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From the desk of Editor-in-Chief

It gives me immense pleasure to present before you the latest issue of our annual research journal, the *International Journal of Multidisciplinary Research* (**PSIT-CHE IJMR**), Volume 5, June 2024. This issue presents research papers focusing on the latest advancements in the field of management and technology that depict the growth of India as a $5 trillion economy. These thought-provoking and insightful research papers significantly contribute to the discourse on different aspects pertaining to the growth of our nation.

We encourage readers to consider the implications of these findings for their own work, and we invite you to provide feedback and consider submitting your own research for future issues.

I deeply appreciate the efforts and dedication of the contributing authors who have put their valuable thoughts into the concerned areas through our research journal, thereby opening the door for future research. We extend our gratitude to our peer reviewers for their rigorous evaluation and to all those who have been directly and indirectly involved in this enriching journey.

Happy Reading!

Prof. (Dr.) Bhagwan Jagwani

Content

The Enablers and Inhibitors of Digital Transformation: Impacting Generation Z in Higher Education Institutions

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ABSTRACT

Digital transformation combines the information, computing, communication, and connectivity technologies to automate tasks. The study aimed to understand how Generation Z students perceive digital transformation in Higher Education Institutions (HEIs) by exploring both enablers and inhibitors of digital transformation. It also aimed to systematically explore Gen Z's attitude regarding the adoption of digital technologies. The study collected responses from 154 Generation Z students using a digital questionnaire. The sampling method employed was convenient sampling to ensure ease of access to participants. After removing irrelevant submissions, 143 valid responses were analysed using NVivo 14 software for qualitative data comprehension. The study utilized an online survey and a detailed review of existing studies to gather information. Analysis was conducted various analytical tools, including word clouds, word frequency analysis, and sentiment matrices were employed. The conclusion revealed that Generation Z students strongly believe in the importance of digital transformation in HEIs. Collaboration with external stakeholders and support from staff and faculty were deemed essential for success in the digital world. However, the study suggests the need for empirical studies to examine Gen Z's attitudes toward institutional education systems.

Keywords: Generation Z, Digital transformation, Higher education institutions, Enablers, Inhibitors

INTRODUCTION

In today's Education 4.0 world of technology, there is a lot of talk about digitization, digitalization and digital transformation. Firstly, "Digitization refer to as the process of turning analog information into a digital format and adding metadata for better organization. Secondly, "Digitalization" involves the widespread integration of digital technology into various aspects of our lives. Digitalization not only involves utilizing technology but also reshapes existing business models for growth and innovation. Additionally, it offers valuable insights for enhancing sustainability and scalability (Brennen and Kreiss, 2016). The term "Digital transformation" defined as the changes brought about by information technologies (IT) through combinations of information, computing, communication, and connectivity technologies to automate tasks (Vial, 2019). This transformation relies on factors such as the digital proficiency of the workforce and the recognition of the value of embracing digital trends in both academic and administrative processes (Limani et al., 2019). Importantly, this transformation is not limited to a specific sector. As noted by Mikheev et al. (2021), digital technologies are significantly reshaping interactions between economic actors across various domains, construction, education, banking, healthcare, transportation, retail, media, and security sectors. In the context of Higher Education Institutions (HEIs), Bertossi et al. (2021) identified seven interconnected elements. Those elements are the institutional framework, campus operations, education, on-campus experiences, research, outreach and collaboration, and reporting and assessment. Together, these elements highlight the multifaceted impact of digital transformation on HEIs. In this transformative landscape, Higher Education

Institutions recognize the necessity to adapt to the evolving needs and expectations of Generation Z students. Generation Z students anticipate a seamless digital experience and prefer technology-mediated communication. Technology and the internet are influencing knowledge acquisition, physical wellness, educational processes, and professional opinions (Mason et al., 2022). Digital smart Institutions can embrace digital transformation and implement innovative strategies to enhance the student experience and optimize learning outcomes for Generation Z.

OBJECTIVE OF THE STUDY:

To explore the enablers and inhibitors of digital transformation in Higher Education Institutions from the perspective of Generation Z students

LITERATURE REVIEW
THE ENABLERS OF DIGITAL TRANSFORMATION
Affordability and Accessibility

In the evolving landscape of higher education, digital transformation is reshaping the learning experience. Colleges are adopting specialized digital strategies to enhance student's learning abilities. They are recognizing the crucial role of Information and Communication Technology (ICT) in achieving inclusive and high-quality education (Nermend et al., 2022; Elmassah et al., 2022). Virtual learning tools such as blogs, wikis, podcasts, and mobile computing contribute to scalable and affordable education. The integration of various technology such as mobile devices and cloud systems are enhancing accessibility, collaborative learning, and inclusivity in higher education (Laufer et al., 2021). Generation Z are ensuring 24/7 access to education driven by factors like perceived ease of use, usefulness, real-time access, affordability, and gratification (Devisakti et al., 2023; Phutela et al., 2020). In essence, technology is propelling education toward a more accessible, adaptable, and globally competitive landscape.

Institutional Commitment

Higher education institutions (HEIs) have embraced online and distance learning to meet student needs (Habib, 2023). Technology plays a pivotal role in enabling innovative practices like Massive Open Online Courses (MOOCs), flipped classrooms, and collaborative distance learning environments (Bygstad et al., 2022). Platforms like Zoom, Google Meet, and Google Classroom facilitate course delivery and interaction between students and educators (Shenoy et al., 2020; Shahzad et al., 2020). Educators upgrade their tech skills through platforms like YouTube, webinars, and Massive Open Online Courses from international universities. Customized technology adoption will lead to a higher level of pedagogical transformation (Castro, 2019).

Generation Z Learners

Generation Z are the true digital natives who are integrally involved in digital environment. Digital learning act as a powerful tool aligned with their tech-savvy lifestyles (Tran et al., 2020). They prioritize the internet and social media for information and interactive experiences (Vyugina, 2019). Many researchers have viewed that traditional learning is no longer sufficient for Generation Z. They seek seamless digital experiences and technology-mediated communication that transform various aspects of their lives (Szymkowiak et al., 2021). Educational institutions are mobilizing and empowering this generation for recognizing their digital-savvy demand of education (Seemiller & Grace, 2017).

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Infrastructural and Technical Support

The concept of the smart campus represents a tech-empowered educational environment (Omotayo et al., 2021). Digital evolution incorporates cloud services, and immersive technologies (Santoso et al., 2019). Adapting to evolving digital technologies means restructuring the educational paradigm to prepare learners for flexibility and rapid adaptation (Szymkowiak et al., 2021). Digital transformation strives for contemporary education, ICT infrastructure, diverse resources, and competitive infrastructure (Ovchinnikova et al., 2023; Nikou and Maslov, 2022; Helmer et al., 2022; Awuzie et al., 2021).

Research on Educational Technologies

Research highlights the pivotal role of intellectual capital influencing sustainable inter-professional education (Yenugu, 2022). Digital transformation within HEIs emphasizing the evolving relationship among Generation Z needs, higher education, and technology (Carvalho et al., 2022).

Government Policies and Initiatives

India's National Education Policy, 2020 emphasizes technology integration for improved accessibility, teaching methods, administration, and professional development in HEIs (Singh et al., 2021). Initiatives like Baadal, Free and open source software for education (FOSSEE), Virtual Labs, and the Global Initiative of Academic Networks (GIAN) foster collaboration, enhance technological capacity, and promote contemporary education.

COVID-19 Pandemic

The pandemic is rapidly driving digital transformation in higher education. Institutions adapting swiftly to online learning navigate economic challenges more resiliently. Rapid digital transformation is due the long lasting impact of the pandemic on education (Iivari et al., 2020; Xue and Crompton, 2022; Joshi et al., 2020).

Instructional Innovator

Internet and powerful tools and technologies including learning management systems (LMS), Artificial Intelligence, Cloud Technologies, Internet of Things, Augmented reality, Virtual Reality, and the emerging metaverse are redefining the educational landscape (Ovchinnikova et al., 2020; Al-Adwan et al., 2023; Ahalt et al., 2017; Helmer et al., 2022; Awuzie et al., 2021).

International Collaboration

To boost India's global reputation, it is essential to empower students to earn credits from foreign institutions, increase the enrollment of international students, encourage research collaborations, and support Indian educational institutions in establishing campuses abroad (Yenugu, 2022).

Behavioural Intentions

The role of the Internet and Communication Technology in digital learning is crucial and influenced by factors like computer anxiety, computer self-efficacy, perceived enjoyment, perceived usefulness, perceived ease of use, student satisfaction, and the intention to use (Sayaf et al., 2021; Nguyen et al., 2022; Zacharias and Nikolopoulou, 2022; Al-Maroof et al., 2021). Additionally, the perceived usefulness and actual usage of social media have a significant impact on learning engagement (Alalwan, 2022). The acceptance of digital learning platforms is influenced by various factors, including attitudes, technology self-

efficacy, subjective norms, and facilitating conditions (Sayaf et al., 2021; Al-Maroof et al., 2021).

Table 1: Enablers of Digital Transformation

Enablers	Factors	References
Affordability and Accessibility	Real-time Access, Affordability, Ease of access, Timesaving, Variety of resources, Availability of search tools, No physical space limitation	Mishra et al., 2020; Nikou and maslov, 2023
Institutional Commitment	Educational institutions' preparedness to provide quality education, Digital communities in e-learning	Awezie et al., 2021; Castañeda and Selwyn, 2018; Ahel et al., 2023
Generation Z Learners	Generation Z's traits and characteristics, Technology addiction, Expectations, Entrepreneurial vision	Szymkowiak et al., 2021; Hernandez-de-Menendez et al., 2020; Mohr & Mohr, 2017
Infrastructure and Technical Support	ICT Infrastructure, Technical support, Variety of resources, Physical space availability, Information technology quality support	Helmer et al., 2022; Awuzie et al., 2021; Sharma and Srivastava, 2019; Lee et al., 2015; Tashkandi and Al-Jabri, 2015; Laupichler et al., 2022
Research on Educational Technologies	Research on educational technologies, Research collaborations between Indian and foreign HEIs	Sharma and Srivastava, 2019; Englund et al., 2017; Carvalho et al., 2022; Ahel et al., 2023
Government Policies and Initiatives	Government policies and initiatives, Quality Education, New education policy, Diksha, Swayam Prabha Channel, Shiksha Van, E-Pathshala, and National Repository of Open Learning	Singh et al., 2021; Srivastava, 2020; Jana and Smrity, 2021; Elmassah et al., 2022
Covid-19 Pandemic	Educational institutions' preparedness to conduct distance learning, Satisfaction with e-learning outcomes	Xue and crompton, 2022; Joshi et al., 2020; Awasthi, 2020; Jena, 2020; Shenoy et al., 2020; Al-Maroof et al., 2020; Zancajo et al., 2022
Instructional Innovation	Enriching the Information Systems, Technical and innovation skills, Knowledge capabilities, and Availability of search tools, Makes the subject interesting, Course design quality, Educators' Beliefs, and Skills	Helmer et al., 2022; Awezie et al., 2021, Sharma and Srivastava, 2019; Englund et al., 2017
International Collaborations	International collaborations, Partnering institutes, Internationalization of Indian education, International student enrollment, research collaborations between Indian and foreign HEIs	Yenugu, 2022; Awuzie et al., 2021; Bordoloi et al., 2020
Behavioural Intentions	Attitude, Perceived Usefulness, Perceived Ease of Use, IT Ability and Self-study Ability satisfaction, Education system quality and Information Quality	Thi et al., 2022; Zacharis and Nikolopoulou, 2022; Sayaf et al., 2022; Al-Maroof et al., 2021; Andoh, 2018; Meet et al., 2022; Al-Adwan et al., 2023; Altalhi, 2021; Meet et al., 2022; Müller & Leyer, 2023

Source: Author's work

THE INHIBITORS OF DIGITAL TRANSFORMATION

Contextual Inhibitors

Financial challenges rely heavily on annual grants granted by Higher Education Institutions. These Institutions are posing a threat to long-term sustainability (Gkrimpizi et al., 2023). Overcoming these challenges requires sustainable financial strategies, addressing investment barriers, and establishing governance frameworks. Internal obstacles, such as political decisions and bureaucratic processes are emphasizing the need for comprehensive strategies and institutional commitment to navigate digital transformation successfully.

Operational Inhibitors

Some of the operational challenges such as shortage of technical staff are creating many obstacles for the adoption of digital transformation in smart institutions. Due to shortage of technical staff, the proper implementation of ICT infrastructure is not possible (Tarus et al., 2015). The lack of operational e-learning policies and underutilization of online platforms impede successful implementation. Ineffective leadership leads to inefficiencies. Addressing staffing, leadership, and policy issues is crucial to fully unlock digital technology potential in higher education.

Technical Inhibitors

Technical challenges in the digital transformation journey of HEIs include a lack of technical support, delays, and regulatory compliance concerns (Gkrimpizi et al., 2023). Overcoming these challenges requires addressing support service issues, navigating intellectual property regulations, and ensuring compliance. Inadequate IT infrastructure and security risks are also the reason for hesitating full adoption of digital infrastructure. The essential steps for technology adoption are strengthening technical support and ensuring IT infrastructure to its full potential.

Cultural Inhibitors

Cultural barriers, such as resistance to change, insufficient equipment, reliance on outdated systems, and a digital literacy gap present hurdles in the context of HEIs (Gkrimpizi and Peristeras, 2022). Overcoming these challenges requires short-term focus, decentralized decision-making, and internal resistance. A focus on both technological and cultural aspects fosters effective digital transformation within higher education institutions.

Behavioural Inhibitors

Behavioural intentions like fear, uncertainty, and resistance to new information systems pose significant barriers in the context of digital transformation (Radmehr et al., 2022). Overcoming these hurdles requires addressing individual attitudes and perceptions. The lack of faculty willingness or interest in adopting educational technologies presents another substantial barrier. Addressing these challenges is crucial for overcoming resistance to change and advancing digital transformation within the education sector.

Table 2: Inhibitors of Digital Transformation

Inhibitors	Factors	References
Contextual	Lack of Strategy, Vision, Policy, Action Plan, Prioritization Plan, Funds, Legislation, Organizational Complexity, Organizational Agility, Inadequate Research, Management Support, Inadequate Resources, Legal Issues/Copyright Laws	Okoye et al., 2022; Radmehr et al., 2022
Operational	Lack of Expertise, Digital Skills, Digital Literacy of Academic Staff, Leadership for Changes, Time Constraints, Technological Challenges, Knowledge and Training, No Physical Presence, Organizational Leadership Skills	Gkrimpizi et al., 2023; Esteve-Mon et al., 2021
Technical	Quality of Data, IT Infrastructure, Legacy Systems, Data Fragmentation and Diversity, IT Security Risk, Standards, lack of exploration of Digital Technologies, Poor Technology Support Integration, Security Concerns, Inadequate IT Support	Jha, 2023; Okoye et al., 2023; Awuzie et al., 2021; Tandon & Tandon, 2020
Cultural	Organizational Resistance, Academic Staff Resistance, Lack of Collaboration, Coordination Issues, Conservative/Bureaucratic Culture, Institutional Barriers, Improper Infrastructure, Digital Generation Gap	Gkrimpizi and Peristeras, 2022; Trevisan et al., 2022;
Behavioural	Mindsets and Behaviors, Lack of Commitment, Unwillingness to Adapt, Resistance to Change, Lack of Interest, Demotivation	Rekha et al., 2023; Songkram et al., 2023; Bordoloi et al., 2020

Source: Author's work

RESEARCH METHODOLOGY

This study identifies the factors influencing the use of digital technology by Generation Z students in universities and finds out the consequences on career success and societal contributions. A mixed research design implemented with an online survey with a digital questionnaire and an extensive literature review of prior studies being used as well. To effectively collect the responses of the students, the survey applied a convenience sampling method for this research. From there, the survey managed to gather 154 entries but screened out 11 that were deemed irrelevant; therefore, yielding 143 valid submissions. Data collected were analysed qualitatively using the NVivo 14 software, which provided a detailed analysis of the information gathered. Visual representations of major themes in digital transformation were identified using the techniques applied in word clouds in which key terms were used in summarizing the findings. Another technique used is word frequency analysis, which provides an inclusive method in the identification and quantification of both the past and main themes by use of recurring words. A sentiment matrix was created through NVivo to categorize the sentiments expressed concerning Generation Z participants, and this study made use of the same. It brought an in-depth understanding of the overall emotional tone regarding digital transformation. Sentix matrix was used to systematically investigate the perception and engagement of Generation Z with the implementation of digital technologies. This analytical framework helped in the organization and interpretation of the data giving insightful results about Generation Z's attitudes and behaviour for the adoption of digital technologies. This is through the combination of survey data and analytical tools with an NVivo platform that allows for an in-depth exploration of the factors that drive Generation Z

students regarding their interrelationship with digital technology and its influence on success and contribution to society.

Figure 1: Demographic Profile of Generation Z Respondents

Most of the participants representing both male and female of 17-22 age group are indicating a predominantly young Generation Z demographic. The result shows a significant number of females reported spending 2-3 and 3-4 hours surfing the internet daily in terms of internet usage. Interestingly, males tended to use the internet more frequently with a higher percentage of them spending over 4 hours online. This suggests that males in this Generation Z group were more likely to engage in longer internet sessions.

Figure 2: The Word Cloud of Digital Transformation

The word cloud predominantly emphasizes themes related to education and learning with a strong focus on digital and online resources. "Learning," "resources," "quality," and "digital" are central, highlighting the importance of high-quality digital education. "Training," "professional," and "development" reflect a commitment to skill enhancement. "Education" and "transformation" suggest a broader educational impact, while "internet" and "technology" underscore the role of digital tools. "Access" indicates a priority for equal opportunity in education. "Student" and "online" point to the learner's perspective and online learning. The lightly seen words, like "intelligence," "research," "blended," and "international," may represent secondary, yet valuable aspects, such as a focus on research,

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blended learning approaches, and a global or international context in education. Overall, this word cloud conveys a strong commitment to digital education, quality, and professional development with a global perspective and a nod to research and blended learning approaches.

Table 3: The Word Frequency of Similar Words

Word	Length	Count	Weights (%)	Similar Words
processes	9	236	6.45	access, change, development, feedback, learning, processes
change	6	187	6.05	access, change, development, speed, strengthening, transformation
cognitive	9	172	5.04	cognitive, faculty, learning
using	5	123	5.02	development, technology, using
initiatives	11	110	3.9	initiatives, student
faculty	7	107	3.82	faculty, staff
resources	9	119	3.61	funding, resources, support
support	7	119	3.61	funding, support, supported
student	7	103	3.55	students
insufficient	12	69	3.5	inadequate, insufficient
digital	7	81	3.3	change, digital
training	8	88	3.24	development, training

The word frequency analysis shows that "Processes" is the most frequent term appearing 236 times and holding a significant weighted percentage of 6.45. It is linked to words like "access," "change," "development," "feedback," and "learning." Similarly, "change" is another prominent term occurring 187 times with a weight of 6.05%. It is associated words include "access," "development," "speed," "strengthening," and "transformation." "Cognitive" follows closely with 172 mentions and a weighted percentage of 5.04%. It relates to "cognitive," "faculty," and "learning."

Figure 3: The Sentiment Matrix of Generation Z's Opinions
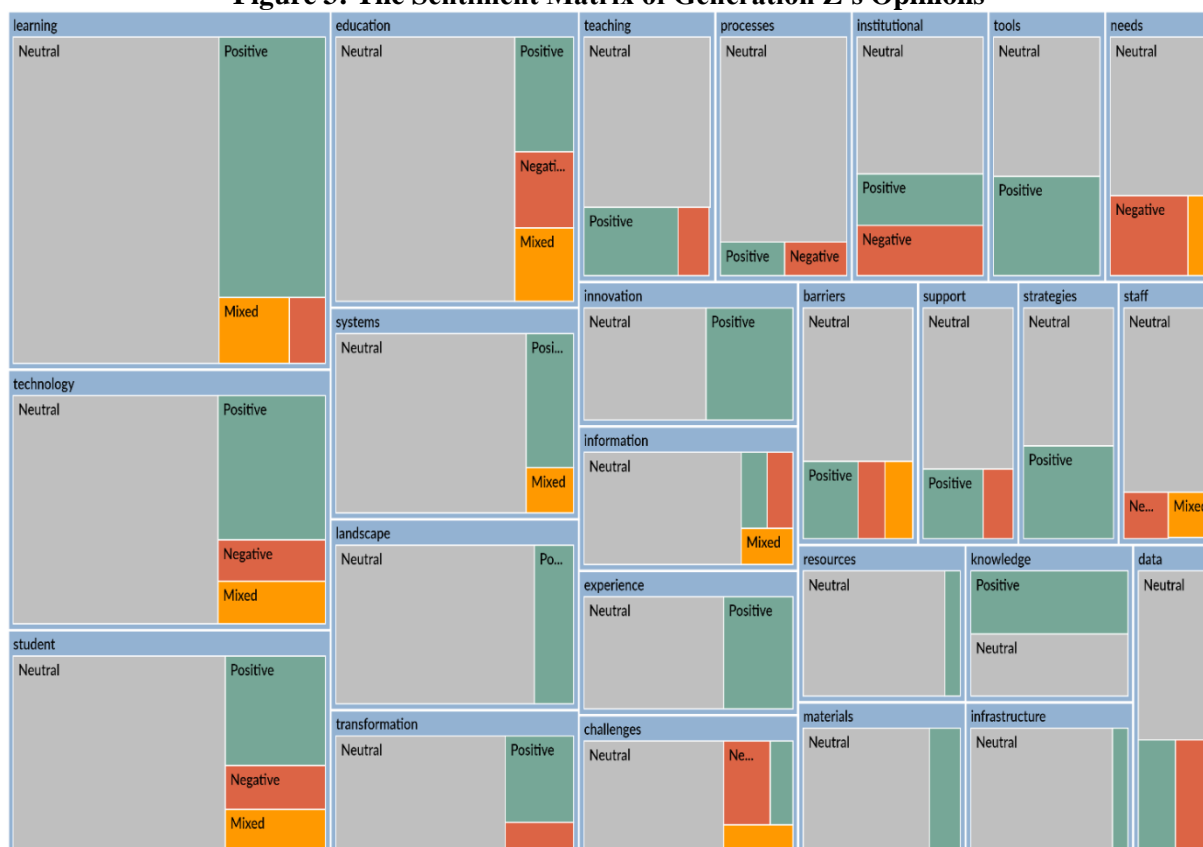
The sentiment matrix provides insight into the diverse range of feelings expressed by participants on educational and technological themes. The most common sentiment is "neutral" indicating that many respondents hold balanced views in showcasing a variety of perspectives. In contrast, the "positive" sentiment reflects optimism and enthusiasm regarding learning, innovation, and knowledge. However, the presence of "negative" sentiments suggests that some participants have concerns or criticisms related to challenges and needs. The category of "mixed" responses highlights participant's sentiments revealing a blend of both positive and negative views within their perspectives.

CONCLUSION

The study shows the impact of digital transformation in HEIs from the perspectives of Generation Z students. The results indicate that Generation Z strongly believes in the adoption of Digital Transformation in smart institutions. They have the opinion that working together with external stakeholders as well as receiving support from staff and faculty are essential to drive digital transformation and digital initiatives. They see collaboration and support as vital elements for success in the digital world.

Figure 4: Generation Z's opinion towards Digital Transformation in Higher Education
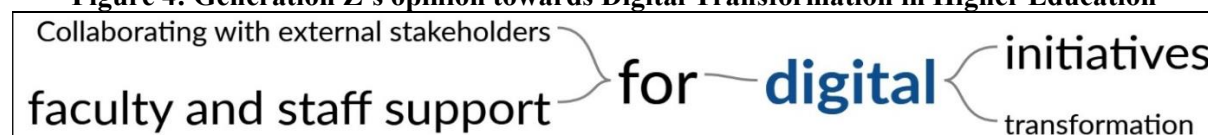
The word cloud highlights a strong focus on digital and online resources, quality education, professional development, and a global perspective. Word frequency analysis reveals "Processes," "Change," and "Cognitive" as key terms showcasing priorities related to access, development, and learning. The sentiment matrix are reflecting diverse participant perspectives on educational and technological themes. So, it has been realized that digital transformation can take the education system to the next level for the betterment of the education system.

IMPLICATIONS AND LIMITATIONS

In this era of digital transformation, sustainability guided by the principles of environmental management within the complex structure of universities is emerging as a new paradigm Educational systems, research institutions, and scholarly publications have placed higher priority on sustainable development in higher education. The benefits of adoption of digital technology and sustainable development in learning can enhance outcomes by facilitating active, collaborative learning, real-time feedback, and personalized instruction. Embracing digital transformation and new strategies can enhance the student experience and optimize academic outcomes for Generation Z. The respondents had not responded clearly and the study concluded based on intuition and subjective understanding. It is suggested to conduct an empirical study to examine the attitude and behaviour of Generation Z towards institutional education systems.

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An overview of Investor Sentiment: Uncovering Emerging Trends, Themes, and Future Directions via Bibliometric Analysis

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ABSTRACT

Investors' sentiments refer to the overall attitude, emotions & opinion of investors in the financial markets. Investors' sentiments plays an important role in shaping dynamics of the stock market influencing trading decisions, overall market trends, particularly in relation to their expectations about future market conditions and asset prices. These emotional and psychological factors that underlie investors' perceptions and reactions often contribute significantly to market volatility and can impact efficiency of financial markets. The present research article defines the significance of understanding investor sentiments in stock market & role of bibliometrics in mapping research landscape. It outlines the scope of study, encompassing a broad range of publications related to investors' sentiments in the context of stock markets. This bibliometric study aims to provide a comprehensive analysis of scholarly literature on investors' sentiments in stock market, offering insights into evolving trends, influential research areas and key contributors. The present study will be helpful for market participants, policymakers, corporate executives, entrepreneurs and academicians seeking to navigate and analyze the stock market's sentiment-driven landscape.

Keywords: Investors' Sentiments, Financial Markets, Bibliometrics, Academicians, Asset Prices.

INTRODUCTION

The foundation of traditional finance was laid down by John Stuart Mill in 1848 by introducing the concept of "homo-economicus" (Mill, 1848). The term "homo-economicus" means that human beings are rational and always try to maximize their utility through rational assessment of different available alternatives. From then onwards traditional finance models have started dominating the financial world over the last few decades. But neither all the times, nor all investors consider the trade-off between risk and reward while making the investments. Investors' judgements are frequently influenced by instinct, sentiments, and heuristics rather than logic (Tversky and Kahneman 1974). Thus, classical finance theories' inability to account for market volatility and the gains made by active investors has led to the origin of behavioral finance (BF) theories (Olsen, 1998). Baker and Wurgler's seminal cross-sectional analysis (2006, 2007) brings attention to profound impact of sentiments on stock returns, challenging conventional views on market efficiency. Their work underscores the need to explore the intricate interplay between investor sentiment and pricing dynamics, opening avenues for further research in understanding behavioral aspects of financial markets. Echoing this sentiment, Barber's investigation into noise trading (1994) emphasizes the role of non-informational trading in market fluctuations, highlighting the necessity of distinguishing noise from information-driven trading. Additionally, (Barberis et al., 1998) provides a theoretical framework for comprehending the behavioral dimensions of sentiment, offering insights into its broader impact on market dynamics.

Investor sentiment refers to the degree of optimism or pessimism of investors in relation to financial and securities markets (kamath et al., 2022). Investor sentiment, characterized by

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the beliefs and emotions of market participants, plays an important role in shaping capital market and affecting asset pricing dynamics.

The dynamics of sentiment are not confined to traditional financial markets alone; they extend to emerging areas like crypto-currency markets. Entrop et.al's investigation (2020) into price discovery in Bitcoin markets illuminates the determinants of price movements in this nascent but influential space. The globalization of sentiment effects is highlighted by Schmeling's international evidence (2009) on impact of investor sentiments on the stock returns, contributing to broader understanding of how sentiment transcends geographical boundaries.

Due to the significant influence of investor sentiment on market returns, volatility, and liquidity (Baker & Wurgler, 2006; Liu, 2015), a thorough grasp of how research on this topic has evolved is crucial. To achieve this, a comprehensive analysis of the existing research landscape is essential. This study aims to illuminate current state of learning on investor sentiment by examining existing body of literature through bibliometric analysis.

LITERATURE REVIEW

This literature review encompasses a comprehensive exploration of studies delving into complex relationship between investor sentiment & various facets of financial markets. Baker and Wurgler's seminal work (2006, 2007) lays the foundation by examining how sentiment significantly influences cross-section of stock returns, challenging traditional notions of market efficiency. Barber's investigation into noise trading (1994) sheds light on role of non-informational trading in market fluctuations, emphasizing the necessity of distinguishing noise from information-driven trading. Barberis et al., (1998) contribute a theoretical model of investor sentiment, providing a framework to understand the behavioral aspects of sentiment and its impact on market dynamics. Bhatia and Bredin's exploration (2018) scrutinizes whether investor sentiment enhances asset pricing models, adding valuable insights to the ongoing debate on sentiment's role in refining traditional pricing models. Bergman and Roychowdhury (2008) uncover the link between sentiment and corporate disclosure, revealing how firms adjust communication strategies based on prevailing sentiment, influencing information asymmetry. Brown and Cliff's research (2004, 2005) delves into near-term predictions of stock market movements based on sentiment, highlighting its short-term impact on asset valuation. Chordia, et al., study (2020) investigates the relationship between index option trading and market returns, providing a contemporary perspective on sentiment-induced market volatility. Chu et al., (2015) employ a nonlinear Granger causality test to explore dynamic interactions between stock returns and investor sentiment in the Chinese stock market. Cobo et al., approach (2011) for field evolution detection and visualization showcases practical applications to the Fuzzy Sets Theory field. Das and Chen (2007) demonstrate the potential of sentiment extraction from web-based small talk for understanding investor sentiment. Olsen's study (1998) on behavioral finance and its effects on stock-price volatility offers essential insights into the psychological factors influencing financial markets. Osipovich (2020) discusses the transformation of the U.S. stock market due to the rise in individual investors, focusing on recent trends in market participation. Paule-Vianez et al., (2020) present a bibliometric analysis of behavioral finance, outlining the field's development and key contributors. Schmeling (2009) provides international evidence on how investor sentiment affects stock returns, enhancing the global understanding of sentiment-driven effects. Singh (2021) conducts a bibliometric analysis of behavioral finance and accounting, shedding light on the evolving trends in these disciplines. Stambaugh et al., (2012) investigate the impact of short selling and investor sentiment on market anomalies, adding to the literature on sentiment-driven market irregularities. Zhu and

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Liu (2020) compare the Web of Science and Scopus databases, highlighting differences in their coverage and utility for academic research.

METHODOLOGY

The research methodology involves a systematic approach to understanding the dynamics of investors' sentiments. Initiated by an extensive literature review, the study focuses on existing concepts, theories, and methodologies within the field. Data collection is conducted using the Scopus Database, employing a comprehensive keyword search strategy encompassing variations like "investors' sentiments" and "investor sentiment." The subsequent refinement narrows the scope to documents in specific subject areas—Economics, Econometrics, and Finance; Business, Management, and Accounting; & Social Sciences. To ensure the reliability of findings, articles in the publication stage are excluded, resulting in a selection of 1854 fully published and peer-reviewed documents. The focus is exclusively on journal publications, excluding conference proceedings and book series. The study concludes by summarizing key findings, discussing their implications for future research & practical applications in the financial domain. This methodology ensures a comprehensive exploration of the evolving landscape of investors' sentiments, incorporating diverse analytical tools for a nuanced understanding.

Fig 1: Inclusion-Exclusion Criteria

keywords search strategy
- **2483** documents found from Scopus Database using keywords:
- ("investors' sentiments" OR "investors sentiments" OR "investor sentiments" OR "investors sentiment" OR "investor sentiment")

Refined documents in subject area
- **2051** documents left after limiting to subject area:
- Economics, Econometrics and Finance
- Business, Management and Accounting
- Social Sciences, Multidisciplinary

Refined documents in publication stage
- **1905** documents left after excluding the article in press.

Final documents
- Finally, **1854** documents selected after limiting the source type to journal only (excluding conference proceedings and book series)

Source: Biblioshiny

Table 1: Main Information about the Data

Description	Results
Timespan	1991:2023
Sources (Journals, Books, etc.)	428
Documents	1854
Annual Growth Rate %	19.37
Document Average Age	6.06
Average citations per doc	30.07
References	68290
DOCUMENT CONTENTS	
Keywords Plus (ID)	1152
Author's Keywords (DE)	3696
AUTHORS	
Authors	3146
Authors of single-authored docs	238
AUTHORS COLLABORATION	
Single-authored docs	295
Co-Authors per Doc	2.61
International co-authorships %	24.87
DOCUMENT TYPES	
Article	1800
conference paper	13
Review	41

Source: Biblioshiny

The above table gives us a snapshot of a collection of academic publications spanning from 1991 to 2023. In the above dataset, there are a total of 1854 documents, which could include research articles, conference papers, and reviews, sourced from 428 different places like journals or books. The data shows a yearly growth rate of about 19.37%, indicating a steady rise in the no. of publications over time. On average, these documents are around 6.06 years old, and each one has been cited approximately 30.07 times, suggesting their impact. There are 3146 authors involved, and interestingly, about 24.87% of the collaborations include researchers from different countries, highlighting an international aspect. The document types include 1800 articles, 13 conference papers, and 41 reviews. This data provides valuable insights into the productivity, impact, and collaboration patterns within the academic community over the specified period.

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PRESENTATION OF DATA:

❖ **Annual Scientific Production**: The provided data represents the number of documents published in alternate years from 1991 to 2023. In 1991, there was 1 document, followed by no publications in 1992. In 1993, there were 3 documents, and this pattern alternates between years with various document counts. The document counts show a fluctuating trend over time. For example, in the early years, there are small numbers, and then there's an increase in 1996 (3 documents) followed by a period of lower counts until 2004.

Fig 2: Annual Scientific Production
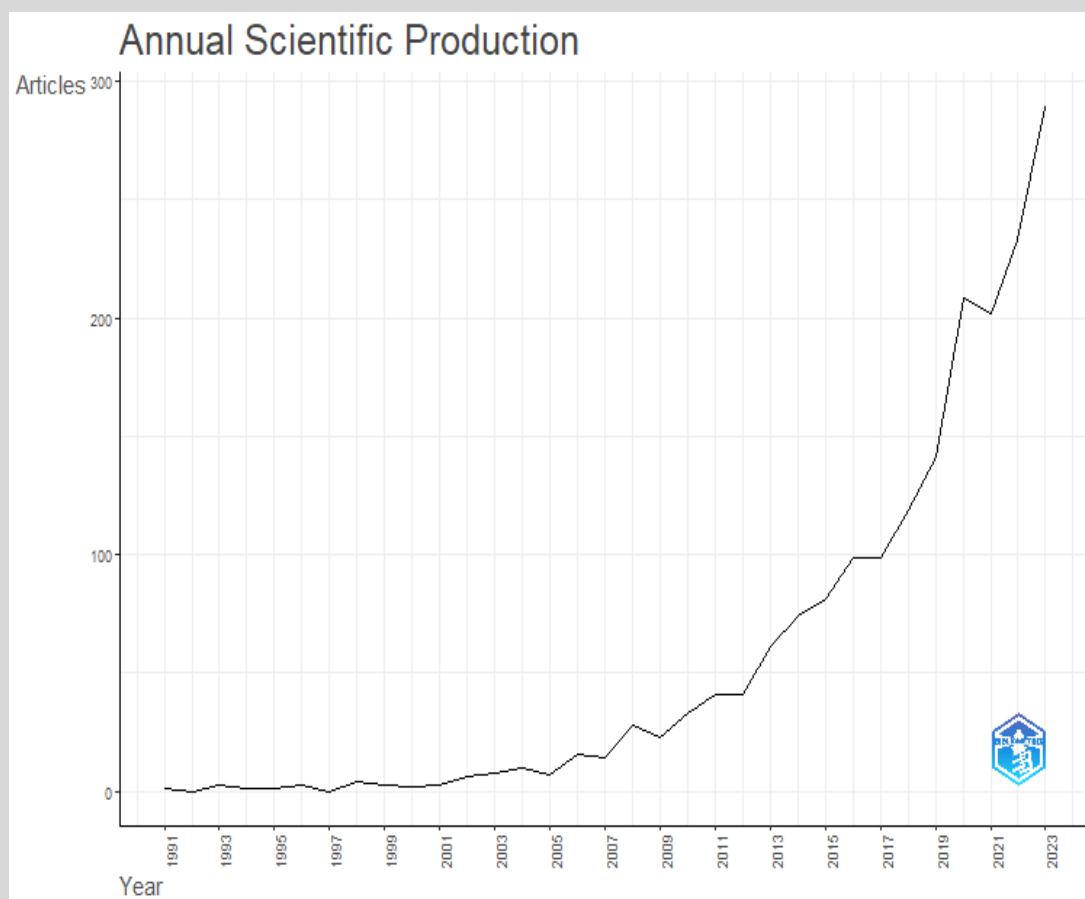
Source: Biblioshiny

From 2004 onwards, there's a notable upward trend, with an increasing number of documents in each subsequent year. The data indicates a significant growth in publications from 2008 onwards, with the numbers reaching their peak in 2023 with 289 documents. This suggests a changing pattern of scholarly output over the years, with more substantial contributions and increased research activity in recent years.

❖ **Three Field Plot:** This three-field bibliometric plot integrates authorship, geographic distribution, and keyword analysis. The left field illustrates the countries of authors, allowing insights into global dispersal of research contributors. In middle field, individual authors or research groups are represented, providing information on prolific contributors or collaboration patterns. The right field displays keywords associated with the publications, indicating prevalent topics or research themes.

Fig 3: Three Field-Plot
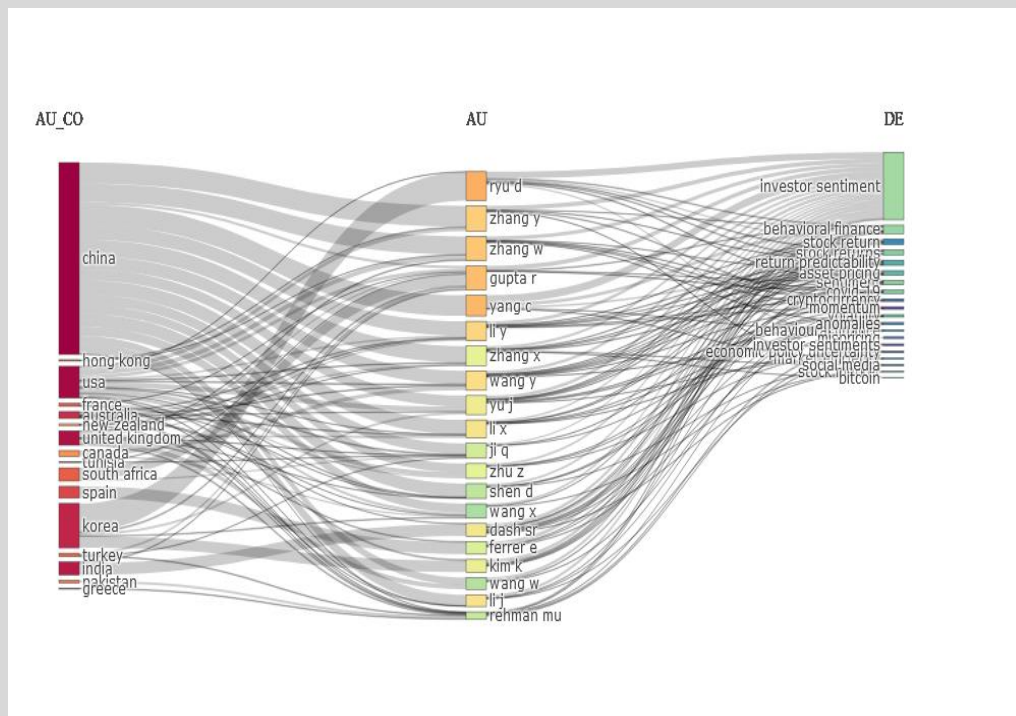
Source: Biblioshiny

❖ **Most Relevant Sources:** The provided data reveals the publication counts for specific sources in the field of finance research. The data indicates the most relevant sources for understanding investor sentiments based on the no. of documents published in each source.

Fig 4: Most Relevant Sources

Source: Biblioshiny

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These sources are likely journals that specialize in topics related to investor behavior, sentiments, and decision-making in the realm of finance. "Journal of Behavioural Finance" stands out with 43 publications, emphasizing its significance in exploring the psychological aspects of financial decision-making. Other notable sources include "Finance Research Letters" with 78 documents, "International Review of Financial Analysis" with 56, and "Journal of Behavioral and Experimental Finance" with 34. These journals contribute significantly to the understanding of investor sentiments, reflecting the research community's focus on behavioral and experimental aspects within the field of finance.
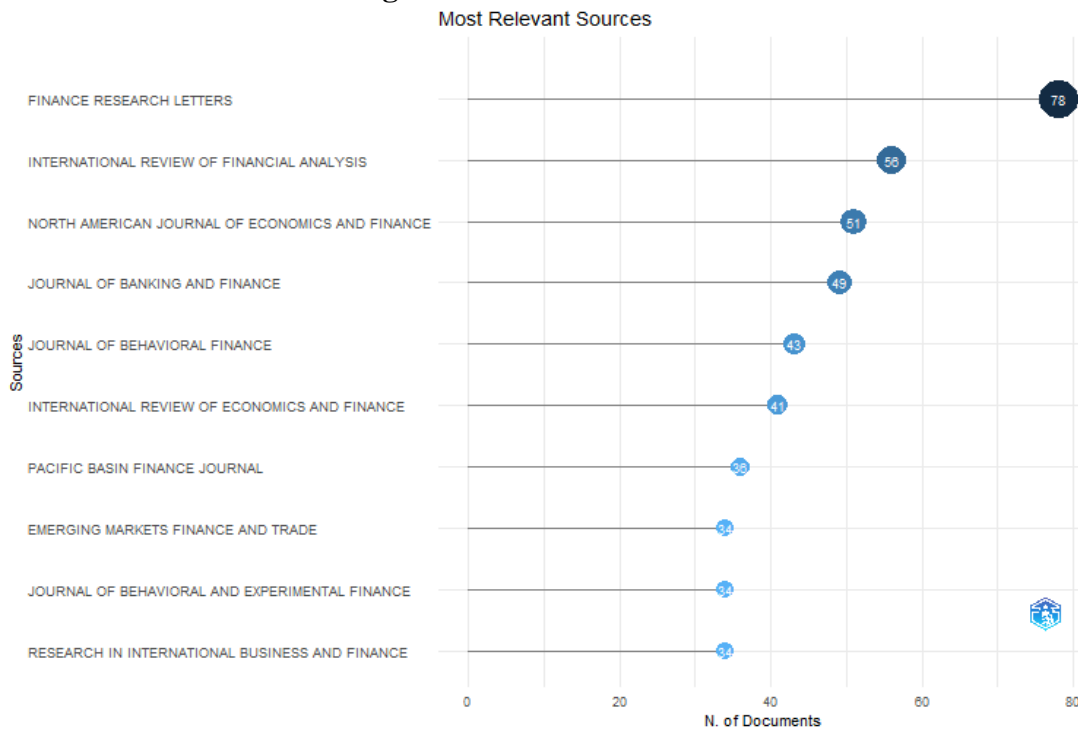
Table 2: Top 20 global cited countries on investor's sentiments

Country	Total citations	Average Article Citations	Country	Total citations	Average Article Citations
1. USA	18655	72	11. PORTUGAL	473	18.2
2. CHINA	6151	14.2	12. TUNISIA	456	11.1
3. UNITED KINGDOM	1803	22.3	13. ISRAEL	455	35
4. GERMANY	1263	27.5	14. SINGAPORE	419	41.9
5. KOREA	1211	17.3	15. HONG KONG	396	22
6. AUSTRALIA	963	18.9	16. IRELAND	381	34.6
7. FRANCE	893	25.5	17. .NEW ZEALAND	347	26.7
8. INDIA	819	9.8	18. JAPAN	272	18.1
9. GREECE	584	25.4	19. NETHERLANDS	261	16.3
10. SPAIN	556	17.9	20. SLOVENIA	227	75.7

Source: Biblioshiny

The above table outlines the top 20 globally cited countries in the context of investor sentiments. The USA leads the list with a substantial 18655 citations, representing a dominant 72% share in the global discourse on investor sentiments. China follows with 6151 citations, holding a notable 14.2% share, highlighting its growing influence in this field. The United Kingdom, with 1803 citations, maintains a significant 22.3% share, emphasizing its relatively high impact on investor sentiment research. Germany and Korea also contribute significantly, with 1263 and 1211 citations, holding 27.5% and 17.3% shares, respectively. Other noteworthy contributors include Australia, France, and Greece, each with varying citation counts and shares, reflecting their prominence in global discussions on investor sentiments. These percentages indicate the proportional impact of each country's research output within the broader landscape of investor sentiment studies.

❖ **Word cloud:** The word cloud presented in this analysis encapsulates a rich tapestry of key terms and themes in the field of finance and economics. Notable words, represented by varying font sizes, reflect the frequency of their occurrence in the dataset. Prominent concepts such as "investment," "stock market and financial markets" highlight a core focus on investment dynamics and financial market behaviors. The prevalence of terms like "investor sentiments" and "investor's sentiments" underscores a keen interest in understanding and gauging the sentiments of market participants. The impact of external events is evident through keywords like "covid-19," "financial crisis," and "uncertainty analysis," suggesting a focus on the economic repercussions of crises and the methodologies employed to analyze uncertainty.

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Fig 5: Word Cloud

Source: Biblioshiny

Furthermore, the cloud encompasses a range of methodological approaches, including "numerical model," "panel data," "granger causality test," and "vector autoregression," indicating a commitment to rigorous empirical analyses and modeling techniques. Regional perspectives are captured through terms like "China," "United States," "Europe," "United Kingdom," and "India," reflecting a global outlook in economic analyses. The cloud also touches upon the intersection of finance and technology with "social media" and "sentiment analysis," highlighting the growing importance of digital platforms in shaping financial decision-making processes.

Table 3: Most Frequent Trend Topics on investors' sentiments

Europe	Data Mining	Prediction	Crude Oil
United Kingdom	Capital Flow	Investment	China
Economic Analysis	Economics	Commerce	Investor's Sentiments
Capital Market	Finance	Price Dynamics	Covid-19
Taiwan	Stock Market	Investments	Geopolitical Risks
Stock Returns	Investor Sentiments	Financial Markets	

Source: Biblioshiny

The most frequent trend topics identified in the dataset encompass a diverse range of subjects, reflecting key areas of focus in scholarly literature or research. Europe emerges as a prominent theme, suggesting a considerable volume of research addressing economic, financial, or geopolitical aspects specific to the European continent. Data Mining and

Prediction indicate a strong emphasis on analytical methodologies, highlighting a keen interest in extracting insights and forecasting trends within the academic discourse. The United Kingdom is a noteworthy topic, Capital Flow and Investment further underscore the attention given to financial flows and investment dynamics, while China appears as a significant focus, reflecting the global interest in the economic and financial developments of this major player on the world stage. Economic Analysis and Economics suggest a robust engagement with core economic principles and analyses within the dataset. Commerce and Investor's Sentiments point to an exploration of business and market sentiments, Capital Market and Finance feature prominently, indicating a substantial body of research in the areas of financial markets & capital market dynamics.

Fig 6: Trend Topics
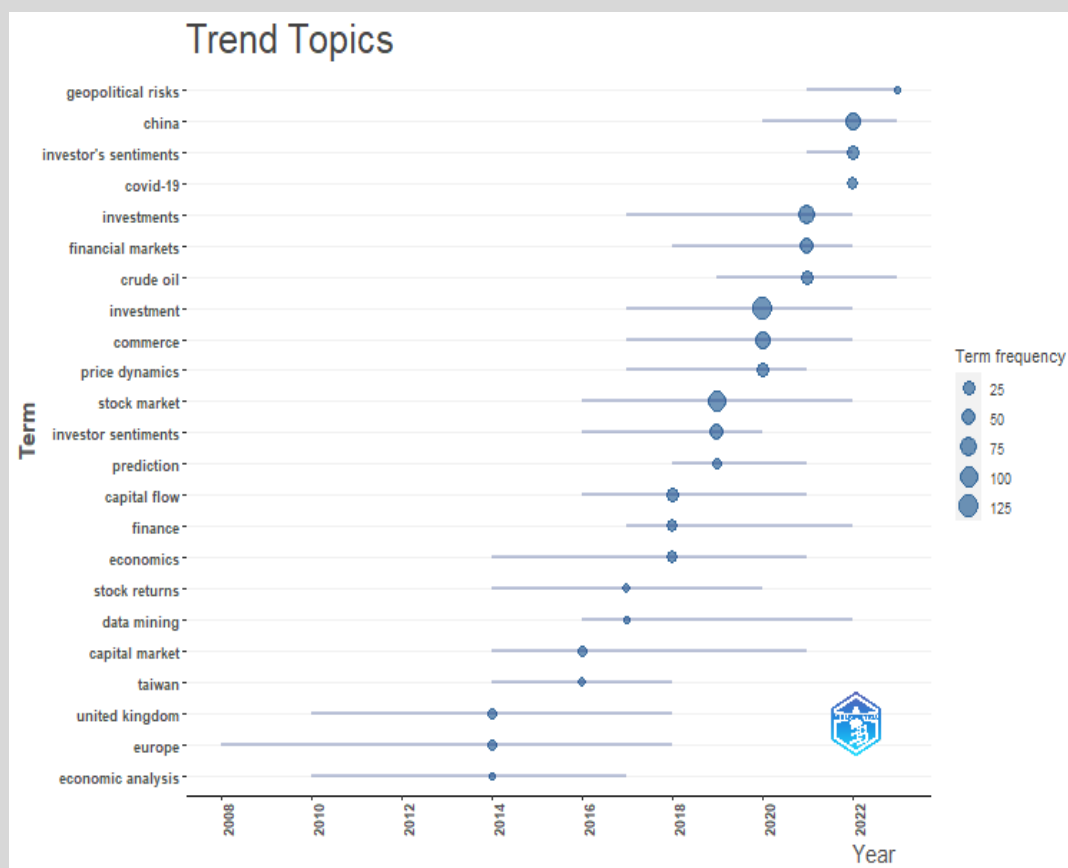
Source: Biblioshiny

Price Dynamics and Covid-19 reflect the timeliness of research, with a likely focus on the impact of dynamic pricing & repercussions of the COVID-19 pandemic on various economic & financial aspects. Stock Returns, Investor Sentiments, and Financial Markets highlight ongoing interest in understanding the performance of financial assets, investor perceptions, and broader dynamics within financial markets. Collectively, these frequent trend topics offer a comprehensive overview of the diverse and dynamic research landscape, with researchers delving into various dimensions of economics, finance, and global economic trends.

- ❖ **Keyword co-occurrence network:** This keyword co-occurrence network analysis reveals several interconnected thematic clusters that provide a comprehensive overview of the research landscape. One major cluster centers around financial markets and investment-related themes, with keywords like "financial markets," "finance," and "investment" forming a cohesive network. Another cluster revolves around sentiment analysis and

investor sentiments, including terms such as "investor sentiments," "sentiment analysis," and "investor's sentiments," indicating a distinct focus on understanding investor behavior.

Fig 7: Keyword co-occurrence network
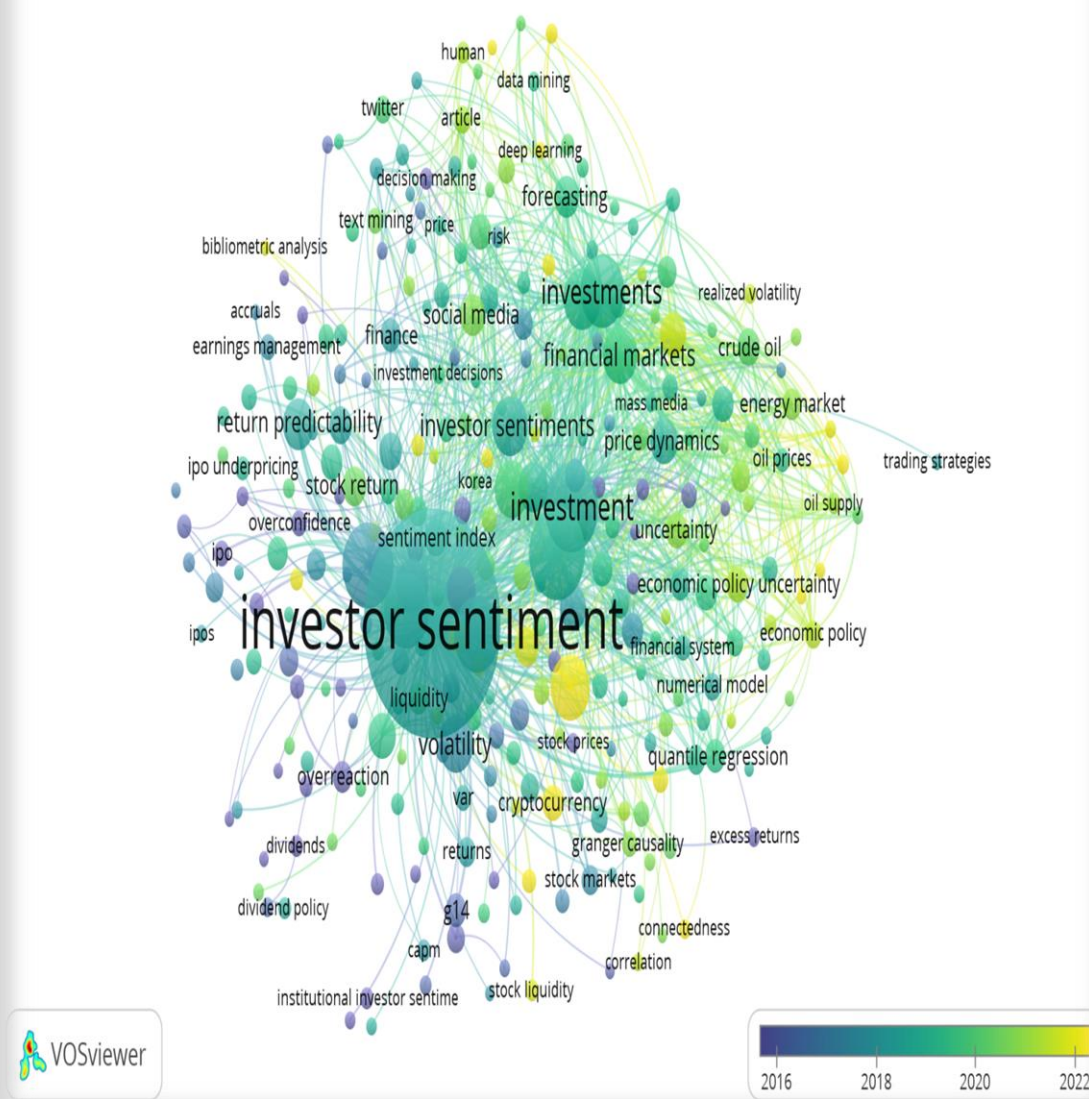
Source: VOS viewer

A third prominent cluster encompasses keywords related to economics, forecasting, and macroeconomics, revealing research interests in economic analyses and predictive modeling. Additionally, a cluster focused on risk and uncertainty emerges, with terms such as "risk assessment" and "uncertainty analysis."

Another noteworthy cluster revolves around global economic influencers, with "China," "United States," and "spillover effect" forming a cohesive network, suggesting a focus on the interconnectedness of these major players in the world economy. The cluster involving "price dynamics," "regression analysis" and "capital flow" signifies a concentration on quantitative methodologies and financial dynamics. The inclusion of terms like "financial crisis" and

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"empirical analysis" further emphasizes a focus on understanding financial systems, especially in the context of crises.

A separate thematic cluster includes keywords related to energy and commodities, such as "crude oil," "energy market," and "oil supply." This cluster may indicate research interests in the economic impact of energy markets and oil supply dynamics. Additionally, the co-occurrence of "Covid-19," "forecasting," and "uncertainty analysis" suggests a specialized focus on the economic implications of the pandemic, with an emphasis on forecasting methodologies and uncertainty assessments.

The inclusion of terms like "social media," "sentiment analysis," and "decision making" forms a cluster highlighting the intersection of finance and technology, underscoring the growing importance of social media and sentiment analysis in financial decision-making processes. The keyword "gold" stands out, possibly indicating a specific focus on precious metal markets and their economic implications.

Moreover, the co-occurrence of "Europe," "United Kingdom," "India," and "macroeconomics" forms a cluster representing a global perspective, particularly with respect to economic policy, macroeconomic analyses, and regional considerations.

In summary, the keyword co-occurrence network in this bibliometric paper reflects a diverse and interconnected research landscape, encompassing financial markets, global economic influences, quantitative methodologies, energy markets, economic impact of crises such as Covid-19, and the intersection of finance and technology. This analysis provides valuable insights into key research themes & their relationships within the studied literature.

CONCLUSION

The above bibliometric provide a comprehensive exploration of academic landscape related to investor sentiments, spanning from 1991 to 2023. The data collection, conducted through the Scopus Database, employed a meticulous keyword search strategy and subsequent refinement to focus on specific subject areas, ensuring the selection of 1854 fully published and peer-reviewed documents. The exclusive focus on journal publications, excluding conference proceedings and book series, enhances the reliability of findings.

The bibliometric data paints a vivid picture of scholarly productivity and impact. The yearly growth rate of approximately 19.37% indicates a sustained increase in publications, reflecting the evolving nature of research in the field. The average document age of 6.06 years and an average of 30.07 citations per document suggest a lasting impact, emphasizing the significance of the selected publications. Collaboration patterns are notable, with about 24.87% of collaborations being international, highlighting the global nature of research in this domain.

The document types, including 1800 articles, 13 conference papers, and 41 reviews, showcase the diverse scholarly output. Furthermore, the analysis of document counts in alternate years reveals changing patterns over time, with a notable surge in publications from 2008 onwards, reaching a peak in 2023.

The examination of relevant sources in finance research unveils key journals contributing significantly to the understanding of investor sentiments. Notable sources such as "Finance Research Letters," "International Review of Financial Analysis," and "Journal of Behavioral Finance" highlight the emphasis on behavioral and experimental aspects within the field.

The top 20 globally cited countries further elucidate the geographical impact on investor sentiment studies. The dominance of the US, followed by China & the United Kingdom, underscores their significant contributions to the global discourse. The word cloud and keyword co-occurrence network analyses offer a visual representation of key themes, methodological approaches, and global perspectives within the dataset, capturing the richness and complexity of the research landscape.

In essence, this bibliometric study serves as an insightful source for scholars, policymakers, and practitioners interested in the dynamics of investor sentiments. The evolving trends, diverse thematic clusters, and global perspectives identified in this analysis pave the way for future research directions & contributes to a nuanced understanding of multifaceted field of investor sentiments within the broader context of finance and economics.

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Assessing Challenges in Rural Development and Water Sustainability: A Socioeconomic Viewpoint on Groundwater Management and Integrated Governance Solutions in India

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ABSTRACT

Understanding the variability in extreme meteorological events attributable to climate change and anthropogenic activities is a pressing concern, profoundly relevant in guaranteeing water sustainability. India, predominantly characterized as an agrarian society, heavily relies on natural resources to sustain a significant portion of its populace. Significant advancements and the integration of various technological innovations in academic focus have been made. However, it is imperative to comprehensively grasp and address the contemporary bundled situation. This situation includes upcoming challenges led by multidimensional ecological and anthropogenic concerns, particularly pertinent to the rural transformation in India. It necessitates a concerted effort to achieve sustainability, effective groundwater policy implementation, and a technologically equipped governance mechanism. Thus, it is of utmost essential to tackle this by embracing an integrative approach encompassing practical, political, and personal heuristic spheres to address this multidimensional transformation effectively. The paper produces management gateways by preliminary triangulation of institutional practices, primary observations, and secondary empirical dataset methods. The findings of this paper are structured to manage water resources and are encircled around three major institutional frameworks in the public system. Inclusion, Innovation, and Regulation of Groundwater is further divided into its subparts assessment of aquifer and modern recharge management technique, sensitization, and governance models by pre-examining the periodical timeline. It advocates for integrated governance approaches to drive transformative changes for rural regions. This model demonstrates how to achieve Sustainable Development Goals (SDGs), rural livelihoods, socio-political, economic growth, and public health.

KEYWORDS: Groundwater Regulation, Groundwater and Public Health, Groundwater Governance, Groundwater Sustainability, Integrated groundwater Management, Sustainable Rural Development.

INTRODUCTION

Groundwater plays a crucial role in rural development (Jaiswal, Mukherjee, Krishnamurthy, & Saxena, 2003). Groundwater, serving as the primary water resource within India, supports approximately 85% of the population, rendering water an indispensable commodity crucial for human survival. Groundwater is often a primary source of irrigation, vital for agriculture, which is a significant component of rural economies (Shah, Singh, & Mukherji, 2006). As Albert Szent-Gyorgyi, the eminent Nobel laureate in Medicine (1937) and discoverer of Vitamin C (1893-1986), articulated: *"Water is life's mater and matrix, mother and medium."* Life without water is inconceivable. The Constitution of India, in Article 47, mandates the State to ensure clean drinking water. However, excessive groundwater exploitation leads to depletion, contamination, and diseases, posing substantial challenges to rural water management policies. The National Water Policy 2012 prioritizes safe drinking water for all rural and urban areas. Available statistics reveal that among the 649,481 villages in India, 1,96,813 villages grapple with

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chemical water contamination, reaching levels deemed toxic for humankind as per WHO standards. These distressing figures underscore the pressing need for immediate and effective administrative interventions to safeguard groundwater resources and ensure water availability while meeting future requirements and water sustainability. The preservation of India's ecology, economy, and living level has been greatly aided by groundwater. It is the most significant and most effective source of irrigation water in addition to being the main supply for both residential and commercial use. Economically, the government of India has given much attention to natural water resources. The interim budget for 2024–2025 allotted Rs 98,418 crore to the Jal Shakti Ministry, of which a maximum share of 71 percent went to its Jal Jeevan Mission. The budget includes Rs 77,390 crore for the Department of Drinking Water and Sanitation (DoDWS), a minor increase of 0.4% from 2023–2024. Of this, Rs 69,926 crore goes towards the Jal Jeevan Mission, aimed to supply all rural Indian homes with sufficient and clean drinking water by2024. Through individual family tap connections, the Jal Jeevan Mission seeks to supply all ruralIndian households with safe and sufficient piped drinking water by 2024. A few of the source sustainability measures the plan will need are rainwater collection, greywater management, and recharge and reuse. As of right now, the initiative has connected 14.22 crore of the 19.26 crore rural households in the nation to tap water. The Uttar Pradesh government has allotted Rs 22,000 crore for the Jal Jeevan Mission in the 2024–2025 Budget Estimate, with Rs 2,000 crore designated for maintenance activities. According to news sources, the state will spend Rs 2400 crore on irrigation energy supply. Simultaneously, a Rs 1100 crore budget has been set aside to provide farmers with free irrigation through government tube wells and canals. Despite all of this, India's groundwater is essential to the country's socioeconomic and sustainable growth. The United Nation's sixth SDG ensures the availability and sustainable water and sanitation management for all (United Nations, 2015). In the realm of groundwater studies, there is a notable emphasis within academia. My investigation revealed that various academic disciplines, including health, law, policy, economics, governance, management, and others, have demonstrated concerns regarding groundwater challenges. The literature review highlighted a significant contribution from the health discipline, particularly concerning the procurement of safe drinking water for human consumption and the associated challenges with groundwater in India (Mukherji, 2005). The literature underscores the pressing need for comprehensive measures to address water contamination in Uttar Pradesh, particularly in light of the widespread prevalence of arsenic toxicity (Ahamed et al., 2006). Furthermore, the looming issues of overexploitation and declining water quality underscore the necessity for sustainable management of groundwater resources from a long-term perspective (Saha et al., 2018). Nevertheless, despite these insights, an integrated approach to groundwater management is still required to incorporate innovation and regulation. Such an approach should not solely rely on a top-down approach but should also incorporate bottom-up strategies while simultaneously integrating both methods, particularly in rural India and the agrarian sector. It is imperative to recognize that initiatives undertaken by the legislature, proposed policies, and technological advancements are not always unidirectional in their effects; instead, the end also influences the means (Heidegger, 1977). Collaborative efforts are indispensable in order to progress towards economic sustainability.

OBJECTIVE OF THE STUDY

The main objective of this study is to investigate issues and the status related to groundwater in India, specifically Uttar Pradesh. The study aims to propose policy recommendations and suitable models applicable to groundwater regulation, innovation,

and sustainable rural development. Another study objective is to formulate an integrative approach encompassing practical, political, and personal sensitization, especially for groundwater resources and their active role in economic prosperity. This study also aims to identify challenges and gateways in rural India to achieve sustainable economic growth. A period-wise analysis of the historical groundwater trajectory in India will be conducted to analyze the outcomes and impacts of past initiatives by the administration and determine how to manage groundwater with an integrative approach.

DATASET AND RESEARCH METHODOLOGY

The dataset for this study was derived from observation and multiple secondary data repositories rather than relying solely on a single database. The study integrates information extracted from a variety of sources, including Indian Budget documents, Economic Surveys, governmental records, reports, national surveys, policy documents, legal records, and other pertinent sources. Additionally, attention was directed towards examining other nations' policy frameworks and operational models to evaluate their applicability within the context of groundwater sustainability for rural development. Furthermore, relevant literature pertaining to groundwater was thoroughly reviewed. The methodology employed in this research is exploratory and encompasses both qualitative and quantitative data sources. It is acknowledged that numerical data and records hold paramount importance in informing policy interventions; however, an extensive literature review observed that academic discourse related to numbers is rich and nuanced. Sometimes, numbers become obscured as a fog (Ghosh, 2021). Often, we become entangled in numerical data, and relying solely on numbers may constrain our ability to think beyond our limitations. This paper endeavours to elucidate an integrated mechanism for groundwater management in rural India rather than simply presenting numerical figures.

HISTORICAL BACKGROUND AND PERIOD WISE ANALYSIS OF GROUNDWATER:

This section provides an overview of the groundwater management system in India in Chronological Order, starting from pre-colonial India to independent India, which is historically significant for understanding the layers and for period-wise evaluation. In ancient India, groundwater management and development received sufficient attention in ancient texts such as *Rigveda* and *Yajurveda*, which also contained references to water management (Singh et al., 2020). Much recognition is discernible, specifically in *Brihat Samhita* (550 AD) (Jha, 1988). Chapter 55, "*Dakargalam*", connotes Sanskrit's word for "water exploration". "*Daka*" originates from the Sanskrit word for Udaka for water, and "*argalam*" refers to a branch of science dealing with water trapped deep within the earth. This chapter of the Brihat Samhita focuses on examining the availability, occurrence, distribution, and measurement of groundwater resources by utilizing geographical indicators and soil characteristics. The chapter is also concerned with groundwater exploitation (Sivaraman et al., 2022). The Dakargalam provides comprehensive details on the fluctuation of water table levels, hot and cold springs, and methods of groundwater extraction through wells, as well as techniques and equipment for Well construction (Jain et al., 2007). According to Varahamihira, through conspicuous morphological or physiological attributes, specific plants were observed to indicate the presence of groundwater at depths ranging from 3 to 171 meters across various arid and semi-arid environments (Dash & Sabar, 2022). Varahamihira's Brihat Samhita delineates the physical and biological markers indicating the presence of groundwater in lowland areas abundant with groundwater resources (Prasad, 1986). With the commencement of

Colonial rule in India, groundwater management was a minor priority. The colonial administration focused primarily on exploiting India's natural resources for their economic benefit, with little regard for sustainable management practices. During the Colonial period, In rural India, the farmers were Legally and illegally forced to cultivate Indigo (Sah, R. 1980). The production of Indigo requires large amounts of water from irrigation to the final indigo dyeing and extraction process. Water was selected as the environmentally harmless extraction solvent for the dyeing procedure (John, 2009). In 1870, groundwater was extracted through wells in the villages. The irrigation wells are circular, with a diameter of 8 to 10 feet (2.5 to 3 meters) and a depth of 20 to 50 feet (6 to 15 meters). Two bullocks propelled a *Rahat* with a series of leather or iron containers, which raised the water from the ground (Bhat et al., 2023). In the province of Uttar Pradesh, mechanized tube wells were promoted. During that time, the constraints of electricity and mobile fuel increased the operational costs of tube wells, making the return on investment comparably high. To address this issue, the Colonial administration initiated the development and promotion of large-capacity deep tube wells (DTWs) instead of shallow wells lacking mechanisms. In Uttar Pradesh, more than half a thousand tube wells were installed in 1934. (Dhawan B. D.,1982). Which resulted in Groundwater depletion in those Areas. The Indian Easements Act 1882 is a piece of legislation enacted during the British colonial period in India. Landowners were granted certain rights over the land they owned, including the right to collect and dispose of groundwater within their property limits (Cullet, P. 2012). Groundwater management during the colonial period was largely unsustainable in Nature. After Indian independence, several steps were taken for groundwater management and aquifer sustainability (Saha et al., 2018). In order to improve water distribution and storage, infrastructure projects were started, such as the construction of dams, which were called the "Temples of modern India"(Morrison, 2010). The government of India and State Governments has taken several legislative actions. An Act of Parliament created the National Bank for Agriculture and Rural Development (NABARD) on July 12, 1982, and it was essential in addressing groundwater challenges in Indian agriculture (Gulati et al., 2019). The Central Ground Water Authority (CGWA) has been established in accordance with section 3(3) of the "Environment (Protection) Act, 1986" to regulate and control groundwater use in the nation by mining companies, infrastructural projects, and other industries (Sharma, 2009). The Uttar Pradesh Bhoomi Evam Jal Sanrakshan Adhiniyam, 1963, was passed by the government of Uttar Pradesh to regulate and protect land and water resources. It aims to prevent degradation, misuse, and pollution while promoting sustainable management (Upadhyay, 2006). Another policy intervention was the Uttar Pradesh State Water Policy of 1999, which aims to maintain surface and underground water quality (Kaushal, 2011). The state government of Uttar Pradesh passed the Uttar Pradesh Water Management and Regulatory Commission Act of 2008. The objective is to create a regulatory organization that will oversee the management of water resources, guarantee fair distribution, settle conflicts, and encourage sustainable water use throughout the State (Kaushal, 2011). Another regulatory measure taken by the State is The Uttar Pradesh Ground Water (Management and Regulation) Act, 2019. The Act aims to guarantee sustainable groundwater management in the State, both quantitatively and qualitatively, particularly in stressed rural and urban regions, by providing for its protection, conservation, control, and regulation. Despite all these measures, Groundwater resources are being used excessively in Uttar Pradesh as a result of rising demand, especially in the agricultural sector (Ahmad, 2023). Groundwater is essential to India's $5 trillion economy since it supports industry, tourism, urbanization and agriculture. Agrarian Productivity, employment growth, infrastructure expansion, and ecological services are all guaranteed

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by sustainable management, which supports equitable and sustainable economic development.

GROUNDWATER IMPLICATIONS IN SUSTAINABLE ECONOMIC GROWTH

One of the most important goals of groundwater management is to promote sustainable economic growth. It guarantees sustainable water access in agriculture, which is the backbone of rural India. Implementation of efficient water use methods such as drip irrigation to reduce the energy cost and soil moisture control considerably promotes agricultural yield. Increases in agricultural yields lead to comparatively higher farmer incomes, which in turn promote rural economic growth and contribute to India's GDP. Crop diversification and the use of high-value, drought-resistant crops reduce reliance on water-intensive crops. This diversification generates multiple economic streams for rural areas and lowers reliance on conventional crops. Livestock pushing agro-processing, and the production of value-added products are examples of secondary sectors that boost rural economies' stability and influence on the overall economy of the nation. Investments in water-efficient technologies, water infrastructure projects, and watershed management programs accelerate rural development in the building, maintenance, and operating sectors. The demand for workforce in farming operations, agribusinesses, and rural companies is fueled by increased agricultural production and diversification, which raises earnings and improves living standards in rural areas. Adopting climate-smart agriculture techniques and effectively conserving groundwater resources can help adapt to climate change-induced obstacles such as erratic rainfall patterns. By doing this, rural communities are better prepared to withstand climate shocks, maintaining the sustainability of agricultural output and the stability of the local economy. Sustainable groundwater management promotes the expansion of micro, small, and medium-sized enterprises (MSMEs) that produce irrigation equipment, water purification systems, and water-efficient technologies, which in turn propels rural industrialization and economic diversification.

FINDINGS AND WAY FORWARD

This section is divided into three parts to follow an integrated approach. We cannot solely rely on one institutional framework for the public system. Findings aim towards inclusion prophecies in order to achieve full affordability and ensure individuals in society have access to resources and opportunities while also upholding individual personal responsibilities. With the advent of technological innovation, we have to apply techniques to achieve sustainable economic growth. Models and approaches without regulation and proper governance mechanisms are hard to manage. Our findings aim to propose a significant regulatory mechanism for groundwater, further divided into its subparts: assessment of aquifer and modern recharge management techniques, transformative changes for rural regions.

INNOVATIVE APPROACHES AND MODELS

One of the significant approaches for groundwater is Integrated Water Resources Management (IWRM), which also gathered much attention in the United Nations' International Decade for Action 'Water for Life' 2005-2015. It provides a framework for efficient, equitable water management and balancing competing water uses and ensures the sustainability of groundwater and surface water resources (Giordano & Shah, 2017). The excessive use of groundwater in agricultural activities not only causes environmental deterioration due to soil salinity and changes in flora but also introduces energy

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consumption. This emphasizes the need for immediate implementation of sustainable water management measures. The WEF Nexus framework is a good approach that explores the interdependencies between water, energy, and food systems (Lalawmpuii & Prabhat, 2023). In order to gain valuable insights from alternatives, it is necessary to check the Computable General Equilibrium (CGE) Models to assess the macroeconomic effects of water scarcity, resource depletion, or regulatory reforms on key economic variables such as GDP, employment, and income distribution (Calzadilla et al., 2010). In order to view from a personal heuristic, the Community-Based Natural Resource Management (CBNRM) approach empowers local communities to actively participate in the management of natural resources, including groundwater. (Richards and Syallow 2018). By fostering ownership and accountability at the grassroots level, CBNRM contributes to the sustainability of groundwater resources and the socio-economic well-being of rural communities.

LEGISLATIVE AND REGULATORY MEASURES

Many states have passed legislation to regulate groundwater. The Legal angle is a critical component to look at, but the goal of water sustainability is impossible without Union and state-level law instruments. Just after the independence, the Union and all state governments passed legislation such as the Water (Prevention and Control of Pollution) Act, 1974, passed by the Indian parliament and in recent Atal Bhujal program Guidelines 2020 (IELRC, n.d.). In 1974, the Punjab government passed the Punjab State Tubewell Act, 1954, especially to maintain tube wells. Modern groundwater extraction giants in rural India are uncontrolled electric submersible Tube wells. With reference to primary observation, I found that in Uttar Pradesh, water is extracted mainly from Tube wells, and the tube well operators refrain from following the guidelines. With the unstructured interview, I found they need information about groundwater regulatory mechanisms. They answered that we are paying electricity bills to the board; they are allowed to extract as much water as they need. In rural regions, Uttar Pradesh canals are not always operational. In this case, agriculture irrigation completely depends on groundwater and rainwater. Licensing and permitting frameworks necessitate individuals in rural areas or entities to obtain permits for tube well drilling and groundwater extraction, specifying extraction rates and volumes based on hydrological assessments. Mandating water meters on tube wells enables accurate extraction measurement, while regular monitoring programs track water levels, extraction rates, and quality to ensure adherence to regulatory standards. Groundwater assessments can be conducted to delineate aquifer characteristics and establish sustainable extraction limits, with management zones tailored to hydrogeological and socioeconomic factors. Implementation of water pricing mechanisms, alongside strict enforcement measures and penalties for violations, aims to incentivize efficient use and deter overexploitation. Community participation would be implemented through mechanisms such as Water User Associations, empowering stakeholders to oversee usage and promote sustainability. Awareness campaigns and capacity-building initiatives are needed to educate stakeholders on sustainable management practices. Technological innovations such as remote sensing and groundwater modeling enhance monitoring and management effectiveness, facilitated by online platforms for real-time reporting. In order to facilitate smooth monitoring, assessment, and regulation in the State, a bottom-up approach can be followed from the block level to the subdivision, then the district, and finally to the state level. These integrated approaches are essential for effective groundwater governance and conservation.

ASSESSMENT AND RECHARGE MANAGEMENT

In order to achieve sustainable groundwater management, firstly, we must admit that regular monitoring of Aquifers and recharge is essential. Various institutional steps have been taken after independence. In 2022, the Ministry of Rural Development launched the "JALDOOT" App to enable monitoring of groundwater tables across the country. The Department of Land Resources MoRD implemented the Integrated Watershed Management Programme (IWMP), now subsumed under the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), which focuses on the sustainable development of rainfed areas through watershed management interventions. The Groundwater Department government of Uttar Pradesh is committed to conserving and Managing the state groundwater and studying, Evaluating, and Solving Groundwater-related problems. Remote Sensing Applications Centre, Uttar Pradesh, has been established as an autonomous organization under the Department of Science & Technology, Government of Uttar Pradesh. The division primarily focuses on conducting studies related to groundwater resources, such as Groundwater Targeting, Geophysical surveys for determining the horizontal and vertical characteristics of aquifers, aquifer mapping, research on rainwater harvesting and artificial recharge of groundwater, and studies dealing with the assessment and management of groundwater.

There is an imperative need for comprehensive assessment methodologies to quantify modern recharge rates in arid aquifer systems like the Saq aquifer system located in the northern parts of Saudi Arabia; one pivotal method involves Data Analysis, utilizing data from the Gravity Recovery and Climate Experiment (GRACE) to accurately estimate average annual groundwater recharge rates (Fallatah et al., 2019). Additionally, Rainfall-Runoff Modeling, employing tools such as the Soil and Water Assessment Tool (SWAT), plays a crucial role. By simulating modern recharge based on intricate rainfall patterns and hydrological processes, these models contribute significantly to understanding and managing groundwater resources sustainably in regions facing water scarcity and increasing demands. The assessment must consider various factors influencing recharge through geospatial and multi-criteria decision analysis (MCDA) techniques, including geomorphology, drainage density, rainfall, and soil properties. Their findings reveal distinct recharge potential zones characterized by gentle slopes, low drainage density, and favorable soil types exhibiting higher potential. The use of MCDA, particularly the Analytical Hierarchy Process (AHP), aids in weighting thematic layers effectively; it provides valuable insights for groundwater resource management, offering a robust methodology for identifying recharge zones (Kadam et al., 2020). Many GIS-based approaches exist for Managed Aquifer Recharge (MAR) site selection. GIS technology with decision support tools to address water scarcity challenges effectively, thus contributing to sustainable water resource management. MAR involves intentionally recharging aquifers with surface water or treated wastewater to enhance water availability and quality. Employing Spatial Multi-Criteria Decision Analysis (SMCDA) techniques, the study systematically evaluates various constraints and criteria, such as land use, soil characteristics, and groundwater quality, to identify optimal locations for MAR implementation. Surface conditions limit suitable sites; underground characteristics exhibit favorable conditions for MAR. This approach offers a robust framework for MAR planning and management. Employing geophysical (conventional electrical resistivity), isotopic (O, H), and continuous rainfall-runoff modeling techniques demonstrates modern recharge in the Sinai Peninsula under present arid conditions (Sultan et al., 2011). Geophysical surveys identify unconfined NSS aquifers at recharge sites, while isotopic analysis confirms mixing with contemporary precipitation. Rainfall-runoff modeling estimates an annual modern recharge of ~13.0 million m3 for the NSS aquifer (Ibid).

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These findings disrupt prior assumptions, influencing sustainable Nubian Sandstone (NSS) aquifer management and guiding global strategies for similar aquifer utilization.

POLICY RECOMMENDATION

The Ministry of Jal Shakti, Government of India, has launched several initiatives to promote water sustainability. National Hydrology Project (NHP), the National Water Mission (NWM), the Jal Jeevan Mission (JJM), and the National Rural Drinking Water Programme (NRDWP), alongside various schemes such as the Atal Bhujal Yojana (ABHY), the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), and the Jal Shakti Abhiyan (JSA) has been launched. However, effective implementation of these policies necessitates ongoing monitoring and auditing mechanisms at the block-to-state levels. Techniques such as Managed Aquifer Recharge (MAR) can be deployed for aquifer replenishment and assessment. The Australian federal government and state have also initiated the National Water Initiative (NWI), which aims to enhance water management nationwide. This initiative has principles and guidelines for sustainable groundwater management, including provisions for water allocation planning, water trading, and environmental preservation. Legislation tailored specifically for groundwater maintenance, recharge, and extraction in rural India is imperative. This is due to rampant unregulated extraction facilitated by mobile and unauthorized energy consumption in rural areas. Implementing such measures could contribute significantly to sustainable rural development. Rainwater harvesting subsidy programs, mainly focused on groundwater in rural India, can serve as effective nudging tools. It is essential to prioritize capacity building and awareness campaigns in rural regions to foster sustainability ideals. The techniques and approaches discussed in this study represent a foundational step toward achieving sustainable economic development.

CONCLUSION

This paper highlights the critical challenges facing rural development and water sustainability in India, mainly focusing on groundwater management. It underscores the indispensable role of groundwater in sustaining agriculture and rural economies while emphasizing the urgent need for comprehensive governance solutions. The study advocates for inclusive governance mechanisms, innovative strategies, legislative measures, and robust assessment methodologies through an integrative approach encompassing practical, political, and personal spheres. Key findings emphasize the importance of Integrated Water Resources Management (IWRM), the Water-Energy-Food (WEF) Nexus framework, and Community-Based Natural Resource Management (CBNRM). Legislative and regulatory frameworks, including permitting mechanisms and community participation initiatives, are crucial for sustainable groundwater management. Practical assessment and recharge management strategies, such as geospatial analysis and managed aquifer recharge (MAR), are also vital. Policy recommendations include ongoing monitoring, rainwater harvesting subsidies, capacity building, and awareness campaigns to achieve sustainable economic development and environmental preservation in rural India

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Analyzing the Role of Skill India in Bilateral Trade between India and China and its Impact on India's Gross Domestic Product

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ABSTRACT

Skill India aims to empower the country's workforce by providing training and education to enhance employability and promote entrepreneurship. The study analyses the impact of India's exports and imports from China on India's gross domestic product after the skill India initiative. The International Monetary Fund (IMF), World Bank, World Trade Organization (WTO), Reserve Bank of India (RBI), and the Ministry of Commerce and Industry etc. have contributed to the compilation of all data. In this study, Excel was utilized to perform tests for correlation, regression analysis, and analysis of variance (ANOVA). Analysing the data reveals that the correlation between India's exports to China and gross domestic product reveals a very highly positive relationship indicated by the correlation coefficient of 0.90507827. The value of R^2 is 0.819166675, which suggests that approximately 81.91% of the variability in gross domestic product can be explained by the variations in India's exports to China. The value of F is 22.64977092 which is statistically significant with a value of significance F is 0.005063123 which indicates a significant impact of India's exports to China on the gross domestic product after the skill India initiative. The correlation between India's imports from China and gross domestic product is moderately positive with a correlation coefficient of 0.7296743. The value of R Square is 0.532424584which indicates that approximately 53.24% of the variability in gross domestic product can be explained by the variations in India's imports from China. The value of F is 5.693462112 which is statistically significant with a value of significance F of 0.062689776 which indicates no significant impact of India's imports from China on the gross domestic product after the skill India initiative.

In conclusion, the skill India initiative has improved the relationship between India's exports to China and its gross domestic product. The skills gained from this initiative have boosted India's economy, especially in terms of exports to China. Skill India has shown no significant impact on the relationship between imports from China and India's gross domestic product. This indicates that the skills learned through Skill India do not have any impact on the relationship between India's imports to China and India's economic growth.

Keywords: India-China, Bilateral trade, Skill India, Gross Domestic Product

INTRODUCTION

Skill India was launched in 2015 to develop India's workforce by training young people in specialized skills such as plumbing, electrical work, manufacturing, medical care, and information technology programming. The initiative seeks to capitalize on its youth's statistical advantages while simultaneously fostering socioeconomic success. Skill India also seeks to enhance collaborations with businesses to better integrate training programs with industry demands, ensuring that the skills acquired contribute to the job market and give opportunities for interested individuals. Skill India was initiated by the Indian government as a program to provide Indian youngsters with industry-relevant skills to promote economic growth. As India's population enters the demographic dividend era, the government wants to close the skills gap and meet the sector's needs. Skill India strives to provide adolescents with the skills needed to find suitable professions or establish their businesses. The project intends

to skill, reskill, and upgrade India's workforce to meet changing demands, ensuring that they have good lives and contribute to the country's prosperity. The project seeks to close the skills gap in the workforce and meet the needs of various industries, ensuring that adolescents are prepared for acceptable jobs and entrepreneurial enterprises. The effort intends to help India's economic goals by cultivating a competent workforce outside of conventional sectors, with an emphasis on technology, healthcare, and renewable energy. It aspires to keep India competitive in a fast-changing global marketplace by equipping people with updated skills. The initiative intends to provide the country's workers with the necessary skills and capacities to adapt to future employment positions and technology, assuring India's sustained success in the global economy.

In conclusion, Skills India plays a critical role in India's economic progress by catalyzing and unleashing the potential of its young labour. With its holistic approach, this plan aims to develop a competent and dynamic workforce capable of promoting innovation, entrepreneurship, and long-term economic growth, ultimately establishing India as a strong player in the world economy.

REVIEW OF LITERATURE

Jameel Ahmed (2021) in their paper explores the potential for Skill India's development and job generation. Skill India's primary purpose is to raise confidence, increase output, and give guidance through effective skill development. Skill India will create blue-collar jobs for the youth. According to this study, employability improved from 33.95% in 2014 to 45.6% in 2018, demonstrating the government's outstanding performance. This demonstrates how important skill development is to a country's prosperity and growth.[1]

Dr. Rajni Arora and Manoj Chhadwani (2019) evaluated the influence of Skill India on transforming the Indian economy, emphasizing the importance of the Skill India Campaign. The Skill India initiatives are implemented as part of the government's effort to boost the economy. This study concludes that while the government has built a regulatory framework, the sector should also participate in a public private partnership to increase skills.[2]

Gawade Santosh Bhiwa examines that Knowledge, skill, and technology are the backbone of the economy. A skill development process should also be implemented along with education to improve the quality of education. [3]

Dr. Ranjit Kumar Elamadurthi, Dr. R S Varahala Dora, Dr. Chitti Babu Putcha and Dr. Ramana Yadla (2023) examine the importance of skill development initiatives in India's poverty-reduction efforts. It employs literary references and empirical studies to examine many elements of these projects, including their influence on poverty reduction and the obstacles they encounter. The essay presents a detailed knowledge of how skill development might help India become wealthier and more egalitarian. It also highlights government policies and programs to assist communities in emerging from poverty. [4]

Dr. Deepa Gupta and Sugandha Agarwal (2018) examine the extant literature on skill development in India, with an emphasis on government efforts, public-private partnerships, and methods for increasing employable skills. It examines the obstacles encountered in these programs, addresses the skills taught through educational programs, the rapid learning age group, and the need for further sector-specific courses. The goal is to identify the requirements, problems, and extent of skill development initiatives in India. [5]

Sonali Kanchan and Sakshi Varshney (2015) analysed that skill development is an important aspect of promoting macroeconomic growth and social stability. India has set lofty targets for quicker and more sustainable economic growth, emphasizing the need to equip its workers with necessary skills. As a national priority, different steps have been implemented to address the issue. This study examines the present state of skill development in India, as well as the problems associated with executing various programs and plans. [6]

Radhika Kapur (2014) emphasized the role of skill development in India, as well as the numerous measures and policies to encourage it. India has progressively become a more conscientious nation due to its profusion of highly qualified, informed, and experienced human resources. Literacy, reading, writing, computer skills, artisan skills and manufacturing have all been taught in training facilities in both urban and rural communities.[7]

Ankul Pandey and Dr. D K Nema (2017) in their paper analysed that Indian youth face unemployment due to a lack of technical knowledge, despite being educated. The country's skills development system faces obstacles in training the youth, as most are unaware of modern technology. [8]

Vandana Saini (2015) explores India's skill capability and the issues associated with skill development projects. It demonstrates that 38% of the Indian workforce aged 15 to 59 is illiterate, 25% has less than elementary education, 36% has medium and higher education, and just 10% is vocationally skilled.[9]

Lavina Sharma And Asha Nagendra (2016) examined that the youngest workforce country globally, has the lowest median age, making it the largest provider of workforce. However, the country is having difficulties to fill the jobs due to a lack of qualified applicants. This also has an impact on matching jobs to available talents. In terms of skill transfer, India lags behind nations such as China and Singapore. [10]

Anita Swain and Sunita Swain (2020) in their paper examined the various challenges faced by our country's youth, as well as the schemes particularly the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) and the Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY), implemented by government to address such challenges. In this paper they have analyzed that there is a tremendous opportunity to create a skilled workforce and take advantage of "demographic dividend" and also branding initiatives and active participation of public-private partnerships to enable the greater supply of skilled workforce. [11]

Mishil Trivedi (2023) examines the Skill India Mission's influence on the national economy and people. It examines various government efforts within the mission's scope, with an emphasis on their economic and skill development implications. The study examines the program's success and degree of achievement, concluding that it was moderately successful. The goal of the study is to examine if the Skill India Mission has had a substantial influence on the nation's economy. [12]

RESEARCH GAP

After reviewing the research paper, it was found that researchers conducted the studies on the impact of skill India initiative in various aspects. Some researchers have looked at the impact of Skill India on job creation while others have looked at the impact of Skill India on the Indian economy. Researchers have found that due to Skill India implementation, tremendous opportunities are being created for skilled workers. In the paper, we studied the impact of India's exports and imports from China on Gross Domestic Product after the Skill India initiative.

SIGNIFICANCE OF THE STUDY

The study on the role of Skill India in bilateral trade between India and China holds significant importance in understanding the dynamics of economic collaboration between these two nations. The research aims to identify potential impacts on India's gross domestic product by analyzing the impact of the Skill India initiative on the workforce and its subsequent impact on bilateral trade. This investigation is crucial for policymakers and stakeholders, providing insights that can guide strategic decisions to enhance economic cooperation, address skill gaps and optimize the positive impact of such collaborations on India's overall economic growth.

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OBJECTIVES OF THE STUDY

1. To provide an overview of bilateral trade between India and China from 2015-2016 to 2021-2022.
2. To examine the impact of India's exports to China on gross domestic product after the Skill India initiative.
3. To examine the impact of India's imports from China on gross domestic product after the Skill India initiative.

HYPOTHESIS OF STUDY

H_{01}: There is no significant impact of India's exports to China on gross domestic product after the Skill India initiative.

H_{11}: There is a significant impact of India's exports to China on gross domestic product after the Skill India initiative.

H_{02}: There is no significant impact of India's imports from China on gross domestic product after the Skill India initiative.

H_{12}: There is a significant impact of India's imports from China on gross domestic product after the Skill India initiative.

RESEARCH METHODOLOGY

This study aimed to analyze the role of Skill India in bilateral trade between India and China and its impact on India's gross domestic product. This research is based on secondary data sources. In the study, data have been collected from the International Monetary Fund (IMF), World Bank, World Trade Organization (WTO), Reserve Bank of India (RBI), Ministry of Commerce and Industry etc. between the time-frame of 2015-2022. In the research, MS Excel is used for the calculation and correlation, regression analysis and Anova have been used to examine the impact of imports and exports to China on India's gross domestic product after the Skill India initiative.

Table 1: Variables used in the study (amount in US $ BILLION)

YEAR	EXPORTS TO CHINA	IMPORTS FROM CHINA	GROSS DOMESTIC PRODUT
2015-2016	9.01	61.7	2290
2016-2017	10.17	61.28	2650
2017-2018	13.33	76.38	2700
2018-2019	16.75	70.31	2840
2019-2020	16.61	65.26	2670
2020-2021	21.18	65.21	3150
2021-2022	21.25	94.57	3420

Source: Ministry of Commerce and Industry, World Bank Database

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OVERVIEW OF INDIA AND CHINA BILATERAL TRADE FROM 2015-2016 TO 2021-2022

Figure 1: India's exports and imports from China from 2015-2016 to 2021-2022
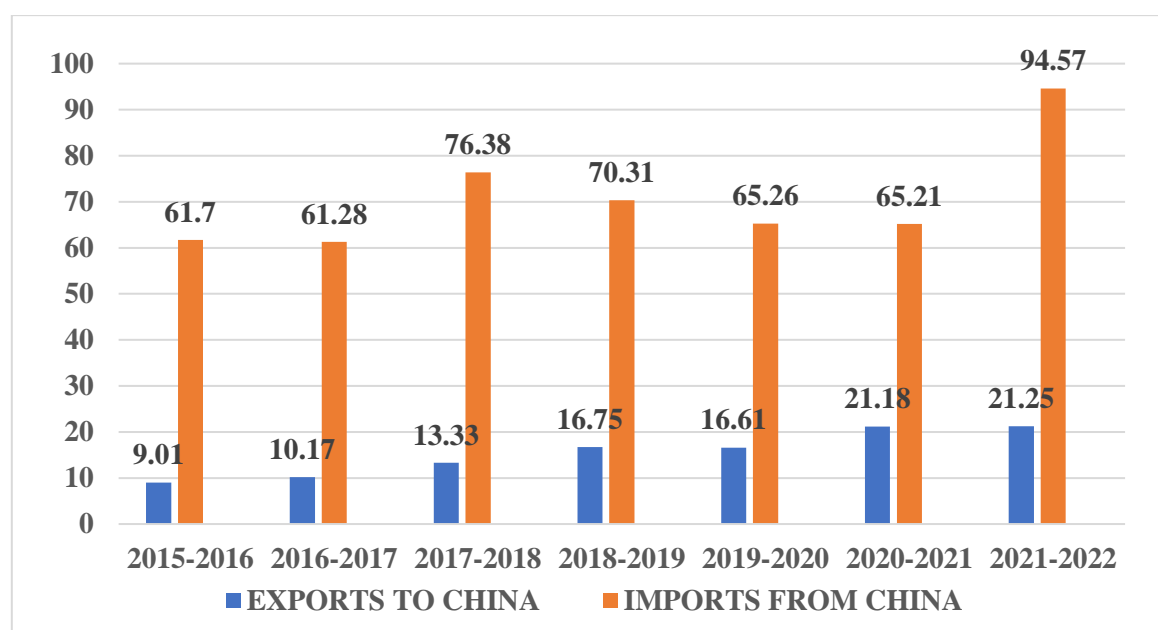
Source: Ministry of Commerce and Industry

India and China are two largest and fastest-growing economies in world. Bilateral trade between these countries has been growing rapidly over the past few years, but the relationship between the two countries has been marked by tensions, particularly in the political and military spheres. Here is an overview of India and China's bilateral trade from 2015-2016 to 2021-2022:

Trade Volume - In 2015-2016, the total bilateral trade between India and China was US $ 70.71 billion. In 2019-2020, this figure had risen to US $ 81.87 billion. However, in 2020-2021, total bilateral trade reached US $ 86.39 billion and in 2021-2022, the total trade volume further increased to US $ 115.82 billion.

Trade Balance - India has had a significant trade imbalance with China in recent years. In 2015-2016, India's imports from China totaled US $ 61.70 billion, while its exports to China were just US $ 9.01 billion. This trade deficit has grown over time, and in 2019-2020, India's imports from China were worth US $ 65.26 billion, while its exports to China were just US $ 16.61 billion. In 2021-2022, India's imports from China were worth US$ 94.57 billion, while its exports to China were worth US $ 21.25 billion.

Tensions And Restrictions - The bilateral trade relationship between India and China has been marked by tensions and restrictions. In 2020, India imposed restrictions on the import of certain Chinese goods, to reduce its dependence on Chinese imports and China also imposed restrictions on Indian products.

Table 2: Correlation result of India's exports to China and Gross Domestic Product

	EXPORTS TO CHINA	**GROSS DOMESTIC PRODUCT**
EXPORTS TO CHINA	1	0.90507827
GROSS DOMESTIC PRODUCT	0.90507827	1

Source: Excel output

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Table 3: Regression result of India's exports to China and Gross Domestic Product

REGRESSION STATISTICS	
Multiple R	0.90507827
R Square	0.819166675
Adjusted R Square	0.78300001
Standard Error	171.7845509
Observations	7

Independent Variable: Exports to China
Dependent Variable: Gross Domestic Product (GDP) (Annual)
Source: Excel output

Table 4: Anova result of India's exports to China and Gross Domestic Product

ANOVA					
	Df	**SS**	**MS**	**F**	**Significance F**
Regression	1	668393.1976	668393.1976	22.64977092	0.005063123
Residual	5	147549.6596	29509.93191		
Total	6	815942.8571			

Source: Excel output

INTERPRETATION AND ANALYSIS OF THE IMPACT OF INDIA'S EXPORTS TO CHINA ON GROSS DOMESTIC PRODUCT AFTER THE SKILL INDIA INITIATIVE

The correlation analysis between India's exports to China and gross domestic product reveals a very highly positive relationship, with a correlation coefficient of 0.90507827. This indicates a high degree of correlation between the two variables which indicates that as India's exports to China increase there is a corresponding rise in the gross domestic product. The coefficient of determination is 0.819166675 explaining approximately 81.91 % of the variance in gross domestic product based on the variations in exports to China. The Adjusted R Square is 0.78300001 which implies that the model's explanatory power remains robust even after considering potential confounding factors. The F-statistic, with a value of 22.64977092, tests the overall significance of the regression model. The Significance F value of 0.005063123 is below the significance threshold of 0.05, indicating that the model is statistically significant. This suggests that India's exports to China have a significant impact on the gross domestic product.

Table 5: Correlation result of India's Imports from China and Gross Domestic Product

	IMPORTS FROM CHINA	GROSS DOMESTIC PRODUCT
IMPORTS FROM CHINA	1	0.7296743
GROSS DOMESTIC PRODUCT	0.7296743	1

Source: Excel output

Table 6: Regression result of India's Imports from China and Gross Domestic Product

REGRESSION STATISTICS	
Multiple R	0.7296743
R Square	0.532424584
Adjusted R Square	0.4389095
Standard Error	276.2299119
Observations	7

Independent Variable: Imports from China
Dependent Variable: Gross Domestic Product (GDP) (Annual)
Source: Excel output

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Table 7: Anova result of India's Imports from China and Gross Domestic Product

ANOVA					
	Df	SS	MS	F	Significance F
Regression	1	434428.0359	434428.0359	5.693462112	0.062689776
Residual	5	381514.8212	76302.96424		
Total	6	815942.8571			

Source: Excel output

INTERPRETATION AND ANALYSIS OF THE IMPACT OF INDIA'S IMPORTS FROM CHINA ON GROSS DOMESTIC PRODUCT AFTER THE SKILL INDIA INITIATIVE

The correlation analysis between India's imports from China and gross domestic product reveals a moderate positive relationship with correlation coefficient of 0.7296743. This indicates a moderate degree of correlation between the two variables, suggesting that as India's imports to China increase, there is a corresponding rise in the gross domestic product. The R square is 0.532424584 explaining approximately 53.24 % of the variance in Gross Domestic Product based on the variations in imports to China. The Adjusted R Square is 0.4389095 which implies that the model's explanatory power remains robust even after considering potential confounding factors. The F-statistic, with a value of 5.693462112, tests the overall significance of the regression model. The Significance F value of 0.062689776 is more than the significance threshold of 0.05 which indicates that India's imports from China have no significant impact on gross domestic product.

CONCLUSION

This paper has tried to analyze the impact of India's exports and imports from China on gross domestic product after the Skill India initiative. The statistical analysis highlights a strong and positive relationship between India's exports to China and its gross domestic product, with a substantial portion of the variability in gross domestic product explained by variations in exports. The statistical significance F value indicates that India's exports to China have a significant impact on its gross domestic product after the Skill India initiative. The correlation between India's imports from China and gross domestic product is moderately positive. While there is a statistically significant relationship, the explanatory power of variations in imports on gross domestic product is moderate. The statistical significance F value indicates that India's imports from China may not have a significant impact on its gross domestic product after the Skill India initiative.

The Skill India project is helping to boost India's economic position in China. By focusing on talent development, this effort has become a cornerstone in improving the link between exports and gross domestic product. The trained workforce generated by Skill India not only helps to increase productivity but also allows for adaptive responses to the changing needs of the global market. The initiative's emphasis on skill development trains individuals to thrive in industries important to India's exports to China. This involves enhancing product quality, using cutting-edge technology, and enabling better communication and engagement. The strategic partnership with Skill India guarantees that the Indian workforce stays inventive and capable of dealing with the difficulties of global commerce. This increases and broadens India's economic presence in the Chinese market.

Skill India emerges as a revolutionary force in determining economic dynamics. A competent staff is acknowledged as a valuable asset for fostering innovation, improving efficiency, and increasing global competitiveness. Skill India strives to reduce India's dependency on Chinese imports by boosting indigenous companies and improving manufacturing capabilities.

The significant influence of Skill India is seen in the empowerment of the workers to engage in value-added activities, which benefits the manufacturing process. Skill India helps long-term economic growth by boosting the native workforce and industry, lessening India's reliance on external variables such as Chinese imports.

In conclusion, the Skill India Initiative emerges as a crucial driver in increasing India's exports to China by building a highly trained workforce. This trained labour force, capable of fulfilling global market needs, is critical to increasing India's exports to China. Furthermore, Skill India contributes significantly to reducing reliance on Chinese imports by boosting domestic firms and expanding manufacturing capabilities. This initiative's larger impact extends beyond immediate economic concerns, contributing to long-term prosperity and building a robust, self-sufficient economic environment for India in the face of complicated global trade dynamics.

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Empirically Analyzing the Impact of Remittances on the REER: An Indian Context

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ABSTRACT

Given the importance of remittances being instrumental for growth and development in developing economies, its impact on various macroeconomic factors form a very significant segment of the wide spectrum of literature related to remittances. The influence of remittances on the Real Effective Exchange Rate, is an essential macroeconomic variable to research thoroughly since, by itself, the exchange rate is a powerful force that may modify other macroeconomic aspects in the economy. And exchange rate again is a dynamic factor which is sensitive to slight variations in the economic sphere and oscillations in the exchange rate has got direct influence on the trade competitiveness. Surely, the growing inflow of remittances will impact the same and this needs to be deliberated upon closely. In order to determine the exact amount and kind of effect that remittances are having on the rate of exchange, it is necessary to conduct a thorough analysis of the behavior of the two variables that are present in tandem with one another. It is even more important to understand how the increasing inflow of remittances may affect the exchange rate given its significance in relation to other macroeconomic drivers. The present study mainly focuses upon the inflow of remittances into India and its impact on the REER, for which quarterly data ranging from 2012-13 to 2022-23 has been extracted from the RBI's Data Base. After assessing the stationary of all the variables concerned the ARDL model for the same has been used to assess the relationship existing between the given two factors in the long-run.

Keywords: Remittances, REER, Macroeconomic Factors, Indian Economy, Exchange Rate

INTRODUCTION

Exchange rate is subject to a range of factors. With the growing inflow of remittances into the country; its dynamics with the exchange rate has also undergone considerable changes. The behavior of the given two variables alongside each other is something that requires in-depth study to know the degree and extent of impact that remittances are may have on the rate of exchange. Owing to the eminence of REER along with other macroeconomic determinants, makes it even more crucial to know how the growing inflow of remittances can potentially impact the same.

Remittances seem to follow an upward trajectory and seeing the growth potential of remittances; its impact on other macroeconomic variable needs a careful analysis. With India continuously maintaining the top most position among the remittance receiving nations, it requires due consideration and focus on the part of policy makers to build a sustaining environment for all the growth that remittance inflow into the country is facilitating. Alongside, it must also be carefully studied that how the remittances inflow into the country is changing the dynamics at macroeconomic level specifically REER which again has influence on various macroeconomic determinants.

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Chart 1: Remittances as a percentage to GDP
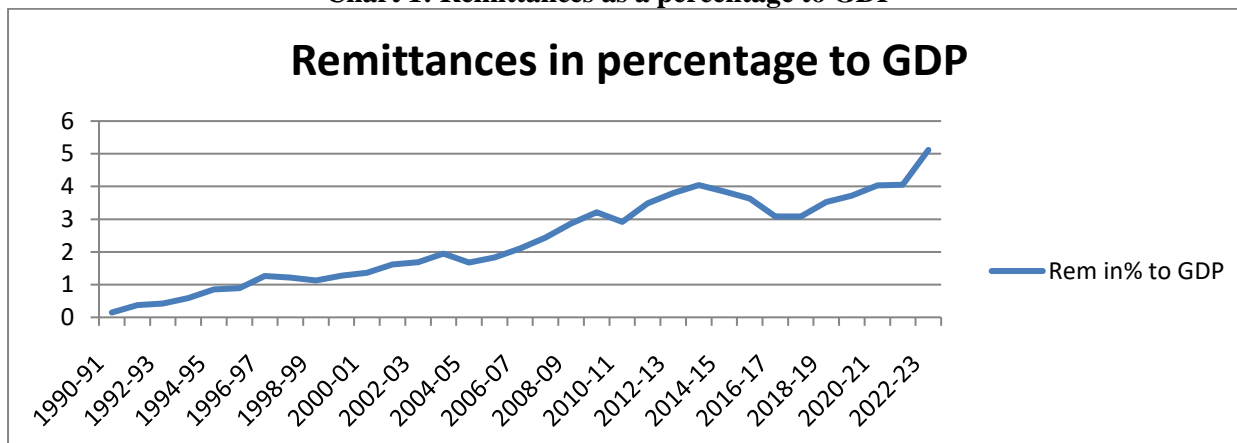
Source: created using the data from RBI

Remittances inflow into the country is surely adding to the foreign exchange reserve, but this will also affect the exchange rate of the country. Consequently, increased inflow of remittances can potentially make the exchange rate appreciate in the global arena which might be a welcoming phenomenon to a certain extent but the same may not prove to be beneficial as appreciation of country's real exchange rate will also hurt its competitiveness leading to a situation called Dutch Disease[2] (Hien., et al. 2020). Seeing the growth impact of the remittances in case of developing countries, it has become even more crucial to assess and examine how this inflow of remittances has affected other macroeconomic determinants and what course of trajectory they are going to follow with that.

In this study the time period is ranging from 2012-13 to 2022-23, for the analysis quarterly data set has been considered. With this short-run dynamics of the relationship between REER and other macroeconomic variables particularly remittances, has been assessed and the long-run behavior of the same has been determined.

Over the past ten years, remittances have surpassed portfolio inflows, FDI, and FII as a substantial source of capital inflow. In addition to its increasing significance, its effect on the REER also requires careful consideration.

Chart 2: Remittances, FDI, FII and Portfolio investments
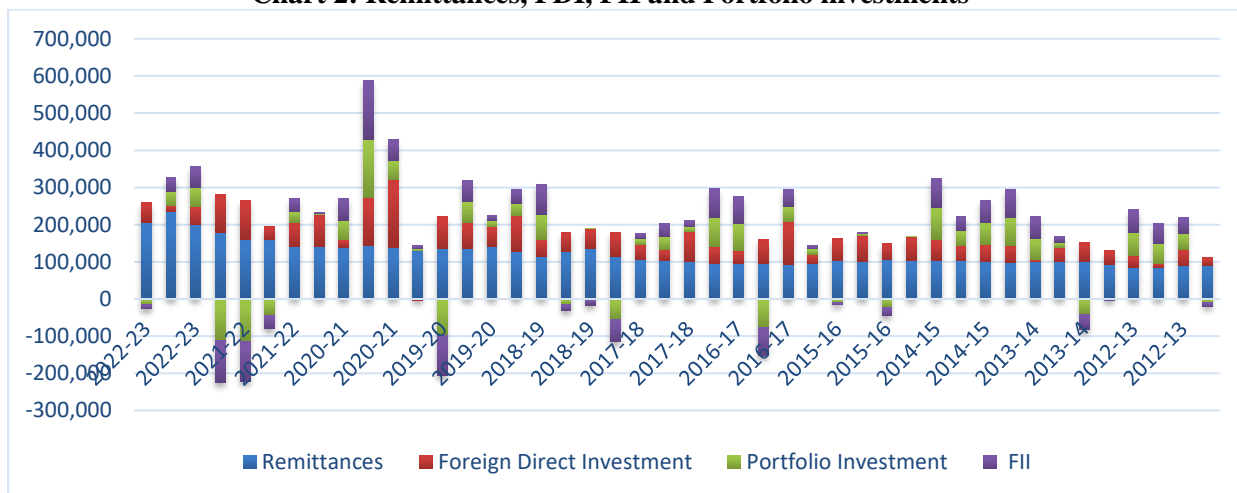
Source: Author's own creation

Remittances as volume are more than the half of the total capital inflows, as seen in the chart 5 given below. It is observed to be almost 55%, whereas 45% is the share of remaining three inflows.

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[2] *The term was coined in 1970 in The Economist Magazine*

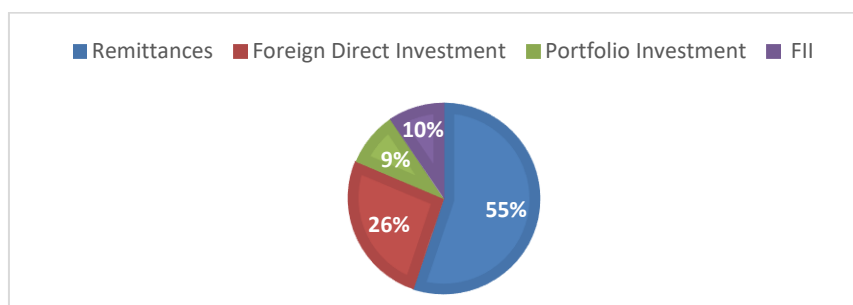**PSIT College of Higher Education: International Journal of Multidisciplinary Research**
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Chart 3 – Remittances, FDI, FII and Portfolio investments

Source: Based on data aggregated over a decade

Owing to this growing importance of remittances, its tendencies to affect the macroeconomic variables have strengthened which has led to a paradigm shift in the equations that has been determining the exchange rates so far.

The above-mentioned variables are considered for the present study, the selection of these variables have been done after a diligent and careful literature review so as to single out appropriate determinants that contribute to the exchange rate dynamics in any economy. Due to this, the variables considered include REER, Remittances, GDP growth rate, Government Final Consumption Expenditure, Foreign Investment and Terms of Trade.

REVIEW OF LITERATURE

Hien., et al. (2020) undertook a study with a data set comprising of 36 countries for the time period of 2006-2016 to study the impact of remittances on the rate of exchange. The study concluded that with 1% growth in the remittances, 0.103% appreciation of the REER was seen. Appreciation in the rate of exchange was a common thing to occur with the inflow of remittances among the countries with low remittances to GDP ratio, whereas in case of countries with relatively higher percentage of remittances to GDP a depreciation in the exchange rate occured. Another study in case of Kyrgyz Republic conducted be Sultonov (2020) found for the time period of 2005 to 2017 that remittances were not causing any change in the REER conversely it was REER which proved to be useful in predicting remittances' returns and volatility. So the relationship between REER and Remittances varies from time to time and from place to place. Oleksiv and Mirzoieva (2022) conducted a similar study and found that remittances do influence the exchange rate and make it appreciate. Datta and Sengupta (2018) analyzed the relationship between REER and Remittances and found that REER appreciating but eventually it adjusted to its long-run equilibrium level. Joof and Touray (2021) undertook a similar study in case of Gambia using the monthly data from the time period of 2009 to 2019 and concluded that with every 1% increase in remittances, there was currency appreciation by 1.5%. Hassan and Holmes (2013) identified asymmetric relation between exchange rate and remittances. Remittances have played pivotal role in case of development of various countries, Brahim., et al. (2017) did a similar study among Middle East and North African countries, which considered nine countries for the time period of 1980 to 2015. The study concluded that remittances did not result in the phenomenon of Dutch Disease for these countries. Habibi (2020) in his study on Turkey concluded that the long run the impact of remittances on the real effective exchange rate of the country is positive substantiated by number of other studies, including that of Lopez., et al. (2007). As concluded by Lartey., et al. (2012) remittances tend to have spending effects which leads to appreciation in the REER, there is movement of resources in the favour of non-tradable sector over the tradable sector. As per the result they derived this resource movement effects in the favour of non-tradable sector are supposed to operate in case of fixed nominal exchange rate regime since in that case relative price stability can be achieved.

SELECTED VARIABLES AND METHODOLOGY

Data pertaining to the present study covers the time frame of 2012-23 taken from Reserve Bank of India Database on Indian Economy. Quarterly data for all the selected variables have been taken. The details of variables are as follows;

- Real Effective Exchange Rate is basically a currency weighted against average of the currencies of that nation's major trading partners. REER is also an effective indicator of international competitiveness making it an ideal variable for the exchange rate than taking any particular foreign currency.
- Remittances is the term that is used to denote money sent by migrants to their home country from the host country to which they have migrated for livelihood purpose. This study concerns majorly with the kind of influence that remittances have on the REER. Net quarterly inflows of remittances have been considered in this study. Since remittances access great influence on the economic development.
- Quarterly GDP growth rate has been used to indicate the overall health of the economy. Better GDP performance will lead to increased investment in the economy.
- Government Final Consumption Expenditure is a key driver of economic activity. And is used as a proxy of how fiscal policy can shape exchange rate dynamics.
- Determining Foreign Investment's impact on the REER is helpful in understanding the role of international capital flows.
- Changes taking place in the Terms of Trade provides insight into the impact of trade dynamics on REER. has been calculated for the given time period using the formula $\frac{Index\ of\ Export\ Price}{Index\ of\ Import\ Price} * 100$

In the present study REER is the dependent variable 2 to 5 being the independent ones. The model specification is as follows-

Table 1- Selected Variables

Variable	Definition
REER	Real Effective Exchange Rate
Rem	Remittances as a percentage to GDP
GDPr	GDP growth (quarterly)
GFCE	Government Final Consumption Expenditure
FI	Total Foreign Investment
ToT	Terms of Trade

Source: Author's own creation

$$REER = \beta_0 + \beta_1 \cdot Rem + \beta_2 \cdot GDPr + \beta_3 \cdot GFCE + \beta_4 \cdot FI + \beta_5 \cdot ToT + \varepsilon$$

To check if the given variables are stationary or not, ADF test has been used. The study makes use of ARDL Bound Test approach to empirically analyze if the there is any relationship between the remittances inflow coming into the country and the REER. Owing to its popularity as an ideal choice since it works great with stationary as well as non-stationary data, ARDL has proved to be an appropriate methodology for this particular study.

The F-test result has later been taken into consideration in the analytical process to assess the long-term link among the variables covered above. The null hypothesis indicating no cointegration will be rejected in this scenario if the computed F statistics is higher than the upper limit, which is I(1) for the upper bound and I(0) for the lower. This will evince that there is a long-term relationship between the variables. The short-run parameters were computed using the Error Correction Model connected to the ARDL model taken into consideration in the study after the long-run connection was verified.

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RESULTS AND DISCUSSION

First step, the diagnostic part of the study constituted of assessing the nature of the data considered for the given study.

Table 2 – Descriptive statistics of all the variables

	REER	*Rem*	*GDPr*	*GFCE*	*FI*	*T0T*
Mean	100.1914	4.235818	11.35174	10.26224	2.321383	114.033
Standard Error	0.617428	0.169805	2.989601	0.242058	0.282741	1.277835
Median	101.0011	3.901813	6.124272	10.22907	2.239844	116.0762
Std. Deviation	4.095554	1.126357	19.83077	1.605629	1.875495	8.476195
Sample Variance	16.77356	1.26868	393.2594	2.578043	3.51748	71.84589
Kurtosis	0.064324	0.024876	6.040828	0.405575	0.819064	-0.39582
Skewness	-0.79741	1.049405	2.49245	0.494316	0.772084	-0.38198
Range	16.78127	3.985864	100.415	7.481907	8.128826	37.03064
Minimum	89.94537	2.982989	-23.3672	7.667142	-0.35185	92.63544
Maximum	106.7266	6.968854	77.04788	15.14905	7.776972	129.6661
Sum	4408.422	186.376	499.4766	451.5385	102.1408	5017.452
Count	44	44	44	44	44	44

Source: Author's own calculation

Depending on the characteristics of the data, it can be seen that every variable requires a preliminary stationarity check but before moving on to that having a scatter chart for each variable will give us the idea about the distribution of the data, at the same time trend can well be observed that is not linear type.

Chart 4 to 9 – Scattered plots
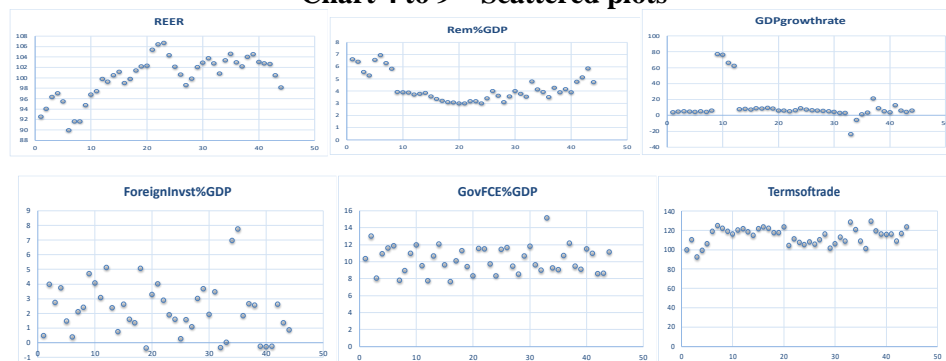
Source: Author's own creation

For a rather comprehensive picture about the frequency distribution and the spread of data points for the respective variables can be assessed with the help of histogram given below;

Chart 10 to 15 - Histograms

Source: Author's own creation

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In order to assess if the inflow of remittances is leading to fluctuations in the REER, Granger causality test has been used;

Table 3 – Granger causality test

Null hypothesis	p-value	Results	Causality
Remittances do not granger cause REER	0.03626 *	null hypothesis reject.	Unidirectional causality found.
REER do not granger cause Remittances	0.3998	null hypothesis could not be rejected	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '

Source: Author's own calculation

As the results suggest that Remittances are causing fluctuations in the REER, so to address the same further analysis has been done to apply the appropriate regression model

Following the same, stationarity for each variable in the data set has been checked with the help ADF Test;

Table 4 – Stationarity results using ADF Test

Variables	ADF	Result
REER	0.02495	I(1)
Rem	0.01466	I(1)
GDPr	0.02908	I(0)
GFCE	0.01	I(1)
FI	0.02132	I(0)
ToT	0.01	I(1)

Source: Author's own calculation

Since some of the variable in the data set are stationary at level and some are stationary at the first difference; the conditions for the ARDL or the Autoregressive Distributive Lag Model is fulfilled. Next step would comprise of assessing the optimum lag in the given data set. So further down the analysis, it will be best to go with the AIC or the Akaike Information Criterion to assess and interpret the regression model. ARDL Bound test has been performed as this model uses F and t-statistics to test the significance of the lagged levels of the variables in the given data set.

Table 5: Pesaran, Shin and Smith Cointegration Test

F-test		
	I(0)	I(1)
10% critical value	3.012	4.147
5% critical value	3.532	4.8
1% critical value	4.715	6.293
F-statistic	7.263846355	

Source: Author's own calculation

According to the Cointegration test, the F-Statistic 7.263846355 is more than the upper bound limit of 6.293 at 1% level of significance which depicts there is a cointegration.

Table 6: Error Correction Model Output

Coefficients:				
	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	107.52823	11.52392	9.331	2.99e-06 ***
ec.1	-0.94254	0.10095	-9.336	2.97e-06 ***
dRem.t	-1.21541	0.39769	-3.056	0.012124 *
dRem.1	-2.39152	0.2957	-8.088	1.07e-05 ***
dRem.2	0.46065	0.34715	1.327	0.214031
dRem.3	1.48474	0.42913	3.46	0.006124 **
dRem.4	1.90943	0.61028	3.129	0.010713 *

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dGDPr.t	-0.15876	0.02638	-6.019	0.000129 ***
dGDPr.1	0.0222	0.01015	2.188	0.053553 .
dGDPr.2	0.05175	0.01054	4.912	0.000612 ***
dGDPr.3	0.10186	0.011	9.26	3.20e-06 ***
dGFCE.t	-0.56926	0.13413	-4.244	0.001705 **
dGFCE.1	0.7513	0.17934	4.189	0.001860 **
dGFCE.2	0.04391	0.17931	0.245	0.811504
dGFCE.3	-0.26744	0.1649	-1.622	0.135897
dGFCE.4	-0.25284	0.09534	-2.652	0.024233 *
dFI.t	0.7553	0.06972	10.833	7.60e-07 ***
dFI.1	-0.77629	0.13693	-5.669	0.000207 ***
dFI.2	-1.23692	0.16399	-7.543	1.96e-05 ***
dFI.3	-1.0323	0.14511	-7.114	3.24e-05 ***
dFI.4	-0.46031	0.08945	-5.146	0.000434 ***
dToT.t	-0.12198	0.02424	-5.032	0.000513 ***
dToT.1	-0.18982	0.03406	-5.574	0.000236 ***
dToT.2	-0.2159	0.03442	-6.272	9.23e-05 ***
dToT.3	-0.19722	0.03002	-6.571	6.31e-05 ***
dToT.4	-0.06981	0.01524	-4.581	0.001009 **
trend.t	0.09156	0.01598	5.73	0.000190 ***
dREER.1	0.28476	0.08801	3.235	0.008939 **
dREER.2	1.03194	0.14832	6.957	3.91e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '

Source: Author's own calculation

According to the ECM Output, fluctuations can be seen in the short-run and with the ec.1 or the error correction term it is concluded that any deviation from the given equilibrium will restore itself back to the same level as before. Going further with the diagnostic checks, normality of the residuals has been assessed with the help of Shapiro-Wilk normality test. Since the p-value is more than 0.05, the alternate hypothesis is accepted that the residuals are normally distributed. Next, homoskedasticity has been checked using the Breusch-Pagan test(table is given in the appendix).

Following the p-value, it can be seen that there is homoskedasticity in the residuals, this means that the variables are scattered and variances are also there equally spread. Similarly for assessing the autocorrelation, Breusch-Godfrey test has been used which follows that there is no autocorrelation among the residuals (table is given in the appendix).

In order to assess the stability of the ARDL model, Recursive CUSUM and recursive CUSUM of squares test has been used the same is provided above, showing a stable model withing the upper and the lower bound limits(chart is given in the appendix).

Table 7- Long run coefficients

REER.1	-0.94253901
Rem.1	-0.43168532
GDPr.1	-0.14192899
GFCE.1	-1.1737586
FI.1	1.55464243
ToT.1	-0.02340741

Source: Author's own calculation

As shown in the given two graphs below, there have been points in the time period considered where Remittances in proportion to GDP has gone down while at various points it can be seen that the proportion has increased but again the same has gone down as well afterwards. So with the given result it can be assessed that the effect of remittances on REER found in the study could be due to the factor that even though the remittances grew in volume and amount over the years, but its proportion comprising in the GDP of the country has changed many a times leading to this inverse relationship. Similarly the time preceding the period taken into the study has also witnessed a global melt-down in the form of "Financial Crisis" of 2008. The time period saw some major shifts in terms of capital flows and trade deficit as per the economic survey data. Similarly, as per the data provided the world bank data (2015) India surely is the largest recipient of remittances but it is not dependent on it the way countries like Nepal, Bangladesh, Philippines are. The ratio of remittance to GDP is surely less than that in case Nepal which is around 29% and 11% in case of Bangladesh and Philippines. So the above result makes it rather clear that there are other factors that exercise more influence on the REER and Foreign investment being the most active out of all that has led to positive influence on the REER leading it to appreciate.
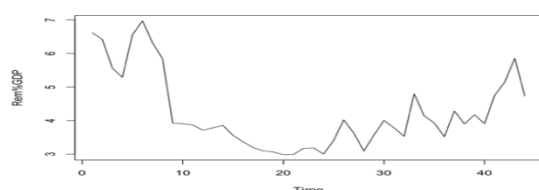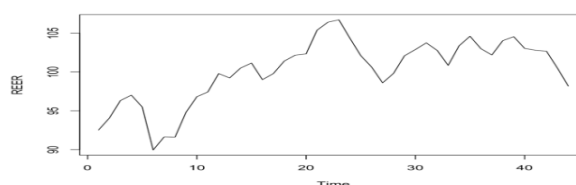
<div align="center">

Chart 16 - Remittances % to GDP   **Chart 17 - REER**

</div>

Source: Author's own creation

The long-run coefficients from the ARDL model shed light on the equilibrium relationships existing between the REER and key independent variables. In the long run, a one-unit decrease in the first lag of the REER corresponds to a 0.9425 unit increase in the equilibrium level of the current REER. This suggests a corrective mechanism over time, where deviations from the long-run equilibrium are adjusted. Furthermore, the negative coefficients for Rem.1 (-0.4317), GDPr.1 (-0.1419), GFCE.1 (-1.1738), and ToT.1 (-0.0234) indicate that decreases in the first lag of remittances, GDP, government final consumption expenditure, and the terms of trade are associated with increases in the long-term equilibrium REER. This implies that lower remittance levels, GDP, government expenditure, and terms of trade in the past contribute to a higher long-term equilibrium REER. Conversely, the positive coefficient for FI.1 (1.5546) suggests that higher financial inflows in the past are associated with a higher long-term equilibrium REER.

The Auto Regressive Distributed Lag or the ARDL model (given in the appendix) results reveal insightful relationships between the REER and remittances (Rem). The coefficient for REER.1 (-0.94254) signifies an inverse relationship between the first lag of the real effective exchange rate and the current REER, suggesting that a decrease in the REER in the previous period is associated with an increase in the current REER. Turning to remittances, the coefficients offer nuanced insights. The negative coefficients for Rem.1 (-0.43169), dRem.t (-1.21541), and dRem.1 (-2.39152) suggest that a decrease in remittances in the previous period, as well as overall declines and specific lags in remittance levels, is associated with an increase in the current REER. This implies that reduced remittance inflows contribute to a relative strengthening of the domestic currency. However, the positive coefficient for dRem.2 (0.46065) reveals that an increase in remittances two periods ago is associated with a rise in the current REER. This lagged effect indicates a lasting impact, underscoring the intricate dynamics between remittance patterns and exchange rate movements. In essence, the model

<div align="center">53</div>

emphasizes the importance of considering both lagged values and changes in remittances to comprehend the complex relationship between these variables and the real effective exchange rate.

CONCLUSION

The ARDL model results indicate a significant and nuanced relationship between remittances and the Real Effective Exchange Rate (REER). The negative coefficients for both lagged and differenced remittance variables suggest that a decrease in remittances in the previous period or an overall decline in remittance levels is associated with an increase in the current REER. This implies that, over the long term, reductions in remittance inflows contribute to a relative strengthening of the domestic currency. Conversely, the positive coefficient for the lagged difference in remittances suggests that an increase in remittances two periods ago is associated with a rise in the long-term equilibrium REER. Therefore, while decreases in remittances appear to exert a strengthening effect on the domestic currency, the lagged positive effect implies a lasting impact, highlighting the complex and dynamic nature of the relationship between remittances and the REER. Similar findings were proposed (Lopez et. al., 2007) (Osigwe and Obi., 2016) where the inflow of remittances has led to appreciation of exchange rate. (Hassan and Holmes, 2013) have also identified unidirectional causality where remittances were causing fluctuations in the exchange rate. In case of Ukraine also, remittances inflow have caused the exchange rate to appreciate (Oleksiv and Mirzoieva, 2022). The inflow of remittances affects the foreign exchange reserve of the country directly, this further has substantial impact on the exchange rate dynamics. It was in the year 2022 that India reached 100 billion mark in terms of remittances inflow but the same has caused the exchange rate to shift its trajectory many a times and it is yet to see what course it follows next. Not just that, the possibility of remittances leading to appreciation in the exchange rate in future is also dependent on the level of economic activity that would be prevailing, India's trade relation with other countries, level of government final consumption expenditure and the extent and pace of foreign investment. Since remittances making their way into the country is not the only thing happening, the same foreign exchange is also making its way out of the economy too for various reasons.

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APPENDIX

Table 8- Shapiro Wilk Test

Shapiro-Wilk test of normality of residuals	
W	0.98484
p-value	0.8681

Source: Author's own calculation

Table 9 – Breusch- Pagan Test

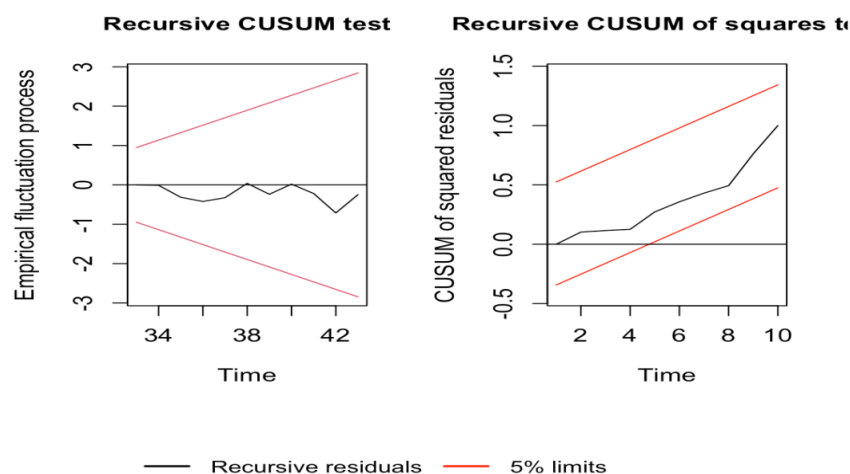| Breusch-Pagan Test for the homoscedasticity of residuals	
studentized Breusch-Pagan test	
BP	36.057
df	33
p-value	0.3275

Source: Author's own calculation

Table 10 – Breusch-Godfrey test

Breusch-Godfrey Test for the autocorrelation in residuals	
LM test	2.1686
df1	1
df2	4
p-value	0.2148

Source: Author's own calculation

Chart 18- Recursive CUSUM and Recursive CUSUM of Squares

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Source: Based on author's own calculation

Table 11- ARDL Model

ARDL model	
Coefficients	
(Intercept)	107.52823
REER.1	-0.94254
Rem.1	-0.43169
GDPr.1	-0.14193
GFCE.1	-1.17376
FI.1	1.55464
ToT.1	-0.02341
dRem.t	-1.21541
dRem.1	-2.39152
dRem.2	0.46065
dRem.3	1.48474
dRem.4	1.90943
dGDPr.t	-0.15876
dGDPr.1	0.0222
dGDPr.2	0.05175
dGDPr.3	0.10186
dGFCE.t	-0.56926
dGFCE.1	0.7513
dGFCE.2	0.04391
dGFCE.3	-0.26744
dGFCE.4	-0.25284
dFI.t	0.7553
dFI.1	-0.77629
dFI.2	-1.23692
dFI.3	-1.0323
dFI.4	-0.46031
dToT.t	-0.12198
dToT.1	-0.18982
dToT.2	-0.2159
dToT.3	-0.19722
dToT.4	-0.06981
trend.t	0.09156
dREER.1	0.28476
dREER.2	1.03194

Source: Author's own calculation

An Empirical Analysis of Remittance Flow in India

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ABSTRACT

Remittances are the amount that was received by a country through their diaspora around the world. Remittances are an important agent of Current Account balance which helps any economy to cover the trade deficit. They are the major inflow for many developing countries like India. India is the largest receiver of remittances in the World. The share of Gulf Countries in the remittances was also high for many years. This study tries to improve the knowledge of trends and patterns of remittances in India. The paper is both descriptive and analytical as it incorporates growth rate methods and ranking methods for analysing the remittances flow of India. The data was incorporated from different sources like the RBI database, the World Bank Database and also from published literature. The result showed that India's inward remittances grew by approximately 5% while outward remittances grew by 10% approx.. from the period of post-economic reform. The study has found the relationship of Gulf countries concerning remittances flow and concluded that the United Arab Emirates is the largest provider of remittances to India also it has shown that India's neighbouring countries (especially Bangladesh and Nepal) are getting the highest amount of remittances from India. The paper concludes that India's outward remittances go to South-East Asian Countries showing the high labour mobility in the region while India's inward remittances majorly come from the Gulf Countries.
Keywords: Remittances, Balance of Payment, Invisibles, India, Gulf Nations, South East Asia.

INTRODUCTION

Remittances (*Remit*) are transfers of money for household purposes by foreign workers, members of diaspora communities, or citizens with family relatives in a foreign country to contribute to living expenses in their home country or homeland. For developing countries, like India, it is one of the largest sources of financial inflow. It is an important component of the Balance of Payment for any developing nation. Since 2008, India has been the largest recipient of *Remit* in the world due to its large diaspore, in many countries, especially in Gulf Cooperation Countries. Among the top receiving countries of *Remit* in 2022, India is the top recipient with an inflow of US$ 100 billion, followed by Mexico with US$ 60 billion, China with US$ 51 billion, the Philippines with US$ 38 billion, Egypt with US$ 32 billion, and Pakistan with US$ 29 billion.

For India, the most amount of *Remit* come from GCC. The United Arab Emirates is the highest contributor to *Remit* inflow followed by the United States of America, and Saudi Arabia. While Bangladesh is the top recipient of *Remit* outflow from India followed by Nepal and China. Below are the two figures, showing the inflow and outflow of India's *Remit* from and to countries. *Remit* inflow shows the 128 countries' data, while the outflow results only for 32 countries.
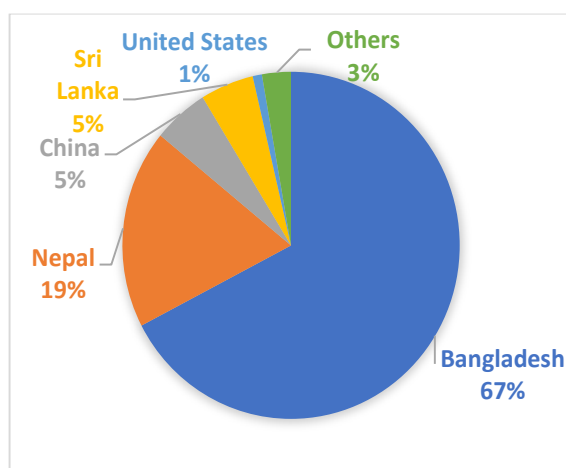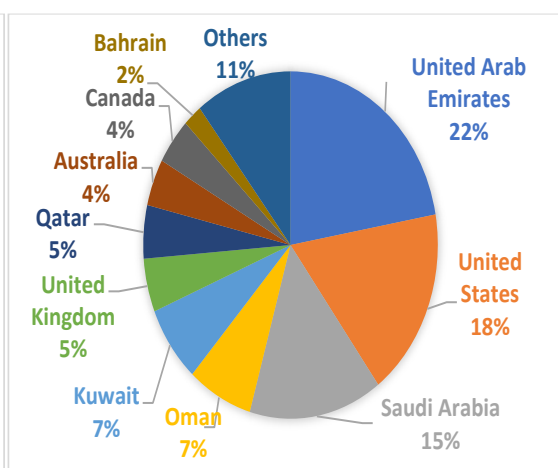
Figure 1 *Remittances Send to Abroad*   **Figure 2** *Remittances Received from Abroad*

Source: KNOMAD (2022)

REVIEW OF LITERATURE

Manjhi (2018) conducted a study to examine the trends and patterns of inward *Remit* to India. The research aimed to assess changes in the trends and compositions of *Remit* entering India over time, as well as changes in the origins of Indian remittances over the same period. The study shows "…nearly 70% of remittances come from either the United States of America or the Gulf countries combined". Furthermore, the share of Europe in terms of its contribution to total *Remit* flowing into India has decreased due to an increase in the relative share of the USA and the Gulf countries; however, Britain remains the main source of inflow of *Remit* in India from Europe. Jain et al. (2018) in their paper used the RBI remittances survey data of 2018 and found that UAE is the largest sender of *Remit* to India in 2016-17, followed by the USA and Saudi Arabia. The largest share of inward *Remit* is diverting towards Kerala, Maharashtra and Karnataka. Gulf Cooperation Council countries are the major sources of *Remit* to India and their business tie-ups with various exchange houses have made the transmission of *Remit* cheaper relative to other countries. Yang et al. (2021) examined the relationship between *Remit* inflows, technological innovation, financial development, and their impact on the ecological footprint in BICS countries, including India. The study highlighted the potential influence of remittance inflows on the ecological footprint, indicating that higher *Remit* inflows may contribute to increased environmental impact. This finding suggests the need for further research to explore the environmental consequences of *Remit* flow in India and its implications for sustainable development. Tewari and Mishra (2022) have shown the impact of Covid-19 on the Indian *Remit* flow and found that there is a decline in the inward *Remit* from the Gulf Countries due to lockdown in those countries and low diaspore in the informal sector. India has the second lowest cost of *Remit* in G20 countries after Mexico. It was also found that private banks have become the major channel of remittance inflow for India followed by public banks. It was also been seen that the cost of remittance has increased in the market compared to the last survey due to increasing prices by private banks.

RESULT AND ANALYSIS
Trends of Remittances Inflow/Outflow
The trend of India's *Remit* is shown in Figures 3 and 4. Figure 3 shows the inflow of *Remit* to India from Abroad in US$ million. Figure 4 shows the *Remit* outflow from India to Abroad in US$ million.

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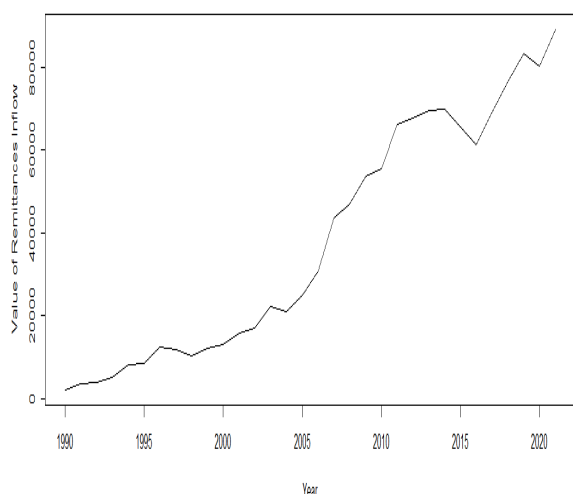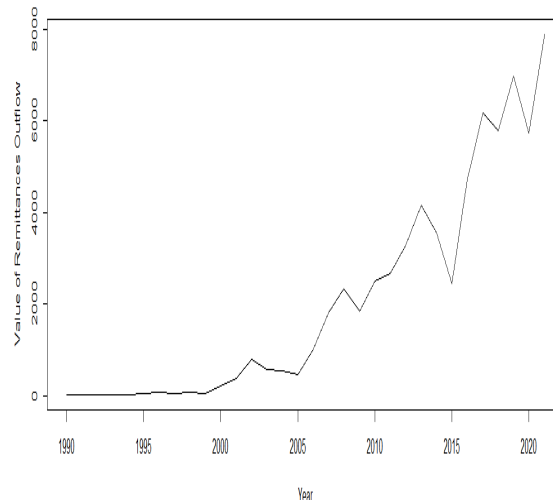**Figure 3** *Value of Remittances Inflow to India*   **Figure 4** *Value of Remittances Outflow from India*

Remittances Flow in India (US$ million)

Remittances Flow from India (US$ million)

Source: RBI (2022)

Figure 3 shows the Inflow of *Remit* to India. Through the figure, it can be easy to analyse that the Flow of *Remit* to India has a constant growth throughout the period. It has fewer fluctuations through this period. While figure 4, analyse the outflow of *Remit* from India, showing more fluctuations than Inflow. It is also been taken into account that the value of outflow from India is less than the value of inflow to India.

The analysis of *Remit* from 1990 to 2021 was done and it has shown a positive rising trend for the data. Further, the growth rates of data will be calculated to know the growth trend of *Remit* inflow and outflow. The CAGR was used to obtained the growth rate with the help of a Semi-log linear model as used in the Tupe (2013) study. The Zivot-Andrews (1992) Unit Root test was applied to the yearly data of both *Remit* in and out-flows for dividing the periods to calculate CAGR. This test suggests one break point which has been used to divide the periods for the growth rate analysis. The results are provided in Table: 1

Table 1: Zivot-Andrews Unit Root Test			
Variables	Intercept	Trend	Both
Inflows	-3.6718	-2.2811	-3.49
Break Dates:	2006-07	1998-99	2006-07
Outflows	-4.2482	-4.7478**	-4.6597*
Break Dates:	2015-16	2005-06	2004-05

Note: **5% significance; *10% significance. Source: Author's Calculation

The Zivot-Andrews (1992) test suggests that in inward *Remit*, there is a break at 2006-07 in intercept after that there is a break in trend at 1998-99, while considering a break in both intercept and trend simultaneously the test suggests that the break can be at 2006-07. The break of 1998-99 can be due to the Gulf crisis that occurred because of the Iraq war, which can be the reason for the change in the trend of remittance inflow in India. For the outflow of remittance, it was shown in the result of the test that the break in intercept only occurred in 2015-16, while only in trend occurred during 2005-06 and the break for both intercept and trend occurred during 2004-05. The reason for the break in 2015-16 can be the demonetization because of which a change in intercept for outflow has occurred, while the break in trend persisted in 2005-06 can be because of the high economic growth of India during that period. The one reason for the break in 2006-07 could be because of the introduction of the New Liberalised Remittance Scheme in 2006 which promoted inward

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remittance flow, while the 2004-05 break could be because of the high economic growth experience in that period. The break was considered when there was a simultaneous change in both intercept and trend. So, for inward *Remit*, the growth rate will be measured during two periods, i.e., from 1990-91 to 2006-07 and from 2007-08 to 2021-22. While for outward *Remit*, the periods were from 1990-91 to 2004-05 and from 2005-06 to 2021-22.

Table 2 shows the CAGR for the inflow of *Remit* from abroad to India.

Table – 2: Growth of Inward *Remit* Flow in the Different Periods (in %)			
Periods	1990-91 to 2006-07 (Breakpoint at 2006-07)	2007-08 to 2021-22 (Breakpoint at 2006-07)	1990-91 to 2021-22 (Whole Period)
Inward Remittances	6.07	1.80	4.78

Source: DBIE-RBI; Note: Author's Calculation

So, from Table 2, it can be analysed that the growth rate before the breakpoint of the growth of *Remit* is high as compared to the period after the breakpoint. This can be due to different crises which occurred after 2006-07. These crises have lowered the flow of income for many years. The total growth of *Remit* during the whole period is seen to be 4.78% or approximately 5% growth annually. The reason for having a breakpoint in 2006-07 can be because of the high-income growth in 2004 which increased the investment in diaspore bonds by NRIs, other reasons can be the change in the Foreign Exchange Act in 1999 which impacted the break in the trend of *Remit* flow to India, there can another reason like the RBI has started the process of liberalization of Current Account again in 2006 (Khan, 2022), etc.

There is a possibility that this pattern of growth is due in part to the major declines in the years following the start of 2006. There have been several drops in that decade, including the 2008 financial crisis, the 2016 demonetization, and the 2020 Covid-19 lockdown, which all took place between 2007-08 and 2021-22.

Now, it's time to analyse the growth of Outward *Remit* through its breakpoint of 2004-05. The table 3 below will show the growth of Outward remittance in these periods.

Table-3: Growth of Outward *Remit* Flow in the Different Periods (in %)			
Periods	1990-91 to 2004-05 (Breakpoint at 2004-05)	2005-06 to 2021-22 (Breakpoint at 2004-05)	1990-91 to 2021-22 (Whole Period)
Outward Remittances	13.50	5.78	9.92

Source: DBIE-RBI; Note: Author's Calculation

From Table 3, it can be analysed that the outward *Remit* are also showing the same pattern of growth as seen in the inward *Remit*. The period before the breakpoint has a high growth compared to the after-break period. The overall growth of the period is double the growth of inward *Remit*. The break at this point can be because of the liberalization of the outward flow of *Remit* from India, as well as this can be because of the liberalized exchange rate, etc. Through these growth rates of inward and outward *Remit*, it can be easy to know the trend pattern of *Remit* in India.

The condition for the inward remittance's low growth in the period after the break can be the same reason for the low growth rate of outward remittance flow. Other than those reasons

through Figure 4, it can be seen that there is a drop in the 2017-18 period which can be because of the new indirect tax reforms, i.e., GST.

Further the pattern of the flow of *Remit* will be analysed. The sources of *Remit* flowing to India as well as the destination of *Remit* flowing from India were given.

Patterns of Remittances of Inflow and Outflow

Figure 1 shows that the United Arab Emirates is the top remittance-sending country with a share of 22% of *Remit* received by India from the World. Based on previous surveys done by Indian researchers, this article has provided different periods of remittance flow to India concerning different geographical regions. Tables for the region-wise inflow of *Remit* to India are given below:

Table 4: Sources of *Remit* to India from 1950 to 1997 (Share in %)					
Year	Sterling Areas	Dollar Areas	OECD	Rest of the Non-Sterling Areas	Total
1950-51	87	11.8	-	1.2	100
1970-71	45.1	37.7	13.4	3.8	100
1990-91	46.6	23.8	12.8	16.7	100
1993-94	52.57	25.3	11.4	10.7	100
1994-95	53.2	28.8	9.4	8.5	100
1995-96	52.6	30	10	7.4	100
1996-97	34.7	51.3	7	7	100

Source: (Manjhi, 2018)

In Table 4, the sterling area presents the area that came under the British Empire in the past. These countries are the United Kingdom, Pakistan, Hong Kong, Ireland, Caribbean Island, Bangladesh, Sri Lanka, Malaysia, Singapore, Australia, New Zealand, Fiji, United Arab Emirates, Qatar, Kuwait, Oman, Bahrain, Kenya, Zambia, Tanzania, and Nigeria. The Dollar areas represent the countries like United States of America, Canada, and some Central and Latin American countries like Jamaica, Guam, Marshall Islands etc. The OECD area represents Western Europe countries and excludes the United Kingdom and Ireland because they are included in the Sterling area. The rest of the non-sterling area comprises every other country which is not included in the above three currency areas like Saudi Arabia, Iran, Iraq, Libya etc.

After 1998, the workers' *Remit* were measured according to the continent of the country, replacing the old segmentation of currency areas. The next table presents the distribution according to the change format.

Table – 5: *Remit* flow to India (Continent Basis) (Share in %)					
Year	**Africa**	**America**	**Asia**	**Europe**	**Total**
1997-98	2.3	37.1	31.3	26	100
1999-2000	1	45.5	31.9	20.6	100
2001-02	4.5	48.2	23	23.4	100
2002-03	0.6	51.1	22	25.8	100

Source: RBI Bulletin (RBI, 2006)

In Table 5, it can be seen that the remittance inflow from the African continent is the lowest in all periods, while the American continent has remained to be the largest contributor to India regarding the remittance inflow. After the continent-wise distribution of *Remit* inflow, another segregation has been performed in the analysis. The next table provides the group-wise segregation of *Remit* to India.

Table 6: Sources of *Remit* to India (Share in %)					
Year	North America	Gulf Countries	Europe	Others	Total
2006-07*	33	29	17	21	100
2007-08*	33	29	17	21	100
2008-09*	29	31	20	20	100
2009-10#	30	31	19	20	100
2010-11#	34	37	12	17	100
2011-12#	34	37	12	17	100
2012-13#	34	37	12	17	100

Source: *RBI Bulletin (RBI, 2010); #RBI Bulletin (RBI, 2013)

From Table 6, it can be analysed that the United States of America is the largest contributor to India's remittance inflow followed by Gulf countries and Europe. After this, the country-wise analysis was done for recent years. For showing the country-wise analysis top countries were shown below. This ranking was done by making an average ranking of countries for the period 2012, 2016-17, 2020-21, and 2021.

Table 7: Remittances Inflow to India (Country-wise Analysis) (Average Ranking of 2012, 2016-17, 2020-21 and 2021)					
Countries	Ranking	2012' (US$ million)	2016-17* (Share in %)	2020-21# (Share in %)	2021^ (Share in %)
United Arab Emirates	1	14,255	26.9	18	22.18
United States	2	10,844	22.9	23.4	17.69
Saudi Arabia	3	7,621	11.6	5.1	14.60
United Kingdom	4	3,904	3	6.8	4.99
Kuwait	5	2,673	5.5	2.4	7.11
Oman	6	2,373	3	1.6	7.18
Qatar	7	2,084	6.5	1.5	4.96
Canada	8	3,145	1	0.6	4.29
Australia	9	1,245	0.7	0.7	4.37
Malaysia	10	493	2.3	0.7	0.77
Singapore	NRA	1,113	-	5.7	1.06
Hong Kong	NRA	-	0.9	1.1	0.12
Bahrain	NRA	690	-	-	2.05
Bangladesh	NRA	3,716	-	-	-
Nepal	NRA	2,934	-	-	-
Sri Lanka	NRA	1,283	-	-	-

Source: ' (Bhaskar, 2013); *RBI Bulletin (Jain, Gajbhiye, & Tewari, 2018); #RBI Bulletin (Tewari & Mishra, 2022); ^(KNOMAD, 2022). Note: NRA = No Rank Allotted[1]

Table 7 shows that UAE is the top remittance-providing country followed by the USA and Saudi Arabia respectively. Bhasker (2013) has found that UAE, Qatar and Saudi Arabia have a 5% low cost of *Remit* transfer to India compared to other corridors like the European Union. The above result also signifies this as UAE, Saudi Arabia and Qatar are the highest remittance-providing nations. The top 10 countries in Table 6 were showing that these countries always get into the top 10 or top 15 in these years. This also shows that these countries are the major and permanent partners of India in Inward remittance flow. After the ranking of inward *Remit* flow the table below will show the ranking of outward

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[1] Countries with values (except 2021-22) shows that they were able to get either in top 10 or in top 15 in that year. But missing value in shows that these countries have no rank in that year. That's why no average rank was allotted to any country with missing values.

Table – 8: Remittances Outflow from India (Country-wise Analysis) (For the Year 2021)			
Countries	Ranking	Value (in US$ million)	Value (in %)
Bangladesh	1	5747	67.35
Nepal	2	1583	18.56
China	3	454	5.32
Sri Lanka	4	436	5.11
USA	5	76	0.89
Uganda	6	54	0.63
Kenya	7	37	0.44
France	8	25	0.30
Myanmar	9	25	0.30
Germany	10	13	0.15

CONCLUSION

In this study, it has been found that India is getting the highest level of remittance inflow compared to other countries and India is the largest receiver of *Remit* from 2008 till today. Other than this, the study concludes that India gets most of the *Remit* flow from the Gulf Cooperation Council Countries, and even in that group of nations, the United Arab Emirates is the sender of the *Remit* while the United States and Saudi Arabia come as the second and third runner-up. Bangladesh is the highest receiver of *Remit* from India.

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APPENDIX

Appendix Table – 1: Data of Inward and Outward Remittances		
Year	Remittance (In)	Remittances (Out)
1989-90	3824	26
1990-91	3737	25
1991-92	9419	37
1992-93	11261	35
1993-94	16582	68
1994-95	25474	57
1995-96	28769	109
1996-97	44209	240
1997-98	43930	165
1998-99	43494	252
1999-00	53280	148
2000-01	59792	981
2001-02	75092	1729
2002-03	83115	3886
2003-04	101798	2633
2004-05	94439	2468
2005-06	110596	2031
2006-07	139173	4565
2007-08	174722	7221
2008-09	213877	10668
2009-10	254611	8728
2010-11	253349	11349
2011-12	317629	12727
2012-13	367954	17873
2013-14	421044	25126
2014-15	426893	21739
2015-16	429072	15989
2016-17	411120	31682
2017-18	445567	39827
2018-19	534207	40468
2019-20	589854	49490
2020-21	594728	42540
2021-22	664334	58891

Source: Database of Indian Economy – Reserve Bank of India.

Role of Prime Minister Employment Generation Programme (PMEGP) In Promoting Entrepreneurship and Employment: A Study of Bihar

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ABSTRACT

This study examines the trends and dynamics of the PMEGP's scheme in Bihar, focusing on the interplay between number of project initiation, margin money utilisation, and employment generation. The study spans the period from 2017-2018 to 2022-2023, utilising data extracted from the PMEGP Annual Progress Report. The overarching objectives include a comprehensive examination of project numbers, Margin Money (M.M) utilisation, and employment outcomes in Bihar, coupled with an assessment of the Program's impact on entrepreneurship and job creation. The research employs a methodology, encompassing Correlation, and Regression, analyses conducted through Excel software. The PMEGP Annual Progress Report underscores the programme scheme evolution in Bihar, revealing a notable Increase in approved projects, efficient Utilisation of Margin Money, and a substantial surge in Employment opportunities.

The Annual Progress Report reveals a consistent increase in the No. of projects initiation, from 2307 in 2017-2018 to 4459 in 2022-2023, indicating a burgeoning entrepreneurial landscape in Bihar. Margin Money Utilisation experienced notable growth, escalating from Rs 6558.29 lakhs to Rs 12123.2 lakhs, highlighting sustained efforts to provide financial support. Commendable growth in employment numbers, from 10662 to 38051, emphasizes the program's efficacy in translating entrepreneurial endeavours into meaningful employment opportunities. Correlation analyses underscore a high robust positive relationship between the No. of projects and employment generation (correlation coefficient ≈ 0.795). This affirms a significant rise in employment as the No. of projects increases, highlighting PMEGP's positive impact. Additionally, the correlation between Margin Money Utilisation and Employment (correlation coefficient = 0.887) accentuates the critical role of financial support in promoting entrepreneurship and translating initiatives into meaningful employment. Regression analyses delve deeper, revealing a substantial interdependence between the number of projects and employment (R Square = 0.632), highlighting the model's ability to explain 63.2% of the variance in employment generation. The analysis of Margin Money Utilisation and Employment demonstrates a Multiple R coefficient of 0.887, explaining 78.8% of the variance in employment generation. The findings, which are statistically significant, provide support for alternative hypothesis (H12) and show a positive correlation between the utilisation of margin money and the generation of employment.

In summary, this investigation furnishes compelling substantiation of the favourable impact exerted by PMEGP on entrepreneurship and employment within the state of Bihar.

Keywords: Employment Generation, Entrepreneurship, Margin Money, Economic Development.

INTRODUCTION

Entrepreneurship and employment are essential components of a thriving economy, playing a significant role in driving innovation, economic growth, and poverty alleviation. Entrepreneurship not only fosters creativity and innovation but also generates employment opportunities, particularly in regions with limited industrial development. By empowering

individuals to create their own enterprises, entrepreneurship contributes to employment creation, skill development, and overall economic prosperity. Within the context of Bihar, it is noteworthy that this state ranks as the third most populous in India, with a population of 104,099,452 according to the 2011 Census. Bihar is distinguished by having the highest proportion of individuals under the age of 25, constituting approximately 58% of its population. Furthermore, with an urbanization rate of merely 11.3%, Bihar stands as the second least urbanized state in India, surpassed only by Himachal Pradesh in this regard, a state with a substantial rural population and numerous economic challenges, entrepreneurship and employment assume added significance. Bihar's economy is characterized by a predominantly agrarian base, alongside a growing interest in small-scale industrial activity and services. Given the population density and need for sustainable economic development, fostering entrepreneurship is pivotal to harnessing the state's potential and addressing the unemployment situation.

Government initiatives such as PMEGP are instrumental in channelling resources towards the grassroots, providing a tangible avenue for individuals to translate their entrepreneurial aspirations into reality. In the subsequent exploration, we will delve into the intricacies of PMEGP, dissecting its design and implementation, and critically assessing its impact on entrepreneurship and employment in the specific context of Bihar.

BACKGROUND OF THE PMEGP SCHEME

The Prime Minister's Employment Generation Programme (PMEGP) is an initiative aimed at fostering self-employment and entrepreneurship by facilitating the establishment of micro-enterprises. Managed by the Ministry of Micro, Small, and Medium Enterprises, PMEGP integrates past schemes and operates nationally under the oversight of the Khadi and Village Industries Commission (KVIC). Through collaboration with state-level entities and participating financial institutions, PMEGP offers credit-linked subsidies to empower individuals in both rural and urban regions, contributing to economic development and job creation

PMEGP SCHEME'S OBJECTIVES

- Facilitate job creation in rural and urban regions through the initiation of self-employment endeavours.
- Extend self-employment avenues to conventional craftsmen and jobless young individuals.
- Ensure consistent and enduring job opportunities, curtailing the influx of individuals migrating from rural to urban locales.
- Augment the earning potential of artisans, thereby fostering the advancement of rural and urban employment metrics.

REVIEW OF LITERATURE

1. Choudhury and Ghosh (2015) - A thorough investigation was carried out to assess the effectiveness of the PMEGP program in village industries throughout India, with a specific emphasis on Jharkhand. This study covered important factors such as project start, output quantities, sales numbers, job creation, and profits. Significant correlations were found among all variables at a national level. Nevertheless, the research in Jharkhand uncovered robust connections between project commencement and output, as well as between output and sales. On the other hand, there were not as strong correlations found between project commencement and job creation, as well as between job creation and income. The regional impact of Naxalism may be the reason for these weaker correlations.

2. Md. Motahar Hossain and Nitin Pathak (2022) – Examine the macroeconomic approach to job creation through technological innovations in Indian MSMEs and utilizes

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secondary data to assess the sector's current employment impact. The findings suggest policy measures for enhancing MSME sustainability and growth.

3. Kaur and Kaur (2017) - conducted a comprehensive assessment of the relative contributions of various types of banks (public sector, Regional Rural Banks, and cooperative banks) in the implementing of the PMEGP across India. Utilizing secondary information from diverse sources such as KVIC's annual reports, websites, journals, and newspapers, the study scrutinized key parameters encompassing the number of projects, margin money, production, sales, employment generation, earnings, awareness campaigns, workshops, exhibitions, Entrepreneurship Development Program (EDP) training participants, bankers' meetings, and monitoring committee meetings. The findings revealed declining trends in specific aspects, prompting recommendations to the government to augment awareness through increased events related to the scheme.

4. J.Suresh Kumar and Imnaonen Ozukum (2022) – This study assessed how the PMEGP affected the entrepreneurial growth of tribal recipients in Kohima, Nagaland. Its goal was to offer perspectives on how it contributes to the socioeconomic progress of those who benefit from it.

5. Dr. J. Suresh Kumar and Mrs. D. Shobana (2023) – This research assesses the PMEGP in North East India, focusing on its impact on entrepreneurship and employment. It analyses information from different sources, such as PMEGP recipients, initiatives, and employment generation. The findings reveal that PMEGP has played a vital role in promoting entrepreneurship, income opportunities, and skill development in the region. Additionally, it has diversified the local economy through support in sectors like agriculture and tourism, benefitting both urban and rural communities.

6. Dr. Priyank Mishra and Sarita Pandey (2021) – The analyses focus on the influence of India's PMEGP on MSME growth in Bilaspur District. The study finds that PMEGP has a significant positive effect on the sustainable growth of MSMEs in the region.

7. Shamal Arvind Pawar (2023): The paper emphasizes the continuous growth of the MSME sector, its role in youth employment the encouragement of entrepreneurship, and its potential to address broader economic challenges, positioning India for a brighter economic future.

8. S. Shiralashetti and I. S. Bhustali (2016) - This paper examined the role of development institutes in promoting rural entrepreneurship in Karnataka State. It evaluated the impact of PMEGP in fostering entrepreneurship, particularly among male entrepreneurs and in the manufacturing sector.

9. Tripathi and Koley (2015) – The research focused on evaluating West Bengal's performance compared to other Indian states regarding project funding, allocation of margin money, and employment creation within the framework of the PMEGP. It is noteworthy that West Bengal contributed 14% to the overall employment generated and 9% to the projects financed at the national scale.

10. Mrs. Madhuri O. Vartale and Dr. ManasiKurtkot, (2020) – This study investigates the impact of the PMEGP's scheme on women entrepreneurs in Pune. Utilizing both secondary and primary data, it highlights the program's influence on the service sector, emphasizing the need for targeted government initiatives to empower women. With a sample of 185 participants, the research advocates for awareness campaigns to enhance women's economic status through PMEGP.

11. V. R. Palanivelu and A. Apdhulkathar (2016) – The study profound that entrepreneurship is a vital contributor to a nation's development, embodying individuals with initiative, skill, and motivation to establish businesses, ultimately driving economic growth. Entrepreneurs, catalysts for social change, actively seek and exploit opportunities,

primarily for economic gain, demonstrating a proactive and risk-taking orientation in pursuit of their objectives.

12. R. K.Wadichar, J. D.Wadate, and P. Manusmare (2022) – This study examines the impact of the PMEGP on entrepreneurship development in Nagpur District, India. Through a survey of 278 participants, it finds that PMEGP positively influences youth empowerment and entrepreneurial growth. The program encourages innovation and new enterprises ideas among entrepreneurs. Overall, this research has the potential to shape policy decisions in the field of entrepreneurship development.

RESEARCH GAP

This research paper distinguishes itself from existing literature reviews on PMEGP's scheme through its meticulous presentation of empirical evidence and in-depth analyses of PMEGP's impact on entrepreneurship and employment in Bihar spanning 2017-2018 to 2022-2023. Unlike conventional literature reviews, this study integrates quantitative data, correlation, regression, and ANOVA analyses, providing a comprehensive evaluation of the program's effectiveness. Notably, the research focuses exclusively on Bihar, offering context-specific insights into PMEGP's trends, correlations, and implications, thereby contributing invaluable information for policymakers, practitioners, and academia. The six-year timeframe ensures a contemporary assessment of PMEGP's ongoing impact in the specified region, setting this study apart as a nuanced and insightful contribution to the existing body of knowledge.

SIGNIFICANCE OF THE STUDY

The significance of this study is rooted in its thorough analysis of the PMEGP scheme in Bihar state, providing empirical evidence on the relationship between project initiation, margin money utilisation, and employment generation. The findings contribute valuable insights for policymakers, practitioners, and academics, informing strategic decisions in fostering entrepreneurship and addressing unemployment challenges. This research enhances our understanding of the program's impact, offering a foundation for targeted interventions and optimizations to maximise socio-economic benefits in Bihar.

OBJECTIVES

- Examine the trends in the number of projects, margin money (M.M) utilisation, and employment generation (EMP.) in Bihar state under PMEGP.
- Assess the entrepreneurial, employment generation and development in Bihar.

HYPOTHESIS

(H01): There is no significant relationship between the number of projects initiated and employment generated in Bihar under the PMEGP.

(H11): There is a significant positive relationship between the number of projects initiated and employment generated in Bihar under the PMEGP.

(H02): There is no significant relationship between the margin money utilisation and employment generated in Bihar under the PMEGP.

(H12): There is a significant positive relationship between the margin money utilisation and employment generated in Bihar under the PMEGP.

METHODOLOGY

The methodology employed to analyses the prime minister's employment generation program adopts a comprehensive approach covering diverse dimensions. Data obtained from PMEGP Annual Progress Report for the period 2017-2018 to 2022-2023 has been collected for the state of Bihar in which an analysis has been conducted to understand the trends in project

numbers, margin money (MM) Utilisation and employment outcomes. Correlation, Regression and ANOVA have been analysed using Excel software.

PERFORMANCE OF THE PRIME MINISTER'S EMPLOYMENT GENERATION PROGRAMME IN BIHAR

Table 1: Performance of PMEGP scheme in Bihar state (2017-18 to 2022-23)

Year	No of Projects	Margin Money Utilisation (M.M) (Rs in lakhs)	Employment Generation (Nos)
2017-2018	2307	6558.29	10662
2018-2019	3303	9841.15	35169
2019-2020	2216	6950.17	23385
2020-2021	2192	7208.29	23824
2021-2022	2477	8169.4	26132
2022-2023	4459	12123.2	38051

Sources – PMEGP Annual Progress Report2017-2018 to 2022-2023

Figure 1 - Performance of PMEGP scheme in Bihar state (2017-18 to 2022-23)
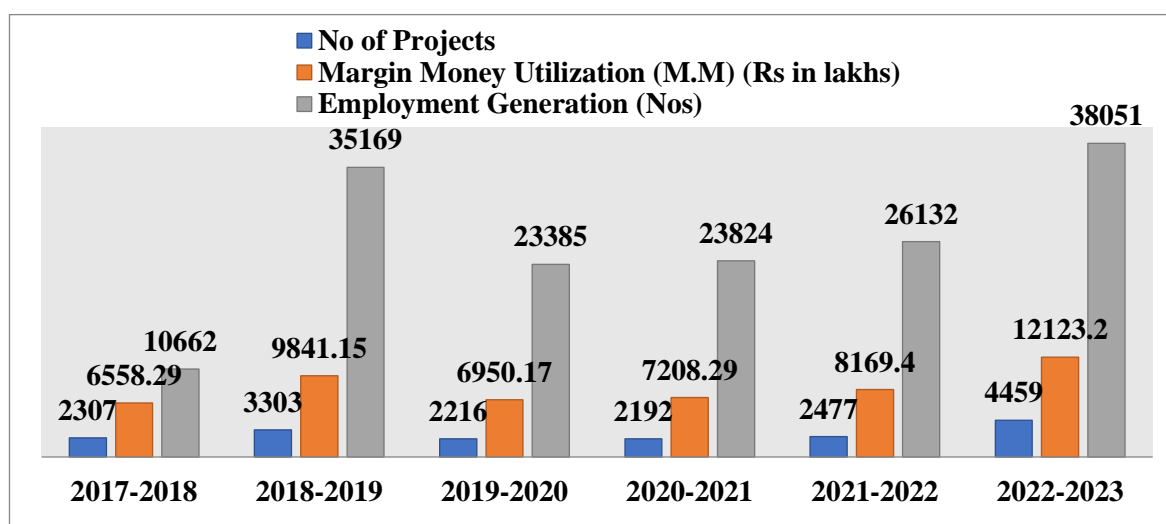
The data provided outlines the yearly progress of the PMEGP scheme in Bihar state spanning six years (2017-2018 to 2022-2023).

Number of Projects (No of Projects) - There's been a significant increase in the No. of projects, going from 2307 in 2017-2018 to 4459 in 2022-2023. This suggests a strong growth in businesses and initiatives in the state. The growing number of projects indicates a thriving environment for entrepreneurs, likely due to the PMEGP effectively supporting business initiatives.

Margin Money Utilisation (M.M) (Rs in lakhs) - The utilization of Margin Money (M.M) has been increasing consistently, reaching Rs 12,123.2 lakhs in the year 2022-2023.. This implies that financial resources are being used well to support business ventures. The consistent rise in Margin Money usage shows careful financial management, strengthening the sustainability of projects and the program's overall impact.

Employment Generation (No's) - Employment generation has witnessed significant expansion, from 10,662 in 2017-2018 to 38,051 in 2022-2023.These points to a significant increase in job opportunities and economic development in Bihar. The substantial increase in

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employment underscores the social and economic benefits of the PMEGP, contributing significantly to job creation and livelihood improvement in Bihar.

Year-wise Variations - There was a bit of a drop in projects and money Utilisation in 2019-2020, but things picked up again in the following years, especially in 2022-2023

Overall, the annual progress report indicates a positive trajectory for the PMEGP scheme in Bihar. The program has successfully stimulated entrepreneurial activities, effectively managed financial resources, and made significant progress in generating employment, aligning with the broader goal of fostering economic development.

Table 2: Correlation between number of projects and employment generation under PMEGP in Bihar

	BIHAR STATE NO OF PROJECTS	BIHAR STATE EMP.(NO'S)
BIHAR STATE NO OF PROJECTS	1	
BIHAR STATE EMP.(NO'S)	0.794996602	1

Source – Excel Output

Table 3 - Regression Analysis of number of projects and employment generation under PMEGP in Bihar

REGRESSION STATISTICS	
MULTIPLE R	0.794996602
R SQUARE	0.632019598
ADJUSTED R SQUARE	0.540024497
STANDARD ERROR	6616.630617
OBSERVATIONS	6

Independent variable -No of Projects
Dependent variable –employment generation
Source – Excel Output

Table 4 –Analysis of Variance outcome of number of projects on employment generation under PMEGP in Bihar

ANOVA					
	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	300773539.9	300773539.9	6.870144107	0.058731813
RESIDUAL	4	175119202.9	43779800.72		
TOTAL	5	475892742.8			

Source - Excel Output

ANALYSIS AND INTERPRETATION

The analysis provided in Tables 2, 3, and 4, which explore the correlation, regression, and analysis of variance (ANOVA) between the no. of projects and employment generation under PMEGP in Bihar state.

Table 2 the correlation coefficient (r) indicates a robust positive association between the no. of projects and employment in Bihar, with a substantial coefficient value of 0.795. This suggests that as the quantity of projects escalates, there is a notable tendency for increased employment generation within the state.

In Table 3, the regression analysis unveils a multiple R coefficient of 0.795, signifying a notable correlation that implies a substantial association between the no. of projects and

employment generation. The R-squared value of 0.632 elucidates that approximately 63.2% of the variability in employment generation can be elucidated by fluctuations in project numbers, showcasing a moderately robust relationship. Furthermore, the adjusted R-squared, factoring in predictors, registers at 0.540, denoting a more dependable estimation of the model's fit. The standard error, positioned at 6616.63, delineates the average deviation of actual employment figures from the regression line. With six observations, this analysis serves as a foundational framework for comprehending the correlation between project counts and employment levels.

Looking at Table 4 the ANOVA results shows that the regression model is not statistically significant at the conventional 5% level (significance F - 0.059). However, the F-statistic (6.87) implies a potential relationship between the no of projects and employment generation in Bihar. While the positive correlation from Table 2 suggests that increasing projects positively impact employment, caution is advised due to the borderline significance.

In overall, the regression analysis suggests a positively but marginally significant association between the number of PMEGP projects and employment in Bihar.

Table 5 - Correlation between Margin Money Utilisation and Employment in Bihar

	BIHAR STATE M.M (RS IN LAKHS)	**BIHAR STATE EMP.(NO'S)**
BIHAR STATE M.M(RS IN LAKHS)	1	
BIHAR STATE EMP.(NO'S)	0.88749122	1

Source - Excel Output

Table 6-Regression Analysis of Margin Money Utilisation and Employment Generation under PMEGP in Bihar

REGRESSION STATISTICS	
MULTIPLE R	0.88749122
R SQUARE	0.787640665
ADJUSTED R SQUARE	0.734550831
STANDARD ERROR	5026.436771
OBSERVATIONS	6

Independent variable –Margin money Utilisation
Dependent variable – employment generation
Source - Excel Output

Table 7- Anova outcome of margin money on employment generation under PMEGP in Bihar

ANOVA					
	DF	*SS*	*MS*	*F*	*SIGNIFICANCE F*
REGRESSION	1	374832476.4	374832476.4	14.83599794	0.018275258
RESIDUAL	4	101060266.5	25265066.62		
TOTAL	5	475892742.8			

Source - Excel Output

ANALYSIS AND INTERPRETATION

The analysis and interpretation provided in Tables 5, 6, and 7, which explore the correlation, regression, and analysis of variance (ANOVA) between the margin money Utilisation and employment generation in Bihar under PMEGP.

Table 5 shows a strong positive correlation coefficient between the utilisation of Margin Money and Employment in Bihar under the PMEGP scheme. The correlation coefficient of 0.8875 indicates a significant and highly positive relationship. In simpler terms, as the utilisation of margin money increases, there is a noticeable and positive impact on employment generation in the state. This finding emphasizes the potential effectiveness of prudently employed margin money in nurturing significant employment opportunities through PMEGP initiatives specifically designed for Bihar.

Table 6 presents a comprehensive regression analysis elucidating the relationship between Margin Money Utilisation and Employment Generation under PMEGP in Bihar. The multiple R value of 0.887 underscores a robust positive correlation between these variables, indicating that as Margin Money Utilisation increases, there is a substantial concurrent increase in employment. The R Square value of 0.788 signifies that approximately 78.8% of the variability in employment generation can be accounted for by variations in Margin Money Utilisation, demonstrating a considerable explanatory power of the model. The Adjusted R Square, adjusting for the no. of variables stands at 0.735, providing a slightly attenuated yet still noteworthy measure of the model's explanatory capability. The standard error of 5026.44 denotes the average deviation of actual employment generation values from predicted values, reflecting the model's precision. Overall, the regression analysis in Table 6 convincingly supports the notion that Margin Money utilisation is a significant and influential factor in predicting employment generation under PMEGP in Bihar.

In Table 7, the ANOVA outcome provides additional insights. The F-statistic of 14.84, coupled with a significance F level of 0.0183, suggests that Margin Money Utilisation significantly affects employment generation in Bihar under PMEGP. This result supports the notion that well-managed and utilise margin money plays a crucial role in driving employment opportunities, contributing to the overall success of the PMEGP initiatives in Bihar.

Overall, these statistical findings highlight the critical relationship between Margin Money Utilisation and Employment Generation, emphasizing the importance of strategic financial planning and allocation in PMEGP projects to maximize socio-economic impact in Bihar.

The evidence derived from the analysis of PMEGP scheme in Bihar provides support for the hypothesis related to the no. of projects. Although a positive correlation with employment is observed, the statistical significance is marginally below the conventional threshold (Significance F value = 0.0587), leading to caution in drawing definitive conclusions.

In contrast, for the hypothesis related to margin money utilisation, the findings are more compelling. There's a clear and significant positive relationship (Significance F value = 0.0183) between well-utilised margin money and employment generation. The strong correlation coefficient (0.8875) and high R-square values emphasize the substantial impact of effective margin money utilisation on employment generation.

KEY FINDINGS

The analysis of the PMEGP scheme in Bihar from 2017-2018 to 2022-2023 has yielded several key findings, shedding light on the program's impact on entrepreneurship and employment generation in the state.

- Positive Trends in Project Approval - The number of approved projects has exhibited a notable upward trajectory, suggesting a thriving environment for entrepreneurial initiatives in Bihar.
- Margin Money Utilisation Effectiveness - Margin Money Utilisation (M.M) has been judiciously employed, reaching Rs. 12,123.2 lakhs in 2022-2023. This underscores the prudent allocation of financial resources, enhancing the sustainability and success of PMEGP projects.

- Significant Employment Growth - Employment generation has experienced significant growth, rising from 10,662 in 2017-2018 to an impressive 38,051 in 2022-2023. This indicates a substantial positive impact on job creation within the state.
- Correlation and Regression Analysis - Correlation analyses reveal a highly positive relationship between the no. of projects and employment generation (correlation coefficient 0.795) as well as margin money utilisation and employment (correlation coefficient 0.887). These findings are consistent with the hypotheses tested.
- Regression analyses support the positive associations, indicating that an increase in the no. of projects and higher margin money utilisation significantly contribute to employment generation in Bihar.
- Entrepreneurial Environment Enhancement - The observed positive correlations and regression coefficients emphasize that the PMEGP is playing a crucial role in fostering a dynamic entrepreneurial environment in Bihar.
- Policy Implications - The findings suggest significant policy implications, indicating that sustained support for PMEGP initiatives in Bihar can further stimulate entrepreneurship, amplify job creation, and contribute to the overall economic development of the state. Policymakers are encouraged to leverage these positive trends to refine and enhance the program for greater impact.

Overall, the study offers strong proof that the PMEGP scheme is greatly and positively influencing entrepreneurship and employment generation in Bihar, playing a crucial part in the state's economic scenario.

CONCLUSION

The study conducted a comprehensive analysis of the PMEGP's scheme in Bihar, spanning the period from 2017-2018 to 2022-2023. The research investigated the interrelationships between project initiation, margin money utilisation, and employment generation. The findings revealed consistent growth in the no. of projects, efficient use of margin money, and a substantial increase in employment opportunities.

Correlation analyses demonstrated a robust positive relationship between the no. of projects and employment, emphasizing the program's efficacy in promoting job creation. Regression analyses further supported these observations, elucidating a substantial interdependence between the no. of projects and employment, as well as a significant positive relationship between margin money utilisation and employment generation.

The study contributed compelling evidence of PMEGP's positive Impact on entrepreneurship and employment in Bihar, highlighting its role in fostering a thriving entrepreneurial landscape and addressing unemployment challenges. The findings underscored the critical importance of strategic financial planning and allocation in optimising the socio-economic impact of PMEGP initiatives.

Overall, this research offers important perspectives for policymakers, professionals, and scholars, enhancing the comprehension of PMEGP's impact on economic growth in Bihar. The positive trends observed in project initiation, margin money utilisation, and employment generation underscore the program's significance in driving entrepreneurial endeavours and fostering job opportunities in the region.

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Multiclass Classification of Coronavirus (COVID-19) using Grey Wolf Optimization and Transfer Learning-based Ensemble Model

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ABSTRACT

Almost everyone's lives, economy, and way of life were shattered by the recent coronavirus pandemic. The rapid spread of COVID-19 has made it one of the worst catastrophes in history. The early phases of infection in patients must be closely monitored whilst battling COVID-19. Additionally, accurate diagnosis leads to early COVID-19 detection, particularly in individuals without obvious symptoms, may lower the patient's mortality rate and prevent COVID-19 from spreading. Chest X-rays (CXR) are increasingly frequently utilized to detect COVID-19 instead of Computed Tomography (CT) scans since CXR images have more robust lung characteristics. This work proposes grey wolf optimization-based ensemble learning (GWO-EL) model for multiclass classification of COVID-19. Grey wolf optimization (GWO) algorithm is used for hyperparameter optimization of CNN models and then majority voting ensemble is utilized to finally classify COVID-19 from lung opacity, bacterial, viral, and normal. 89.66% overall accuracy is achieved by proposed model for 5-class classification.

Keywords-Multiclass classification, X-ray images, GWO, Classification, Ensemble learning, COVID-19.

INTRODUCTION

A vast family of viruses called Coronaviruses can lead to various illnesses, from the ordinary cold and cough to severe respiratory issues. Most coronaviruses do not cause much harm. A novel coronavirus subtype, SARS-CoV-2, has never been discovered in humans (Muhammad, U. et al., 2022). Those who are most impacted by COVID-19 have mild to moderate respiratory issues and recover without any special care. However, certain individuals require specialized medical care as they are experiencing serious respiratory issues (Gandhi, R. T. et al., 2020). Several different tests can be used to check the presence of COVID-19. The reverse transcription-polymerase chain reaction (RT-PCR) (van Kasteren et. al., 2020), also known as molecular test, the antigen test (Mak, G. C. et. al. 2020) for quick testing, the antibody test (Adams, E. R. et. al., 2020), also known as the serology test, and the use of radiological imaging, such as the CT scan and CXR (Chandra, T. B. et. al., 2021; Ai, T. et. al., 2020) , are some of the prominent tests. The method that is most usually used to identify COVID-19 is the RT-PCR test. COVID-19 is present in the subject, if the results of the RT-PCR and antibody tests are both positive. However, RT-PCR's primary drawback is that it takes a lot of time. Due to contaminated samples, mutated viruses, or human error during sample extraction, these tests frequently produce false-positive or false-negative results. Since CT scans demonstrated improved accuracy, various studies (Ai, T. et. al., 2020) recommended using them for completing diagnosis. Therefore, it was determined that the lower lung lobes are typically affected in the early stages of COVID-19 patients with bilateral

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abnormalities and multifocal ground glass opacities being prominent radiographic features and pulmonary consolidation was observed at the final stages (Huang, C. et. al., 2020). CXRs, however, are more readily available and more affordable than CT scans when it comes to cost and speed of image acquisition. They also expose the body to less radiation throughout the process (Brenner, D. j. et. al., 2007). CXRs are currently employed to diagnose COVID-19 (Shi, F. et. al., 2020). In recent years, machine learning has shown tremendous growth. It is specially employed in medicine for a number of tasks, including the diabetic retinopathy treatment, cardiovascular disorders classification and many more (Khalil, H. et. al., 2019). The convolutional neural network (CNN)'s innovative capabilities have allowed medical professionals to employ it for a variety of tasks, including the identification of skin lesion, breast cancer and brain tumour detection (Dong. H. et. al., 2017). Deep learning (DL) algorithms have proven effective in assisting researchers in the diagnosis of lung conditions like COVID-19 pneumonia when applied to CXR images. The following are the paper's remaining sections: Section II discusses about review of literature. In section III, grey wolf optimization technique and transfer learning approach used in this study is discussed. Section IV contains information about proposed methodology. Section V contains information about the simulation environment, results, and comments. At last, the paper is concluded.
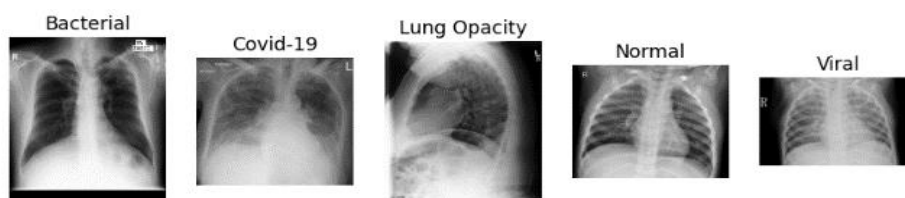

Fig.1. Random images of different size from each class

LITERATURE REVIEW

The widespread adoption of deep learning techniques has provided academics with enormous opportunity to expand the scope of their applications for real-world on-device use with constrained resources. The need to transfer the inference step from powerful computers to devices with constrained resources has grown over the past few years (Chen, S. et. al., 2018). In this context, it is becoming more typical for a variety of applications to deploy trained deep learning models on low resource devices (Pathania. D. et. al., 2019; Shokoohi, H. et. al., 2019). Transfer learning, which involves applying the knowledge that a model has learnt while being trained on one domain to another, is crucial to improve the performance of DL models. Transfer learning dramatically improves the performance of models, according to studies. For CXR (Khan. A. I. et. al., 2020; Loey, M. et. al., 2020), CT (Ko, H. et. al., 2020), and other imaging modalities, researchers are working to create affordable, efficient Computer-Aided Diagnosis (CAD) techniques. The accuracy of 96.78% in MobileNet architecture that (Apostolopoulos, I. D. et. al., 2020) attained while using cutting-edge CNN networks (Chithaluru, P. et. al., 2021) with transfer learning approaches to recognize COVID-19 was superior to others. Several hyper-parameters still need to be adjusted, even if the CNN model works well for COVID-19 identification and classification. The CNN network has several hyper-parameters, including stride, pooling size, network depth, kernel dimension, etc. that significantly affect the various performance statistics. Therefore, to identify values for those hyper-parameters that are close to ideal, optimization techniques are required. To fine-tune the hyperparameter in CNN, (Ucar, F. et.al., 2020) have presented a

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hybrid model termed deep BayesSqueezeNet, which has a 98.3% accuracy in a dataset with three classes. Using 2700 images and an optimized CNN model (Goel, T. et. al., 2021) named OptCoNet, the author achieved a precision score of 92.8%.

There has not been any research that optimizes each hyper-parameter when creating a CNN architecture yet. The CNN model's hyperparameter is selected with care using an optimisation procedure. In order to optimize CNN's hyper-parameters, grid search is a popular technique. However, because it combines all conceivable hyperparameters, it is comprehensive. Recently, grid search was outperformed by random search (Bergstra, J. et. al., 2012). In recent work, the authors have optimized nine hyperparameters, including epochs, learning rates, CNN weights, and contrast normalization parameters of a CNN model, using Bayesian optimization (Snoek, J. et. al., 2012).

MATERIALS AND METHODS
GREY WOLF OPTIMIZATION

By imitating the social interactions, organizational structure, and hunting on collective grounds of grey wolves, Seyadali Mirjalili proposed the GWO in 2014 (Mirjalili, S. et. al., 2014). In places with wildlife, grey wolves frequently live in groups. There are between 5 and 12 participants. The social hierarchy they uphold is rigid and strong. The dominant male or female wolves are referred to as alphas at the top of the hierarchy. They are mostly in charge of making choices about the wolf pack's hunting, sleeping, feeding, habitat, and other activities. All other wolves follow the alpha wolves. The wolves in their social structure below them are known as beta wolves; controlling the lower-level wolves, they adhere to the alpha's decisions. The following group of wolves is made up of the delta wolves, who assist the beta and alpha wolves in seeking for capturing prey. They take care of the injured and weak wolves and protect the borders of their domain, alerting the threat to other wolves. Omega wolves, the lowest level of wolves, obey all other wolves' orders. Wolves' social organization is a major factor that how well they can hunt. Using the wolf's location as the search space's solution and the location of the prey as the optimal solution, it is possible to mathematically simulate the social behaviour of grey wolves. Basically, GWO offers the following three benefits: (i) exploiting and exploring effectively; (ii) actively preventing local optimization; and (iii) Compared to other classic heuristic algorithms, this technique shows promise in the presence of uncertainty, increasing global optimisation (Shaikh, M. S. et. al., 2021).
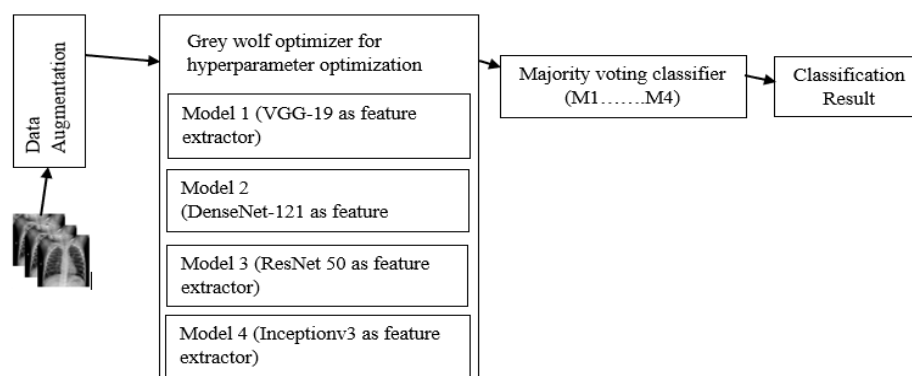

Fig.2: Flow of the proposed work. GWO is used for hyperparameter optimization. Majority voting classifier is used as a classifier

TRANSFER LEARNING

We use transfer learning strategy in this study since earlier research has demonstrated that utilizing a small training dataset might lead to underfitting overfitting issues. Instead, it is preferable to use a CNN that has already been trained on a large-scale database. Transfer learning (TL), which is based on the notion that knowledge is transferred across activities that are linked to one another for improvement of performance on a new task, has its roots in cognitive science. The most important lesson from CNN is that information may be communicated at the parametric level. Parameters of the convolutional layer are used by well-trained CNN model to carry out a novel task in the field of medicine. When using CNN for medical image classification, generic features from natural image classification can be used to train a medical image classification if labels are available in both domains. Many CNN models have already been built and are already available for various technical applications. In order to circumvent the difficulties with deep learning model creation, transfer learning approaches are presented. VGG16 is a common abbreviation for the VGG model, often known as VGGNet, which is a 16-layer CNN model. 92.7% top-5 test accuracy is achieved by VGG16 model in ImageNet database. It performs significantly better than AlexNet by substituting many 3*3 kernel-sized filters for the large kernel-sized filters. Except for the fact that it supports 19 layers, the VGG19 model, commonly referred to as VGGNet-19, is conceptually similar to the VGG16. The numbers "16 and "19 indicate how many weight layers (convolutional layers) are present in the model. Three additional convolutional layers are present in VGG19 compared to VGG16. DenseNet was specifically developed to improve accuracy because information vanishes before it reaches its destination in high-level neural networks due to the enormous distance between the input and output layers. Instead, getting representational power through extremely deep or broad designs, DenseNet make use of network's capacity through feature reuse. Contrary to what is commonly believed, by connecting in this way, DenseNet requires less parameters than an equivalent classic CNN since redundant feature maps are not required to be trained. Google inception is third version of its architecture family (Szegedy, C. et. al., 2015) is called Inception-v3 (Szegedy, C. et. al., 2016). Because it can be difficult for CNN designs to select the ideal kernel size, Inception networks employ filters of various sizes that function on the same level, making the networks wider rather than deeper. 34 weighted layers were present in ResNet-34, a variation of the original ResNet design. It provided a clever workaround for the vanishing gradient problem by increasing the number of convolutional layers in a CNN using the concept of shortcut connections. The ResNet architecture adheres to two main design principles. First, regardless of the output feature map's size, each layer has the same number of filters. Secondly, even when the size of the feature maps is half, it contains twice as many filters to preserve the time complexity of each layer. The ResNet-50 building block is created using a bottleneck design. There are fewer parameters and matrix multiplication when a "bottleneck" residual block using 1*1 convolutions is used. This considerably speeds up the training process for each layer. It uses a stack of three layers as opposed to just two.

PROPOSED METHODOLOGY

This section describes the proposed methodology. We have taken the dataset (Vantaggiato, E. et. al., 2021) belonging to 5 classes i.e., bacterial pneumonia, viral pneumonia, lung opacity, COVID-19 and normal. In this dataset, we have 404 images belonging to each class in train set, 100 images belonging to each class in validation set, and 207 images belonging to each

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class in test set. The idea of the proposed work is employed to obtain augmented data for model training.

Table 1: Upper bound and lower bound of hyperparameters

	Learning rate	Epochs	n1	n2	n3
Upper bound	0.1	50	256	128	64
Lower bound	0.001	5	128	64	32

Color jitter, padding, horizontal flip, random perspective, random rotation, and random crop are used for training set. We have used VGG-19, DenseNet121, ResNet50 and Inceptionv3 as feature extractor for Model1, Model2, Model3 and Model4 respectively. The generalised architecture for all models is shown in fig. 2. All models have pretrained model as a feature extractor and 4 Dense layers after flatten layer. Grey wolf optimization technique is used for hyperparameter tuning. We have taken four hyperparameters i.e. learning rate, number of epochs, n1, n2, n3. Upper bound and lower bound for each hyperparameter is shown in table 1. GWO based optimized models are then fed into the majority voting classifier for classification. A multi-expert recommendation might be made using the majority voting classifier ensemble, which would also lessen the likelihood of making a mistaken diagnosis. We employed an ensemble classifier of four pretrained models that relies on majority vote to limit the likelihood of misclassification. Majority voting ensemble classifier performs well and reduce the chance of misclassification.
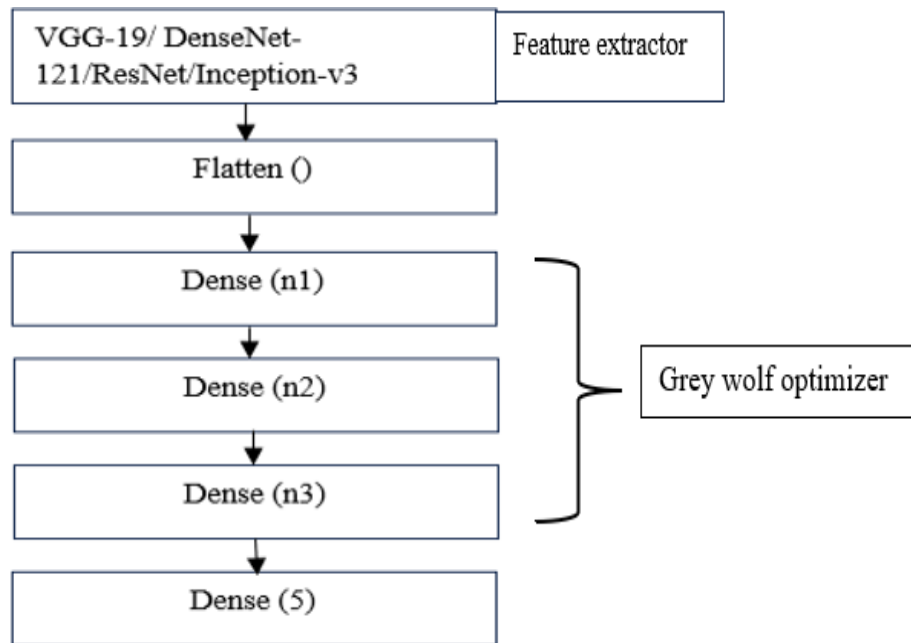

Fig.3: General architecture of models used in this work. VGG-19, DenseNet-121, ResNet50 and Inceptionv3 are used as features extractor in Model1, Model2, Model3 and Model4 respectively. Learning rate, number of epochs, n1, n2, n3 are optimized using grey wolf optimizer.

RESULTS AND DISCUSSION

The experimentation in this work makes use of Tensor Flow and Keras with Python in Google Colab with GPU. The performance of proposed work is assessed using Recall, Precision, F1- Score, and Accuracy. The overall evaluation with existing work for 5-class

classification dataset (Vantaggiato, E., Paladini, E., Bougourzi, F., et.al. 2021)is shown in Table 2.

The degree of precision is a crucial determinant of which among those the prediction was most correct who believed it to be true.

$$Precision = \frac{Tp}{Tp+Fp} = \frac{Tp}{PPV}$$ Eqn. 1

Precision (1) is the proportion of true positives (Tp) to the sum of and false positives (Fp) and true negatives (Tn). Positives predictive value (PPV) is another name for it

	Bacterial	COVID-19	Lung Opacity	Normal	Viral	Classification overall	User's accuracy (Precision)
Bacterial	153	8	5	2	39	207	73.91%
COVID-19	0	202	3	1	1	207	97.58%
Lung Opacity	7	2	198	0	0	207	95.65%
Normal	8	0	24	174	1	207	84.05%
Viral	0	1	1	4	201	207	97.10%
Truth overall	168	213	231	181	242	1035	
Producer's accuracy (Recall)	91.07%	94.83%	85.34%	96.67%	83.05%		

Fig.4: Confusion matrix for proposed method

Table 2: Evaluation of suggested strategy using 5-class dataset with existing works

Method	F1-Score	Recall	Precision	Accuracy
Ensemble-CNN [15]	81.49	82.96	82.99	81.00
SAM [24]	73.88	82.19	76.32	84.64
Proposed Method	89.80	89.70	89.70	89.66

Table 3: Class wise Accuracy and F1-score

Class	Accuracy	F1-score
Bacterial	93.33%	0.82
COVID-19	98.45%	0.96
Lung opacity	95.94%	0.90
Normal	96.14%	0.90
Viral	95.46%	0.90

Recall (2) measures how many positives a model can recognize and classify as positives. When Fp is less expensive than Fn, Recall should be utilized to choose the best model.

$$Recall = \frac{Tp}{Tp+Fn}$$ Eqn. 2

The percentage of an algorithm's predictions that are accurate compared to all other predictions is known as accuracy (3). One can figure it out by dividing precision by recall or by taking one out of the False Negative Rate (FNR) and False Positive Rate (FPR).

$$Accuracy = \frac{Tn+Tp}{Fn+Tn+Fp+Tp} \qquad \text{Eqn. 3}$$

The F1-score (4) is a composite statistic with a scale from 0 to 1 that takes both Recall and Precision into account.

$$F1-score = \frac{2*(Recall*Precision)}{(Recall+Precision)} \qquad \text{Eqn. 4}$$

Accuracy and F1-score for each class is shown in Table 3. Confusion matrix represents precision and recall in Fig. 4. It is obvious from results shown in Table 2 and Fig. 3. With 928 true positives, the proposed model's overall accuracy is 89.66%.

CONCLUSION

Prompt and precise identification of the infectious COVID-19 virus is essential for stopping the virus' transmission. Even for professionals, it can be difficult to accurately classify COVID-19 in its early stages, which has prepared the way for its effective automation. Because X-ray imaging is more affordable, accessible, and rapid than other commonly used methods like RT-PCR and CT, we have used CXR images in this investigation. Data augmentation technique is employed to get around the issue that CNN architectures need enormous volumes of labelled data for training. Four pretrained models are assessed and then ensemble approach is proposed in this study. Majority voting ensemble classifier is developed using GWO technique to classify the COVID-19 from lung opacity, bacterial pneumonia, normal, and viral pneumonia, from the input images. To optimize the models' architecture by enhancing its performance in addressing the COVID-19 multi class problem, the GWO approach is used here to determine the relevant hyperparameters of the CNN. More hyperparameters, such as   regularization rate, activation functions, and training size, can be included in the future to further extend the study. Using appropriate optimization techniques during the model's weight updating and image preprocessing stages, such as Arithmetic optimization algorithm, Hybrid salp swarm algorithm, Grasshopper optimization algorithm, and others, can also improve the model performance. With two class and multi class classification, the improved model can be applied to additional domains.

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