxymethyl cellulose (CMC) plasticized poly (vinyl alcohol) (PVA) and tannin compound. In this study, the tannin compound was extracted from the cashew husk were used as an antioxidant and antimicrobial agent. In the current study, PVA/CMC blend solutions in the presence of tannin in different ratios 5, 10 and 15% were applied on *Musa acuminata* fruits as a way to extend the shelf life of food and the results revealed 5% has increased the shelflife. I. From this study, we concluded that the cashew husk agro-waste can be used to make a sustainable value added product.*

KEYWORDS: *Edible coating, Cashew Husk, PVA, CMC, Tannin, Musa acuminata.*

INTRODUCTION

The rising demand for fresh fruits and vegetables has pushed the food industry to explore advanced techniques that can help in preserving quality and prolonging shelf life. Consumers, on the other hand, increasingly prefer products that are free from synthetic preservatives, yet maintain their freshness, safety, and nutritional value for longer durations. Since most fruits are consumed fresh, attributes such as flavor, visual appeal, and wholesomeness are of prime concern (Velickova, 2013).

One effective strategy to address this challenge is the application of edible films and coatings. These protective layers not only act as physical barriers but can also be enriched with antioxidant and antimicrobial agents, thereby improving the overall quality and safety of the produce (Bonilla, 2012). In recent years, research has increasingly focused on edible and biodegradable coatings as alternatives to synthetic waxes that are widely used for postharvest protection.

Carboxymethyl cellulose (CMC), a derivative of cellulose, has attracted considerable attention due to its desirable properties such as non-toxicity, biodegradability, swelling capacity, and hydrophilicity (Bajpai & Shrivastava, 2005). While cellulose derivatives typically degrade under high-energy radiation, CMC has been found to undergo cross-linking when present in concentrated solutions (Liu et al., 2005). Another material with potential for coating applications is poly(vinyl alcohol) (PVA). It is valued for its optical clarity, strong mechanical properties, and chemical resistance. Moreover, it has been reported that PVA can undergo biodegradation through an initial dehydrogenation process followed by aldol-type cleavage (Matsumura et al., 1999).

In addition to polymers, naturally occurring compounds like tannins provide significant functional advantages. Tannins exhibit multiple biological activities including antimicrobial, antiseptic, and anti-inflammatory effects. They have long been used in traditional medicine for healing and treating digestive disorders, and more recently, their use as renewable raw materials for adhesives and other applications has been explored due to their high reactivity (Moric et al., 2014). Tannic acid (TA), a plant-derived polyphenol, is abundant and relatively inexpensive. Its numerous hydroxyl groups contribute to strong antioxidant, UV-blocking, and antimicrobial properties. Furthermore, TA readily interacts with other biopolymers via hydrogen bonding and cross-linking, which enhances the mechanical strength, barrier properties, and functional performance of coatings (Halim et al., 2018).

Musa acuminata are among the most widely consumed fruits globally and hold particular economic importance in Egypt. Their characteristic sweet flavor and aroma make them highly desirable; however, their perishable nature requires effective postharvest preservation methods. The use of edible coatings presents a promising solution for extending the shelf life and marketability of *Musa acuminata*.

The agricultural leftovers from cereals and plantation crops can be used as processing by-products and organic residues to valorise trash by turning it into the most valuable goods (Patel, 2021). The cashew nut is one of Africa's most significant agro-industrial crops in Brazil, India, and Vietnam. The cashew (*Anacardium occidentale* L.) plant was first transported to other parts of the world in the sixteenth century, mainly for soil preservation. It later became a significant foreign exchange earner in the majority of countries. It is cultivated chiefly for its nuts, while the fruit & residues (cashew nut shell, cashew bagasse juice, cashew husk, cashew apple, cashew nut liquid) are used in different applications and for many value added products (Mubofu et al., 2016, 2018). The dicotyledon kernel of the cashew nut is enclosed by a covering of testa and shielded by the outer nutshell. The cashew's actual fruit is often a nut. It is an achene that can be kidney- or heart-shaped in any typical variation. Its hue ranges from greyish brown to bottle green (dried fruit). It is joined to the end of a swollen footstalk, also known as a peduncle, which is the flower's receptacle, widened and swelling, which develops the fake fruit. The nut consists of a shell or pericarp and kernel. The rear of the kernel has a slight curvature and two cotyledons, each representing around 20–25% of the weight of the nuts. It is encased in a reddish-brown membrane, approximately 5% of the total nut.

REVIEW OF LITERATURE

The “real” fruit of the cashew tree is used as a source of oil, a snack, a culinary component, and cashew butter (Wardowski, et al., 1990). Also, the cashew apple is used to make various delicious dishes like jellies, juices, pulp and alcoholic beverages. Cashew Nut Shell Liquid, also

known as cashew shell oil, is a dark reddish-brown caustic liquid that is found in the cashew shell and is 15–30% of its total weight (Lin, 2018). Phenolic acids such as syringic, gallic, and p-coumaric acids are present in the testa (Sharma *et al.*, 2020). The Cashew Nut Testa separates and shields the developing nut from the shell inside the interior cavity (Ogunsina and Bamgboye, 2014). The constituents of testa seem to be less than other residue parts of cashew nut, but as the annual production of cashew is getting increased, Testa as an agro-waste cannot be ignored. Viz., Earlier, Testa was used in making “Katha” (Catechu “Katha”) for Pan Masala in different countries of Asia, but it got banned because of its toxic phenolic contents.

In 1965, Kantamani reported that testa contains d-catechin, which is the primary ingredient of Catechu/Kattha. Christopher. *et al.* (2014) Carried out work using coconut shell and cashew nut husk (1:1) as adsorbent for the removal of Cd (II) ions from aqueous solution. Sunija *et al.* (2015) Fabricated polyurethane composites by randomly orienting *Thespesia populnea* fibres at various fibre lengths and loadings, then reinforcing them with polyurethane. In order to create the bio-polyurethane (PU1 and PU2) used as the matrix phase, tannin from cashew nut husk was extracted using hexamethylene diisocyanate in both the absence and presence of an extender. .

Nnaji *et al.*, (2014) and (2021) demonstrated work on removable of suspended solids from a fibre-cement industry effluent using Cashew Nut testa as a coagulant have studied the influences of temperature, beginning pH, initial concentration, and duration were investigated when studying the adsorption of metal ions and dyes from water by Cashew Nut Testa tannin resin (CATAR).

Patil *et al.*, (2015) used Cashew Nut Testa to extract catechin as Natural Dye using Taguchi optimization increase efficiency by 46% which resulted in a significant improvement in dye yield compared to conventional methods.

Sunija *et al.*, (2018) used cashew nut husk tannin to treat with hexamethylene diisocyanate (HDI) in a three-necked, round-bottomed flask with and without the extender 1,4-butanediol. Agro-residues and forest products are generally considered the best source of tannin-rich substrate.

However, the commercial usage of testa as an agro-waste is relatively new. In the current work, our objective focused on using cashew husk improve the shelf life of fruits.

OBJECTIVES

- To obtain and prepare cashew husk samples for the study.
- To extract tannins from the husk and estimate their concentration.
- To develop blend formulations of polyvinyl alcohol (PVA), carboxymethyl cellulose (CMC), and tannic acid (TA).
- To apply the prepared PVA/CMC/TA blends as surface coatings for fruit preservation.
- To evaluate the impact of these coatings on the shelf life and quality of *Musa acuminata* fruit.

METHODOLOGY

I. Collection of sample

The sample cashew husk was collected from the SJK cashew industries, Avadi, Chennai.

II. Tannin Extraction Process

Tannin was extracted from cashew husk using a process that involves:

1. **Drying:** The collected cashew husks were dried in a hot air oven at 60°C for 24 hours.
2. **Soaking:** The dried husk was mixed with distilled water and left at room temperature overnight.
3. **Autoclaving:** The mixture is then autoclaved under pressure for 30 minutes.
4. **Filtering:** The filtered solution is used as a source of crude tannin.

III. Quantification of Tannin Content (Ukoha, *et al.*, 2011)

Quantification of tannin was performed by spectrophotometer at 700 nm, serial dilutions of standard tannic acid were used.

IV. Preparation of PVA/CMC/TA blend and application as surface coating Food Preservation (Magdy M. H. Senna *et al.*, 2014)

STUDY 1:

Different concentrations of tannin (5, 10, and 15%) were prepared for the study. To begin with, 1 g of carboxymethyl cellulose (CMC) was dispersed in 100 ml of distilled water at room temperature under continuous stirring. Once the CMC was fully suspended, the solution temperature was gradually increased to 95 °C while maintaining constant stirring. Separately, 3 g of polyvinyl alcohol (PVA) was dissolved in hot water and then added to the CMC solution with continuous mixing. After obtaining a uniform PVA/CMC mixture, tannic acid (TA) was incorporated at concentrations of 5, 10, and 15%. The study was carried out for one week.

The resulting PVA/CMC/TA blend solutions were applied as surface coatings to thoroughly washed and dried *Musa acuminata* fruits, ensuring complete coverage of the surface. Coated fruits were compared against uncoated control samples. All the samples were stored at room temperature and monitored over consecutive days to evaluate changes in quality and shelf life.

RESULTS AND DISCUSSION

The first research on Cashew Nut Testa was done five decades ago when the chemical components of cashew testa were identified by (Mathew *et al.* 1970). Since then, numerous projects have been undertaken on the cashew nut's other components (the shell, liquid, and apple), but relatively little work has been done on the cashew nut's testa.

In our study we have used the cashew husk for tannin extraction to enhance the shelf-life of fruits. Tannin plays a important role in antioxidant and antimicrobial activities.

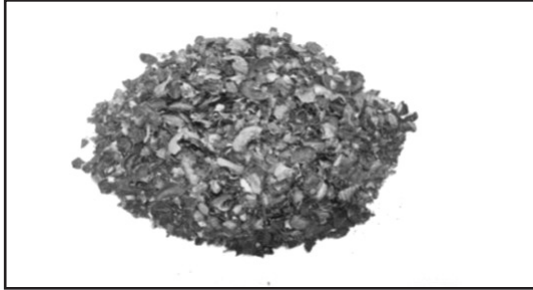


Figure 1 - Cashew Husk



Figure 2 - Tannin Extraction

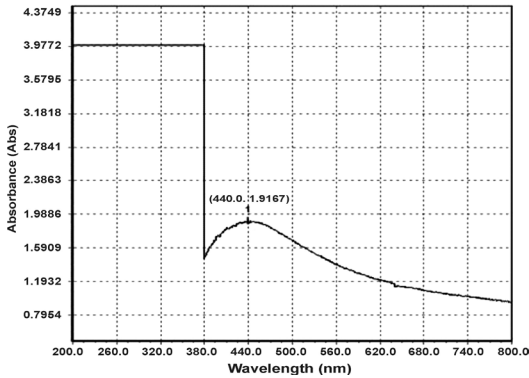


Figure 3-UV-VIS Spectrum of Tannin - Standard

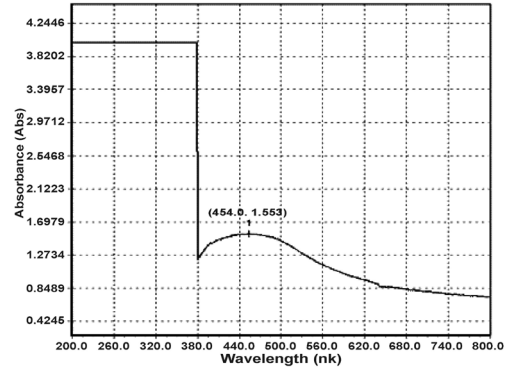


Figure 4-UV-VIS Spectrum of Tannin-Cashew Husk

We have collected the cashew husk, Figure 1, 2, 3 indicates the extraction of tannin by hot water extraction and the tannin content was confirmed by UV-Vis spectrum at 440-454nm compared with standard tannic acid.

PHASE STUDY:

Preparation of PVA/ CMC/ TA blend and application as surface coating Food Preservation



Figure 5 - PVA/CMC



Figure 6 - PVA/CMC/TA Blends



Figure 7 - Day 1



Figure 8 - Day 2

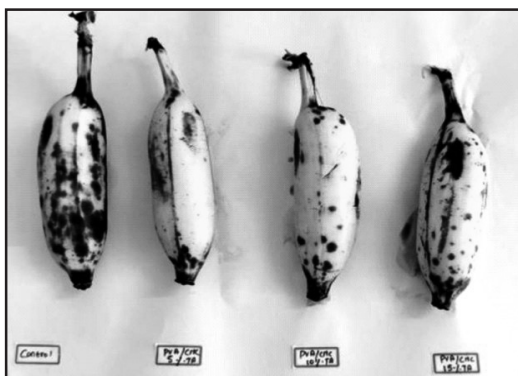


Figure 9 - Day 4



Figure 10 - Day 6

In order to determine the shelf-life of *Musa acuminata* fruit, we have designed the work. Figure 5 & 6 indicates the preparation of the PVA/CMC/TA blend with tannin in the ratio of 5%, 10%, 15%. The blend was applied on *Musa acuminata* fruit and kept at room temperature and noticed for shelf life on interval days. In this phase Figure 7, 8, 9 & 10 indicates and we have analysed that at 6th day, *Musa acuminata* coated with 5% of tannin in good natural colour, whereas *Musa acuminata* coated with 10%, 15% and control is damaged completely and got ripened. These justify that increase in the content of tannin by polymerization which occurs ripening causes a lack of astringency due to the insolubility of tannins (Jackson 2008).

CONCLUSION:

In conclusion, tannin from cashew waste incorporated edible coatings have emerged as a promising method to raise food quality, enhance shelf life, and reduce environmental waste. They are often made from natural polymers like proteins, polysaccharides, and lipids, and offer multiple advantages such as maintaining food freshness, reducing moisture loss, and protecting against microbial spoilage. In addition, they serve as a sustainable substitute for conventional packaging materials, which are frequently nonbiodegradable and contribute to plastic litter. Edible coatings have the potential to decrease food waste by keeping the freshness and safety of perishable

foods. They also create a barrier to oxygen, moisture, and other outside elements, slowing the deterioration process and extending product shelf life. The development of new materials and improved formulation methods is expected to shape the future of edible films and coatings. As these innovations advance, food packaging and preservation are likely to become more sustainable and environmentally friendly increasing advancements and are used widely in the food industry.

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ROLE OF DIGITAL INFLUENCERS IN PROMOTING SUSTAINABLE LIFESTYLE

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ABSTRACT

Digital influencers are important in spreading sustainable lifestyle practices, taking full advantage of their audience and credibility to influence consumer behaviour. They employ a range of approaches and practices to engage people's lifestyle choices creating relatable content which embodies sustainability as a lifestyle choice, creating awareness about environmental issues, eco-friendly products, and ethical practices, and they are able to interpret complex sustainability concepts into relatable ways. Influencers have normalised small-lifestyle changes for the audience. They are facilitated that change through informational, entertaining, engaging storytelling and tutorials and a real-life demonstration of living sustainably as part of daily life. By establishing trendsetting behaviours and normalising sustainable living as aspirational and trendy, digital influencers are making a unique opportunity to positively disrupt the academics and practitioners willing desirably to empower change that fits within the things people care about into a life practice. It's a small step towards cultural change that embraces a more sustainable life. Now it is no exaggeration to say that we are being driven by digital influencers towards sustainable lifestyle trends. In the contemporary digital landscape, they make big use of platforms like Instagram, YouTube, and TikTok to educate audiences about the many aspects of eco-friendly living, including digital content about minimalism, ethical fashion, zero-waste living, and renewable energy decisions. While the influence of the digital influencers is impactful, it also comes with a level of responsibility - social media influencers must be authentic, avoid greenwashing, and ensure evidenced-based recommendations are made. In this way, when done responsibly, digital influencers develop a sort of momentum or ripple effect or shift; changing the attitudes and practices of individuals and, in time, it is these very shifts on an individual basis that ignites change culturally to promote long term environmental sustainability.

KEYWORDS: *Digital influencers, Sustainable lifestyle, Consumer behaviour, Eco-friendly practices, Authenticity, Green washing, Influencer marketing.*

INTRODUCTION

Today the action of digital influencers to promote and educate towards sustainable living is critical. Being able to draw the attention and trust of their publics in directions towards more responsible eco-friendly behaviours is a significant help. Utilization of their focus and interaction by visiting relatable social media content adds much to making people aware and developing more responsible consumption practices.

With the added social and environmental issues that the world is experiencing, social media stars have been more crucial than ever. Social media stars possess vast power to influence the masses and draw the group's attention. They champion environmentally friendly behaviour and sustainable product recommendations, which makes it more possible to popularize and more practical to implement these behaviours in everyday life.

Research indicates that influencers, in fact, possess the ability to bridge the gap that exists between companies and their customers and boost the convenience of purchasing environmentally friendly products. The feeling of belongingness and communality that they instill about sustainable lifestyle is because of their interactions with their followers, which is second boosted due to their intriguing stories interwoven with their everyday sustainable lifestyle experiences. Also, the message is transmitted further with the partnerships that influencers establish with organizations that specialize in environmentally friendly products.

REVIEW OF LITERATURE

Influencer marketing is an effective weapon with which to reach the citizens of this generation, and one that can be utilized for consumerism and sustainable living as well. Influencers are capable and have the ability to influence consumer behavior. When influencers promote sustainable products and practices, they are able to affect a large number of people and positively impact the environment. While the success of influencer marketing depends on some variables like the credibility and believability of the influencer, the message content they deliver, and the audience, the influence remains humongous. (Vemuri et al., 2024)

This trust makes the application of influencer marketing a weapon for advertising. As consumers' interest increases, the sustainable fashion sector has expanded, and social media influencers are being used to change consumers' perception and buying behaviour. Through semi-structured interviews, this study deals with the influence of influencers as a marketing strategy in the sustainable fashion sector to examine the social media habits and financial opportunities of sustainable fashion social media influencers. (Jacobson & Harrison, 2021)

The research adopts a mixed-method that incorporates qualitative meta-analysis, case studies, and a quantitative web survey. The research explores the effects of social media transparency, influencer marketing, and consumer interaction on social media on consumer behaviour and attitudes. Findings reveal high correlations between social media transparency and purchase intentions. (Sipos, 2024)

AI influencers are also trending as a new way for brands to raise consumer engagement and build purchase intention, but little research is available on this new trend in marketing. (Jayasingh et al., 2025)

The primary objective of the focus group is to learn how they are impacted by social media and digital influencers. The participants for this focus group are between 18-30 years old, with male and female participants and varying geography locations. (Carneiro et al., 2022)

The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). To this end, we chose an exploratory quantitative study, gathering information using a questionnaire survey. The paper opens with a literature review, including issues like digital influencers and the world of the digital age, the Internet, the buying process, and digital influencers. (Gonçalves et al., 2024)

OBJECTIVES OF THE STUDY

Digital influencers play a crucial role in promoting sustainable lifestyles by shaping consumer behaviours and attitudes towards eco-friendly products. Key objectives include raising awareness about sustainability, encouraging environmentally conscious purchasing decisions, and fostering community engagement around sustainable practices.

- To employ tools and **methods** – To facilitate sustainability, social media platforms, narratives, product reviews, and partnerships with sustainable brands are employed by influencers.
- To emphasize **benefits** – To make sustainability personal, influencers influence consumer behaviour, facilitate environmentally friendly purchasing, and create supportive communities.
- To solve **challenges** – To overcome obstacles, influencers contend with audience skepticism, misinformation, and greenwashing threats while being authentic.
- To cause **impact** – To trigger change, influencers encourage recycling, waste minimization, and sustainable business support, resulting in permanent lifestyle changes.

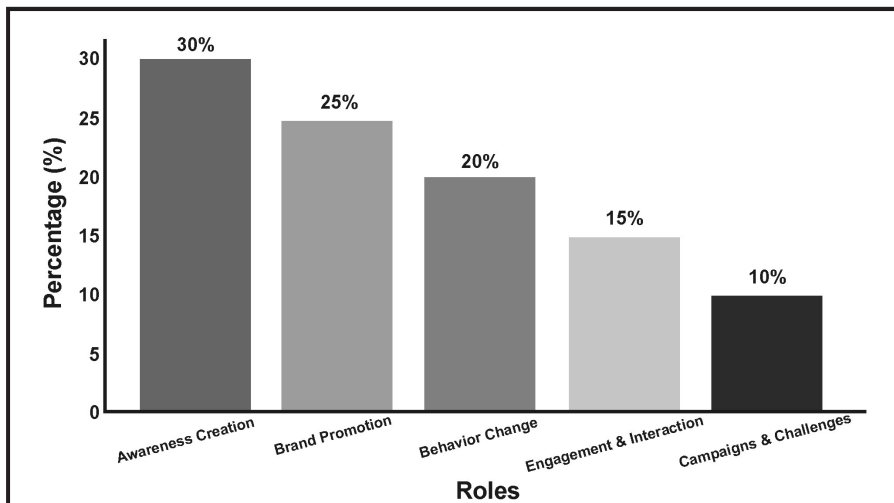


Figure 1- Role of Digital influencers in promoting sustainable lifestyle

ADVANTAGES

1. **Wider Reach:** Influencers have the power to reach out to large audiences and thus the idea of sustainability can be conveyed in a very effective way.
2. **Cost-Effective Marketing:** The major part of the cost for a brand partnership with an influencer is usually significantly lower than that of a traditional advertising campaign.
3. **Relatability:** They have become green through their own lifestyles and therefore green living has become more understandable and relatable to their followers.
4. **Influence on Consumer Behaviour:** Influencers have the power to change consumer behaviour and they can make their followers adopt sustainable methods of living by convincing them.
5. **Engagement and Interaction:** They produce such attractive material that raises the level of interaction and makes the process of engagement easier when talking about sustainability and making eco-friendly choices.
6. **Partnership Opportunities:** Brands based on sustainability are the most suitable partners that can give the influencer the necessary help to raise the awareness of recycled or non-polluting products usage.
7. **Trendsetting:** Influencers are the first movers of the trend, and the use of sustainable products will become more visible and accepted earlier in the market due to their decision.
8. **Community Impact:** If influencers develop sustainable communities, then they can engage more people to cooperate and thus have a greater impact on environmental issues.

CHALLENGES

When digital influencers try to make their content more human-like, one of the biggest problems they have is that, along with keeping the emotional connection with their audience, they also have to keep authenticity. On top of that, not only the necessity of being able to survive the changing algorithms but actually being comfortable with them can lead to their content getting less and less authentic and relatable.

When they see humanized content as a battle to keep authenticity, digital influencers are turning their backs on the struggle. One of the main ways a consumer can tell the difference between a social and virtual influencer is to see the former as more transparent and trustworthy. That puts the pressure on all the digital influencers to be real enough. So that their followers could feel the true connection. Socializing through emotionally structured bonds with followers is the most important aspect of the whole business. Influencers need to deal with the fact that sometimes they are required to be dishonest yet they are to uphold the personality of the brand, by this we mean ensuring the content looks like it is done in a more authentic and less commercial way. Algorithm Adaptation.

The main reason why content is constantly updated to algorithms standards of the platform is to keep up with or even set the new trends. Unfortunately, this focus on trends could lead to the brand losing its humanized side in the content. Brand partnerships such as brand influencers as compatible, the certifications among the authenticity of their signatures may be the question. It can make the followers question the influencer's real thoughts and actions. Content rigor Influencers

are jotted to have their writing and content in a specific manner as demanded by the brands. This may rob their art of its creativity and their ability to make relatable content. Balancing Virtual and Real With the rise of virtual influencers, the human influencers should use the real-life events and emotions of theirs as a means of separating, which is not that easy in a world of digital personas.

DIGITAL INFLUENCERS USED DIFFERENT METHODS AND TOOLS TO PROMOTE PEOPLES LIFESTYLES

Visual Storytelling: Through picture and video platforms such as Instagram and TikTok, social-media stars can spread their ideas with the visuals that attract not only the audience interest but also their attention. Through this visual persona, the public can easily realize the concept and even get engaged in the implementation of these concepts in their lives.

Bloggng: Writing is one of the main methods through which social-media stars can define their ideas while dealing with environmental issues. As a result of sharing tips and product reviews along with personal experiences about eco-conscious life, they can become a part of a community that will consist of friends and supporters which are willing to implement the eco-friendly lifestyle.

YouTube Content: Influencers through video presentations can make the process of adopting eco-friendly habits quite simple for the viewers. Showing their full potential, they can render the whole project through step-by-step instructions, give the most unbiased product reviews and make it easy through tutorial videos.

Personal Narratives: Relating one's own stories and moments of struggle due to a change to a green lifestyle can easily gain the sympathy of listeners. Convincing storytelling could be the ignition for the idea of embarking on another personal sustainability journey in others.

Brand Collaborations: With the help of brands that are conscious of the environment, social media stars can be more accessible in new areas through sponsored content. In this way, both sides benefit: the good news about the products is communicated, and consumers get quality goods that they can trust being advertised.

Sustainability Challenges: Such contests and challenges as plastic-free weeks do not only bring benefits in terms of social media fame but also attract the audience by engaging them in activities that can become their regular lifestyle in which they can get used to healthier consumption patterns that have less waste impact all over the world. Activities like this may allow fans to become acquainted with one another.

Workshops and Webinars: Through educational interactions, the influencers enable their audience to learn from environmental experts, lectures could be on decomposition or green fashion and they would be very eye opening and quite useful as skills acquired during such practice are transferable to one's lifestyle for sustainable living.

Resource Sharing: When guides and checklists are created for the followers to download, they take the sustainable steps with great confidence. Without being a burden, the materials may turn out the followers; great helpers in environmentally-conscious practices of daily life.

Championing: Proactively sharing information with the public being enthusiastic about the cause and lobbying for political changes can greatly increase the influencer's effect. By teaming up and fighting for such causes, they can achieve the effect of reaching more people and encouraging them to do the same.

Daily Integration: Through sustainable day-to-day life (meal preparation or use of eco-friendly products at home) followers are not only going to feel the eco-friendly lifestyle through their throats but also are going to find it very affordable and relatable.

CONCLUSION

Eventually, the social media personalities end up in a bewildering situation in which seeking genuineness is frequently a compromise. They desire to have a one-on-one interaction with their followers by being totally open about their deepest thoughts and feelings and yet, at the same time, by merely adhering to the typical pattern of their online presence.

In some instances, the struggle of always being on top and having to constantly adjust to the changing algorithms can be so difficult that it can, in a way, overshadow the type of closeness they want to have with their audience. However, content with a human touch cannot be all by itself without the main characters - the features of vulnerability and relatability. Those influencers that aren't scared to show their weaknesses and are ready to share their real lives, may get a fan base that never stops growing.

It is not only about receiving more likes and shares but also about the establishment of trust and a feeling of being a part of the group. If the influencers had relied more on truth telling rather than on perfection, they would have made their fans feel that they are there for them, that what they say matters, and that they are important. At this moment, realness is not only a breath of fresh air in the most congested and duldest of markets - it is also a requirement.

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A PRELIMINARY STUDY ON PHYTOCHEMICAL SCREENING AND ANTIOXIDANT ASSAY OF *Euphorbia hirta* L. INFLORESCENCE

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ABSTRACT

In order to determine the bioactive components of Euphorbia hirta L. inflorescences, this study focuses on phytochemical analysis. The phytochemical profiles of different solvent extracts such as water, ethanol, ethyl acetate, and hexane were investigated. Preliminary screening indicated the presence of phenolic chemicals, alkaloids, glycosides, flavonoids, tannins, and coumarins. The aqueous extract had the maximum extraction yield, demonstrating its potential phytochemical richness. These results set the stage for additional research into the plant's antibacterial, wound-healing, and antioxidant qualities.

KEY WORDS: *Phytochemicals, extraction, and Euphorbia hirta L. Inflorescence, Antioxidant-DPPH*

INTRODUCTION

Commonly referred to as tanner's weed or asthma-plant, *Euphorbia hirta* L. is a tropical herb that is widely distributed and a member of the Euphorbiaceae family. Moreover presence of rich phytochemical compounds of the plant used in various therapeutic applications (Singh, 2018, Sharma, 2010 & Patel, 2014).

The plant is known for its milky latex, which has biologically active substances in it but is also toxic, thus its safety profile needs to be carefully assessed. Numerous ingredients with interesting pharmacological activity have been found through phytochemical experiments, confirming its traditional usage and igniting scientific validation.

Euphorbia hirta is a promising option for additional pharmacological and phytochemical research because of the rising incidence of antibiotic resistance and the need for plant-based treatments. Together with conventional knowledge, its wide range of biological activity emphasizes the significance of thorough research to fully realize its medicinal potential. *Euphorbia hirta* plant inflorescence phytochemical components, antioxidant qualities will be examined in this study.

REVIEW OF LITERATURE

The rich phytochemical profile of *Euphorbia hirta* L. and wide range of pharmacological potential are highlighted in the literature. Important bioactive substances that contribute to its therapeutic qualities have been found in numerous research, including flavonoids, phenolic acids, tannins, triterpenes, and phytosterols (Kumar 2007; Sharma 2010). Its traditional use in treating skin, gastrointestinal, and respiratory conditions is supported by phytochemical screening, which consistently finds the presence of alkaloids, flavonoids, tannins, phenols, saponins, glycosides, and coumarins in a variety of plant parts (Patil & Naikwade, 2009; Basma, 2011).

Using techniques like disc diffusion and broth microdilution, as well as the presence of phytochemicals like flavonoids and tannins, numerous studies have shown the antimicrobial activity of *Euphorbia hirta* extracts against a variety of bacterial pathogens, including *E. coli*, *S. aureus*, and *P. aeruginosa* (Sharma, 2018; Kumar, 2007). Furthermore, DPPH scavenging tests and assessments of total phenolic content have validated its antioxidant qualities, which are mostly ascribed to phenolic components (Basma, 2011).

Extracts from the plant have also been shown to have anti-inflammatory and wound-healing properties; in vitro and in vivo models, they have been shown to enhance tissue regeneration, decrease protein denaturation, and promote fibroblast migration. These results lend credence to its potential for creating herbal formulations that successfully harness its medicinal effects.

All things considered, the literature study highlights *Euphorbia hirta* as a potentially valuable natural antibacterial and healing agent that merits more pharmacological and phytochemical research to maximize its therapeutic uses.

AIM AND OBJECTIVE

- To collect and Processing of sample
- To extract crude metabolites by maceration (solvent) and boiling method (water)
- To study qualitative phyto-chemical analysis
- To analyze the antioxidant properties by DPPH and Total phenol assay

MATERIALS AND METHODS

Collection of sample

The *Euphorbia hirta* inflorescences were collected from local area.

Processing of Sample

The samples were cleaned to remove sand particles and shade dry for four days. Then the materials were hand crushed and made as a coarse powder using mixer grinder. The dried grinded powder was used to extract with hot water and solvent.

Extraction Process

Solvent extraction by maceration method

5 g sample was added to glass beaker containing 100 mL of solvent such as ethanol, Ethyl acetate and Hexane. The beaker was covered with aluminium foil and kept at room temperature overnight. After 24 hrs the extract was filtered using whatmann filter paper and air dry. The crude extract was used for further studies.

Preparation of Aqueous Extraction- Boiling Method

Aqueous extraction (Ogueke, 2007)

5 g sample was added to glass beaker containing 100 mL of Milli-Q® water. The mixture was then heated at 75°C for half an hour before being allowed to slowly cool down to room temperature (22 °C). After cooling, the aqueous mixture was filtered using whatmann filter paper. The filtered extract (BE) was stored for further studies.

Phytochemical analysis

The qualitative phytochemical analysis for the presence of Terpenoids, alkaloids, flavonoids, phenol, glycosides, tannin, coumarins was carried out using the methods described by (**Suresh, 2008**).

Antioxidant Assay

DPPH radical scavenging activity:

The antioxidant activity of the extracts was evaluated using the procedure described by Okoli (2009).

Total Phenolic Content

Phenolic content of the extract was estimated by the method followed by (**Abubakar, 2009**). Total phenol content was calculated using linear regression equation from the Gallic acid calibration curve.

RESULTS AND DISCUSSION

Numerous phytochemical ingredients have been verified to be present in *Euphorbia hirta* L. inflorescence. As a result, setting a standard is crucial to preserving their quality. To identify the different phytochemical elements, the extracts underwent a first phytochemical investigation. Alkaloids, glycosides, flavonoids, tannins, coumarins, and phenolic compounds were found in the aqueous, ethanol, and ethyl acetate extracts, according to the analysis. (Figure 3; Table 2)

Antioxidant activity – Invitro

Table 3 and Figure 4 & 6 demonstrate that the samples' DPPH radical scavenging effects were as follows: According to the study, ethanol and aqueous solutions have strong antioxidant activity followed by ethylacetate and hexane; the high antioxidant properties results revealed may be due to the presence of phenolic compounds.

Total phenol content Assay

The Folin-Ciocalteu reagent was used to measure the total phenolic content. The results were varies depending on the solvent. Overall phenolic compounds in extracts ranged from 399.75, 26.125, and 2.321 mg/g expressed as gallic acid equivalents (GAE), according to Table 4. The highest levels of total phenolic content were found in ethanol and aqueous solutions, with ethyl acetate coming in second. (Figure: 5 & 7, Table 4).

CONCLUSION

Phytochemical screening of different solvent extracts of *Euphorbia hirta* L. inflorescences confirmed the presence of variety of bioactive compounds such as alkaloids, glycosides, flavonoids, tannins, coumarins, and phenolics. These phytochemicals are recognized for their medicinal potential, particularly their antioxidant effects. For example, the occurrence of alkaloids and flavonoids is often linked to significant therapeutic activities. With antimicrobial and anti-inflammatory effects, while phenolic compounds and tannins contribute significantly to antioxidant activity. The variation in phytochemical content among different solvent extracts reflects their polarity and extraction efficiency, influencing the pharmacological potential of the extracts. Such phytochemical profiles support the traditional uses of *Euphorbia hirta* L. inflorescence in treating various ailments and justify further pharmacological investigations.

TABLE: 1 - Crude Yield

S.No.	Extracts	Percentage Yield mg/gram
1	Aqueous	130.6 mg
2	Ethanol	64 mg
3	Ethyl acetate	27 mg
4	Hexane	6.2 mg

TABLE: 2 - Phytochemical Analysis of *Euphorbia hirta* L. Inflorescence extracts

Extracts	Terpenoids	Alkaloids	Flavonoids	Phenol	Tannin	Saponoin	Glycosides	Coumarins
Aqueous	+++	++	+++	+++	+++	-	-	+++
Ethanol	+++	-	-	+++	+++	-	+++	+++
Ethyl acetate	+++	-	-	+++	+	-	+++	-
Hexane	-	-	-	-	-	-	-	-

TABLE: 3 Antioxidant assay-DPPH Scavenging activity of *Euphorbia hirta* L. Inflorescence extracts

Extracts	Scavenging %
Aqueous	84.82
Ethanol	76.26
Ethyl acetate	44.9
Hexane	10.37

TABLE: 4 Total Phenol Concentration of *Euphorbia hirta* L. Inflorescence extracts

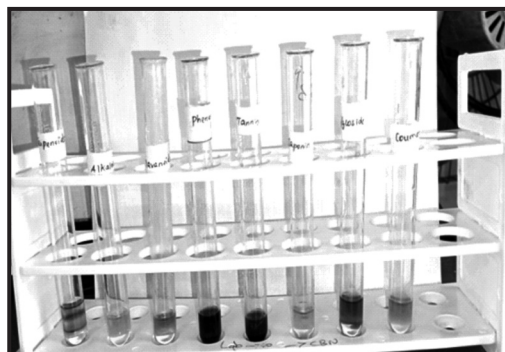
Extracts	Concentration in µg/ml
Aqueous	399.75
Ethanol	399.75
Ethyl acetate	26.125
Hexane	2.321



Figure : 1. *Euphorbia hirta* L. Habit



Figure: 2. Extraction of Inflorescence



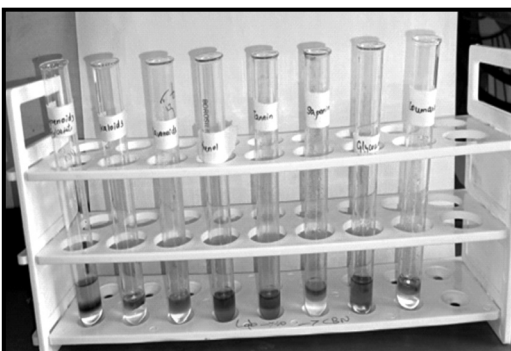
Ethanol



Aqueous



Ethyl acetate



Hexane

Figure: 3. Phytochemical Analysis

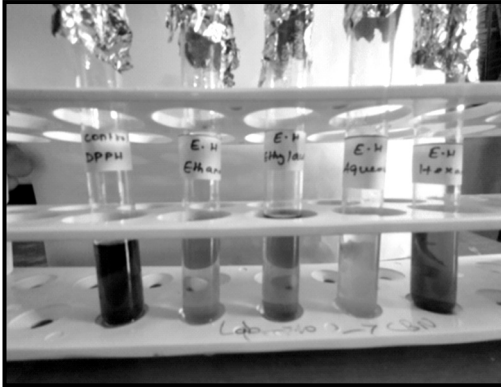


Figure: 4. DPPH Scavenging activity

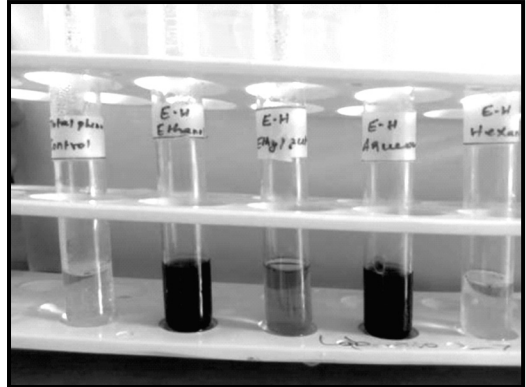


Figure: 5. Total Phenol Assay

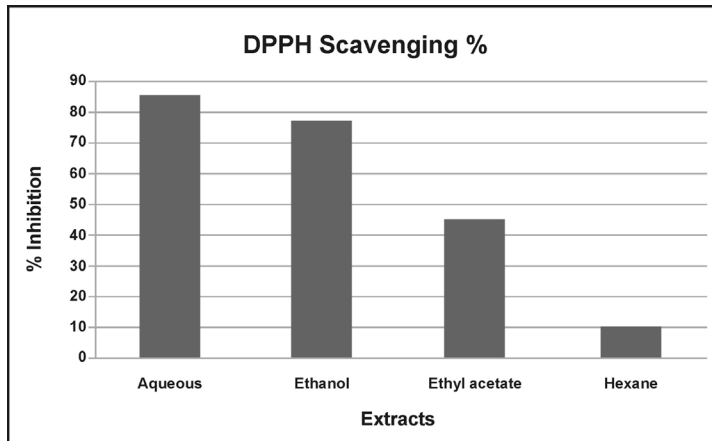


Figure: 6

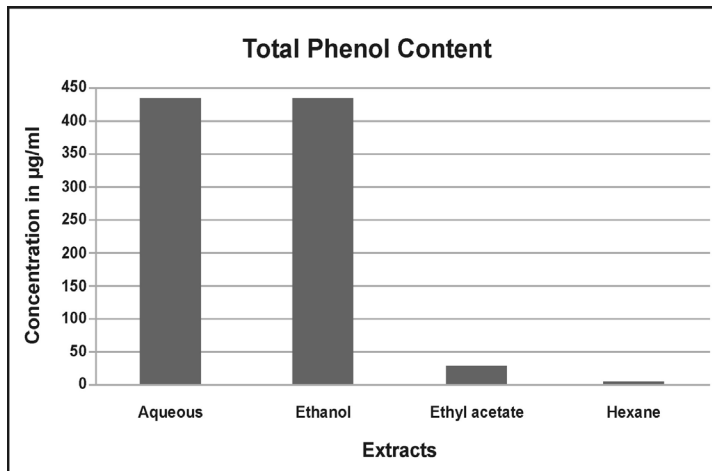


Figure: 7

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RURAL ENTREPRENEURSHIP AND RURAL ECONOMY DEVELOPMENT - AN OVERVIEW

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ABSTRACT

Rural entrepreneurship simply means starting and running businesses in villages. It can happen in many areas—like farming, trade, small industries, or other businesses—and it plays an important role in boosting the local and overall economy. Rural entrepreneurs increase the standard of living and purchasing power of the people by offering employment opportunities to the people in villages. Rural entrepreneurship plays an important role in stimulating the local economic development by creating employment, by utilizing local resources, and promoting economic diversification beyond traditional agriculture. It accredits marginalized groups, improves infrastructure, and increases income levels, and community growth. However, rural entrepreneurs often face many challenges such as limited access to finance, lack of proper infrastructure, and market constraints.

Promoting rural entrepreneurship not only drives economic elasticity in rural areas but also helps reduce urban migration. Rural Entrepreneurship is a process of developing and encouraging businesses in rural areas and enhancing their contribution to the national economy. This is one of the best ways to motivate people residing in rural areas to establish their businesses and get aligned with the mainstream economy.

Keyword: Rural Entrepreneurship, Problems, Constraints, Amenities, Local Economic Development, Economic Diversification, Enhancing Infrastructure, Rural Communities.

INTRODUCTION

Fostering new businesses and encouraging innovation, rural entrepreneurship contributes to job creation, reduces poverty, and curbs the migration of rural populations to urban areas. Furthermore, it promotes economic diversification, reducing the over-dependence on agriculture and integrating rural economies into broader value chains. Economic development means growth of standard of living of people from lower-level income people to higher income people. Entrepreneurs play a big role in the economic growth of a country.

Local economy development, on the other hand, focuses on improving the overall economic health of a community by strengthening local enterprises, enhancing infrastructure, and building human capital. It utilizes local resources such as agriculture, raw materials, and local skills for establishing small-scale industries in the rural regions. Such industries create employment for rural areas, increase household income for rural workers, and enhance village economies.

REVIEW OF LITERATURE

1. Sharma and Singh (2013)

The creation of alternative income sources through rural entrepreneurship is taking place in many ways throughout the world. Many rural entrepreneurs create non-agricultural job opportunities for their communities, which can help alleviate poverty. There are many ways that rural entrepreneurship contributes to equal opportunities for all areas by supporting equalization of regional economic development. The creation and operation of rural businesses are only possible with access to local resources; thus, developing these resources is essential for encouraging rural entrepreneurship.

2. Saxena (2012)

The government heavily influences the entrepreneurial ecosystem that exists in rural areas. There have been numerous studies that have established a relationship between government policies and rural entrepreneurship, specifically regarding the positive impacts of credit programs, training programs, and grant programs for rural entrepreneurs. However, once rural entrepreneurs try to access these programs, the complicated nature of the requirements outweighs the benefits of utilizing them. Therefore, Saxena has suggested that the administrative processes necessary for accessing these rural development tools should be streamlined to support rural economic growth through government policy reform.

3. Mishra and Tripathi (2011)

Mishra and Tripathi's 2011 research investigated how female entrepreneurs in rural areas can benefit from micro-financing. They discovered that by receiving small amounts of credit through micro-finance programs, women could increase their income, independence, and business success over time. The authors noticed that female entrepreneurs who engaged in micro-enterprise activities became better decision-makers. Also, the study found that Micro-Finance programs also eliminated financial exclusion from female entrepreneurs' communities. Therefore, the authors conclude that Micro-Finance can serve as a catalyst for creating sustainable rural development.

4. Sarkar (2017)

Sarkar's 2017 research examined how Digital Technologies can support Rural Entrepreneurs. This research demonstrated how Information and Communications Technology (ICT) can enable Rural Businesses to access markets. Using digital platforms reduces transaction costs and increases efficiency. Sarkar concluded by stating that Developing Digital Literacy will improve the probability of success for Rural Entrepreneurs and that Technology Adoption will support the Economic Development of Local Rural Areas.

SCOPE OF THE STUDY

- a) The contributions of Rural Entrepreneurship to Rural Economic Development.
- b) The impact of Rural enterprises creating jobs and improving livelihoods.
- c) The impact of Rural Entrepreneurship in creating Sustainable and Inclusive Developments.
- d) The use of Local Resources, Skills and Innovations in developing Rural Enterprises.
- e) The influence of Governmental Policy, Financial Assistance and Infrastructure on Rural Entrepreneurship.

OBJECTIVES

- To identify how farmers contribute to the creation of jobs in their community and reduce the migration of individuals from the rural community to urban communities.
- To identify the socio-cultural and institutional factors that hinder rural businesses from effectively operating within their rural community.
- To understand the relationship between rural businesses and community members - the impact of rural businesses on social inclusion, gender equality, and economic development in the region.
- To evaluate the financial, infrastructure, and technology-related barriers that pose the greatest challenges for rural entrepreneurs.

RURAL ENTREPRENEURSHIP AND SUSTAINABLE DEVELOPMENT

1. Employment Generation

- Rural entrepreneurs establish small-scale and argo-based industries, handicrafts, and service enterprises that directly create jobs for the local population.
- By promoting self-help groups (SHGs), cooperatives, and micro-enterprises, they empower rural communities, especially women, to participate in economic activities.\
- Entrepreneurship also fosters skill development and entrepreneurship culture among youth, reducing dependency on agriculture alone.

2. Income Enhancement

- Rural enterprises diversify income sources beyond agriculture, reducing vulnerability to crop failures and seasonal fluctuations.
- Value addition to agricultural produce (like food processing, dairy, and organic products) ensures higher income for farmers and entrepreneurs.
- Improved income levels enhance purchasing power, living standards, and overall quality of life in rural households.

3. Reduction of Regional Disparities

- o Rural entrepreneurship promotes balanced regional development by decentralizing industries and reducing pressure on urban economies.
- o It bridges the rural-urban divide by creating infrastructure, market linkages, and employment opportunities within villages.
- o By harnessing local raw materials and traditional skills, it strengthens local economies and reduces economic inequality.

THE OPPORTUNITIES AND CHALLENGES FACED BY RURAL ENTREPRENEURS

Reduces migration: By creating work opportunities and improving income levels in villages, rural entrepreneurship can help reduce the movement of people from rural to urban areas in search of jobs.

Improves infrastructure: When businesses grow in rural areas, they also bring better facilities like electricity, roads, and bridges, which benefit the whole community. It helps to check the migration of people from rural areas to urban areas in search of jobs.

Balanced regional growth: Rural entrepreneurship can dispel the concentration of industrial units in urban areas and promote regional development in a balanced way. It also utilizes local resources, such as raw materials and labour, this promotes economic development in rural areas and reduces regional disparities.

OPPORTUNITIES

1. Crashed scheme for rural development.
2. Food for work programs.
3. National Rural Employment Program.
4. Regional Rural Development Centres.
5. Entrepreneurship Development Institute of India.
6. Bank of Technology.
7. Rural Innovation Funding.
8. Social Rural Entrepreneurship.

CHALLENGES FACED

1. Financial problems faced by rural entrepreneurs include difficulty in obtaining loans due to lack of collateral and lengthy procedures, dependence on high-interest loans from moneylenders and landlords. The low purchasing power of rural consumers which affects sales, limited access to government subsidies and financial institutions, and challenges in raising funds through equity due to low financial literacy.

2. Marketing problems include intense competition from large-scale and urban industries, high production costs and lack of product standardization, poor marketing due to low literacy and communication barriers, inadequate storage, transportation facilities and exploitation by middlemen who take large profits.
3. Management challenges include a lack of IT knowledge and modern business skills, difficulty in complying with legal formalities due to illiteracy, problems in procuring quality raw materials and storing them, a lack of technical knowledge and training facilities, and poor product quality due to inferior tools and materials.
4. Limited Access to Finance and Poor infrastructure Rural entrepreneurs often struggle to secure loans or investment due to lack of collateral, high interest rates, and absence of financial institutions nearby. Inadequate transportation, unreliable electricity, limited internet connectivity, and lack of storage facilities hinder business operations and market access.
5. Low Skill Levels and Education Low skill levels and education in rural areas significantly hinder entrepreneurship and management because essential business competencies—planning, budgeting, marketing, and customer service—are often not taught. Limited access to quality schooling and vocational training leaves people with poor numeracy, literacy, and digital skills, making it hard to read contracts, manage cash flow, or use productivity tools.

RURAL ENTREPRENEURSHIP AND DEVELOPMENT GOALS

Rural entrepreneurship is not just an economic activity but also a social tool that drives inclusive growth and supports the broader vision of sustainable development. By ensuring participation of marginalized groups, empowering women, and promoting environmentally friendly practices, rural entrepreneurship aligns closely with the **Sustainable Development Goals (SDGs)** set by the United Nations.

1. Contribution to Inclusive Growth

- o Rural entrepreneurship provides equal opportunities for all sections of society, including women, youth, and disadvantaged communities, thereby fostering social equity.
- o Women-led enterprises and SHGs promote gender equality by enhancing women's decision-making power and socio-economic status.
- o Inclusive financial models such as microfinance and cooperative banking enable small entrepreneurs to access credit and resources.

2. Support to National Development Goals

- o By creating local employment, rural enterprises reduce migration to cities and contribute to balanced regional development, in line with India's rural development policies.
- o Promotion of eco-friendly businesses (organic farming, renewable energy projects, handicrafts) supports environmental sustainability and resource conservation.
- o Rural entrepreneurship contributes to food security, poverty reduction, and education by reinvesting income into community welfare.

3. Alignment with Sustainable Development Goals (SDGs)

- o **SDG 1 (No Poverty):** Rural enterprises generate income and reduce poverty in rural households.
- o **SDG 5 (Gender Equality):** Women entrepreneurs are empowered through SHGs and microenterprises.
- o **SDG 8 (Decent Work and Economic Growth):** Small businesses create productive employment opportunities.
- o **SDG 10 (Reduced Inequalities):** Rural entrepreneurship bridges the rural-urban divide and reduces economic disparities.
- o **SDG 12 (Responsible Consumption and Production):** Many rural businesses utilize local resources sustainably.

CONCLUSION

Rural businesses contribute not only to their own success, but also to the long-term success of the economy. The creation of new jobs and higher wages through rural business leads to reduced income disparities between rural and urban communities, while fulfilling some of the major social needs of these communities, such as education and health care, and helping to achieve some of the national development and inclusive growth goals. However, because they are faced with many of the same obstacles that all entrepreneurs are faced with (limited access to capital, poor infrastructure and limited access to markets), rural businesses will continue to need enhanced policy support for rural entrepreneurs in order to build a stronger rural entrepreneurial ecosystem, expand access to financial services, develop skills and build rural infrastructure if they wish to reach their maximum potential for the creation of new and developing businesses. Rural businesses not only generate economic opportunities within their communities; they also act as agents of change by empowering their communities to create jobs, decrease poverty, and provide better health care, education and social services. Rural business also creates an opportunity to promote and support environmentally and socially sustainable business development and employment that aligns with the United Nations Sustainable Development Goals (SDGs). As rural businesses continue to develop and grow, they also create opportunities for innovative business development and bridge the gap between urban and rural economies, create a more sustainable use of natural resources, and build a resilient rural economy.

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BIOACTIVE COMPOUNDS AND ANTI-INFLAMMATORY EFFICACY OF *Macrocystis pyrifera*

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ABSTRACT

Marine macroalgae are recognized as rich sources of bioactive compounds with diverse therapeutic properties. Among these, Macrocystis pyrifera (giant kelp), a brown alga, has garnered significant interest due to its complex phytochemical composition and biological potential. The study revealed the presence of bioactive phytochemical constituents in Macrocystis pyrifera, which are associated with antioxidant, antimicrobial, anticancer, anti-diabetic, and anti-inflammatory activities. These compounds are known for their antioxidant, antimicrobial, anticancer, anti-diabetic, and anti-inflammatory activities. The anti-inflammatory efficacy of M. pyrifera extracts was evaluated through human red blood cell membrane stabilization and protein denaturation inhibition assays, demonstrating significant protective effects. The observed activity is likely attributable to the synergistic action of fucoidan, phlorotannins, and fucoxanthin, which modulate inflammatory pathways, regulate cytokine expression, suppress oxidative stress, and enhance cellular defense mechanisms. These findings underscore the potential of M. pyrifera as a sustainable marine resource for developing natural anti-inflammatory agents. Future research should focus on isolating specific bioactive fractions, elucidating their mechanisms of action, and assessing their pharmacological efficacy in vivo and through clinical trials, paving the way for novel marine-derived therapeutic products.

KEYWORDS: *Macrocystis pyrifera, Bioactive compounds, Anti-inflammatory efficacy, Seaweed extracts, Marine pharmacology.*

INTRODUCTION

Algae are a diverse and ecologically important group of photosynthetic organisms found in freshwater, marine, and terrestrial environments. They include big multicellular seaweeds and unicellular microalgae. Algae are vital to the ecosystem as primary producers and play a major role in carbon fixation and the worldwide cycling of nutrients. In addition to their ecological significance, algae are becoming more and more recognised as renewable sources of bioactive

chemicals that have uses in the pharmaceutical, biomedical, and nutraceutical sectors (Holdt & Kraan, 2011). Algae are a diverse group of photosynthetic organisms found in freshwater, marine, and terrestrial environments, ranging from large multicellular seaweeds to unicellular microalgae. They are essential as primary producers, contributing significantly to carbon fixation and nutrient cycling globally (Guiry, 2012).

Additionally, algae are increasingly recognized as renewable sources of bioactive compounds with applications in pharmaceuticals, biomedical fields, and nutraceuticals (Holdt & Kraan, 2011). Because of their distinct phytochemical makeup, which includes polysaccharides like fucoidan, laminarin, and alginate, as well as phenolics (phlorotannins), carotenoids (fucoxanthin), and bioactive lipids, brown algae (Phaeophyceae) are highly significant.

These metabolites are associated with various bioactivities such as antioxidant, antibacterial, anticancer, anti-diabetic, and anti-inflammatory properties (Fernando et al., 2016; Fitton, 2011). *Macrocystis pyrifera*, or gigantic kelp, is the largest marine alga, found in temperate coastal regions. Traditionally harvested for alginate, it is now recognized as a source of bioactive compounds with notable anti-inflammatory and antioxidant properties. For example, fucoidan extracts from *M. pyrifera* have demonstrated protective effects by reducing oxidative stress and restoring antioxidant enzyme activities in a murine colitis model (Zhao et al., 2021).

In light of these findings, *Macrocystis pyrifera* is increasingly regarded as a sustainable marine resource with promising biomedical applications. However, comprehensive investigations at the preliminary level are still necessary to strengthen the phytochemical evidence and validate its functional potential. Therefore, the present work is designed to conduct a preliminary screening of *M. pyrifera* for phytochemicals and to evaluate its anti-inflammatory properties using standard laboratory techniques. This approach will provide baseline insights into its bioactive potential and contribute to the growing understanding of marine-derived therapeutic agents.

REVIEW OF LITERATURE

The gigantic kelp *Macrocystis pyrifera* is a rich source of bioactive substances that have been shown to have anti-inflammatory and antioxidant properties, including lipids, alginates, phlorotannins, and fucoidans. The existence of these phytochemicals and their function in lowering oxidative stress and regulating inflammatory responses were validated by early research (Zubia et al., 2009; Rajan et al., 2015). Recent studies have provided experimental and clinical data to support this understanding. Bioactive substances such lipids, alginates, phlorotannins, and fucoidans, which have strong anti-inflammatory and antioxidant properties, are known to be abundant in the gigantic kelp *Macrocystis pyrifera* (Hernández-Carmona et al., 2021).

The existence of these phytochemicals and their functions in lowering oxidative stress and regulating inflammatory responses were confirmed by early studies (Kok et al., 2023; Torres et al., 2019). These conclusions are corroborated by recent experimental and clinical research, which shows the potential therapeutic advantages of *M. pyrifera* extracts in the treatment of oxidative damage and inflammatory diseases (Fidanza et al., 2021). *Macrocystis pyrifera* contains bioactive compounds such as fucoidan, lipids, and polysaccharides, which have demonstrated anti-inflammatory and antioxidant effects. For example, fucoidan extracts have shown protective effects against colitis in mice by decreasing inflammatory cytokines, inhibiting oxidative stress markers, and enhancing antioxidant enzyme activity (Ale et al., 2011; Li et al., 2024). Lipid fractions from *M. pyrifera*

have been effective in reducing TNF- α -induced inflammation and maintaining epithelial barrier integrity in human keratinocyte (HaCaT) models (Fernando *et al.*, 2018; Kim *et al.*, 2023). Furthermore, recent clinical evaluations indicate that topical application of *M. pyrifera* ferment serum can significantly accelerate skin barrier repair after cosmetic procedures like chemical peels and laser treatments.

These findings support the potential of *M. pyrifera* as a source of therapeutic agents for inflammatory and skin barrier-related conditions. According to Lopez *et al.* (2025), *Macrocystis pyrifera* bioactives have been linked to improved barrier strength, increased moisturization, and a faster resolution of inflammation. These investigations demonstrate that *M. pyrifera* compounds possess translational potential beyond laboratory models, with promising applications in cosmeceuticals, nutraceuticals, and medicinal fields (Purcell *et al.*, 2021; Gold *et al.*, 2025). The overall literature supports the future development of *M. pyrifera* in health and biomedical research, highlighting its diverse bioactive substances—such as alginate, fucoidan, phlorotannins, and proteins—that exhibit synergistic antioxidant and anti-inflammatory effects.

MATERIALS AND METHODS

SAMPLE COLLECTION

Macrocystis pyrifera, commonly known as giant kelp, naturally grows in cold, nutrient-rich coastal waters. For this study, dried *M. pyrifera* samples were obtained from a certified commercial supplier to ensure purity and authenticity for experimental analysis.

PREPARATION OF EXTRACT BY SOXHLET METHOD

Dried kelp was ground into a coarse powder to increase surface area. The solvent used was methanol, and the Soxhlet extraction thimble was filled with 10–20 g of powder. While a mantle heated the Soxhlet device, cooling water was pumped through the condenser to condense the vaporised methanol. Four to eight hours were spent on the extraction procedure. The resulting extract was stored in sealed containers in a cold, dark place to prevent the bioactive compounds from deteriorating (Harborne, 1998).

PHYTOCHEMICAL ANALYSIS

Using conventional qualitative techniques, the methanolic extract was screened for phytochemicals such as proteins, amino acids, phenolic compounds, alkaloids, carbohydrates, saponins, flavonoids, terpenoids, and steroids (Harborne, 1998; Trease & Evans, 2009). Because proteins are less soluble in organic solvents, methanol may not be an effective way to extract them; aqueous extraction is a better method for protein detection (Li *et al.*, 2016).

1. DETECTION OF CARBOHYDRATE

FEHLING'S TEST

A reddish precipitate indicates presence.

2. DETECTION OF GLYCOSIDE

BORNTRAGER'S TEST

A pink precipitate confirm the presence of a glycoside.

3. DETECTION OF SAPONINS

FOAM TEST

persistent foam indicates presence.

4. DETECTION OF PROTEIN

BIURET TEST

A pink precipitate confirms the presence of protein.

5. DETECTION OF AMINO ACIDS

NINHYDRINE TEST

A purple precipitate indicates presence

6. DETECTION OF PHENOLIC COMPOUNDS

FERRIC CHLORIDE TEST

The dark green precipitate indicates the presence of phenolic compounds.

7. DETECTION OF FLAVONOID COMPOUNDS

Addition of ammonia and sulfuric acid — yellow coloration indicates presence.

8. TEST FOR TERPENOIDS

Chloroform and sulfuric acid — a reddish precipitate indicates presence.

9. DETECTION OF STEROIDS

Chloroform, sulfuric acid, and acetic anhydride — specific reactions confirm presence.

ANTIOXIDANT ACTIVITY (DPPH ASSAY)

The DPPH radical scavenging experiment was used to evaluate the methanolic extract's antioxidant capacity. After mixing 1 mL of a 0.4 mM DPPH solution in methanol with various extract concentrations (20, 40, 60, 80, and 100 µg/mL), the mixture was let to sit at room temperature in the dark for 15 minutes. The % suppression of DPPH radicals was computed in relation to a control using absorbance measurements at 517 nm (Blois, 1958; Rathod *et al.*, 2020). Antioxidants, 2023. Advanced processing of giant kelp (*Macrocystis pyrifera*) for protein extraction and hydrolysates with antioxidant and anti-hypertensive activities. Antioxidants.

RESULTS AND DISCUSSION

QUALITATIVE ANALYSIS OF PHYTOCHEMICAL SCREENING IN *Macrocystis pyrifera*

The qualitative phytochemical screening of *Macrocystis pyrifera* revealed the presence of alkaloids, carbohydrates, proteins, amino acids, saponins, flavonoids, and terpenoids, while phenolic compounds, steroids, and glycosides were absent (Table 1). These findings align with previous studies highlighting the rich phytochemical profile and bioactive compound abundance in *M. pyrifera* (Dinis Almeida & Santos, 2001; Sahoo & Ray, 2014; Sadiq & Al-Khayri, 2019; Zhang & Yang, 2020). The presence of proteins and amino acids suggests that the alga may provide nutritional and functional benefits beyond its antioxidant properties.

FUNCTIONALIZED SYNTHESIS OF SILVER NANOPARTICLES USING *Macrocystis pyrifera*

Silver nanoparticles (AgNPs) synthesized using bioactive compounds from *M. pyrifera* serve as natural reducing and stabilizing agents, offering an eco-friendly green synthesis approach. Functionalization of these AgNPs enhances their stability, dispersibility, and substrate compatibility, with biomolecules or ligands further improving their properties. (Rathod *et al.*, 2020).

RADICAL SCAVENGING ACTIVITY

AgNPs and methanolic extracts derived from *M. pyrifera* demonstrated significant antioxidant activity in the DPPH radical scavenging assay, with activity increasing in a concentration-dependent manner. The DPPH absorbance decreased to 61.18 ± 0.375 mg/mL at IC₆₀ for the AgNPs, indicating strong antioxidant potential (Table.1). The figure demonstrates that both the methanolic extract and AgNPs synthesized from *Macrocystis pyrifera* exhibit a concentration-dependent increase in radical scavenging activity, with higher concentrations resulting in greater inhibition of DPPH radicals. This indicates an enhanced antioxidant potential at increased concentrations (Fig.1). These results align with previous studies showing that phlorotannin extracts and algae-mediated nanoparticles possess potent antioxidant properties that vary with concentration (Li *et al.*, 2016; Rathod *et al.*, 2020; Ismail *et al.*, 2004). Overall, *M. pyrifera* is a valuable source of proteins, amino acids, and bioactive compounds that support antioxidant activity and potential medicinal applications.

CONCLUSION

The methanolic extract of *Macrocystis pyrifera* contains a diverse array of bioactive compounds, including proteins, amino acids, alkaloids, carbohydrates, flavonoids, terpenoids, and saponins, highlighting its nutritional and functional potential. Its significant antioxidant activity, especially when formulated as silver nanoparticles, underscores its promising applications in medicine, functional foods, nutraceuticals, and eco-friendly nanotechnology. Future research should focus on isolating and characterizing individual bioactive constituents to elucidate their specific roles in medicinal and antioxidant activities.

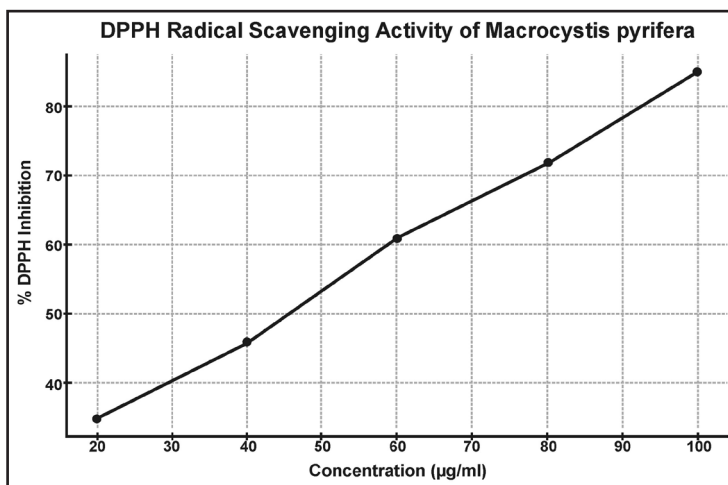
TABLE: 1 - QUALITATIVE PHYTOCHEMICAL SCREENING OF METHANOLIC EXTRACT OF *Macrocystis pyrifera*

S.No.	Phytochemical	Presence (+) / Absence (-)
1	Alkaloids	+
2	Carbohydrates	+
3	Proteins	+
4	Saponins	+
5	Flavonoids	+
6	Terpenoids	+
7	Amino acids	-
8	Phenolic compounds	-
9	Steroids	-

Note: “+” indicates presence; “-” indicates absence.

TABLE: 2 - DPPH RADICAL SCAVENGING ACTIVITY OF *Macrocystis pyrifera* EXTRACT AND SILVER NANOPARTICLES

S.No.	Sample / Concentration ($\mu\text{g/mL}$)	% DPPH Inhibition
1	20	35.42 ± 0.42
2	40	45.78 ± 0.51
3	60	61.18 ± 0.38
4	80	72.34 ± 0.44
5	100	85.67 ± 0.50



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INVESTIGATING AWARENESS AND BEHAVIOURAL DIMENSIONS OF CIRCULAR ECONOMY FOR SUSTAINABLE DEVELOPMENT AMONG UNDERGRADUATE WOMEN

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ABSTRACT

This research explores awareness and behavioral aspects of the Circular Economy (CE) for sustainable development among female undergraduate students. The main aims were to measure the level of CE awareness, determine the correlation between awareness and sustainable consumer behavior, and investigate factors affecting willingness to implement CE practices. Data were gathered through a set response sheet and examined with percentage analysis, Chi-square tests, and correlation procedures in SPSS. The results indicated that 30.8% of the respondents only had knowledge about the concept of CE, while cost sensitivity and uncertainty constrained their willingness to pay for eco-friendly products. Chi-square findings indicated that there was a significant relationship between CE awareness and the purchase of refurbished or recycled products, while correlation analysis revealed a moderate positive relationship between awareness and brand loyalty. The research also noted a blatant gap between intention and practice whereby favorable dispositions toward CE were not necessarily followed through as a result of affordability and accessibility constraints. From these findings, it concludes that even with the limited awareness, awareness has a significant influence on undergraduate women's sustainable consumer behavior. It recommends consolidating education campaigns, offering affordable eco-products, and implementing CE at the academic and lifestyle levels to close the knowledge-practice gap. In sum, the research underscores the effectiveness of awareness creation and policy support in fostering CE towards future sustainable development.

KEYWORDS: *Circular Economy, Awareness, Sustainable Development, Consumer Behavior, Eco-friendly Products, Sustainability Education.*

INTRODUCTION

In the modern world, the growth of e-commerce has transformed from how consumers shop and how businesses supply goods and services worldwide. However, the increase in the expansion of online retail also has some complications like waste generation, resource consumption, and environmental sustainability. Traditional e-commerce followed a take-make-dispose, and it's a model that results in considerable environmental impacts through inadequate disposal of used products, increased use of packaging materials, and return of the products. According to these challenges, circular economy models are creating new strategies in e-commerce sectors. A circular economy follows reduce, reuse, and recycle. The main focus of e-commerce is from designing out of single-use products, creating out of waste, using products and materials as long as it is discarded, and the rehabilitation of the environment. This will be achieved by implementing techniques like reuse of product, refurbished products and materials, recycling, increased usage of eco-friendly packaging, and logistics systems reversal. For example e e-commerce companies are supporting second-hand companies by offering repair services and refurbishment services to extend the life span of the products and minimize waste. By considering circular economy importance and principles, e-commerce can achieve better benefits, including reducing material usage, achieving financial benefits, building customer loyalty, and enhancement of brand reputation. In addition, these models neither promote sustainability and efficiency of resources nor prepare companies to face growing expectations of consumers and government regulatory standards to be focused on environmental impact. Adoption of circular economy models sets importance to move towards a more sustainable and resource-efficient future by minimizing waste and maximizing the value of materials throughout their lifecycle. It presents a vital role for e-commerce to promote a sustainable and regenerative world.

REVIEW OF LITERATURE

Kirchherr et al. (2018) looked into young people's awareness of the circular economy (CE) and found that while awareness was low, exposure to sustainability education greatly enhanced attitudes and knowledge. Their research also showed that young women could play a significant role in encouraging sustainable consumer behavior. The results indicate that in order to empower students—especially women—to embrace sustainable practices, it is imperative that CE topics be incorporated into school curriculum. Using statistical analysis and structured questionnaires, the researchers came to the conclusion that raising awareness through education is essential to attaining sustainable development.

Bocken et al. (2016) studied how consumers behave towards refurbished, recycled, and second-hand products. They looked at the factors that influence purchasing decisions. Their research showed that perceived quality, trust in sellers, and affordability heavily affected consumer acceptance. Women students were more willing to buy eco-friendly products when eco-labeling and awareness campaigns were in place. The study recommended that e-commerce platforms should focus on transparency and clear labeling to improve consumer confidence. Using surveys and regression analysis, the authors concluded that awareness and labeling can directly promote sustainable consumption among women students.

Geissdoerfer et al. (2017) discussed the difference between being aware of CE principles and practicing sustainable behavior. The study indicated that awareness existed but implementation was constrained by concerns about cost, peer group influences, and limited access to green alternatives. They recommended using subsidies, peer campaigns, to make eco-products easier and more affordable to access in order to close the intention - action divide. The authors used case studies and cross-tabulated data with these interviews, and concluded that while awareness is important, it does not guarantee sustainable consumption; supportive activities at a society and finance level are important actions that must be addressed.

The Ellen MacArthur Foundation (2020) studied the impact of eco-labels and eco-conscious branding practice on consumer loyalty, particularly among online shoppers. The researchers analyzed the survey responses of undergraduate students, which, ultimately, demonstrated that students preferred brands that demonstrated environmental responsibility with identifiable eco-labels and were willing to pay slightly more for eco-branded products. The study concluded that retailers could attract the younger generations given the scale, provided sustainability claims were more transparent, and eco-conscious marketing was adopted in their brands. Survey data and chi-square analysis were used to confirm their findings that a transition towards circular economy in e-commerce can be fast-tracked through eco-branding and eco-labeling strategies.

Lastly, Agyeman (2021) examined the impact of education level and gender on sustainable attitudes and behaviors. The results were significant because they highlighted that undergraduate women were more likely to become embracers of CE practices when awareness campaigns included digital media and everyday life contexts. Education was a strong predictor of positive behavioral change. The study provided suggestions to use social media, workshops, and lifestyle-based awareness campaigns to promote CE. Utilizing questionnaires and factor analysis, the study found that education and gender are significant drivers of sustainable behavior and the success of CE initiatives.

OBJECTIVES OF THE STUDY

1. To assess the level of **awareness of circular economy practices** among undergraduate women.
2. To examine the **behavioural dimensions** influencing the adoption of CE practices in online and offline consumption.
3. To analyze the relationship between **awareness and sustainable consumer behaviour** for promoting CE in the context of sustainable development.

Research Design

- Type of Research: Descriptive and analytical research.
- Population: Undergraduate women students.
- Sample Size: 156
- Sampling Method: Convenience sampling
- Data Collection Tool: Structured questionnaire covering awareness, behaviors, and influencing factors.
- Data Analysis: Percentage analysis, descriptive statistics, and inferential tests (Chi-square, correlation, factor analysis) to examine relationships between awareness and behavior.

This paper explores global research on how people behave and understand the circular economy. Its goal is to deepen our knowledge of how people engage with and practice circular economy principles in their everyday lives.

1. Percentage Analysis

Table 1: Awareness of Circular Economy

Awareness of CE	Frequency	Percentage (%)
Yes	48	30.8
No	108	69.2
Total	156	100.0

Interpretation:

From the above table, it is clear that only **30.8%** of undergraduate women are aware of the concept of the circular economy, while a large proportion (**69.2%**) lack awareness. This indicates that awareness levels are still at a developing stage and more educational interventions are needed.

Table 2: Willingness to Pay More for Eco-friendly Products

Response	Percentage (%)	Frequency
Yes	25.6	40
Maybe	48.7	76
No	25.6	40
Total	100.0	156

Interpretation:

From the above table, it is found that nearly **half of the respondents (48.7%)** are uncertain about paying extra for eco-friendly products. Only **25.6%** expressed clear willingness, while an equal proportion (25.6%) were unwilling. This highlights the importance of pricing strategies in promoting circular economy adoption.

The systematic literature review method has been used to gather. This study systematically gathers, analyzes, and synthesizes existing research on the circular economy, organizing and interpreting the findings to build deeper insights. It aims to understand the current perspectives and practices globally.

2. Chi-Square Test

Objective:

To test whether there is a significant relationship between **Awareness of CE** and **Purchase of refurbished/recycled products**.

Hypothesis:

- **H0:** There is no significant association between awareness of CE and purchase of refurbished/ recycled products.
- **H1:** There is a significant association between awareness of CE and purchase of refurbished/ recycled products.

Table 3: Cross Tabulation

Awareness of CE	Purchased Refurbished (Yes)	Not Purchased (No)	Total
Yes	25	23	48
No	30	78	108
Total	55	101	156

Table 4: Chi-Square Results

Test	Value	df	Sig. (p-value)
Pearson Chi-Square	8.712	1	0.003 **

(Significant at 0.05 level)

Interpretation:

From the above table, the Chi-square test shows a significant association ($p = 0.003 < 0.05$) between awareness of CE and purchase of refurbished/recycled products. This implies that respondents who are aware of CE are more likely to purchase recycled or refurbished products compared to those who are not aware.

Social implications

This research shows the demographic and sociocultural factors, including age, education, social norms, and attitudes, on Circular Economy engagement. It examined potential areas of research and cultural influences on personal and brand loyalty relevant to circular economy behaviours. It shows the need for be coordinated, cross-sectoral effort to facilitate a sustainable transition to a Circular Economy.

3. Awareness, behaviours and addressing barriers to circular practice s

Objective:

To test the correlation between **awareness of CE** and **loyalty to eco-friendly brands**.

Table 5: Correlation Results (SPSS output style)

Variables	Awareness of CE	Brand Loyalty
Awareness of CE	1	0.412**
Brand Loyalty	0.412**	1

(Correlation is significant at the 0.01 level)

Interpretation:

From the above table, the correlation coefficient ($r = 0.412$) indicates a **moderate positive relationship** between awareness of CE and loyalty to eco-friendly brands. This means that students with higher awareness of CE are more likely to remain loyal to sustainable brands.

Opportunities for implementation

- Cost is saved in raw materials, energy consumption, and waste management practices by promoting reuse, recycling, and efficient use of resources to cut cost on waste disposal.
- Companies that follow sustainability gain reputation as innovators and environmental leaders improving customer loyalty.
- Circular economy incorporates innovation in designing of products, packaging, materials and delivery methods keeps the market competitive and adaptable to sustainability.
- It also helps in job creation process for labor intensive sectors by supporting local economies.
- By designing products that last longer and easily repairable can drastically reduce carbon emissions and pollution linked to manufacturing, transportation and waste disposal.

FINDINGS

- **Awareness of Circular Economy (CE):**

Only about 30.8% of undergraduate women are aware of the concept of the circular economy, while 69.2% are not, showing that awareness levels are relatively low.

- **Willingness to Pay for Eco-friendly Products:**

Nearly 48.7% of respondents were uncertain (“Maybe”) about paying more for eco-friendly products, while only 25.6% were clearly willing to pay extra. Cost sensitivity is a major barrier.

- **Relationship between Awareness and Purchase Behavior:**

The Chi-square analysis indicated a significant association ($p = 0.003$) between awareness of CE and the purchase of refurbished/recycled products. Respondents with higher awareness showed greater likelihood of purchasing sustainable products.

- **Consumer Loyalty to Eco-friendly Brands:**

Correlation results ($r = 0.412$, $p < 0.01$) revealed a moderate positive relationship between awareness of CE and brand loyalty. Students who were more aware of CE tended to prefer and stay loyal to eco-friendly brands.

- **Gap Between Intention and Action:**

Although many respondents agreed that CE can reduce environmental impact, this belief did not always translate into behavior due to pricing, trust, and availability barriers.

SUGGESTIONS

1. **Building Awareness via Education:**

By including Circular Economy (CE) concepts into undergraduate curricula, workshops, and seminars, we can build levels of awareness and help motivate the students and particularly young women to engage with sustainable practices.

2. **Affordable Pricing strategy:**

Since prices are a significant hurdle when purchasing Eco-Friendly products, governments, educational institutions, and e-commerce platforms can help subsidize these products, offer discount cards, student offers etc to bring the price of sustainable products down.

3. **Eco-Label Transparency:**

Both online and offline brands should prominently display eco-friendly features, recycling information, and sustainability certifications allowing for building trust and information-based purchasing decisions when buying products as young consumers.

4. **Behavioral Adoption:**

Opportunities to engage students in sustainability can be achieved through initiatives like return-and-reuse, rewards for recycling, loyalty points for eco-friendly products etc.

5. **Targeting Digital Platforms:**

Awareness campaigns in social media, programs with YouTube influencers, and student-centric apps can be the most effective means for spreading CE knowledge and practices, as young women spend huge amounts of time on social media and consumption-focused apps.

CONCLUSION

From the above findings, it can be concluded that awareness of the circular economy among undergraduate women is still limited but plays a **critical role in influencing sustainable consumer behavior**. Students who are aware of CE are more likely to purchase refurbished or recycled products and show stronger loyalty towards eco-friendly brands. However, cost considerations and uncertainty about paying extra remain major challenges that limit behavioral adoption.

Therefore, to strengthen the transition from awareness to practice, **educational campaigns, institutional awareness programs, and incentives such as price reductions or subsidies** are necessary. Integrating CE principles into academic curricula and promoting sustainability-driven marketing in e-commerce can further bridge the gap between knowledge and practice, leading to sustainable development among young women.

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PRELIMINARY PHYTOCHEMICAL STUDIES OF THE RED ALGA *Rhodymenia palmata*

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ABSTRACT

Marine algae are recognized as a prolific source of bioactive secondary metabolites with potential therapeutic and industrial applications. Among them, red algae (Rhodophyta) have been studied for their diverse phytochemical constituents, which include phenolics, flavonoids, terpenoids, alkaloids, and polysaccharides. The present study investigates the preliminary phytochemical profile of *Rhodymenia palmata*, a red algal species, using ethanolic extract subjected to qualitative phytochemical tests showed the presence of alkaloids, flavonoids, phenols, tannins, saponins, and terpenoids. Steroids and glycosides were not detected, giving the extract a clearly defined phytochemical composition. Results revealed the presence of phenols, flavonoids, alkaloids, saponins, and terpenoids, indicating that *R. palmata* is a promising candidate for further pharmacological and biodegradation research. This study provides baseline data for subsequent investigations into the bioactive potential and industrial applications of this species.

KEYWORDS: *Rhodymenia palmata*, phytochemical screening, red algae, secondary metabolites, preliminary study.

INTRODUCTION

Marine macroalgae are ecologically and economically important resources of the marine environment, providing habitat, primary productivity, and a wide range of biochemicals with human health applications. In recent decades, Macro-algae play an important role in marine ecosystems, contributing to ecological stability and serving as valuable sources for food, medicine, and industrial applications. Among them, red algae are particularly noteworthy due to their abundance of bioactive compounds, such as polysaccharides, phenolics, and other metabolites with antioxidant, antimicrobial, and therapeutic activities (Carpena et al., 2022; Eladl, Elnabawy, & Eltanahy, 2024; Ghaliaoui, Hazzit, & Mokrane, 2024; Anonymous, 2020).

Among marine algal groups, red algae (Rhodophyta) constitute one of the most diverse classes, with more than 7,000 described species distributed worldwide. They are a well-known source of hydrocolloids such as agar and carrageenan, which are widely applied in the food, cosmetic, and pharmaceutical industries (Manivannan et al., 2017). In addition, red algae have been reported to contain bioactive compounds such as phenolic acids, flavonoids, terpenoids, and alkaloids that contribute to their antioxidant and antimicrobial activities (Rao & Parekh, 2018; López et al.,

2021). *Rhodymania palmata*, commonly known as dulse, is an edible red alga found along the North Atlantic coasts. Traditionally, it has been used as food and medicine, valued for its nutritional content including proteins, vitamins, minerals, and dietary fibers (Gupta & Abu-Ghannam, 2017). Some studies have highlighted its antioxidant potential and polyphenolic content, suggesting its utility in reducing oxidative stress and promoting health (Yuan et al., 2019). Despite these reports, systematic phytochemical studies on *R. palmata* remain limited compared to other red algae such as *Gracilaria* and *Laurencia*.

Preliminary phytochemical screening provides important baseline information by identifying the classes of bioactive compounds present in an organism. Such investigations are particularly relevant in algae, where the diversity of metabolites may contribute to novel drug discovery, nutraceutical applications, and even environmental uses such as biodegradation (Suresh Kumar et al., 2015; Hernández-Carmona et al., 2022). *Rhodymenia palmata*, a species of red algae, is nutritionally rich, containing proteins, vitamins, minerals, and antioxidants. However, its phytochemical composition remains insufficiently explored, highlighting a research gap. Therefore, this study aims to conduct qualitative phytochemical screening of ethanol extracts of *R. palmata* to identify major metabolites and assess its bioactive potential

REVIEW OF LITERATURE

Marine macroalgae have long been recognized as prolific producers of natural compounds with diverse structural and functional attributes. Several reviews and experimental studies have emphasized that phytochemicals from algae serve as protective agents against oxidative stress and microbial invasion, and also contribute to various therapeutic effects in humans. According to Manivannan et al. (2017), red algae such as *Gracilaria* and *Gelidium* are enriched with bioactive constituents like flavonoids, terpenoids, and polysaccharides that play critical roles in antioxidant defense mechanisms. Similarly, Silva et al. (2020) noted that secondary metabolites from red algae possess antimicrobial and anti-inflammatory activities, supporting their potential pharmaceutical applications. The genus *Laurencia* has been extensively studied for its halogenated secondary metabolites, which demonstrate potent antimicrobial and anticancer activities (Kumar et al., 2018). Another group of red algae, *Gracilaria corticata*, was reported to contain phenolic compounds and alkaloids with significant antioxidant potential (Rao & Parekh, 2018).

BIOACTIVE METABOLITES IN RED ALGAE

Red algae are widely recognized for consistently producing valuable phytochemicals across different taxa. They contain polysaccharides, phenolics, alkaloids, terpenoids, and other bioactive compounds with antioxidant, antimicrobial, and therapeutic properties (Carpena et al., 2022; Eladl, Elnabawy, & Eltanahy, 2024; Ghaliaoui, Hazzit, & Mokrane, 2024; Anonymous, 2020). These metabolites contribute significantly to the ecological and nutritional importance of red algae.

STUDIES ON *Rhodymenia palmata*

Research specifically on *R. palmata* is relatively limited. Gupta and Abu-Ghannam (2017) investigated its nutritional profile and reported the presence of phenolic compounds with potential antioxidant activity. Guiry (2019) described the taxonomy and global distribution of the species but did not include detailed phytochemical analyses. While some studies have highlighted its richness in dietary minerals and proteins, systematic characterization of secondary metabolites remains scarce.

The limited phytochemical information on *R. palmata* represents a clear research gap. To address this, the present study aims to conduct preliminary qualitative screening to establish a basic phytochemical profile. These findings will expand the phytochemical database of red algae and provide a reference for future pharmacological studies and potential applications in biodegradation research.

MATERIALS AND METHODS

COLLECTION OF ALGAL MATERIAL

Fresh samples of *Rhodymenia palmata* were sourced from Vedha Organics, a certified organic supplier. The collected biomass was rinsed thoroughly with distilled water to remove soil particles, salts, and surface impurities. Clean algal material was oven-dried at 40°C for 24 hours to preserve its biochemical integrity and then powdered using a grinder to obtain a uniform sample for extraction.

PREPARATION OF EXTRACT

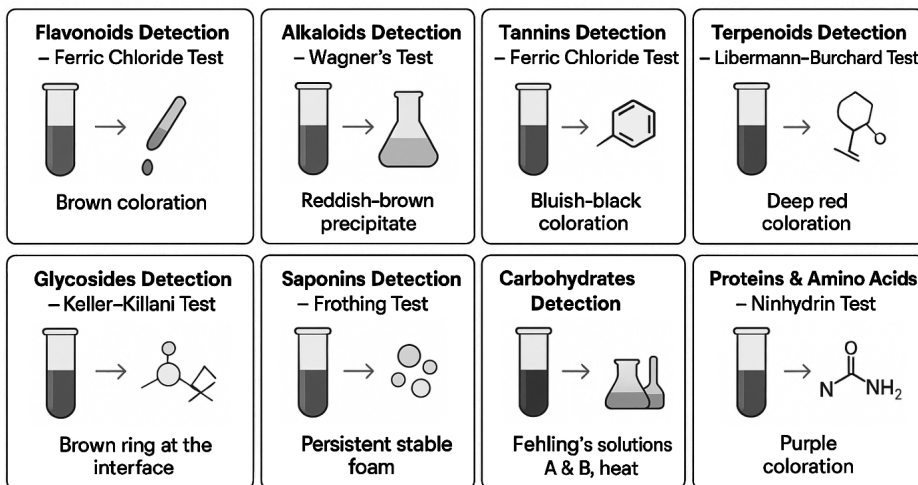
Twenty grams of dried algal powder were soaked in 200 mL of 95% ethanol. The mixture was left to macerate overnight at room temperature to facilitate the extraction of bioactive compounds. After maceration, the mixture was filtered through Whatman No. 1 filter paper, and the filtrate was concentrated under reduced pressure at temperatures below 40°C using a rotary evaporator. The concentrated crude extract was stored at 4°C in sterile containers until further use.

PHYTOCHEMICAL SCREENING

Preliminary phytochemical analysis was carried out on the ethanol extract using standard biochemical assays: Harborne, 1998; Trease & Evans, 2002)

Preliminary Phytochemical Screening of Ethanol Extract

Harborne (1998); Trease & Evans (2002)



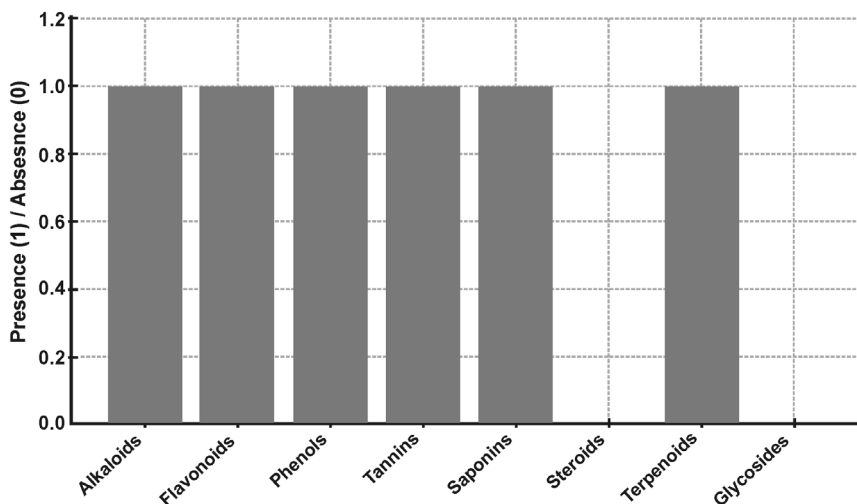
RESULTS AND DISCUSSION

The results of the preliminary phytochemical screening of *Rhodymania palmata* are shown in Table 1 and Figure 1. The study revealed the presence of major secondary metabolites such as alkaloids, flavonoids, phenols, tannins, saponins, and terpenoids, while steroids and glycosides were absent.

Table 1: Detection of Phytochemical Groups in *Rhodymania palmata* Extracts

Phytochemical	Presence (+) / Absence (-)
Alkaloids	+
Flavonoids	+
Phenols	+
Tannins	+
Saponins	+
Steroids	-
Terpenoids	+
Glycosides	-

Figure: 1. Preliminary Phytochemical Screening of *Rhodymania palmata*



CONCLUSION

The present investigation provides the first preliminary phytochemical profile of *Rhodymania palmata*. The detection of phenols, flavonoids, alkaloids, tannins, saponins, and terpenoids highlights its potential as a reservoir of bioactive metabolites. These phytochemicals indicate potential usefulness in antioxidant, antimicrobial, and biodegradation applications. Further research should focus on quantitative assays to measure their exact levels. Advanced techniques such as GC-MS and LC-MS can help profile the active metabolites. Such analyses will deepen understanding of the extract's functional properties.

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USER INTERFACE - UI

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ஆய்வுச்சுருக்கம்

இருபதாம் நூற்றாண்டின் இணையற்ற கண்டுபிடிப்பான கணினி, சில நொடிகளில் எண்ணிலடங்கா கணக்குகளைச் செய்துகாட்டும் வலிமை மிகுந்தது. இதனை முறையாக இயக்கினால் மனித மூளையைப் போன்று நுண்ணறிவுத் திறனோடு சிறப்பாக வேலைச்செய்யும் தன்மைமிக்கது. நம் பயன்பாட்டிலிருக்கும் கணினி பல்வேறு வடிவமைப்புகளையும் தொழில் நுட்ப வளர்ச்சிகளையும் கடந்து இன்றைய பரிணாம வளர்ச்சியை அடைந்துள்ளது. கணினியில் பயனர் இடைமுகத்தின் பங்களிப்பு இன்றியமையாத ஒன்றாக உள்ளது. பயனர் இடைமுகத்தின் செயல்பாட்டினை விளக்கும் நோக்கின் இக்கட்டுரை இயங்குகிறது.

திறவுச் சொற்கள்

1. எழுத்துருக்கள், 2. செயற்கை நுண்ணறிவு, 3. வலைத்தளங்கள், 4. மொழிப்பெயர்ப்புகள், 5. அச்சிட்ட எழுத்து.

முன்னுரை:

இன்றைய கணினியின் தோற்றமும் வளர்ச்சியும் நீட்சியும் இன்றைய அறிவியல் தகவல் வளர்ச்சி உலகத்தை உள்ளங்கையில் கொண்டு வந்துவிட்டது. தகவல் தொழில் நுட்பத்துறையில் ஏற்பட்டுள்ள மிகப்பெரிய முன்னேற்றம் நம் வாழ்வில் மறுமலர்ச்சியை ஏற்படுத்தி வருகின்றது. தகவல் தொடர்புச் சாதனங்களால் ஓரிடத்தில் நடைபெறும் நிகழ்வுகளைக் கூட உடனுக்குடன் மற்றோரிடத்தில் அறிய முடிகிறது. கணிப்பொறியின் மூலம் தமிழ் எழுத்துருக்களை ஏற்றி தமிழ் மொழியில் சொற்களைப் பதிவிடுதல், அகராதிகள் அமைத்தல், விளக்கங்களைப் புகைப்படங்களுடன் செய்திகளாகக் காட்சி படுத்துதல் முதலிய செயல்களைச் செய்ய முடிகின்றது.

கணிப்பொறி அறிமுகம்

இருபதாம் நூற்றாண்டின் இணையற்ற கண்டு பிடிப்பான கணினி, சில நொடிகளில் மில்லியன் கணக்குகளைச் செய்துகாட்டும் வல்லமை மிகுந்தது. இதனை முறையாக இயக்கினால் மனித மூளையைப் போன்று நுண்ணறிவுத் திறனோடு வேலைச்செய்யும். நம் பயன்பாட்டிலிருக்கும் கணினி பல்வேறு வடிவமைப்புகளையும் தொழில் நுட்ப வளர்ச்சிகளையும் கடந்து பரிணாம வளர்ச்சி அடைந்துள்ளது.

கணிப்பொறி சார்ந்த தகவல் தொழில்நுட்பம், 1822 'வேற்றுமைப் பொறி' என்னும் முதல் கணிப்பொறியை சார்வன் பாபேஜ் உருவாக்கினார் என்றாலும் இலக்க முறையிலான (Digit) 'மार्க்-2' கணிப்பொறி ஓவார்டு அய்க்கன் என்ற அமெரிக்கராம் 1944-ஆண்டு அமைக்கப்பட்டது. இன்றைய கணிப்பொறிகளுக்கெல்லாம் முன்னோடி இக்கணிப்பொறியாகும். கணினியின் அமைப்பில் பல மாற்றங்களைத் தொழில் நுட்ப வளர்ச்சிகளைத் தன்னகப்படுத்திக் கொண்ட கணினியின் பரிணாம வளர்ச்சியை ஐந்து தலைமுறைகளாகப் (Generations) பகுக்கலாம். அவை,

1. முதல் தலைமுறைகணிப்பொறி :1946-1957
2. இரண்டாம் தலைமுறைகணிப்பொறி 1957-63
3. மூன்றாம் தலைமுறை கணிப்பொறி:1965-1976
4. நான்காம் தலைமுறை கணிப்பொறி:1976-1987
5. ஐந்தாம் தலைமுறைக் கணினி:1987.

என்று கணினியை வகைப்படுத்தலாம்.

செயற்கை நுண்ணறிவு அறிமுகம்

மனிதனுக்கும் இயந்திரத்திற்கும் இடையே காணப்படுகின்ற வேறுபாடு அறிவுத் திறன் என்ற படைப்பாக்கத் திறன் ஆகும். அறிவுத்திறனுடைய படைப்பாக்கத் திறன் இயந்திரங்கள் மூலம் செயற்படுத்தப்படுமானால் அது செயற்கை நுண்ணறிவு என்ற கட்டமைப்புக்குள் அடங்குகிறது. கணினி அறிவியலின் பரந்த பார்வையாகச் செயற்கை நுண்ணறிவு செயல்படுகிறது. மனித நுண்ணறிவு கொண்டு செயல்கள் மற்றும் பணிகளைச் செய்ய, மிகுந்தத் திறன் கொண்ட இயந்திரங்கள் தேவைப்படுகின்றது .

பயனர் இடைமுகம் (USER INTERFACE - UI)

பயனர் இடைமுகம் என்பது கணினி மற்றும் அலைபேசி அல்லது இணையதளத்தின் வெளிப்புற வடிவமைப்பாகும். இதன் மூலம் பயனாளி, அந்த பயன்பாட்டுடன் தொடர்பு கொள்கிறார். (User Interface & UI) என்பது ஒரு பயனர் கணினி, சாதனம் அல்லது மென்பொருளுடன் எவ்வாறு தொடர்புகொள்கிறார் என்பதைக் குறிக்கும் காட்சி கூறுகள் மற்றும் ஊடாடும் அம்சங்கள். திரையில் காணப்படும் பொத்தான்கள், சின்னங்கள், நிறங்கள், எழுத்துருக்கள், பட்டியல் அமைப்பு, படங்கள் என அனைத்தும் பயனர் இடைமுகத்தின் பகுதிகளாகும்.

பயனர் இடைமுகத்தின் வரையறை

மமனித வாழ்வில் தொழில்நுட்ப முன்னேற்றம் நாளுக்கு நாள் அதிகரித்து வருகின்றது. ஒவ்வொருவரும் காலை எழுந்தது முதல் இரவு தூங்கும் வரை

இணையதளம், மொபைல் பயன்பாடுகள், சமூக வலைத்தளங்கள், வணிக பயன்பாடுகள், கல்வி சார்ந்த தளங்கள் என பல்வேறு டிஜிட்டல் கருவிகளைப் பயன்படுத்துகின்றனர். பரவலாகப் பயன்படுத்தப்படும் தொழில்நுட்ப கருவிகளை எளிதாகவும், சுலபமாகவும், அனைவருக்கும் அணுகக்கூடியவாறு வடிவமைப்பதே பயனர் இடைமுகத்தின் முக்கிய நோக்கம் ஆகும். ஒரு பயன்பாடு எவ்வளவு முன்னேற்றமான தொழில்நுட்பத்தைக் கொண்டு உருவாக்கப்பட்டிருந்தாலும், அது பயனாளிக்கு எளிதில் புரியவில்லை என்றால் அதன் மதிப்பு குறைந்துவிடும். அதனால் தான், இன்றைய தகவல் தொழில்நுட்பத் துறையில் பயனர் இடைமுகம் மற்றும் பயனர் அனுபவம் மிகப் பெரிய பங்கு வகிக்கின்றன.

பயனர் இடைமுகத்தின் தேவைகள்

எளிமையாக அதிக சிக்கல்களில்லாமல், ஒரே பார்வையில் புரிந்துகொள்ளும் வகையில் அமைந்திருக்கும். ஒற்றுமை நிறங்கள், எழுத்துருக்கள், வடிவமைப்பு அனைத்தும் ஒரே மாதிரியாக இருந்து பயனாளி குழப்பமடையாமல் இருக்க வேண்டும். பயனாளி செய்த ஒவ்வொரு செயலும் உடனடியாக விளைவு அளிக்க வேண்டும். உதாரணமாக, பொத்தானை அழுத்தியவுடன் நிறம் மாறுதல். அணுகல் வசதி மாற்றுத் திறனாளிகளும் எளிதில் பயன்படுத்தக் கூடிய வகையில் வடிவமைக்கப்பட வேண்டும். பயனர் அனுபவம் என்பது, ஒரு பயன்பாட்டை பயன்படுத்தும் போது பயனாளி பெறும் முழுமையான அனுபவம். இதில் எவ்வளவு நேரத்தில் அவர் தனது பணியை முடிக்கிறார் என்பதில் அனைத்தும் அடங்கும்.

பயன்கள்

கணிப்பொறியில் இணைய (Internet) இணைப்பினைப் பெற்றால் பயனர் இடைமுகத்தைப் பயன்படுத்தி தமிழ் மொழிப்பெயர்ப்புகள், தமிழ் மொழியில் கையெழுத்தால் எழுதியதை அச்ச நகலாக மாற்றுதல், தமிழ் மொழியில் பேசுவதை அச்சிட்ட எழுத்தாகக் கொண்டு வருதல், காலம் காட்டும் கடிக்காரமாகவும் புகைப்பட அரங்காகவும், ஒளி விளையாட்டுக் கருவியாகவும், பலவகைகளில் பயன்படுகின்றன. இவ்வாறு பரவலாகப் பயன்படுத்தப்படும் தொழில்நுட்ப கருவிகளை எளிதாகவும், சுலபமாகவும், அனைவருக்கும் அணுகக்கூடியவாறு வடிவமைப்பதே பயனர் இடைமுகத்தின் முக்கிய பணியாகும்.

முடிவுரை

திறன் கொண்ட இயந்திரங்களைக் கையாள பணிகளை எளிமையாக்க, மிகுந்த பொருட் செலவின்றி, விரைந்து செய்து முடிக்க, செயற்கை நுண்ணறிவு பயனர் இடைமுகத்தின் பங்களிப்பு பெருமளவில் இருப்பதை மறுக்க இயலாது.

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SHAPING THE FUTURE OF OUR PLANET: INNOVATIONS AND RESPONSIBILITIES FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

The future of Earth and humanity's exploration of the unknown are intrinsically linked to the decisions and technologies we embrace today. This research paper investigates how human actions influence ecological balance, environmental stewardship, and clean power innovations that are critical to sustainable development. Emerging technologies such as BioSync AI and Eco Matrix, as well as industries like Green Flex and Thrive Biz Green, exemplify how data-driven intelligence and adaptive business models can support environmental conservation while promoting economic growth. Furthermore, advancements in ocean-based energy through Blue Spark Energy, space exploration optimization by Orbit Wise, and the study of extraterrestrial atmospheres via Alien Skies emphasize the broader implications of balancing innovation with responsibility. By integrating scientific inquiry, technological development, and ethical frameworks, this paper argues for a holistic approach to ensure a resilient and thriving future on Earth and beyond.

KEYWORDS: Sustainable Development, Ecological balance, Earth, Ocean.

1. INTRODUCTION

“Science is about exploring the unknown and cannot offer guarantees.” — Virginia Postrel

The rapid acceleration of scientific and technological advancements has positioned humanity at a critical threshold where ecological stability, resource management, and space exploration are interconnected challenges that demand urgent attention. The future of Earth is increasingly threatened by climate change, biodiversity loss, and pollution, while the mysteries of outer space offer both promise and uncertainty. Our decisions today—whether concerning energy production, ecosystem preservation, or interstellar exploration—will shape not only environmental outcomes but also the survival and prosperity of future generations.

Environmental degradation, coupled with rising global temperatures and the depletion of natural resources, has led to unprecedented challenges (Ellis et al., 2023; Sharma et al., 2010). Simultaneously, scientific innovations present opportunities for sustainable solutions and deeper cosmic understanding. Thus, it is imperative to explore how responsible stewardship, technological advancement, and economic transformation can collectively guide humanity toward a balanced, sustainable future.

2. REVIEW OF LITERATURE

2.1 Ecological Imbalance

Human-induced climate change, deforestation, and industrial pollution have caused severe disruptions in global ecosystems (Mathevet et al., 2018; Iqbal et al., 2014). The decline of key species, coral reefs, and wetlands reduces Earth's natural resilience (Gupta et al., 2013; Nair et al., 2007), while habitat destruction increases the risk of zoonotic diseases and contamination of surface and groundwater (Wang et al., 2017; Sinha et al., 2012). Scholars warn of irreversible tipping points that may permanently alter planetary systems, leading to sea-level rise and coastal erosion (Bose et al., 2016; McLeod et al., 2024), as well as variability in rainfall affecting agriculture (Mehta et al., 2015).

2.2 Environmental Stewardship

Environmental stewardship emphasizes conservation, sustainable resource management, and ethical practices in both individual and institutional contexts (Mathevet et al., 2018). Effective conservation efforts include protecting wetlands as carbon sinks (Nair et al., 2007) and promoting vegetation cover for erosion control (Gupta et al., 2013). Recent incidents, such as glacier shrinkage in China and hazardous waste dumping in Mexico, underscore the urgency for stronger regulations (Ramesh et al., 2008). Pollution control measures are also essential to mitigate groundwater contamination by heavy metals and fertilizers (Sharma et al., 2010; Sinha et al., 2012).

2.3 Clean Power Innovation

The transition from fossil fuels to renewable energy sources is essential in mitigating carbon emissions and ensuring long-term energy security (UNCTAD, 2019). Emerging technologies like smart grids, advanced battery storage, and solar desalination offer efficient energy solutions in water-scarce regions (Rao et al., 2010). Green hydrogen and pumped hydro storage provide promising long-term solutions (UNCTAD, 2019). Energy efficiency technologies, such as smart meters and energy-efficient appliances, further reduce environmental footprints while enhancing infrastructure resilience.

2.4 Emerging Industries and Technologies

The rise of adaptive sustainability sectors, including the Green Flex Industry and Thrive Biz Green, demonstrates how businesses can integrate ecological responsibility with profit-oriented models (Huang, 2021; Singh et al., 2025). Innovations like BioSync AI and Eco Matrix leverage artificial intelligence to enhance environmental monitoring and resource optimization (Raihan, 2025; Mishra et al., 2025). These sectors encourage lifestyle changes and corporate policies that prioritize waste reduction, renewable energy adoption, and ethical entrepreneurship.

2.5 Ocean-Based Energy

Blue Spark Energy harnesses tidal, wave, and hydroelectric technologies to convert ocean currents into renewable power, offering scalable energy solutions to meet net-zero emission goals (Su et al., 2025). As cities and industries shift towards carbon-neutral infrastructures, ocean-based energy sources present stable and eco-conscious alternatives to fossil fuels.

2.6 Space Exploration and the Study of Alien Atmospheres

Technologies like Orbit Wise optimize spacecraft trajectories, fuel efficiency, and mission planning, reducing costs and enhancing space exploration strategies (Goodwill et al., 2024). In parallel, Alien Skies investigates planetary atmospheres beyond Earth, using telescopes and AI-driven models to search for biosignatures and explore extreme environments, such as molten rain or high-velocity storms (Brennan, 2023; Tuhin, 2025). These efforts expand our understanding of habitability and interstellar life.

3. METHODOLOGY

This research synthesizes interdisciplinary studies by reviewing peer-reviewed articles, government reports, and industry white papers. The data collection focused on identifying key trends in ecological degradation, renewable energy technologies, AI-powered sustainability solutions, and space research. Analytical frameworks were applied to compare technological interventions across sectors and evaluate their impact on environmental health and resource optimization.

4. DISCUSSION

4.1 Addressing Ecological Imbalance

Ecological imbalance threatens global ecosystems through climate-induced variability, salinity rise, and urban heat islands (Mehta et al., 2015; Bose et al., 2016; Banerjee et al., 2009). Effective interventions include restoring degraded landscapes (Gupta et al., 2013), improving groundwater management (Sharma et al., 2010), and minimizing pollution sources (Ellis et al., 2023).

4.2 Implementing Environmental Stewardship

Stewardship requires coordinated actions at governmental and community levels, integrating conservation policies with awareness campaigns (Mathevet et al., 2018). Protecting wetlands and forests not only preserves biodiversity but also serves as carbon sinks, mitigating climate change (Nair et al., 2007; Gupta et al., 2013).

4.3 Advancing Clean Power Innovation

Renewable energy technologies, including solar desalination (Rao et al., 2010) and pumped hydro storage (UNCTAD, 2019), are reshaping power generation. Efficient resource management, coupled with carbon-neutral policies, supports global sustainability goals.

4.4 Transformative Industries

The Green Flex Industry and Thrive Biz Green demonstrate how adaptive sustainability frameworks create accessible, eco-friendly solutions without compromising lifestyle preferences or profitability (Huang, 2021; Singh et al., 2025). These models encourage consumer engagement and long-term corporate responsibility.

4.5 AI-Driven Environmental Solutions

Technologies like BioSync AI and Eco Matrix utilize big data to monitor pollution levels (Chakraborty et al., 2019), optimize energy grids (Mishra et al., 2025), and predict environmental threats, empowering governments and industries to adopt proactive solutions.

4.6 Harnessing Ocean-Based Energy

Blue Spark Energy's use of tidal and wave energy (Su et al., 2025) offers a reliable alternative to fossil fuels. Ocean energy systems can meet large-scale electricity demand while reducing harmful emissions.

4.7 Expanding Space Exploration

Optimized space missions powered by Orbit Wise algorithms (Goodwill et al., 2024) and the study of extreme extraterrestrial atmospheres by Alien Skies (Brennan, 2023; Tuhin, 2025) reveal new pathways for exploring the cosmos while seeking signs of life and planetary habitability.

5. CONCLUSION

Humanity's future hinges on the integration of environmental stewardship, clean power innovation, and scientific exploration. Ecological imbalance, if left unchecked, poses existential threats, but emerging technologies and adaptive industries offer practical solutions. AI-powered monitoring systems, renewable energy infrastructures, and space exploration initiatives must be grounded in ethical and sustainable frameworks. By aligning economic growth with environmental responsibility, we can ensure a thriving planet and unlock the secrets of the cosmos—leaving a legacy of resilience and innovation for future generations.

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SPEECH TO SIGN LANGUAGE TRANSLATION SYSTEM

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ABSTRACT

In everyday life, effective communication is crucial, especially for those who struggle to understand spoken language due to hearing problems. This project showcases a mobile application created with Firebase serving as the backend database, Flutter serving as the frontend framework, and Dart serving as the programming language. Through real-time translation of spoken language into comparable sign language motions, the program seeks to close the communication gap. The identified text is mapped to a database of sign language gesture GIFs using speech-to-text technology, allowing for smooth gesture based communication. To guarantee mobility and user-friendliness, the system is made for mobile devices. With a focus on real-time processing, usability, and accessibility, this study examines the system architecture, implementation procedure, and performance evaluation. The results demonstrate the potential of integrating cross-platform development tools with cloud-based services to create effective assistive technologies. Future improvements will focus on expanding the gesture database, enhancing recognition accuracy, and incorporating support for regional sign languages.

KEYWORDS: *Speech-to-Text, Sign Language Translation, Flutter, Firebase, Hearing Impairment, Real-Time Communication, Assistive Technology.*

INTRODUCTION

In today's rapidly evolving technological environment, communication is essential for building relationships, connecting with others, and sharing ideas. Sign language is the mother tongue of people who are deaf. People who are deaf or mute may find it challenging to communicate themselves due to the limitations of spoken language. It might be difficult to communicate with people who do not know sign language, even though it is a vital tool for communication within this group. There are 135 distinct types of sign languages in the world. These include Australian Sign Language (ASL), ISL, BSL, and many more. Modern systems that can recognize and translate sign language into speech or text have made it easier for deaf and mute people to interact with the outside world.

In order to provide real-time translations, these systems are constructed employing methods such as face expression analysis, body pose identification, and hand gesture recognition. However, a number of obstacles remain to be addressed, including language difficulties, real-time processing, and the precise recognition of dynamic gestures. The difficulty of distinguishing a foreground object from a cluttered background makes gesture recognition a crucial topic. Increasing the accessibility, usability, and efficacy of these technologies for real-time communication is still a challenge.

The goal of this Indian Sign Language (ISL) project is to create a system that enables the deaf people to take use of all facets of everyday life, from basic communication to information access. Sign language recognizers use a mix of facial expressions, arm or body movements, and hand gestures to identify sign language. Deaf persons use their faces, hands, or eyes to communicate via sign language; they do not use their vocal tracts. In order to promote inclusivity and connections between the hearing and the deaf communities, this system is essential.

LITERATURE SURVEY

1. Abu Saleh Musa Miah, Md. Al Mehedi Hasan, Satoshi Nishimura, and Jungpil Shin (2024)

This research introduces a new method for sign language recognition by combining hand skeleton data, body movements, and facial expressions. Many systems focus only on hand gestures, which creates problems when hands are blocked or the background is confusing. The proposed approach, called GCAR, uses graph convolution and attention modules to improve how the system understands signs. It dynamically focuses on important parts of the gesture during specific movements. This method increases the accuracy of recognizing signs from large datasets. However, more work is needed to make it faster and practical for real-time use.

2. Tangfei Tao, Yizhe Zhao, Tianyu Liu, and Jieli Zhu (2024)

This study reviews various methods for recognizing sign language, including older techniques and new deep learning methods. It explains how different algorithms extract features and model the timing of gestures. The paper also discusses available datasets and the challenges faced by researchers, such as limited data and complex sign variations. By comparing different approaches, the authors provide guidance for future research. Their review aims to help scientists build better and more efficient recognition systems that can assist people with hearing impairments.

3. Abu Saleh Musa Miah, Md. Al Mehedi Hasan, Yoichi Tomioka, and Jungpil Shin (2024)

The researchers developed a system called GmTC that can translate sign languages from multiple cultures, like American, Korean, and Japanese sign languages. Since there is no universal sign language, this tool helps people from different regions communicate. The system uses two streams: one based on graphs to understand relationships between hand positions and another using attention models to capture long- and short-range gestures. It processes the gestures and translates them into text for easier understanding. The experiments showed that this method works better than older models and can be applied in real-life situations.

4. Giray Sercan Özcan, Yunus Can Bilge, and Emre Sümer (2024)

This paper addresses a problem called Zero-Shot Sign Language Recognition (ZSSLR), where the system must recognize signs it has never seen before. The researchers used hand and body landmark data to teach the system how to predict unseen gestures. They combined visual information with textual descriptions to help the system learn new signs without extra labeled data. Their approach makes it easier to build recognition tools when only limited data is available. Tests show that this method works well on popular benchmarks and can support real-time recognition in diverse environments.

5. Mariam Almaazmi, Salma Elkadi, Lamis Elsayed, Lina Salman, and Tamer Shanableh (2024)

The study focuses on recognizing continuous sentences in Arabic sign language, rather than isolated words or letters. The authors created motion images from videos by tracking movement and positioning of signs over time. These images allow the system to focus on different segments of the sentence while considering the whole context. By using a simplified model with Bi-LSTM layers and softmax functions, the system performs well in recognizing sign language both when the signer is known or unknown. The results show improved accuracy while reducing computational complexity.

6. Deepak Bhagat, Hitesh Bharambe, and Jashpal Joshi

This research uses speech recognition and natural language processing (NLP) techniques to convert spoken sentences into sign language animations for Indian Sign Language (ISL). The system is cost-effective and accessible, making it suitable for everyday communication. It also helps individuals without hearing impairments learn ISL by providing grammar-based translations. However, the approach is limited by the availability of ISL dictionaries and requires further improvements to cover more signs. Despite this, it achieves 85% accuracy in converting speech to sign language under controlled conditions.

7. Saritha M. B., Yaswanth A., Anshitha V., Karthik Y., and Abhinay R.

The authors proposed a system that converts speech into text and retrieves video clips of Indian Sign Language (ISL) gestures from a database of over 1000 videos. It helps in real-time translations of words and phrases, making communication faster and smoother. The tool is particularly helpful in situations where human interpreters are not available. Though the system performs well, it faces challenges like limited video resources and the need for manual corrections when some phrases are missing. The study shows that this approach can achieve 92% accuracy in translating speech into sign gestures.

8. Gurdeep Singh, Vishal Goyal, and Lalit Goyal

This work focuses on converting audio into text and reorganizing sentences for Indian Sign Language (ISL) translations. It provides real-time phrase-based translations, making it easier for

people to understand spoken language. However, the system's database has limitations and may need manual input when certain words are missing. Despite these shortcomings, it achieves a high accuracy rate of 92% and offers practical solutions for real-time communication between hearing and hearing-impaired individuals.

EXISTING SYSTEM

Real-time communication and interactivity are frequently absent from these platforms.

- Camera quality, illumination, and background noise all have a significant impact on accuracy.
- They are resource-intensive since they need a large quantity of training data.
- Many are difficult to grow and manage, and many are not cross-platform. They rely on limited or pre-recorded sign language databases, and they typically don't recognize any new words or phrases that aren't in the database.

Most of these systems face common challenges:

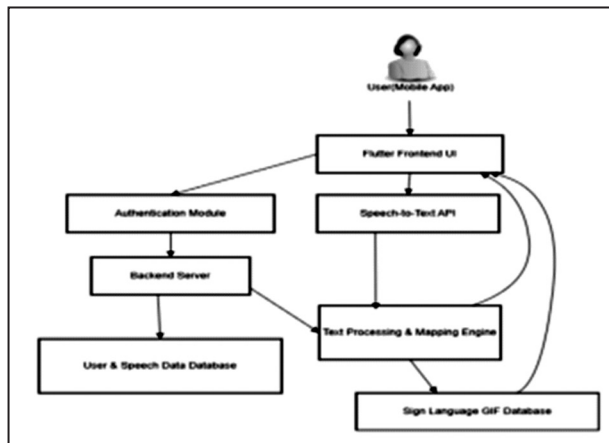
- They depend on pre-recorded or limited sign language databases.
- Any new words or phrases not in the database are usually not recognized.
- Accuracy is highly affected by background noise, lighting, and camera quality.
- They require a significant amount of training data, which makes them resource intensive.
- Many are not cross-platform or easy to scale and maintain

PROPOSED SYSTEM

The suggested system is a smartphone software that translates speech into sign language to improve communication between hearing and hearing-impaired people. It rapidly translates spoken words into text using speech-to-text technology, and then uses animated GIFs to map those words to corresponding sign language gestures. Hearing-impaired individuals can immediately comprehend discussions because of this real-time conversion. The application, which was developed with the Flutter framework, guarantees seamless operation on a range of Android devices. It makes use of Firebase for safe user authentication and real-time database operations, making account management simple. Users of all ages can use the app because of its easy-to-use UI, which is interactive and doesn't require any technological expertise. All users have to do is speak; the system takes care of the rest. Unlike traditional methods that rely on complex image processing or advanced hardware, this system is easy to use and adaptable. It can be updated with new gestures as needed, making it future-ready. The use of animated GIFs makes the signs visually clear and easy to understand, promoting inclusivity and empowering the hearing-impaired community. Overall, this mobile application provides a fast, practical, and user-friendly solution to bridge the communication gap between different groups, making everyday interactions more accessible and natural.

MAIN OBJECTIVES

1. To convert spoken words into sign language using animated GIFs.
2. To provide real-time speech-to-sign translation for better communication.
3. To offer a simple, user-friendly mobile interface for all age groups.
4. To ensure secure login and data handling using Firebase.
5. To deliver a cost-effective and easily updatable solution.
6. To promote inclusivity and support the hearing-impaired community.



EXPLANATION

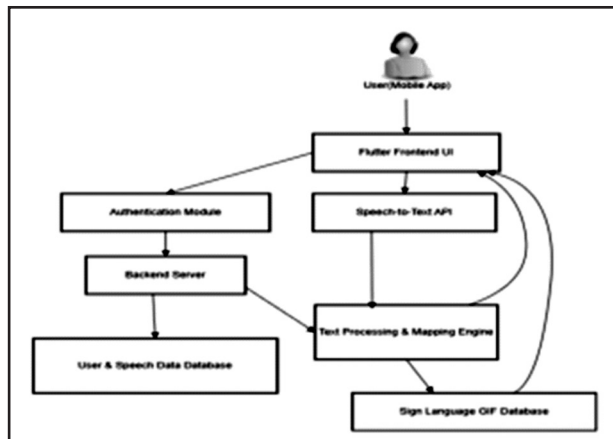
The use case diagram for the Speech To Sign Language Translation system application illustrates the interactions between the user and the system’s core functionalities. The user begins by registering or logging into the application to gain access. Once authenticated, they are directed to the home screen, where they can use the primary feature—speech-to-text conversion. This feature captures spoken input, transcribes it into text, and then displays the corresponding sign language GIFs, enabling effective communication. Additional use cases include managing the user profile and accessing help and support, ensuring a smooth and personalized user experience. This diagram provides a clear view of how users interact with the app to perform various tasks aimed at bridging the communication gap between hearing and hearing-impaired individuals.

SYSTEM ARCHITECTURE

EXPLANATION

The Speech to sign language translation system application’s architecture is made to allow for seamless communication between the data management, processing engine, and user interface elements. The Flutterfrontend user interface (UI) is used by users to engage with the mobile

application. The authentication module verifies user credentials via the backend server linked to a central database that houses user and speech-related data when a user logs in or registers. The application uses a Speech-to-Text API to translate user speech into text as they talk. The



processing and mapping engine receives this transcribed text, finds keywords, and matches them with sign language GIFs from the sign GIF collection. Real-time communication is thus made possible by the user interface displaying the corresponding GIFs. This transcribed text is sent to the processing and mapping engine, which identifies keywords and matches them with corresponding sign language GIFs from the sign GIF database. The matched GIFs are then displayed on the user interface, enabling real-time communication. The backend also facilitates interaction between components, ensuring data flow, processing, and user experience are consistent and reliable throughout the system.

METHODOLOGY

Methodologies are the process of analyzing the principles or procedure of a Progressive Anonymous Database management system.

MODULES:

1.1 USER LOGIN MODULE

MODULE 1: REGISTRATION & LOGIN

Purpose:

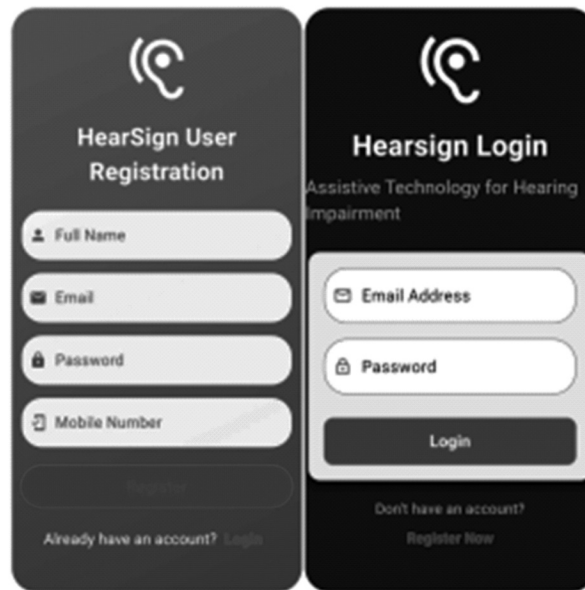
To provide secure access to the application by allowing users to register and log in.

Features:

- **Registration Page:**
 - Users can create a new account by entering their email, password, and mobile number.
 - The entered data is stored securely in Firebase using Realtime Database and Authentication services.
 - Validation checks ensure all fields are filled correctly and securely.

- **Login Page:**

- Registered users can log in by providing their email and password.
- Firebase Authentication is used to verify user credentials.
- Once authenticated, users are redirected to the main interface of the application.
- Invalid login attempts are handled with clear error messages.



1.2 SPEECH-TO-TEXT CONVERSION MODULE

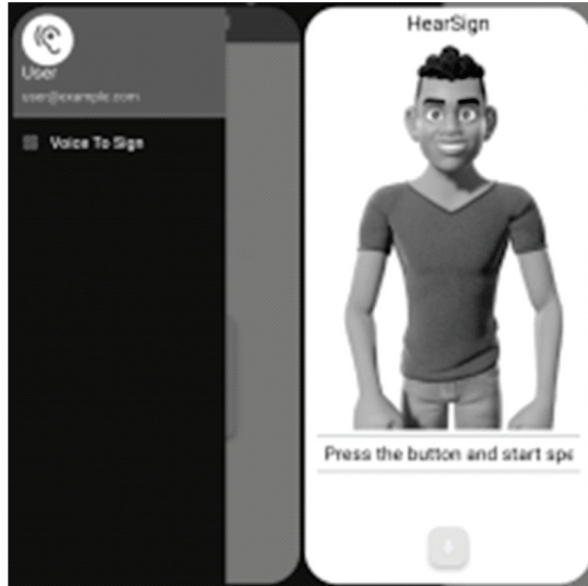
MODULE 2: SPEECH-TO-TEXT CONVERSION

Purpose:

To convert spoken words into text using voice input.

Features:

- The module uses the `speech_to_text` package available in Flutter.
- When the user speaks into the device microphone, the app listens and processes the speech.
- The spoken words are accurately converted into text in real-time.
- This text is then used in the next module for gesture (sign language) display.
- The system handles errors and allows the user to re-record if needed.
- Supports continuous listening or tap-to-talk functionality for ease of use.



1.3 TEXT-TO-GIF CONVERSION MODULE

MODULE 3: GESTURE DISPLAY

Gesture Visualization Module (GIF Integration)

- Downloaded 3D animation images (A–Z, 0–9) from the GitHub repository Audio-Speech-To-Sign-Language-Converter.
- Uploaded these images to the Giphy platform to create animated GIFs using descriptive prompts like “Hello”, “Hi”, “Good”, etc.
- Converted images into dynamic sign language GIFs for use in the Speech-to-Sign Language Translation System.

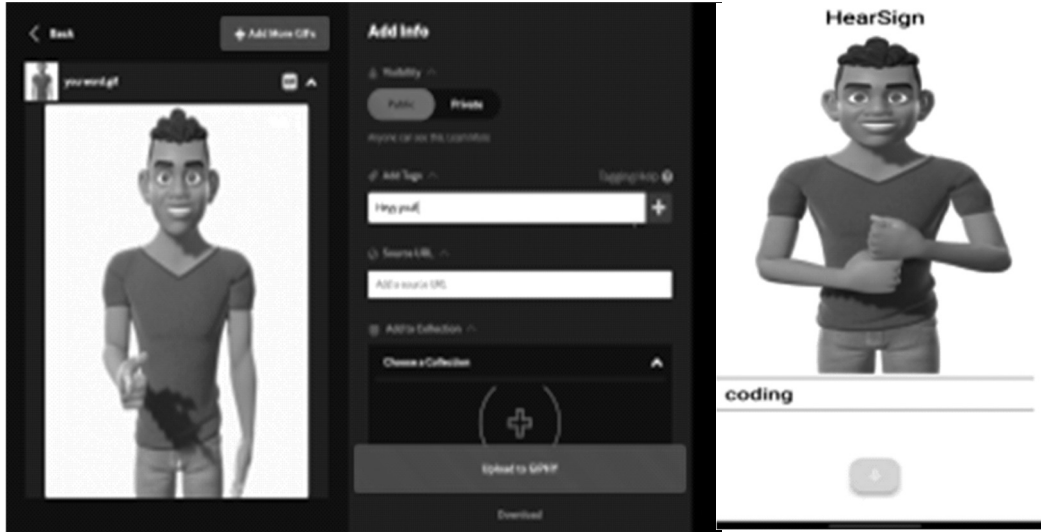
Purpose:

- To visually represent recognized speech as sign language gestures using animated GIFs.
- To improve accessibility and understanding for users with hearing impairments.

Features:

- Recognized text from Module 2 is mapped to corresponding gesture GIFs.
- Real-time display of the correct hand gesture on the mobile screen after speech recognition.
- High-quality looping GIFs ensure better visibility and comprehension.
- User-friendly interface that visually translates each spoken word.
- Scalable system—new words and gesture GIFs can be added easily.
- Supports both alphabet-based gestures and common spoken words.

- Enhances user interaction through dynamic and engaging visual feedback.
- Checks if the word has a predefined sign → Displays corresponding GIF.
- Otherwise, breaks words into letters → Displays letter-by-letter sign images.



FUTURE ENHANCEMENTS

- Challenges in Noisy Areas – Works best in quiet environments but may struggle with background noise. Future updates will include better noise filtering.
- More Words Needed – Right now, it supports basic words and phrases, but adding more vocabulary will improve conversations.
- Expanding Sign Language Support for multiple regional variations.

CONCLUSION

In conclusion, the proposed speech-to-sign language translation system offers a modern, efficient, and inclusive solution to the longstanding communication barrier between the hearing and hearing-impaired communities. By harnessing the capabilities of Flutter, Firebase, and speech-to-text APIs, the system ensures fast, secure, and seamless translation from spoken words to animated sign language gestures. Its mobile-friendly design, combined with ease of use, makes it accessible to users across all age groups and technical backgrounds. Unlike traditional hardware-heavy systems, this application is cost-effective, adaptable, and future-ready, capable of expanding its gesture library as needed. Ultimately, this project not only empowers individuals with hearing impairments but also fosters greater awareness and integration in everyday communication.

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