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ڈاکٹر طیب خرادی

ساجد حسین ندوی

جوش ۔ انقلاب، شباب اور فطرت کا شاعر

فہرست مضامین

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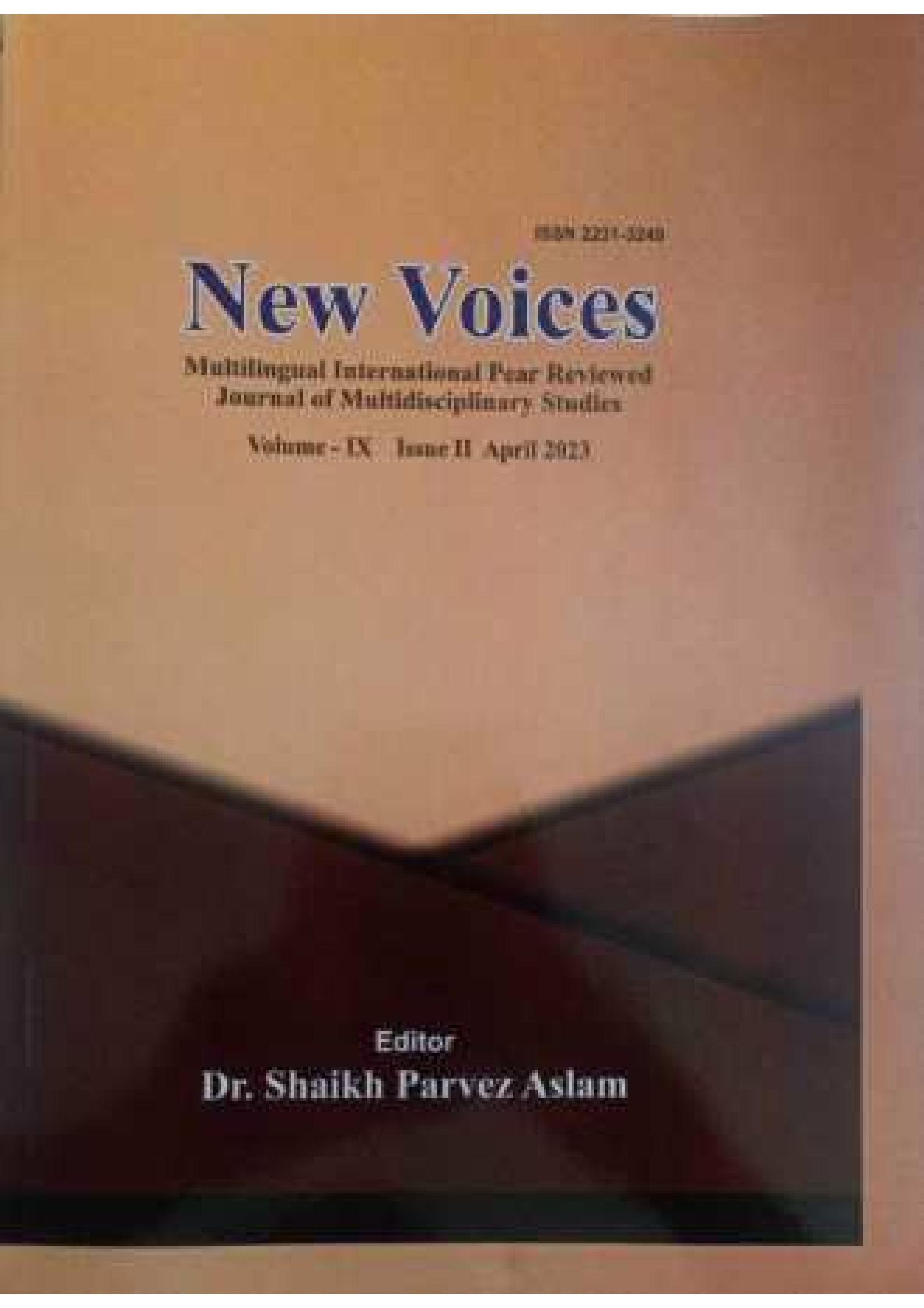

Editor

Dr. Shaikh Parvez Aslam

فہرست

ایران میں لسانی عصبیت اور اقلیتی زبانوں کی حاشیہ سازی: ایک جائزہ

جاوید اختر فاروقی

ایران یوں تو اپنی فارسی زبان اور اس کے شہرۂ آفاق ادب کے لیے دنیا میں جانا اور پہچانا جاتا ہے۔ لیکن یہ بھی حقیقت ہے کہ یہ ملک ایشیا کے ان چند ممالک میں ہے جہاں لسانی اور نسلی تنوع اور گوناگونی بھی بڑے پیمانے پر پائی جاتی ہے۔ یہ ملک صدیوں سے مختلف نسلی گروہوں کا گہوارہ رہا ہے جو مختلف زبانیں بولتے اور سمجھتے رہے ہیں۔ بلکہ ایران میں اقلیتی تنوع میں سب سے بڑا حصہ لسانی اقلیتوں کا ہے۔ ایران کے بنیادی قوانین کی دفعہ ۱۵ کے مطابق ایران کی سرکاری زبان اور رسم الخط فارسی ہے۔ اور ایران کے باشندوں کا ہر وہ گروہ یا جماعت جو فارسی کے علاوہ کوئی اور زبان بولتی ہو اسے لسانی اقلیت قرار دیا جاتا ہے۔

یہاں یہ وضاحت ضروری ہے کہ ایران میں زبانی اقلیتیں دو طرح کی ہیں: ایک وہ جو ایک مستقل زبان رکھتی ہیں اور دوسرے وہ جو فارسی زبان ہی سے نکلے ہوئے مختلف مقامی لہجوں میں سے کسی ایک سے وابستہ ہیں۔ اس طرح ایران کی لسانی اقلیتیں حسب ذیل ہیں:

اقلیت زبانی ترکی آذری	☆	اقلیت زبانی کردی
اقلیت زبانی عربی	☆	اقلیت زبانی مسیحیان و یہودیان

اسی طرح فارسی سے نکلے ہوئے اہم مقامی لہجے حسب ذیل ہیں:

لری	☆	گیلکی
مازندرانی	☆	بلوچی

بختیاری وغیرہ

اس طرح اگر دیکھا جائے تو ایرانی آبادی کا ایک بڑا حصہ بلکہ یہ کہا جا سکتا ہے کہ تقریباً نصف حصہ ایسا ہے جس کی مادری زبان فارسی نہیں ہے بلکہ دوسری اقلیتی زبانیں ہیں۔ اور ایران کے آئین کی دفعہ ۱۵ کی رو سے ان ساری زبانوں کے بولنے والوں کو یہ حق حاصل ہے کہ وہ اپنی زبان کا استعمال پریس، ذرائع ابلاغ عامہ اور اسکولوں میں اس زبان کا ادب پڑھانے کے لیے کر سکتے ہیں۔ اس قانونی دفعہ کے الفاظ یہ ہیں:

"اسناد و مکاتبات و متون رسمی و کتب درسی باید با این زبان و خط فارسی باشد ولی استفاده از

زبانوں میں بھی ترقی اور مطبوعات و رسائل جاری کر سکیں وقت رس ادبیات آپ کا اور عالم اور

"کہ زبان فارسی آزاد است"

(https://www.radiofarda.com/a/f1_languages_iran/435... .html) (ریڈیو فردا)

(یعنی) سرکاری اسناد، خط و کتابت، سرکاری دستاویزات، سرکاری کتابیں فارسی زبان اور خط میں ہوں گی۔ عام مقامی اور خصوصی (قومی) زبانوں کا اخبارات، رسائل میں استعمال کرنے کی اجازت ہے، وہ کے ادبیات، علاقائی اور اسکولوں میں اس زبان کا ادب پڑھانے کے لیے فارسی کے ساتھ ساتھ آزاد ہے۔

لیکن زمینی حقیقت یہ ہے کہ دستور کے آرٹیکل کے آج تک ۴۳ سال بعد بھی نہ صرف یہ کہ ایرانی حکومت اقلیتی زبانوں میں تعلیم و تعلم کے خلاف ہے بلکہ اقلیتی حقوق کے کارکنوں بالخصوص اقلیتی زبان کے پڑھنے پڑھانے والوں پر عرصہ حیات تنگ کرتی ہے اور انھوں نے سزا بھگتی ہے۔ اسی طرح عوام میں بھی ایسے افراد پائے جاتے ہیں جو فارسی کے علاوہ دیگر اقلیتی زبانوں کو ترقی یافتہ نہیں سمجھتے اور نہ صرف یہ بلکہ یہ بولنے والوں کو ہدف مذاق بنانے سے بھی گریز نہیں کرتے حتی کہ ان کے ساتھ بھی اس سے دور رکھیں۔

ذیل میں ہم لسانی تعصب کی چند مثالیں پیش کرتے ہیں جس سے یہ اندازہ ہوگا کہ ایران کے اندر اقلیتی زبانوں کو کس طرح کے تعصب کا سامنا ہے اور کس طریقے سے انھیں حاشیے پر دھکیلنے کی کوشش ہوتی رہی ہے۔

۲۰۰۹ء میں ایران کے اندر عربی اہوازی صوبے کے ایک موقع پر وہ اہوازی عرب لڑکیوں کو ایک ٹیچر نے صرف اس لیے سزا دی یا سرزنش کی کیونکہ وہ اسکول کے اندر آپس میں عربی بول رہی تھیں۔ اس معلمہ نے بطور سزا ان طالبات کو مجبور کیا کہ وہ یہ جملہ لکھیں کہ "ہم اسکول میں عربی بولنے سے باز رہیں گے"۔

یہ واقعہ ملک کی دوسری اقلیتوں کے درمیان ایک عوامی بحث کا موضوع بن گیا۔ لیکن اس کے باوجود لسانی اقلیتوں کے حقوق کو ایک بنیادی وسیلہ تسلیم کرتے ہوئے اپنے ایران کے وزیر تعلیم نے جون ۲۰۱۹ء میں یہ بیان دیا کہ "فارسی زبان میں تعلیم و تعلیم حکومت کا بنیادی مقصد ہے"۔

۲۰۱۰ء کو ایران نے چار کرد قیدیوں کو پھانسی دے دی جس میں ایک کرد اسکول ٹیچر فرزاد کمانگر بھی شامل تھے۔ ہیومن رائٹس واچ کے مطابق فرزاد کمانگر ۲۰۰۶ء میں ایک کرد والے کے ساتھ وہ شمالی مغربی ایران کے ایک شہر کامیاران میں ایک پرائمری اسکول ٹیچر تھے جہاں وہ کردستان ٹیچرز ایسوسی ایشن کے ممبر تھے اور انسانی حقوق کی مختلف اشاعتوں کے لیے لکھتے

تھے اور رسمات ہی انتخابی طور پر اپنے کردش طلبہ کو اپنی مخصوص کردش زبان سکھاتے تھے اور اپنی تاریخ و تہذیب سے جڑی کہانیاں بھی بتاتے تھے۔

۱۴ جولائی ۲۰۱۰ء کو کردش زبان کی ایک مقامی اور سول سوسائٹی ایکٹیوسٹ زارا محمدی کو ایران کی انقلاب اسلامی کی عدالتوں نے ۱۰ سال قید کی سزا سنائی۔ زارا کا جرم کیا تھا؟ صرف یہ کہ اسنے اپنی مادری زبان کی تدریس کی تھی۔ اور اس سال کی یہ سزا جج نے ٹھیک ٹھیک حساب لگا کر دی تھی یعنی چونکہ اس نے دس سال اس زبان کی تدریس کی تھی اس لیے ہر سال کے لیے ایک سال کی قید۔

شرح خواندگی میں کمی:

اعداد و شمار کے تجزیے سے پتہ چلتا ہے کہ ایران کے انتخابی علاقوں میں تعلیم تک رسائی کی سطح فارسی زبان بولنے والے علاقوں کی نسبت نمایاں طور پر کم ہے۔ مثال کے طور پر ۱۳۸۵ء میں (۲۰۰۶ء) کی مردم شماری کے مطابق ایران کے فارسی گو مرکزی صوبہ جات جیسے تہران، اصفہان، سمنان اور یزد میں شرح خواندگی تقریباً ۹۰ فیصد تک آگئی تھی۔ جبکہ غیر فارسی زبان صوبوں مثلاً سیستان و بلوچستان میں یہ شرح ۶۸ فیصد اور کردستان میں ۷۵ فیصد سے آگے نہ بڑھ سکی۔

سماجی اور تعلیمی ترقی پر برا اثر:

مادری زبان کے بجائے کسی مسلط کردہ دوسری زبان میں حصول تعلیم کی مجبوری انتخابی طبقات کے لیے اس وجہ سے بھی نقصان دہ ہے کہ اس سے کہیں نہ کہیں انکی سماجی اور تعلیمی ترقی متاثر ہوتی ہے لہذا ہم دیکھتے ہیں کہ ایران کے فارسی زبان علاقوں کی نسبت غیر فارسی زبان علاقوں کے طلبہ میں فیل ہونے والوں کا فیصد زیادہ ہے۔۔۔

نفسیاتی مشکلات اور خود اعتمادی کی کمی:

جو بچے اپنی مادری زبان کے بجائے دوسری زبان میں تعلیم حاصل کرنے کے لیے مجبور ہوتے ہیں انکی نفسیات بھی اس سے متاثر ہوتی ہے اور وہ خود اعتمادی کی کمی کا بھی شکار ہوتے ہیں چنانچہ صدیقہ عدالتی جو ایران کی ایک ماہر سماجیات ہیں وہ فرماتی ہیں:

> "ایک اہم مسئلہ جسکی طرف حکومت، وزارت تعلیم اور ماہرین تعلیم و تربیت توجہ نہیں دیتے وہ یہ کہ بچے نفسیاتی طور پر متاثر ہوتے ہیں۔ اور پہلے مرحلے میں ہی اپنی خود اعتمادی کھو دیتے ہیں۔ کیونکہ جب وہ اسکول جاتے ہیں اور دیکھتے ہیں کہ تعلیم ایک ایسی

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ہے۔ یہیں قومی اقلیتوں پر اس بات کے لیے دباؤ ڈالا کہ وہ اپنی زبان میں گفتگو بھی نہ کریں۔ اس کا نتیجہ یہ ہوگا کہ ثقافتی تنوع سے عاری قوموں کے زبان و ادب بربادی کے خطرے سے دوچار ہو سکتے ہیں"۔

علی رضا اردبیلی کہتے ہیں:

> "ثقافتی تنوع سے معاشی ترقی ہوتی اور اخلاقی احساس پیدا ہوگی۔ جبکہ جب اسے معاشرے کے ایک حصے سے چھین لیا جاتا ہے تو معیشت اور پیداوار میں پسماندگی کی طرف لے جاتا ہے۔ جس کا اثر معاشرے کی لوگوں کی اقتصادی غربت میں ظاہر ہوتا ہے۔ جسے ہم ایران جیسے ملک کے حالات میں مشاہدہ کر سکتے ہیں"۔

(https://www.radiofarda.com/a/1_languages_iran/436948.html(ریڈیو فردا)

حکومت کی پالیسی کے خلاف اور اپنے لسانی حقوق کی حمایت میں ایرانی اقلیتیں ثقافتی مظاہرے بھی کرتی رہتی ہیں۔ بالخصوص حال کے چند سالوں میں بہت سے مظاہرے ہوئے ہیں۔

حکومت کا ردعمل

ایرانی اقلیتوں کے ان مظاہروں کو حکومت نے بہت سختی سے جواب دیا ہے۔ صوبہ آذربائیجان، اردبیل اور صوبہ خوزستان میں ہونے والے مظاہروں کو ایرانی حکومت کی سخت مخالفت، تشدد اور زیادتی کا سامنا کرنا پڑا ہے۔ "تنظیم برائے دفاع حقوق انسانی اقلیت ہائے قومی ایران" کے سربراہ رضا وشاہی اس سلسلے میں ایران کے مختلف علاقوں کے حوالے سے گفتگو بتاتے ہیں۔ ان کے بقول:

"اہواز شہر میں تین سال پہلے ہونے والی گرفتاریوں کے سلسلے میں پھانسیوں کا سلسلہ ابھی جاری ہے۔ آذربائیجان کے علاقے میں لسانی اور ثقافتی حقوق کے سرگرم کارکن آقای [illegible] کو اہر جیل منتقل کر دیا گیا ہے۔ کردستان کے اندر دو [illegible] کو جو ثقافتی موضوعات پر لکھتے تھے ان کے لیے پھانسی کا حکم صادر ہوا ہے اور بلوچستان میں ایک صحافی اور شہری حقوق کے کارکن جناب [illegible] کو سزائے موت سنائی گئی ہے"۔

حکومت کا موقف:

ایرانی حکومت اپنی لسانی پالیسی کے خلاف اور لسانی اقلیتوں کے حقوق کے لیے اٹھنے والی آوازوں کو فارسی زبان کے خلاف سازش اور ملک کی سالمیت سے جوڑ کر دیکھتی ہے اور اسے علیحدگی پسندوں کی سازش قرار دیتے ہوئے

[illegible] مستقل سہ ماہی "ترجمان" اشاعت کے [illegible] ملک کی [illegible] اور [illegible] کے [illegible] لسانی [illegible] کے مسئلے میں تبدیلی ہو گیا ہے"۔

ManoFarsi' not an innocent debate on language education [illegible]

"[illegible] ایران کے خلاف سازش قرار دیتے ہوئے لکھتے ہیں:

> Fueling seperatism in a country that is a kaleidoscope of ethnic groups and lingual minorities is another handy alternative, and to play the ethnicity card efficiently, why not cherry-pick the modern Persian language, the national language of Iran and the lingua franca of Iranian minorities since AD 600, and attempt to cannibalize it

ہو سکتا ہے [illegible] لسانی تنظیموں [illegible] علاقائی [illegible] کی پابندی یا ثقافتی سرگرمیوں میں بھی شامل رہے ہوں۔ [illegible] حکومت [illegible] کی تشویش [illegible] ہو سکتی ہے۔ لیکن چند افراد کی غلطیوں کی وجہ سے پوری قوم یا مختلف قوموں کو [illegible] حقوق سے محروم [illegible]۔

تجزیہ و نتائج:

مذکورہ بالا معلومات سے اندازہ ہوتا ہے کہ ایران کے اندر لسانی تنظیمیں نہ صرف حکومت بلکہ عوام کی طرف سے بھی لسانی تعصب کا شکار ہیں۔ حکومت کے تحت [illegible] نہ صرف ثقافتی لحاظ سے بلکہ تعلیمی اور اقتصادی لحاظ سے بھی یہ تنظیمیں حاشیہ پر [illegible] ہیں۔ ایسے میں یہ ضروری ہے کہ حکومت اس مسئلے کی اہمیت کو سمجھے اور اپنے نظریہ میں تبدیلی لائے۔ لسانی حقوق [illegible] کی پابندی کو الگ کر کے دیکھنے کی ضرورت ہے۔ تاکہ ان زبانوں اور ان کے بولنے والوں کی تہذیب و ثقافت جو ایک عظیم انسانی ورثہ ہے اس کی حفاظت کی جا سکے۔ یہ ایک خوش آئند خبر ہے کہ ایرانی حکومت کے [illegible] اس مسئلے کی اہمیت کو سمجھا ہے اور تجربہ [illegible] سے آذربائیجان میں ترکی آذری زبان کی تدریس کی اجازت دی ہے۔ [illegible] ایسے اقدامات کی ضرورت ہے۔ آخر میں ہم سعید پیوندی (فرانس میں یونیورسٹی [illegible]) کے اس اقتباس [illegible] اپنے اس مقالے کو [illegible]

اردو

بولیاں صرف لوگوں کے درمیان رابطے کا ایک آسان ذریعہ نہیں۔ (بلکہ) ان میں سے ہر ایک زبان اور لہجے کے قلب میں کسی خطے اور انسانی برادری کی تاریخ، روایات، ثقافت اور زندگی پوشیدہ ہے"۔

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हिन्दुस्तानी ज़बान

ہندستانی زبان

سرپرست

مدیر

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"Reportage Writing intended to give an account of observed or documented events."

The Oxford English Dictionary

Webster Third New International

"Writing intended to give a factual and detailed account of directly observed or carefully documented events and sources."

(Webster Third New International Unabridged Dictionary, 1976)

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THE ASIATIC SOCIETY OF MUMBAI

CERTIFICATE OF PUBLICATION

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Role of Women Entrepreneurship in social and Economic Development of India

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Abstract
This study looks into how women entrepreneurs contribute to India's social and economic advancement. Using a deductive methodology and an interpretivist research philosophy, the study addresses four thematic areas: creativity and diversity, governmental and institutional support, hurdles and challenges, and empowerment and economic impact. By utilizing a descriptive methodology and gathering secondary data, the study illuminates the revolutionary roles played by women-owned enterprises. Innovation functions as an instrument or a catalyst for entrepreneurship. Indian women are respected for their accomplishments in their fields and stand out from the crowd in spite of all the societal obstacles they face. Indian women's lifestyles have to alter due to the shift in women's educational standing and their different ambitions for better lives. This essay aims to investigate research on women's innovation and entrepreneurship in light of their unique personal and professional traits. The paper acknowledges the limitations, which include potential regional differences and reliance on historical data, but it also acknowledges their major influence. The results highlight the necessity of creating an ecosystem that supports women entrepreneurs in India and is guided by specific laws and institutional assistance in order to fully realize the potential of this sector.

Keywords: Women, Entrepreneurship, social, Development, Economic, India, society.

Introduction

Women entrepreneurship has emerged as a powerful factor which is driving the social and economic development in India, a nation which is known for its vibrant diversity and complicated challenges. Over the last few years, the woman in India have broken through the societal barriers and accepted entrepreneurship as a means to not only achieve financial independence but also to contribute in a huge manner towards the nation's growth and development. This kind of transformational shift in the dynamics of gender within the field of landscape has created a spark and interest in exploding the multidimensional role of woman entrepreneurs in structuring India's social and economic future.

Over the past 20 years, there has been a profound shift in the way that women's entrepreneurship is perceived throughout the world. National economic policy makers, international development organisations, and civil society have all shown a growing amount of interest in and support for the growth of women's enterprises (Agarwal, 2019). Women's empowerment is now more often seen through the lenses of social justice and economic development; it is often seen as guaranteeing equality of opportunity rather than merely correcting inequality of situation. More and more decision-makers are coming to the conclusion that increasing the number of women in business ownership makes financial sense since they are an underutilised economic resource. It has been acknowledged that women entrepreneurs contribute significantly to the economy. In addition to creating new jobs for themselves and others, women entrepreneurs provide society with a wide range of unique solutions to issues related to management, organisation, and business. They still make up a small percentage of all entrepreneurs, though (Jain, & Pandey, 2019). Women entrepreneurs typically

encounter gender-based obstacles when starting and expanding their firms, such as restrictive mobility, limited access to information and networks, discriminatory property, marital status, and inheritance laws and/or cultural practises, etc., in addition to a lack of institutional financing options (Gopinath, & Chitra, 2020). Women's entrepreneurship has the potential to significantly impact women's empowerment, poverty alleviation, and the financial health of families and communities. Therefore, governments everywhere are actively working to promote women entrepreneurs through a variety of programmes, incentives, and promotional measures, as well as many developmental organisations.
As per study, Verma (2010), "Difficulties faced by female entrepreneurs in developing nations." Verma (2010), discovered that women business owners had obstacles related to money, marketing, production, workspace amenities, and other issues. The inability to get long-term financing and the ongoing requirement for working cash were the financial issues. One of the issues with marketing is the lack of transit options and location. Lack of raw material availability was a manufacturing issue. These business owners also struggled with issues including headaches, stress, and exhaustion. They also struggle with a lack of room and water. Governmental and non-governmental organisations can assist female entrepreneurs in efficiently addressing these issues (Jain, &Pandey, 2019). India has historically seen some remarkable resilience and resourcefulness of women in several aspects of life. However, the participation of women in the entrepreneurial field has always been limited due to some cultural norms, lack of access to resources and some gender-based biases. But in the recent times women entrepreneurs in India r now breaking the glass ceiling and are venturing into several sectors and also driving innovation and job creation. The role of women entrepreneurship in the social and economic development of India is a topic of utmost importance and compelling for several reasons (Bullough *et al.* 2022). Firstly it has started to contribute to the economic growth by first studying a more inclusive and diversified entrepreneurial ecosystem. Women entrepreneurs sometimes prioritize the social impact in their respective ventures and they are also interested in addressing some issues like education, healthcare women empowerment end sustainable development. Thirdly they are actively participating in the field of business world, which is challenging the traditional gender roles and also is promoting gender equality and that is how shifting the societal perceptions about the capabilities of the feminine gender.

Problem Statement

The insufficient number of women in the business world presents a serious obstacle to India's socioeconomic advancement. Women-owned businesses continue to confront several obstacles despite significant advancements in many areas, such as restricted access to money, societal and cultural prejudices, and inadequate support systems. This imbalance maintains gender inequities and stifles possibilities for economic growth. Furthermore, this problem is made worse by the absence of appropriate legislation and focused actions (Chhabra *et al.* 2020). Unlocking women's potential, promoting economic success, and attaining more equal treatment for women in India's business landscape require addressing these issues and creating an atmosphere that supports women's entrepreneurship.

- The aim of the study is to evaluate how women's entrepreneurship has impacted India's social and economic advancement and to pinpoint methods for creating an atmosphere that is supportive of women-owned enterprises.
- This research tries to thoroughly assess the crucial contribution made by female entrepreneurs to India's economic growth and employment creation. It aims to look into the numerous difficulties as well as hurdles Indian women encounter as they set out on the path of starting and growing their businesses.
- The study also aims to evaluate the efficiency of government support programs and policies as well as prospective areas for development with regard to the engagement of women in entrepreneurship. This research intends to synthesize these observations in order to provide a set of beneficial suggestions and tactics for promoting and upholding women's entrepreneurship in India, with the overriding objective of accelerating long-term socioeconomic progress and empowerment.

Literature Review

The role of women entrepreneurship in the social and economic development of India has gathered some increasing amount of attention in the last few years. Women in India are breaking the societal class of norms and are venturing into entrepreneurship. This is making a significant amount of contribution to the growth of the nation. This literature review will explorer the multidimensional impact of women entrepreneurs in India, and also will consider both the economic contributions and also the role of women in fostering social development. It also will discuss the challenges and opportunities which the women entrepreneurs are encountering on their journey.

Economic contributions of women entrepreneurs:

Women entrepreneurs are playing a pivotal role in the field of fostering economic growth in India. They are also contributing in the field of creating jobs across several sectors which includes manufacturing, services and also sum of the informal sectors. A recent study which is done by national sample survey organization showed that the number of women who are entrepreneurs in India Today are increasing significantly over the years end which indicates that their contributions towards employment generation are also increasing. Women entrepreneurs are very much actively engaged in the field of micro small and medium enterprises which can be considered as the backbone of the Indian economy

(Rosca Agarwal & Brem, 2020). Their participation in this field has created an increase in the fields of innovation, diversification and exports. The government of India also introduced several schemes and incentives to support the MSMEs which are owned by women to recognize their economic potential. Women entrepreneurs in India have also ventured into several export-oriented businesses and that is how they are also contributing to foreign exchange earnings. This kind of involvement in the sectors for example handicrafts, textiles and agri-business has also helped India to expand the export market (Jain et al., 2019). Women entrepreneurs are also driving some innovation and technology adoption-based organizations in several industries. These start-ups are also sometimes at the forefront of innovation and creating new products, providing services and business models which are also contributing to the economic health of this country. Despite all these, access to finance still remains a crucial challenge for women entrepreneurs in India. While there are several efforts to improve the financial inclusion through schemes like the Stand-up India initiative women are still facing several kinds of hurdles to obtain loans and venture capital.

Figure: 1
Women Empowerment through Women Entrepreneurship

(Source: insightssikhiri.wordpress.com, 2021)

Social Development through Women Entrepreneurship:

Women entrepreneurship is a very powerful tool for not only woman's empowerment but also for gender equality. Through becoming economically independent, the feminine gender gains greater decision-making power within themselves and also within the households and communities. They are success sometimes challenges the stereotypical traditional gender roles. Women entrepreneurs sometimes invest in education and skill developmental initiatives. They also establish organizations which provide training and employment opportunities to the underprivileged women particularly in the rural areas. This has a relatable effect on the improvement of the female literacy rates and skill sets. The women entrepreneurs are also good in creating businesses which provide to the unique needs and challenges which are faced everyday by the women in India. This type of ventures includes healthcare menstrual hygiene products, products related to child care, a woman's safety and these organizations also address some critical social issues. Many women entrepreneurs also engage in some activities which are directly related to the community development. The invest hugely in the social infrastructure for example schools and healthcare facilities and also contribute to overall community well-being (Panwar et al., 2021). In the rural areas, the women entrepreneurs focus on agricultural and Agri business ventures. This kind of efforts lead to rural development and also increases agricultural productivity and indirectly impacts poverty alleviation.

Women entrepreneurs who are successful often serve as the role models and advocates for the rights, empowerment and entrepreneurship of women. Women who have succeeded in the field of entrepreneurship becomes the visible symbol of what a woman can achieve in the sector of business. They inspire and motivate other women to pursue the same stream. This is particularly impactful in a society where the woman may have some limited amount of access to female role models in the business sector. Women entrepreneurs also challenge the traditional stereotypes and norms of gender and their success demonstrates that women are equally capable of performing significantly well in the fields of

entrepreneurship and leadership. This kind of success challenges the deeply rooted biases which restricts woman's participation in any kind of economic activities. These women entrepreneurs also play a significant role in the creation of support networks for the upcoming and aspiring women entrepreneurs. These networks offer mentorship, guidance and also resources to help the other woman overcome the challenges in front of them way more easily. Many of the successful women also become the advocates of gender equality. They use their respective positions to influence and push for policies and practices that will promote gender equality for example equal pay maternity leave and flexible work timings. Women entrepreneurs are more frequent to engage with their community and participate in the community development initiatives. They use this kind of influence and resources to address the typical social issues and also for the upliftment of the marginalized groups. Some women entrepreneurs also gain recognition on some of the biggest international platforms where they represent their own country and that is how they inspire the feminine gender of the world. This not only shows their achievements but also portrays the potential of women from several backgrounds. By interacting with other females and sharing their own success stories these women entrepreneurs are also able to encourage the investors and also the venture capitalists to invest in women-oriented start-ups and businesses (Ingalagi*et al.* 2021). This also increases funding opportunities for other fellow women entrepreneurs. The role modelling and advocacy efforts of the women entrepreneurs are a very significant component of the social development. Their ability and influence go beyond their individual businesses and success. They serve as the catalyst for gender equality, cultural shift and for a more increased opportunities for women in the field of entrepreneurship and leadership roles. These kinds of efforts will not only empower the women but also will contribute to a broader amount of societal change through the promotion of gender equality and through the creation of a more inclusive society.

Challenges and Opportunities:

There are some challenges and opportunities for the women entrepreneurs in the context of India. There are some deep-rooted gender biases and stereotypes which are still in persistent in India and it affects the woman and their access to resources, opportunities and support in entrepreneurship. There is a societal expectation which is to prioritize woman's role as only the caregivers and homemakers and that is how making it more challenging for the woman to pursue any kind of entrepreneurial ambitions. Women entrepreneurs sometimes also faces difficulties in accessing any kind of capital and alone as it is considered as high-risk borrowers. Traditional lending institutions sometimes need collateral which the woman does not possess and that is how it becomes harder for the feminine gender to secure any kind of loans. Balancing the family responsibilities with entrepreneurial ambition can be demanding and specifically in some cultures where women are expected to prioritize only family, starting and entrepreneurship venture is almost next to impossible. A lack of family support which includes child care facilities can also hinder woman's ability to focus on their businesses. There are several women who till now lack the formal education and training and exposure to business management and skills which are required for entrepreneurship. Limited access to networks and mentorship also hinders their business growth. In the rural areas there is not enough infrastructure and limited amount of access to technology also prohibits women to dive into any kind of business.

The Indian government has introduced several schemes and programme for example Start-up India to support the women entrepreneurship with some financial assistance, training and mentorship. Skill development programs and training initiatives which includes the developmental programs which are required to set up a business r presently available to equip women with the necessary kind of skill sets and knowledge. There are some specialized women centric banks like the Bharatiya Mahila Bank, which provides financial products and services to the woman who are into business. There are some micro financing institutions also who focuses on only the women borrowers and that is how promotes financial inclusion. Business incubators and accelerators for example the Atal Incubation Centers are also offering mentorship and resources and also funding opportunities for women entrepreneurs. The growth of e-commerce platform also created some opportunities for the women to start and scale businesses online and that is how they are able to bypass the traditional barriers. Initiatives are also being taken to promote digital literacy which will help the women to leverage online markets in an effective manner. There are many educational institutions and organizations which are establishing women on entrepreneurship cells to help and create a supportive ecosystem for the women who wants to start a business. There are some women focused networking events and conferences also being organized for providing opportunities for women entrepreneurs to connect and collaborate.

In India, women's entrepreneurship has been a major force behind both social and economic advancement. It acts as a catalyst for community development, gender equality, and empowerment in addition to economic metrics. Women entrepreneurs are inspiring change, transforming sectors, and creating jobs through their creative pursuits. This essay explores the critical role that women entrepreneurs have played in India's transition to holistic development, providing actual case studies of businesses that best demonstrate this revolutionary influence.

- ***Empowerment and Gender Equality***

The powerful force of empowerment is at the core of women's entrepreneurship. It gives women a chance to take advantage of their abilities, potential, and goals, which eventually results in financial independence and the ability to make decisions. Kiran Mazumdar-Shaw's Biocon Limited is a noteworthy example. Since its founding in 1978, Biocon

has expanded to become one of the biggest biopharmaceutical firms in India. In addition to bringing the business to praise on a global scale, Kiran Mazumdar-Shaw's leadership and vision broke down barriers within the predominately male pharmaceutical sector. Her story serves as an example of how female entrepreneurs may defy expectations and open doors for others.

- ***Employment Generation and Poverty Alleviation***

Businesses run by women are powerful sources of new jobs. They provide the whole community with job options in addition to those for women. An example would be Falguni Nayar's creation Nykaa. Since its founding in 2012, Nykaa has emerged as a major force in the Indian market for cosmetics and other beauty items. Beyond its financial success, Nykaa has made a substantial contribution to the creation of jobs in the e-commerce and retail industries (Chhabra, Raghunathan & Rao. 2020). This is a perfect example of the critical role that female entrepreneurs can play in lowering unemployment rates and rescuing underprivileged areas.

- ***Innovation and Diversity of Perspectives***

The involvement of women in entrepreneurship infuses industries with new ideas and inventive methods. This intellectual diversity promotes a culture of constant improvement and raises competition. One such example is the online job platform for women called SHEROES. SHEROES, an organization started by Sairee Chahal, gives women a place to look at job options, meet mentors, and get resources for developing their careers. SHEROES focuses on the special requirements of women in employment to show how female entrepreneurs can lead innovation and provide customized solutions.

Table 1
Policy and Support Ecosystem

Company	**Founder**	**Industry**	**Impact**
Biocon Limited	Kiran Mazumdar-Shaw	Biopharmaceuticals	Empowerment, Economic Growth, Breaking Industry Norms
Nykaa	Falguni Nayar	Cosmetics	Employment Generation, Retail Sector Growth
SHEROES	Sairee Chahal	Online Platform	Innovation, Career Opportunities for Women
Rangsutra	Sumita Ghose	Social Enterprise	Community Development, Rural Artisan Empowerment

- ***Community Development and Social Impact***

The populations they serve are frequently greatly impacted by women entrepreneurs. Their prosperity is reinvested in ways that improve healthcare, education, and infrastructure. This idea is best illustrated by the social enterprise Rangsutra, which is run by Sumita Ghose (Rosca, Agarwal & Brem, 2020). By giving them access to marketplaces, Rangsutra empowers rural artisans who are primarily women. Rangsutra does this in a way that benefits these craftsmen' financial circumstances as well as the general advancement of their local communities.

- ***Policy and Support Ecosystem***

Although the accomplishments of Indian women entrepreneurs are praiseworthy, an ecosystem of support must also be recognized. Policies and programs from the government are essential in fostering an atmosphere that supports women-owned enterprises. Financial assistance, skill development courses, and loan availability are a few examples of policies that can greatly support the expansion and long-term viability of women-owned businesses.

Methodology

The interpretivism research philosophy is employed in this study with the goal of comprehending the individualized experiences and viewpoints of Indian women entrepreneurs. Interpretivism, which is in line with the complex social and cultural subtleties surrounding entrepreneurship, places a strong emphasis on context and individual viewpoints. We'll use a logical approach, starting with well-known theories and frameworks on women in entrepreneurship. This methodology facilitates the examination of extant theories within the particular context of India, yielding significant insights into the distinct obstacles and prospects encountered by female entrepreneurs. The primary goal of the descriptive research approach would be to present a thorough picture of the state and significance of women-owned business in India.The goals of the study are best served by this design since it makes it possible to collect and analyze data in a methodical way that will produce an accurate and comprehensive picture of the phenomena. The main technique that will be used is secondary data collection (Korreck, 2019). A comprehensive examination of extant literature, papers, and research about women entrepreneurs in India will be carried out. Academic journals, official government publications, industrial reports, and reliable internet sources will all fall under this category. By using secondary data to support the research findings, a wide and thorough viewpoint is ensured, drawing from a variety of sources.

Analysis

Empowerment and Economic Impact

Women's entrepreneurship is a potent tool for empowering women because it gives them financial independence and a stage on which to express their autonomy in the business sector. Women who start and run their own businesses have a sense of accomplishment and self-determination in addition to financial independence. This empowerment penetrates communities and families in addition to the individual entrepreneur, resulting in a more significant positive impact on society as a whole. Women-led enterprises not only empower but also have significant economic effect. They serve as essential engines of creating employment and provide a substantial contribution to job creation. These businesses are essential in lowering unemployment rates because they give men and women equal chances to enter the workforce. Businesses like as Kiran Mazumdar-Shaw's Biocon Limited, for example, show how economic influence and empowerment may coexist. In addition to making Biocon a major participant on the international stage, Kiran Mazumdar-Shaw's innovative work in the biopharmaceutical industry served as an example for other women who aspired to be entrepreneurs (Goel & Madan, 2019). The business's development trajectory demonstrates the enormous potential for economic growth that women-owned businesses have. Furthermore, Falguni Nayar's enterprises, such as Nykaa, have not only upended the health and beauty goods market but have also played a significant role in the development of jobs in the retailing and online shopping sectors. These businesses have a real impact on India's economy and have significant economic knock-on consequences.

Barriers and Challenges in Women Entrepreneurship

Even with the notable advancements in the field of gender equality, women entrepreneurs in India still confront numerous difficult obstacles and difficulties. These obstacles, which have their roots in structural, sociological, and cultural issues, may prevent them from reaching their full potential as entrepreneurs.

Access to Finance: A major obstacle for female entrepreneurs is their restricted ability to obtain financing. It's possible that conventional financial institutions won't want to lend money or make investments in women-owned companies. Their potential for expansion may be limited by this lack of funding, which may make it difficult for them to launch or build their businesses.

Social and Cultural Biases: Pervasive social and cultural conventions can provide significant obstacles for women wishing to pursue entrepreneurship. Preconceived beliefs about the duties and skills of women in the workplace might breed discrimination or distrust. It will take coordinated efforts to dispel myths and advance an inclusive entrepreneurial environment in order to overcome these biases.

Work-Life Balance: Women may find it especially difficult to juggle the demands of being entrepreneurs with their family obligations (Cho, Li & Chaudhuri, 2020). The prevailing social norm that women ought to shoulder the majority of domestic and caregiving duties may restrict their capacity to allocate time and resources towards their enterprises.

Figure: 2
Social Entrepreneur

(Source: wallstreetmojo.com, 2021)

Policy and Institutional Support

Policy and institutional assistance are essential for creating a favorable climate for women-led firms in India, given the important part that women entrepreneur plays in the economy and gender equality. These actions play a crucial role in breaking down barriers and giving women entrepreneurs the tools and chances, they need to succeed.

- ***Governmental Programs***: The number of government-led programs in India that support women entrepreneurs has increased. Programs like the "MUDRA Yojana," making credit more accessible, and the "Stand up India" initiative, which provides financial support and advice to female entrepreneurs, have been essential in enabling women to launch and grow their own enterprises.
- ***Programs for the Development of Skills:*** Women entrepreneurs need specific programs for the development of their skills in order to increase their competitiveness and capacities. These courses give women the tools they need to succeed as entrepreneurs by covering topics including financial literacy, business management, and technology expertise.
- ***Obtaining Financial and Credit Resources:*** One of the biggest obstacles facing women entrepreneurs can be lessened by creating financial institutions or programs designed especially for them: financing. Growth and innovation can be promoted by offering venture capital, microfinance choices, and collateral-free loans specifically designed for women-owned businesses.

Figure: 3
Different Policy and Institutional Support programs

(Source: self-developed)

Innovation and Diversity in Women-Led Businesses

Businesses run by women are becoming more and more acknowledged as centers of innovation and forces behind industry diversity. Their distinct viewpoints and methods push new concepts and remedies to the fore, boosting competition and upending established markets.

Novel Product Offerings	Women business owners frequently identify untapped consumer demands and markets, which inspires the development of novel goods and services. Companies in the cosmetics sector, such as Nykaa, have revolutionized the skincare and cosmetics market by introducing innovative ideas and goods that cater to a wide variety of consumers (Ingalagi*et al.* 2021).
Technology & Digital creativity	Women-led tech companies are advancing the use of technology for a range of purposes. These businesses are at the cutting-edge of creating innovative solutions in industries including fintech, e-commerce, and artificial intelligence. In addition to advancing technology, their contributions question gender norms in fields that have historically been controlled by males.
Societal and Environmental Innovation	A lot of female business owners place a high value on profitability as well as the social and environmental effects. They present social firms that tackle urgent global issues and sustainable practices (Bullough *et al.* 2022). Through market access, Sumita Ghose's social company Rangsutra benefits rural craftsmen, who are primarily women. This project promotes ethical and sustainable business practices in addition to aiding in economic development.

Future Scope and Limitations

The groundwork for more investigation into women's entrepreneurship in India is laid by this study. Subsequent research endeavors may undertake in-depth analyses of certain sectors, areas, or legislative measures that affect women-owned enterprises. Furthermore, longitudinal research may monitor the changing terrain of female entrepreneurship through time, offering insightful data on trends and patterns. There are some restrictions on this research. First of all, it mostly depends on secondary data sources, which could be biased or have limited access to data. Furthermore, it is possible that real-time dynamics are not included in the study (Deng *et al.* 2020). Moreover, it is possible that some subsectors or regions of India may not have been fully covered by the research, which could result in an incomplete portrayal of the overall landscape of women entrepreneurs.

Conclusion

The role of women entrepreneurship in the social and economic development of India cannot be denied. The women entrepreneurs in India have transcended they are social barriers and emerged as powerful influencers of change and progress. They also have created substantial contributions to economic growth job creations and some innovations across several sectors which varies from small scale enterprises to export oriented businesses. Moreover, some women entrepreneurs also have championed the social development through their efforts to empower other women, and their efforts to improve the education system and healthcare and also to address some critical social issues which are prevalent in India today. Their efforts extend way beyond making profit for their organizations only, with many women entrepreneurs also focusing on creating a business which will prioritize the social impact and environmental sustainability. Despite the challenges which are still in this country today and despite there are several gender biases and limited accesses to finance and several kinds of struggle to balance the entrepreneurial pursuits with family responsibility, the opportunities for women entrepreneurs in India are growing. Thanks to the supportive Government of India initiatives and skill development programs, through which they are trying their best to create an ecosystem of support for the feminine gender. As India is continuing to harness the potential of the feminine entrepreneurs it is day by day becoming more inclusive, equitable and prosperous where the multidimensional role of women in the field of entrepreneurship will propel the nation forward not only socially and economically but also culturally.

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A STUDY OF THE IMPACT OF SALES PROMOTIONS ON CUSTOMERS EATING AT BRANDED FAST-FOOD RESTAURANTS

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ABSTRACT

This paper attempts to investigate the hypothetical issues associated with fast food sales promotion tools. The purpose of this study is to determine how clients who consume fast food react to sales promotion offers. It assists in determining the frequency with which customers favor promotional offers when purchasing fast food. It reveals which sales promotion offers customers favor and which sales promotion offers influence consumer decisions. It helps to identify sales promotion offers that compel customers to transfer brands. The study also helps us determine the efficacy of the medium through which promotional offers are communicated to consumers. The primary data is collected through a survey of 505 consumers of branded fast food restaurants, including McDonald's, KFC, and Domino's. This study contributes to the literature on Fast Food Sales Promotion Offers. Fast Food Restaurants can use the findings to select appropriate sales promotion offers and channels for communicating the sales promotion offers.

KEYWORDS: Sales Promotion Offers, Fast Food, Brand Switching, Consumer Behaviour, Medium Of Promotion.

INTRODUCTION

According to a report by the Federation of Indian Chambers of Commerce and Industry (2017), the fast food market was valued at Rs 9,000 Crores in 2016 and is expected to reach Rs 30,500 Crores by 2022. There will be a highly competitive market, and one will need to promote their product or service more effectively than their competitors in order to endure. According to Belch and Belch (2008), Sales Promotion is defined as "A direct inducement that offers an additional value or incentive for the product to the sales force, distributors, or end consumers, with the primary goal of generating an immediate sale." Two categories of sales promotion tools and offers exist. 1) For Clients 2) For Merchants. Sale promotions have many advantages, such as encouraging the trial of a new product or service, triggering unplanned purchases, increasing the likelihood of repurchasing a well-known brand, increasing customers' stockpiling, resulting in lower inventory costs for retailers, and increasing customers' foot traffic. Sales promotion offers for retailers encourage and entice retailers to sell manufacturers' brands (Abdelhamied, 2013). Sales promotion aids in increasing customer loyalty, creating awareness, reminding, increasing sales, combating competition, reducing excess stock, rewarding loyal customers, and encouraging brand transitioning (Johnson, 2014).

According to Flores (2014), particular restaurants such as KFC, McDonald's, and Tropical hunt face difficulties when utilizing sales promotion offers. It includes the problem of inadequate monitoring of local and international events, inadequate monitoring of opportunities, restaurants' inability to take full advantage of price reduction as a sales promotion strategy, restaurants' inability to use incentives to boost sales, and a lack of communication in promoting new products and offers to customers. Allaham (2018) observed that it is crucial to determine what consumers want and which promotion will be the most successful. Since restaurants spend a substantial amount on sales promotion tools, it is crucial to determine which sales promotion should be used, when it should be implemented, and by whom. This research paper will assist us in identifying appropriate sales promotion tools for consumers preferred by customers, sales promotion tools that compel fast food customers to switch brands, the

effectiveness of fast food restaurant brands' communication channels in India, and the primary reasons for frequenting fast food restaurants.

LITERATURE REVIEW

According to Kotler (2005), sales promotion consists of short-term incentive tools that encourage consumers and retailers to purchase more products or services quickly. According to some researchers, sales promotion offers also have some disadvantages. It can erode brand preference; it can shift the customer's focus from brand equity to price. It can increase brand switching and decrease brand loyalty and perceptions of quality (Abdelhamid, 2013). A price reduction reduces the perceived risk associated with purchasing a new product, thereby increasing product trial. A discount increases the product's perceived value and sales. Free samples are the most effective way to generate interest in a new product (Meo et al., 2014).

Sagala, Destriani, Putri, and Kumar (2014) found that the purchasing decisions of customers are influenced by two factors: (1) promotional mix and price; and (2) other factors, such as location, product, and service. Approximately 37.2% of consumer purchasing decisions are influenced by promotion mix and price, while 62.8% are influenced by other factors.

The promotion mix consists of advertising, publicity, personal selling, sales promotion, and price, with sales promotion proving to be the most effective instrument. Abdelhamied (2013) suggested that the frequency with which consumers visit fast food outlets increases when restaurants provide promotional offers. The sales promotion encourages the purchase of large quantities of fast cuisine. This also increases customer loyalty. To provide the greatest deals to customers, managers must strike a balance between food costs and promotional costs. According to Segokgo (2016), fast food consumption among millennials is considerable. Customers with below-average nutritional knowledge are influenced by fast food advertising and promotion, according to a study. Regular consumers of fast food (four to six times per week) are susceptible to advertising and promotion. It is essential to provide millennials with nutritious foods, and nutritional information can be utilized in advertising.

According to Flores (2014), particular restaurants such as KFC, McDonald's, and Tropical hunt face difficulties when utilizing sales promotion offers. It includes the problem of inadequate monitoring of local and international events, inadequate monitoring of opportunities, restaurants' inability to take full advantage of price reduction as a sales promotion strategy, restaurants' inability to use incentives to boost sales, and a lack of communication in promoting new products and offers to customers. Allaham (2018) observed that it is crucial to determine what consumers want and which promotion will be the most successful. Since restaurants spend a substantial amount on sales promotion tools, it is crucial to determine which sales promotion should be used, when it should be implemented, and by whom. According to a study by Asha, Bavthira, and Fazila (2017), promotional strategies through television have a significant impact on the psychology of customers, whereas radio has the least impact. Different sales promotions, such as buy x get y free, combo, contests, price reductions, etc., have a significant impact on consumer purchase decisions. Customers have a favorable view of sales promotions, and effective advertising influences consumer purchasing behavior.

According to Kumar, Suganya, and Imayavendan (2018), sales promotions have no long-term impact on brand preference. To make consumers aware of sales promotion offers, one must utilize the appropriate advertising medium. In addition to offering sales promotions, measures should be taken to enhance service quality, product availability, and price. Nikhil Rodrigues and Jacob Rodrigues examined McDonald's promotional strategy in 2016. It utilizes various sales promotion offers, including coupons, contests, and programs. It encourages customers to purchase the products and aids in consumer acquisition. Contests such as "happy family movement", "coast to coast", and "NFL love" have increased sales and raised brand awareness. It uses various media such as the internet, e-mail, billboards, print ads, television ads, online ads, and social media such as Twitter to promote its

activities. Asamoah and Chovancova (2018) reached the conclusion that marketing communication aids consumers in recognizing the various promotional offers of competing brands in the market. Customers are influenced by advertisements and sales promotions due to emotive appeal rather than rational decisions. Advertising and sales promotions have a positive effect on consumer choice. Integrated marketing communication is necessary for firms to target customers. To effectively communicate different types of information, such as price, product, service, and sales promotion, it is necessary to select an appropriate communication medium, such as television, radio, email, and newspapers.

Objectives

1. To find sales promotion offers preferred by fast food eating customers.
2. To find sales promotion offers effective in enforcing brand switching.
3. To find effective medium of communication through which information regarding prices, availability and promotion of fast food can be communicated to customers.

RESEARCH METHODOLOGY

The nature of research design is descriptive. 505 customers of fast food restaurants are surveyed using questionnaires to obtain the primary data. Customers who consume fast food from branded fast food restaurants, such as McDonald's, KFC, and Domino's, are the target audience. Both online and survey methods are used to collect data from Madhya Pradesh. The sample is selected using a technique of non-probability convenience sampling. Frequency of customers preferring sales promotion offers is determined using a nominal scale, preference of sales promotion offers is determined using multiple choice questions, and the effectiveness of sales promotion offers in enforcing brand switching is determined using sales promotion offers. The Chi-square test is utilized to identify significant differences between various sales promotion offers.

FINDINGS AND DISCUSSION

Do you prefer promotional offers in case of fast food?

S No	Particulars	Frequency	Percentage (%)
1	Yes	497	98
2	No	8	2

Majority of customers (98%) responded that they prefer sales promotional offers while purchasing fast food. This shows that sales promotion offers influence the buying behaviour of fast food eating customers from branded fast food outlet. Fast food restaurants must use them properly to attract potential customers and retain existing customers.

What type of promotional offers do you prefer?

S No	Particulars	Frequency
1	Coupon	297
2	Contests/Events	42
3	Buy X get Y free	239
4	Discount	368
5	Premiums (gifts)	68
6	Loyalty Programs	47
7	Combo Deals	296
8	X% Extra	143
9	Cash back	309

Ho = There is no significant difference between sales promotion offers preferred by fast food eating customers.

P value and statistical significance

Chi squared equals 643.224 with 8 degrees of freedom.

The two-tailed P value is less than 0.0001

By conventional criteria, this difference is considered to be extremely statistically significant.

Thus we reject null hypothesis.

Discount (369), Cash back (310), Coupon (296), Combo Deals (296) and Buy X get Y free (239) are top five sales promotion tools preferred by customers eating fast food. All the fast food restaurants must utilise a proper combination of these sales promotion tools in order to attract and retain customers and increase sales.

Which of the following promotional offers enforce you to switch to another fast food restaurant?

S No	Particulars	Frequency
1	Coupon	237
2	Contests/Events	56
3	Buy X get Y free	184
4	Discount	325
5	Premiums (gifts)	89
6	Loyalty Programs	47
7	Combo Deals	223
8	X% Extra	135
9	Cash back	243

Ho = There is no significant difference between sales promotion offers which enforces customers to switch the fast food restaurant brand.

P value and statistical significance

Chi squared equals 425.439 with 8 degrees of freedom.

The two-tailed P value is less than 0.0001

By conventional criteria, this difference is considered to be extremely statistically significant. Thus we reject null hypothesis.

Discount (326), Cash back (244), Coupon (238), Combo Deals (223) and Buy X get Y free (184) are top five sales promotion tools preferred by customers eating fast food. All the fast food restaurants must utilise them to attract customers and enforce them to switch to one's own brand. Fast food restaurants must use a proper combination of the above sales promotion offers for attracting new and potential customers.

Where do you get information about prices, availability and promotions of Fast Food Restaurant?

S No	Particulars	Frequency
1	TV	169
2	Radio	45
3	Messages	231
4	Emails	114
5	In Store Display	221
6	Billboards/Hoardings	101
7	Internet/Social Media	378
8	Friends/Family	280
9	Newspaper/Magazines	153

P value and statistical significance

Chi squared equals 439.266 with 8 degrees of freedom.

The two-tailed P value is less than 0.0001

By conventional criteria, this difference is considered to be extremely statistically significant.

Thus we reject null hypothesis.

Internet/Social Media (378), Friends/Family (280), Messages (231), and In Store Display (221) are major sources of information about price, locality and promotional offers etc for customers. Fast food restaurants must use a proper combination of these mediums for communicating information to customers.

CONCLUSION

According to our research, 98% of Mc Donald's, KFC, and Domino's fast food customers prefer sales promotion offers. Consequently, it influences the customer's purchasing behavior and may influence the purchase decision. Discount, cash back, coupons, combo deals, and purchase x get y free are the most preferred sales promotion tools among fast food eaters. Discount, cash back, coupon, combo deals, and buy x get y free are significant sales promotion tools that compel fast food consumers to transfer to another brand. A combination of these sales promotion offers will assist restaurants in attracting new consumers, retaining existing ones, and boosting sales. Internet/social media, friends/family (word-of-mouth publicity), messages, in-store displays, and television are the most effective means of communicating information about sales promotion offers, product, prices, and availability, etc. It is essential that these sales promotion offers are communicated effectively to customers. Utilizing the appropriate medium will aid restaurants in targeting consumers and communicating various promotional offers. This study will assist academics, researchers, and industry in enhancing sales promotion offers and determining the most effective medium to be used for transmitting information pertaining to sales promotion offers, prices, and availability, among other factors..

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An Effective Heart Disease Detection and Classification using Machine Learning

Abstract: - About 20.5 million people die yearly due to cardiovascular disease (CVD). Early prediction of heart disease and accurate heart severity identification can save the induvial life with timely medications. In many cases, most deaths occur due to inaccurate diagnosis of the heart. In computer science, various existing researchers have dealt with the classification of heart disease on synthetic as well as real-time datasets. But still, those systems have a challenge such as low classification accuracy, high error rate and inaccurate heart severity detection. After identifying all these challenges, we proposed an effective heart disease detection and classification using hybrid machine learning techniques. In this article, we describe how various feature extraction and hybrid machine learning classifiers produce accurate severity of heart disease on real-time datasets. In the first phase, we collected a Cleveland dataset from Kaggle and then applied preprocessing and normalization for data balancing. Various feature extraction and selection methods, such as TF-IDF, Co-relation coefficient, N-Gram, and bi-Gram features, are used for practical module training. The different machine learning we used on normalized datasets for classification. The five supervised machine learning algorithms are used, such as Support Vector Machine (SVM), Naïve Bayes (NB), Artificial Neural Network (ANN) and Hybrid Machine Learning (HML) etc. The HML achieves 99.30% accuracy on the Cleveland dataset using Weka 3.8 machine learning framework. As a result, the proposed system compares with various heart disease predictions using machine learning techniques.

Keywords: Heart disease prediction, CVD, data pre-processing, feature extraction, feature selection, supervised machine learning, body sensor network.

I. INTRODUCTION

Due to the imbalanced lifestyles that are common in today's society, severe ailments can easily affect the human heart. As a direct consequence, it is leading to the development of serious illnesses and issues, such as diabetes, stress, and intense smoking. The human heart is adversely affected by all of these elements, and as a result, a range of heart disorders can develop. A lifestyle that includes having hypertension, raised serum triglycerides – which lead to higher levels of cholesterol is one of the key risk factors for cardiovascular disease. Smoking increases the amount of blood clotting factor, which can include fibrinogen and other substances like this. Diabetes mellitus is associated with high blood pressure and cholesterol levels. A poor diet that consists of more junk food and meals from outside might lead to more severe forms of heart disease. Diet is very important because it is the major source of human survival. Obesity and a lack of physical activity are major risk factors for heart disease. It is critical for the heart to get regular exercise. There are numerous other factors that can cause more severe forms of heart disease, including having a low socio - economic status, being mentally ill, experiencing high levels of stress exposure, using alcohol, having irregular blood clotting, growing older, and having a cardiovascular disease in the family. Blockage in the coronary arteries, which are the main blood vessels that supply the heart with blood, is another primary cause of heart disease.

In addition to this, the above results in decreased nutrients being delivered to the myocardial cells of the heart muscle. In most cases, there are three major arteries that are responsible for supplying blood to the heart. If any of the arteries become blocked, the patient will experience a cardiac arrest or myocardial infarction. As a consequence of this, this can lead in life-threatening complications, and even death in some situations. The earlier these signs are recognised, the greater the likelihood that prompt treatment will be administered, which in turn increases the likelihood that a human life will be saved. The prediction of cardiac illness with an accuracy level that is sufficient is a very demanding and complex topic; nonetheless, it is possible to achieve this goal by utilising

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more effective machine learning algorithms. Not only can the development of an appropriate ML framework forecast cardiovascular illness with a high level of accuracy, but it can also eliminate the need for human intervention, which is the need of additional medical testing. The death rate and the extent of the illness can be deduced from a quick prognosis.

Previous studies have shown us how common it is for people to suffer from cardiac illnesses which are brought on by leading a sedentary lifestyle and eating an unhealthy diet. At the very least once each year, each and every one of us should have our health checked out so that we are aware of the current state of our various body parts, particularly with regards to heart disease. In the event that elderly people live alone at home and need continual care, there is a need for a device or mechanism that allows for the simple monitoring of required critical parameters of the heart. These parameters are crucial for determining the state of the heart's ability to perform its functions.

According to the research that has been done up to this point, it has been discovered that there are certain machines that can compute or monitor things like an ECG or blood pressure. A glucometer may be used to measure sugar in any form. even random sugar. All of them are distinct computing tools that each compute a unique set of parameters. As a result, what we need is a device that can measure all of the important vital signs of the heart in one location and at one time, and that can be accessed by both the patient and the doctor in the event of an emergency. We also design and develop a heart disease detection and prediction system using IoT and various machine learning techniques. This research we collect data from various sensors and extract various features for classification of machine learning algorithms.

II. LITERATURE REVIEW

Senthilkumar Mohan et al. proposed a hybrid machine learning strategy for accurately predicting heart illness in their study [1]. They developed a new method employing machine learning techniques to pinpoint crucial factors that enhance the precision of cardiovascular forecasting. The prediction model is introduced using a range of feature combinations and established classification algorithms. The research used machine learning techniques to analyze raw data, resulting in a novel insight into heart illness.

Amin Ul Haq et al. [2] used cross-validation, three feature selection methods, and evaluation criteria for classifier performance including accuracy, sensitivity, specificity, execution time, and Matthews' correlation coefficient. They used seven established machine learning algorithms. Evaluations were conducted on each classifier to assess accuracy and execution time using all features. The classifiers' performances were tested by using feature selection approaches including LASSO with k-fold cross-validation, mRMR, and Relief on selected features. Researchers have developed a sophisticated algorithm to classify those with healthy hearts and those with heart disease. Li Yang et al. used many strategies in constructing their prediction model. Consistent follow-up was maintained via the use of an electronic health record system. A three-year risk assessment prediction model was provided based on a substantial population in eastern China with a high risk of cardiovascular disease. The heart disease classifier in Youness Khourdifi et al.'s [4] research was improved by eliminating redundant features with Fast Correlation-Based Feature Selection (FCBF). Subsequently, they categorized everything using several categorization methods.

A disease prediction system was developed by researchers using cloud technology as described in Shadman Nashif et al. [5]. An Arduino microcontroller was used to develop a real-time monitoring system that monitors health indicators such as blood pressure, temperature, heart rate, and humidity. The technology can detect cardiac abnormalities using machine learning methods by transferring recorded data to a central server and updating it every 10 seconds.

P. Suresh et al. [6] assessed several prediction models and feature selection strategies before developing an effective prediction model using a genetic algorithm. It outperforms other traditional prediction methods. The various prediction models were validated using real-time data sets and then reassessed with heart disease data sets. The K-Cross validation technique is used to provide a balanced training and testing data set. In the Fahd Saleh Alotaibi [7] study, researchers used the Rapid Miner tool together with several machine learning approaches to enhance the accuracy score and predict heart disease. We analyzed the UCI heart disease dataset. The recommended task improved the precision score compared to the prior one. Lewlyn L. R. Rodrigues promoted the use of partial least squares in structural equation modeling for data analysis.

They used machine learning to analyze the correlation between body mass index, age, systolic and diastolic blood pressure, daily cigarette consumption, weekly alcohol intake, and the presence of hypertension and coronary heart disease. All factors, save age, SBP, and BMI, showed a significant positive association with coronary heart disease (CHD) and hypertension. The results assisted machine learning researchers and professionals in identifying relationships among these elements.

In Mohd Ashraf et al.'s [9] study, researchers introduced the Deep Neural Network technique to create an automated system for predicting heart attacks. Various datasets were used to evaluate the precision of machine learning methods. The proposed solution introduced an automated preprocessing method to the data and removed systemic anomalies

Kathleen H. et al. proposed developing a Deep Neural Network (DNN) classification model and a DNN diagnosis model for heart illness in their research [10]. The classifier achieved an accuracy of 83.67% while using an enhanced Deep Neural Network (DNN).

Researchers presented the Talos Hyper-parameter optimization model for predicting cardiac and heart diseases in Sumit Sharma and Mahesh Parmar [11]. Utilizing deep neural networks is essential for enhancing the accuracy of heart classification in cases of cardiac sickness. Various classification approaches such as SVM, Naive Bayes, and Random Forest showed varying performance. Cardiac arrest at UCI The Talos Hyper-parameter Optimization outperformed the classification algorithms previously discussed in the dataset.

Asma Baccouche and colleagues proposed an ensemble-learning architecture using a CNN and either a bidirectional or unidirectional BiLSTM or BiGRU model, achieving a 91% accuracy in predicting different types of heart disease. Feature selection is used in data preparation to improve the classifier's performance. Nathalie-Sofia Tomov and Stanimire Tomov discovered the HEARO-5, a sophisticated five-layer DNN architecture with the highest predictive accuracy. This model utilizes regularization optimization and can automatically identify missing or abnormal data. They used Matthews correlation coefficient (MCC) and K-way cross-validation to assess the consistency of designs.

Shubhanshi Singhal et al. [14] used Convolutional Neural Networks (CNNs) using 13 clinical variables as input. The improved back propagation training strategy achieved 95% accuracy in predicting heart disease while training the CNN.

Kusuma, S. et al. conducted a comprehensive study on methodologies for heart disease research, focusing on prediction and diagnosis utilizing machine learning and deep learning technologies. SVM and machine learning approaches make for 60% of the methodologies used, with deep learning methods accounting for 30%. The majority of the data used consists of clinical datasets.

Joonmyoung Kwon and colleagues [16] proposed authenticating real-time patient data using deep learning modules. This therapy mainly addressed those with prolonged symptoms of cardiac arrest. This research achieved a classification accuracy of around 82% on a dataset including real-time patient data. Researchers used a language model technique in N. Sowri Raja Pillai et al. [17] to forecast high-risk prognosis from patients' diagnostic histories by using deep recurrent neural networks (RNNs) known as Prognosis Prediction using RNN (PPRNN). The proposed PP-RNN utilizes several RNNs to analyze patient diagnostic code sequences and predict the emergence of high-risk diseases. The recommended technique ultimately resulted in enhanced accuracy.
M. Ganesan and Dr. N. Sivakumar developed an innovative healthcare application using IoT and cloud technology to monitor and identify serious medical conditions. The classifier was trained using data from the benchmark dataset in the training phase. Real patient data were used throughout the testing phase to determine the presence of sickness.

In their article [19], AKM Jahangir and Alam Majumder proposed a multi-sensor system with smart IoT technology to give early warnings of illness risk. The system collects data from the user continuously and transfers it to a smartphone via Bluetooth using a Body Area Sensor (BAS) system. The program enabling users to see real-time charts of possible cardiac arrest completed all processing and data analysis. An IoT system using smartphones was developed with a low power consumption communication architecture to regularly monitor body temperatures and heart rates. Sensor data was examined to provide very accurate forecasts of cardiac arrest using

machine learning and signal processing techniques. A wearable system using an ECG and body temperature combination was developed for heart rate detection, based on a smartphone. Analyze heart rate on Android platform to see body temperature and real-time ECG signal graphs.

Mohm Ayoub Khan et al. proposed an Internet of Things (IoT) architecture for predicting cardiac disease by using a Modified Deep Convolutional Neural Network (MDCNN). Health indicators such as ECG and blood pressure were monitored using the patient's wristwatch and a heart monitor device. The system's performance was evaluated by comparing the suggested technique with existing DNNs. MDCNN outperformed other techniques. Shadman Nashif et al. proposed accurate prediction of heart diseases using machine learning algorithms in WEKA, a java-based Open Access platform for data mining. The proposed method achieves an accuracy of 97.53% using Support Vector Machine (SVM) and 10-fold cross-validation. An Arduino system was developed to monitor patients in real-time by sensing variables like as heart rate, body temperature, humidity, and blood pressure. If a parameter above the threshold, the patient's live video feed is watched, and a designated physical consultant is notified using GSM technology. A smartphone app is developed to store patient and doctor records. A pre-processing technique was proposed to enhance the classification accuracy of ECG data.

According to Deva Priya Isravel et. al. [22], the noise in the collected raw data reduces the classification accuracy. An innovative pre-processing method is used to remove distorted ECG readings. In order to distinguish between normal and pathological cardiac rhythms, classifier algorithms like KNN, Naive Bayes, and Decision Tree are used to assess the classification performance.

Using ML algorithms, Kumar G. Dinesh. et al. [23] suggested Cardiovascular Disease Prediction. This study suggested a prediction approach for determining if a person has heart disease and for alerting or diagnosing them. Here, the rules are applied to each individual result of Gradient Boosting, Random Forest, Naive Bayes Classifier, Logistic Regression, and SVM to compare the prediction accuracy.

A huge data analysis of coronary artery heart disease is presented in Prerna Jain et al.'s [24] study, "Coronary artery disease prediction on large big data." Hospital management is enhanced by employing DM and ML algorithms to analyze a patient's massive quantity of data. It is challenging to evaluate, collect, manage, and store structured and unstructured data in order to leverage big data technologies and tools as the volume of data expands dramatically in every industry.

Jianliang Gao et al. [25] proposed a technique for predicting node-representation learning similarities in their paper, "Similar Disease Prediction with Heterogeneous Disease Information Networks." First, they use data from many sources to integrate semantic score and topological score among disorders. In order to map each illness into a vector with the same spatial dimension and to compute and thoroughly assess disease similarity, the combined scores of each disease with all other diseases were employed. Finally, they conducted out tests based on benchmarks and additional disease nodes not included in the benchmark set. The efficiency of a technique in forecasting comparable illnesses may be shown by comparing several approaches using statistics like average, variance, and variance coefficient as the standard.

III. RESEARCH METHODOLOGY

A visual representation of the framework for the proposed system is provided in figure 4.1. It is made up of a total of five primary components, including Medical IoT sensors, a dataset on heart illness, patient information, a cloud database, and an artificial intelligence-based heart disease prediction system. Figure 1 is an illustration of the typical block diagram for the work that is being suggested. It is considered that IoT devices include both those that can be worn and those that can be implanted. It is used to collect patient data from various geographically dispersed areas. These precise measurements are compiled as patient data through the utilization of Internet of Things (IoT) devices that are connected to a person’s body.

The IoT based real time cardiac disease dataset is utilized which is created after observation various patients. The dataset on heart disease contains historical logs of medical data that have been compiled from various hospitals and other medical facilities. The patient records are comprised of the patients; historical medical files, which are gathered from various institutions across the country. The cloud is where each of these datasets has been saved. The necessary information will be stored in the cloud where it will be accessible at any time. The purpose of the heart disease prediction system seems to be to forecast the occurrence of heart illnesses by the application of

classification techniques that are based on machine learning. The IoT-based healthcare approach that has been outlined here functions in three stages. The data will be obtained in the first stage through the utilization of IoT devices from the human body, information from benchmark datasets, and clinical documentation. The subsequent step will involve storing all of the acquired information in a database that is hosted on the cloud. The classification of the data is what happens in the final stage, and its what allows for the prediction of cardiovascular disease. In the beginning, the classification algorithm will carry out the training process. This process will make use of the heart disease dataset in order to educate the classifier on how to determine whether or not heart disease is present. After then, the classifier that has been trained is prepared to test the incoming patient's information in order to correctly determine whether or not the individual suffering from heart disease. At this point, the user will be presented with the test report after it has been generated.

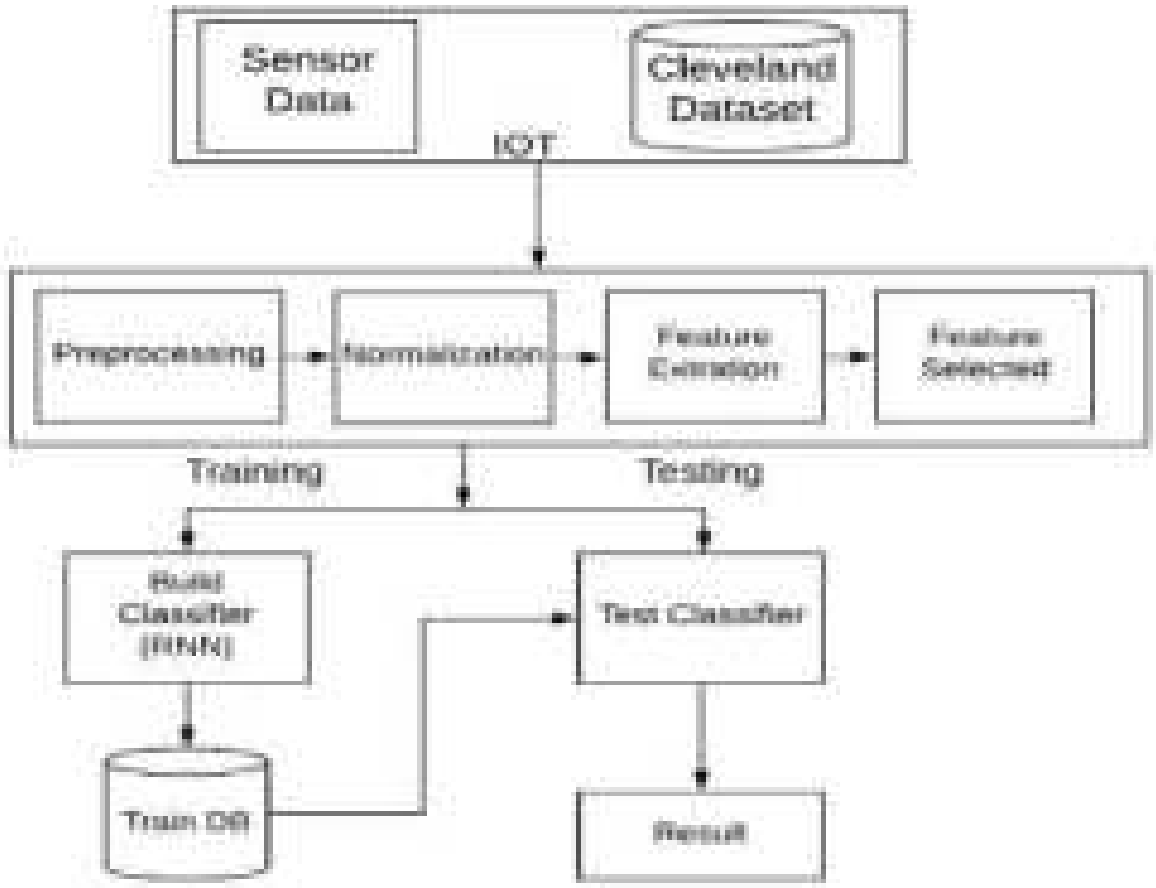

Figure 1: Proposed System Architecture for HDP

The proposed system architecture for a simulated and real-time IoT data processing environment is shown in Figure 1. Two of the data set's twenty-five properties, the patient's age and gender, are used to identify the patient's specifics. This is because only those characteristics have any bearing on the age and gender of the patient. The 12 characteristics are important since they constitute a necessary part of the patient's medical history. When it comes to detecting cardiac disease and determining how serious it is, clinical data are crucial. We compare the RNN's performance to that of various tried-and-true machine learning classifiers. Machine learning was utilised to create a wide variety of classification models that were used here. In order to identify whether model is superior than the RNN, accuracy calculations are performed using the provided dataset. In order to compare numerous outcomes with different cross validation strategies, we employ the three available activation functions: Relu, Sigmoid, and Tanh.

During the HML feature extraction and feature selection processes, the input, hidden, and feedback layers are defined. When it comes time to choose a single feature vector to use for classification, the SoftMax function is used after all others have been eliminated. The following is a description of the SoftMax function;

$$y\hat{}(n) = \text{softmax\_}(W(n)\, h(n) + b(n))$$

For task process n, the extrapolation alternatives are denoted by y(n), the required knowledge is denoted by W(n), and the bias time is denoted by b(n). Our total cost function is a linear representation of the utility function across all possible crossings.

$$\text{ø} = \sum_{n=1}^{N} . \lambda_n L(y\hat{}(n), y(n))$$

Now, λ_n is the respective weight for specific (n) task.

It's important to remember that labelled data for training each task will originate from totally diverse sources. The lessons are then iteratively taught by repeatedly going through the tasks:

Therefore, following the mutual learning stage, we should use a calibrating strategy to further enhance the output with each challenge. Input gate, decoder (ct), forgetting gate (ft), offset gate (ot), and prior hidden (ht) are the Rd vectors defined as LSTM sub-divisions from each stage t. In LSTMs, D represents the total number of models. It, ft, and ot are the values in [0, 1] that correspond to the gating dimensions. All of the above are the LSTM transformation coefficients:

$$\begin{aligned}
\mathbf{i}_t &= \sigma(\mathbf{W}_i \mathbf{x}_t + \mathbf{U}_i \mathbf{h}_{t-1} + \mathbf{V}_i \mathbf{c}_{t-1}), \\
\mathbf{f}_t &= \sigma(\mathbf{W}_f \mathbf{x}_t + \mathbf{U}_f \mathbf{h}_{t-1} + \mathbf{V}_f \mathbf{c}_{t-1}), \\
\mathbf{o}_t &= \sigma(\mathbf{W}_o \mathbf{x}_t + \mathbf{U}_o \mathbf{h}_{t-1} + \mathbf{V}_o \mathbf{c}_t), \\
\hat{\mathbf{c}}_t &= \tanh(\mathbf{W}_c \mathbf{x}_t + \mathbf{U}_c \mathbf{h}_{t-1}), \\
\mathbf{c}_t &= \mathbf{f}_t^{\prime} \odot \mathbf{c}_{t-1} + \mathbf{i}_t \odot \hat{\mathbf{c}}_t, \\
\mathbf{h}_t &= \mathbf{o}_t \odot \tanh(\mathbf{c}_t),
\end{aligned}$$

Here, xt is the time-step source, and LG (logistic regression) denotes fractal dimension and wise element multiplication. The activation function regulates the internal storage state display, the forgotten gate theoretically decides how much each component of the memory module is gone, and the input gate determines how much the other unit is modified. Here is a rundown of the snippet technique that makes learning easier.

System modules

Data Collection: We collect a data from various source such as Kaggle, machine learning repository and some synthetic datasets. The IoT is another dataset which we used for real time scenario. The IoT module consist various attributes including numerical and categorial attributes.

Data pre-processing: It deals with issues such as noisy data, missing information, and so on. When part of the data in the information is missing, several solutions have been used, such as filling in the blanks or ignoring the tuples, depending on the specific situation. There is a possibility that the data will include null values, which are unintelligible to machines. These noisy data might be the consequence of improper data collection, wrong data entry, or any number of other things. In order to solve the problem, methods such as regression, clustering, and the binary approach are used.

Feature extraction: This program will return a wide range of characteristics using the data that is supplied. After the features have been retrieved, a feature selection threshold is applied to them, which removes features that are redundant or otherwise not required for the training process. In order to get a wide range of hybrid attributes, the normalized data with relational features are used, and training is performed by choosing an optimization method. The detailed explanation of the procedures of feature extraction, feature generation, and feature evaluation are explained as follows

Feature Extraction - This dimensionality-reduction technique divides the original information into identifiable categories based on their relationships. These massive datasets are characterized by including several parameters that need significant computer capacity for processing. Therefore, feature extraction may effectively choose certain variables and include important ones, thereby reducing the amount of data. Precision and recall metrics

will be used to evaluate the results. PCA is one of the most used techniques for lowering the number of linear dimensions. It is a technique used for self-directed learning.

Feature generation - It involves generating novel attributes from existing ones. Managing large datasets is challenging due of the significant variations in dataset sizes. The feature generation process might be quite beneficial in simplifying the work. We use several mathematical formulae and statistical techniques to enhance accuracy and clarity while preventing the creation of irrelevant features. This strategy usually enhances the model's understanding to enhance its accuracy. Enhancing model correctness may be achieved with this strategy. This strategy focuses on discovering significant connections while excluding insignificant ones.

Feature evaluation - Prioritizing features and doing feature assessment are key techniques for completing the assignment in an orderly manner. All features are being evaluated to grade them appropriately and then use them as needed. Avoid the irrelevant ones. Feature assessment is essential to provide an accurate final output from the model by reducing bias and missing data.

Linear and Non-Linear Feature Extraction - Feature extraction may be categorized into linear and non-linear methods. PCA is an example of linear feature extraction. Primary characteristics of a dataset are integrated in a normalized linear way to create a main component. Principal Component Analysis (PCA) is a method used to extract important factors from a large range of variables in a dataset. Data is often converted using PCA into a lower-dimensional space in order to optimize the data distribution. Anomalies and outliers, often seen as irrelevant or disruptive data within a dataset, may be used for abnormality and anomaly analysis.

Feature Selection : For several purposes, feature selection is the most important phase in creating a better model. One is being limiting the amount of features that can be taken into account while developing a model through feature selection involves some level of cardinality reduction. The majority of the time, data is either inaccurate or includes more data than is necessary to solve the model. We have gathered real- time data of twitter, which has several features but it has few features which doesn't obtain any advantage after adding. There are some redundant columns, and using them might affect the model. Feature selection not only boosts the model's performance, but it also speeds up the modeling process. When creating a model, if unnecessary columns are included, more CPU and storage are needed for training, and more memory space is required for the produced model. Even if resources were not a concern, it is still crucial to do feature selection and choose the optimal features because unnecessary columns might harm the model's performance in a number of ways, including identifying useful patterns in distorted or redundant information is more challenging, and most DM methods need substantially bigger training data sets if the set of data is highly dimensional.

The technique actively chooses or excludes features during the feature selection process depending on how valuable it is for evaluation. Obtaining too much information that is of low value or not enough data that is of great value are two issues that feature selection aids in resolving. Finding the smallest number of data source attributes that are important for creating a model is our aim while choosing features.

Classification: The system identifies each record as either an attack or normal using a supervised classification approach. We used several machine learning algorithms, including Support Vector Machine (SVM), for supervised categorization. Supervised machine learning is used to train the classifier.

Algorithm for Module Training using HML

Input: Training_DB[ ] as train dataset, set of activation function AF[].
Step 1: Initialize the both methods Train_DB[], AF[], Iteration as epoch_size **Step 2:** Extract_Feat_Set ← Extract_Feat(Train_DB[]) **Step 3:** Select_Feat_Set [] ← optimization(Extract_Feat_Set) **Step 4:** Training.pkl ← Build_Classifier(Select_Feat[]) **Step 5:** Return Training.pkl
Output: Trained module in .PKL file for whole divided dataset

Algorithm for Module Testing using HML

Input: Test_DB [] as test instance set, Train Background Knowledge Training.pkl, threshold Th
Step 1: Read every test records with the help of following equation

test_Feature (m)= $\sum_{m=0}^{n}$(. feature_Set[A[i] … … . . A[n] ← Test_DB)

Step 2: Retrieve selected features from whole testing record $testFeature(m)$ by using following function.

Extract_Feat_set_x[t…n] = $\sum_{x=1}^{n}(t) \leftarrow test\_Feature(m)$

The feature vector is the collection of extracted hybrid attributes from given input

Step 3: Extract every train instance from trained components by using following function

train_Feature (m)= $\sum_{m=1}^{n}$(. feature_Set[A[i] … … . . A[n] ← Train. pkl)

Step 4: Input the testing instances or record set to test classification model as $testFeature(m)$ by using following equation

Extract_Feat_Set_x[t……n] = $\sum_{x=1}^{n}(t) \leftarrow test\_Feature(m)$

The whole class labels' feature vectors are included in the Extract_Feat_Set_x[t].

Step 5: Validate individually all test instance with every training features

Calculate_weight = Calculate_Sim (Feature_Set_x || $\sum_{i=1}^{n} Feature\_Set\_y[y]$)

Step 6: Return calculate_weight

Output: Op_Map <forecasted_class_label, Sim_weight> optimized instance recommends by classification model

Table 1: Detail description of Cleveland dataset which is used for classification

Attribute Name	Description	Attribute type	Value / Range
Age	Age of patient	Numeric	29 to 77
Sex	Gender	Nominal	0 → Female, 1 → Male
Cp	Type of chest pain	Nominal	1→ typical angina, 2 → atypical angina, 3 → non-angina pain, 4 → asymptomatic
trestbps	BP when admitted in hospital (mm Hg)	Numeric	94 to 200
Chol	Serum cholesterol mg/dl	Numeric	126 to 564
Fbs	Blood sugar in fasting if > 120 mg/dl	Nominal	0 → False 1 → True
Restecg	Result of electrocardiographic	Nominal	0 → normal, 1 → ST-T wave abnormality, 2 → definite left ventricular hypertrophy by Estes criteria
Thalach	Heart rate max value	Numeric	70 to 205
Exang	Exercise induces angina	Nominal	0 → No 1 → Yes
Oldpeak	ST depression induced by exercise relative to rest	Numeric	0 to 6.2
Slope	The slope of the peak exercise ST segment	Nominal	1 → upsloping, 2 → flat, 3 → downsloping
ca	Number of major vessels colored by fluoroscopy	Nominal	0 → 4
Thal	The heart status	Nominal	3 → normal, 6 → fixed defect, 7 → reversible defect
Target	Prediction attribute	Nominal	0 → no risk of heart disease, 1 to 4 → risk of heart disease

In order to test how well the suggested categorization method works, the dataset would be used. Machine learning repository at UCI has been accessed using the dataset. There is a hierarchy of significance for the qualities, with basic, intermediate, and significant being the most basic levels.

IV. EXPERIMENT DESIGN

In this experiment, the performance of the HDP using a hybrid machine learning model. The IoT real time data set includes records for 480 patients with a variety of parameters, including age, systolic BP, diastolic BP, body temperature, oxygen saturation, pulse rate etc. To increase the performance of the dataset, preprocessing and normalization are applied. The entire data set is split into two sections after the pre-processing of the dataset is finished. One is testing dataset and other is train dataset. The data set is split into three parts in a 3:1 ratio.

After building the hybrid machine learning technique using HDP, comparative study is done with machine learning methods. The following Table 2 displays the accuracy of classification of different ML algorithms utilizing HDP in the Weka framework.

Table 2: Performance of various machine learning algorithm using HDP

Algorithm	Accuracy	Precision	Recall	F-score
HML	0.9930	0.982	0.981	0.993
ANN	0.923	0.913	0.893	0.901
Naïve Bayes	0.892	0.882	0.932	0.912
Random Forest	0.871	0.861	0.921	0.893
J48	0.903	0.922	0.853	0.881

Consider the following figure 5.2 which depicts the accuracy of prediction of HDP using machine learning techniques.

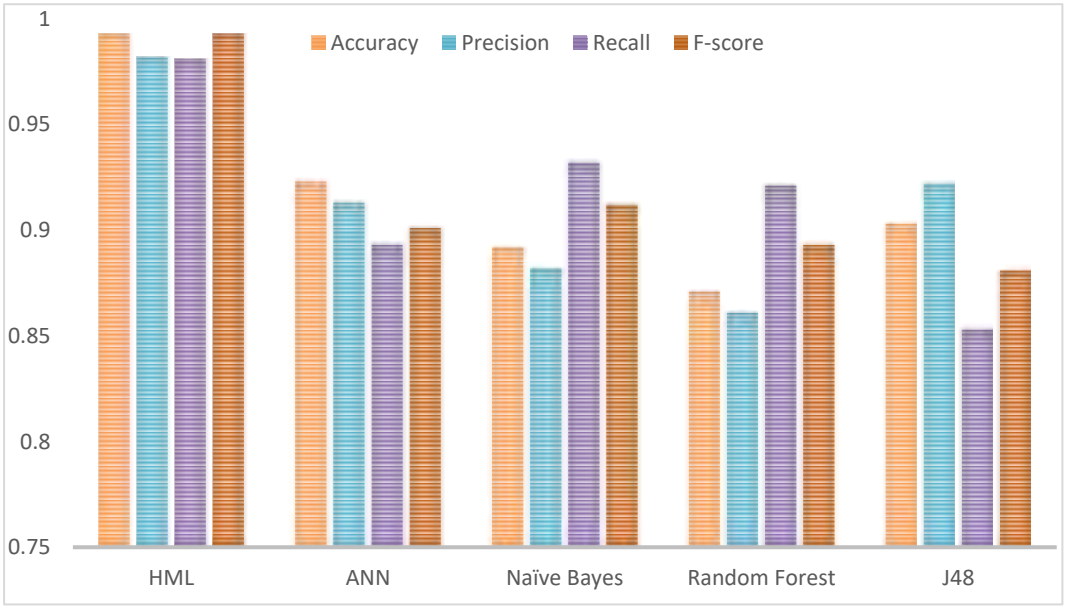

Figure 2: Accuracy of machine learning algorithm using HML for heart disease detection and classification

Figure 2 shows precision of various machine learning algorithms like HML, Naïve bayes, J48, RF, Artificial neural network is 0.99, 0.91, 0.88, 0.86, 0.92 respectively using various learning algorithm for HDP. Consider the following figure 4.4 which depicts the recall of prediction of HDP using machine learning. As a result, it can be concluded from the experimental results that support vector machines outperform other machine classifiers for effective detection of heart disease.

V. CONCLUSION

In the experiment of forecasting HDP using hybrid deep learning classification model, several DL classifiers like artificial neural network, deep neural network and recurrent neural network were used. From the experimental findings, we observed that among all conventional machine learning technique, recurrent neural network obtains highest classification accuracy of 95.4%. In the last experiment which is proposed methodology of HDP using HML classifier, we have used the real-time huge IoT dataset. Data has been pre-processed using data filtration and noise removal using sum rule method. On this filtered data various feature extraction techniques like N-gram, correlation c-occurrence, bi-gram, tri-gram dependency features were applied to obtain the best classification accuracy. We performed three experiments using HML, tan h and sigmoid function and observed that HML function obtained best accuracy of 99.30% for 15-fold cross validation as compared to Tan h and sigmoid function. Thus, our proposed method performs better as compared to traditional learning techniques used for predicting the academic performance of HDP. In future work improvement in research since the majority of the indicators that are beneficial for determining the condition of the heart artery stiffness are not taken into account. Some of these factors include augmentation index, arterial stiffness, and augmentation pressure.

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ORIGINAL ARTICLE

Employing advanced computational drug discovery techniques to identify novel inhibitors against ML2640c protein: a potential therapeutic approach for combatting leprosy

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Abstract
Leprosy, caused by *Mycobacterium leprae*, remains a significant global health challenge, necessitating innovative approaches to therapeutic intervention. This study employs advanced computational drug discovery techniques to identify potential inhibitors against the ML2640c protein, a key factor in the bacterium's ability to infect and persist within host cells. Utilizing a comprehensive methodology, including virtual screening, re-docking, molecular dynamics simulations, and free energy calculations, we screened a library of compounds for their interaction with ML2640c. Four compounds (24349836, 26616083, 26648979, and 26651264) demonstrated promising inhibitory potential, each exhibiting unique binding energies and interaction patterns that suggest a strong likelihood of disrupting the protein function. The study highlights the efficacy of computational methods in identifying potential therapeutic candidates, presenting compound 26616083 as a notably potent inhibitor due to its excellent binding affinity and stability. Our findings offer a foundation for future experimental validation and optimization, marking a significant step forward in the development of new treatments for leprosy. This research not only advances the fight against leprosy but also showcases the broader applicability of computational drug discovery in tackling infectious diseases.

Keywords *Mycobacterium leprae* · Computational drug discovery · Docking · MD simulation · Radius of gyration-root-mean-square deviation-based Free Energy Landscape

Introduction

Leprosy, an ancient infectious disease caused by *Mycobacterium leprae*, continues to pose significant global health challenges despite advances in medical science and public health efforts. [1]. Its continued prevalence, particularly in regions of Africa, Asia, and Latin America, underscores a pressing need for innovative public health strategies and therapeutic interventions [2]. The World Health Organization's report of over 200,000 new cases annually signals not only the disease's stubborn persistence but also the necessity for a sustained and dynamic approach to its management and eventual eradication [1]. Epidemiologically, leprosy's distribution and outbreak dynamics are influenced by an intricate interplay of socioeconomic, environmental, and genetic factors [3]. These elements contribute to the disease's tenacity, facilitating its silent spread within communities often for years before the appearance of clinical symptoms. This latency complicates efforts toward early diagnosis and containment, emphasizing the importance of surveillance and public health intervention in vulnerable populations. The transmission mechanism of leprosy, primarily through respiratory droplets among closely interacting individuals, further highlights the critical need for early detection and prompt treatment to mitigate the spread [4, 5]. A key to understanding *Mycobacterium leprae* resilience and developing effective countermeasures lies in its unique genomic architecture [6]. The bacterium exhibits a significantly reduced genome, characterized by a high number of pseudogenes, which is indicative of its evolutionary shift towards a parasitic lifestyle heavily reliant on host mechanisms for replication and survival [7]. Within this genomic

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landscape, the protein ML2640c has been identified as a critical factor in the bacterium's ability to invade and persist within host cells. This discovery positions ML2640c as a pivotal target for therapeutic development, potentially revolutionizing treatment modalities for leprosy [8]. The advent of computational techniques in drug discovery offers a promising avenue for the development of effective therapies targeting the ML2640c protein. The Diverse-lib database is a major progress in the search for new remedies [9]. It encompasses a variety of chemically diverse compounds, making it a crucial resource for virtual screening experiments aimed at identifying new inhibitors for complex targets like ML2640c.

In this study, we employed a comprehensive computational drug discovery approach to identify inhibitors of Mycobacterium leprae ML2640c from the Diverse-lib database. Our methodology integrates virtual screening, re-docking, molecular dynamics (MD) simulation, and calculations of binding free energy and free energy landscapes. This strong combination of techniques not only enhances the accuracy of our predictions but also provides deep insights into the molecular interactions that may inhibit ML2640c, offering promising leads for novel therapeutic developments against leprosy.

Methodology

Data collection, virtual screening, and re-docking

In this study, we aimed to identify potential inhibitors of ML2640c from *Mycobacterium leprae* by employing a comprehensive computational drug discovery methodology. Our approach began with the collection of protein and ligand data. The protein structure of interest was obtained from Protein Data Bank [10] with the PDB ID 2UYQ [8], ensuring it was of high resolution and relevance to our target. For the ligands, we sourced a wide array of molecules from the Diverse-lib database [9], focusing on chemical diversity to maximize the potential of finding effective inhibitors. Protein preparation played a crucial role in our study. Utilizing the Chimera software, we conducted a meticulous preparation process [11]. This involved cleaning the protein structure by removing water molecules and any bound ligands or ions that were not part of the core structure. We then optimized the hydrogen-bonding network and charged states of amino acids, ensuring that our model was as accurate as possible for docking.

The virtual screening phase was a very important step because it narrowed down the vast library of compounds. For screening purposes, we utilized the Mtipenscreen web server [9], applying the Lipinski filter to ensure that only those compounds with favorable pharmacokinetic properties were selected for further analysis [12]. This step was crucial in maintaining a focus on drug likeness and biological relevance. Following the virtual screening, four compounds that exhibited the highest negative docking scores, indicative of strong potential interactions with the target protein, were chosen for further examination. Re-docking these four compounds, along with the S-adenosylmethionine (SAM) control molecule, was conducted using the Autodock Vina plugin in Chimera [13]. This step was crucial for validating the initial docking results. The re-docking process allowed us to closely examine the binding affinities and modes of interaction between the protein and the ligands, providing a deeper understanding of their potential as inhibitors.

Molecular dynamic (MD) simulation

The MD simulations and subsequent trajectory analyses of four selected compounds in complex with ML2640c, alongside one control complex derived from *Mycobacterium leprae*, were meticulously carried out to understand their dynamic behavior and stability in a simulated physiological environment. The AMBER software suite, leveraging the well-regarded AMBER force field [14], served as the backbone for these simulations, ensuring a robust and accurate representation of atomic interactions and movements [15]. Initially, each complex, including the control, was solvated in an explicit TIP3P water model box, ensuring a minimum distance of 10 Å between the complex and the box edge [16]. This preparation phase also included the neutralization of the system by adding an appropriate number of counterions. After solvation and neutralization, energy minimization was performed on each system to remove potential steric clashes and to ensure that the systems were in their lowest possible energy states before dynamic simulations. This step was crucial for achieving realistic and meaningful simulation outcomes. The minimization process was followed by a gradual heating phase, where the systems were incrementally heated from 0 to 300 K throughout 100 ps, under constant volume conditions. Post-heating, an equilibration phase of 200 ps was conducted under constant pressure and temperature, allowing the systems to adapt and stabilize within the simulation environment. The core MD simulations were then executed for a duration of 200 ns for each complex, enabling a comprehensive exploration of conformational space and the collection of significant trajectory data. During these simulations, the integration time step was set to 2 fs, with periodic boundary conditions. Trajectory analyses post-simulation involved the examination of root-mean-square deviation (RMSD), root-mean-square fluctuation (RMSF), and radius of gyration (RG), alongside the generation of RG-RMSD-based free energy landscapes. These analyses provided insights into the structural stability, flexibility, and

dominant conformational states of the complexes within the simulated environment.

Free binding energy analysis

To estimate the binding affinity of selected compounds to the *Mycobacterium leprae* target, we implemented a meticulous evaluation of their free binding energy. This process, critical for identifying the potential inhibitory strength of each compound, was conducted using the MMPBSA.py tool, a component of the AMBER suite known for its accuracy in such analyses. Initially, we prepared the simulation trajectories of the last 50 ns, which were generated from the molecular dynamic simulations of the four chosen compound–protein complexes. This preparatory step is crucial for ensuring that the data used in the calculation reflect the dynamic interaction between each compound.

Utilizing the MMPBSA.py tool [17], we then calculated the free binding energy for each complex. This tool employs the MM-GBSA method, blending molecular mechanics energies with solvation terms derived from the Poisson–Boltzmann equation and surface area contributions. Specifically, the calculation hinges on the difference in energy between the bound state (the compound–protein complex) and the unbound states (the isolated compound and protein). This differential approach allows for an estimation of the binding affinity, with lower energy values suggesting a stronger interaction between the compound and the target protein.

RG-RMSD-based free energy landscape analysis

To understand the energetic profiles of protein–ligand interactions, we applied a refined RG-RMSD-based Free Energy Landscape FEL analysis [18, 19]. This method unfolds the energetic variations and conformational changes across the simulation span, offering insights into the stability and binding efficiency of the selected compounds against the *Mycobacterium leprae* target. The Geo-Measure [20] plugin in PyMOL [21] was employed to construct the RG alongside the RMSD. These two metrics collectively serve as the axes for constructing the Free Energy Landscape (FEL), representing the fluctuating energy levels as a function of the system's structural deviations. The landscape was generated by plotting the RG value against RMSD data into a free energy metric. This facilitates the visualization of energy wells and barriers, delineating the most stable conformations and the transitions between them. Such a landscape not only illustrates the thermodynamic favorability of the ligand binding but also elucidates the pathways through which conformational shifts occur, shedding light on the dynamic behavior of the complexes.

Results and discussion

Virtual screening analysis

Virtual screening is a crucial computational method used to identify bioactive compounds with known properties from a wide variety of compound libraries that have the potential to interact with a certain biological target. Through the utilization of virtual screening analysis, our study identified chemicals from the Diverse-lib database. The selection of compounds was based on the binding energy values acquired throughout the screening process. A comprehensive analysis was conducted on 1500 compounds obtained from the Diverse-lib database. The binding energies of these compounds varied between − 10.3 and − 8.5 kcal/mol, as indicated in Supplementary Table S1. Four compounds 24349836 (compound 1), 26616083 (compound 2), 26648979 (compound 3), and 26651264 (compound 4), were chosen for further study based on their binding energy.

Re-docking and intermolecular analysis

Re-docking is an essential step in drug development that involves a comprehensive re-evaluation of the docking of ligand molecules with receptor molecules. The process of re-docking involved utilizing the centre grid coordinates ($X = -5.95$, $Y = -27.41$, $Z = -2.07$) and the dimensions of the grid ($X = 20$, $Y = 20$, $Z = 20$). This method is advantageous for verifying the accuracy of the initial docking and uncovering important interactions between receptor and ligand binding site residues. This involved the re-docking of ligands against the protein target ML2640c and their comparison to a control molecule. The re-docking experiment utilized a meticulous methodology, yielding a minimum of nine conformations for each ligand-receptor combination. The pose exhibiting the most significant negative docking score was chosen for further examination. The binding affinity of four selected compounds were observed as − 10.2 kcal/mol for compound 1, − 10.2 kcal/mol, − 10.0 kcal/mol for compound 2, − 10.7 kcal/mol for compound 3, − 10.5 kcal/mol for compound 4. These values played a major part in the selection process. Furthermore, the calculated energy of control (SAM) was (− 7.8 kcal/mol). The 3D structure was generated by using Pymol software [21] as illustrated in Fig. 1.

While the 2D structure of selected complexes is generated through Discovery Studio [22] as illustrated in Fig. 2.

In the analysis of molecular interactions within a protein–ligand complex, distinct patterns of interaction were observed for compounds 1, 2, 3, and 4, and a control

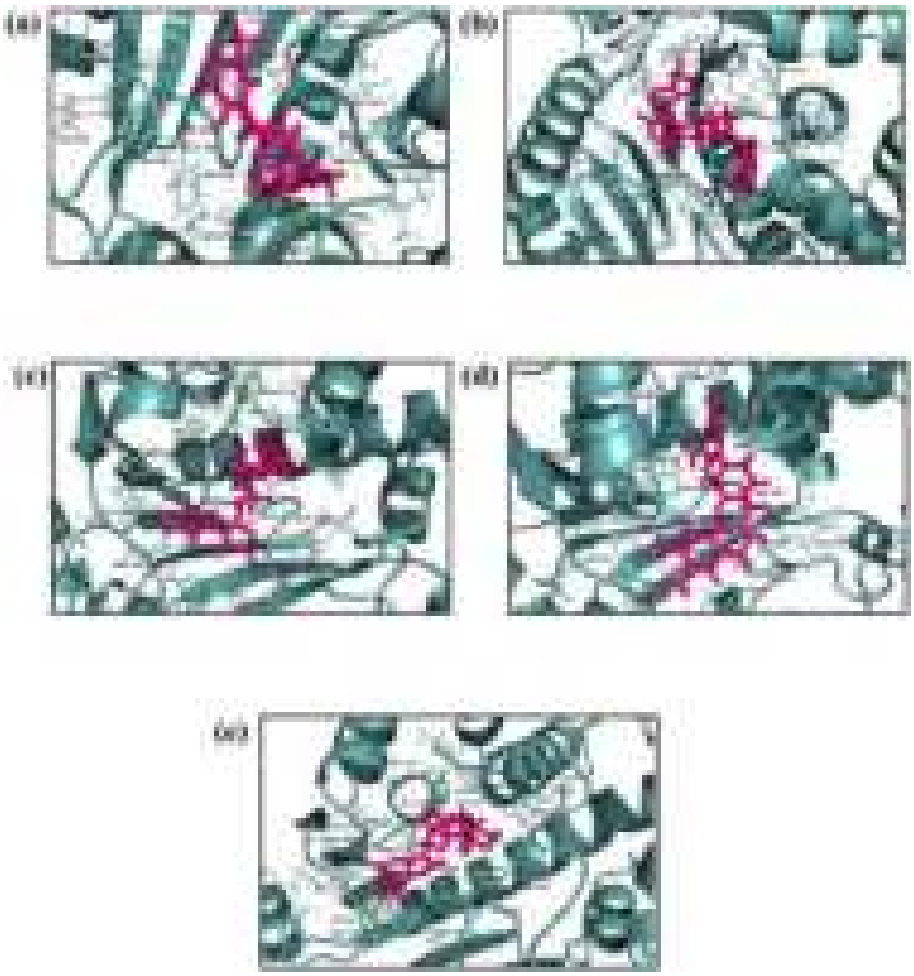

Fig. 1 The 3D structure of four select compounds in complex with the target protein **a** compound 1, **b** compound 2, **c** compound 3, **d** compound 4, and **e** control

molecule with a specified target protein. Specifically, compound 1 exhibited the three hydrogen bonds with the residues Ala18 Arg87, and Leu162, alongside twelve hydrophobic interactions involving residues Leu113, Asp114, Arg25, Glu186, Tyr191, Gly187, Gly15, Asp132, Val136, Gln250, Tyr254, Arg163, Val21, Ala110, Leu188, and Leu192. Compound 2 formed two hydrogen bonds with Gly15 and Leu162, and eighteen hydrophobic interactions with Asp132, Leu188, Leu113, Arg25, Gln133, Gly112, Tyr254, Leu192, Arg163, Ile131, Ile160, Ser111, Asp114, Glu186, Arg87, Thr17, Val136, and Tyr191, in addition to three π–π stacking interactions. Compound 3 exhibited the three hydrogen bonds with Arg87, Leu113, and Gln133, fourteen hydrophobic interactions with Arg163, Ile160, Gly112, Ile131, Ser111, Asp114, Glu186, Arg25, Gly187, Thr17, Val136, Val14, Gly15, and Leu188, and six π–π stacking interactions involving residues Ala18, Val21, Ala110, Leu162, and Leu192. Compound 4 exhibited eighteen hydrophobic interactions with Ala22, Arg25, Asp114, Gln133, Asp132, Ile160, Leu188, Thr17, Asp161, Gly112, Gln250, Tyr191, Ile108, Arg116, Glu186, Leu109, Arg87, and Ser111, alongside six π–π stacking interactions. In contrast, the control molecule exhibited four hydrogen bonds with Asp132, Asp161, Leu162, and Glu186; fifteen hydrophobic interactions with Leu192, Leu188, Tyr191, Gly187, Thr17, Asp114, Leu113, Ser111, Val21, Gly15, Val136, Ile160, Ile131, Gln133, and Ala18; and a single π–π interaction with Ala110. This comparative analysis outlines the specificity and diversity of molecular interactions facilitated by these compounds with the target protein, underscoring their potential implications in modulating the protein's function or stability through distinct binding mechanisms. The interaction pattern is also mentioned in Table 1.

MD simulation

MD simulation provides information on the protein–ligand complex's dynamic stability [21]. To further understand how the selected compounds bind and interact with the target protein, we performed a 200 ns MD simulation. Figure 3 illustrates the initial and last pose of each protein–ligand combination obtained from the MD simulation trajectory created by the Desmond-maestro program [23, 24].

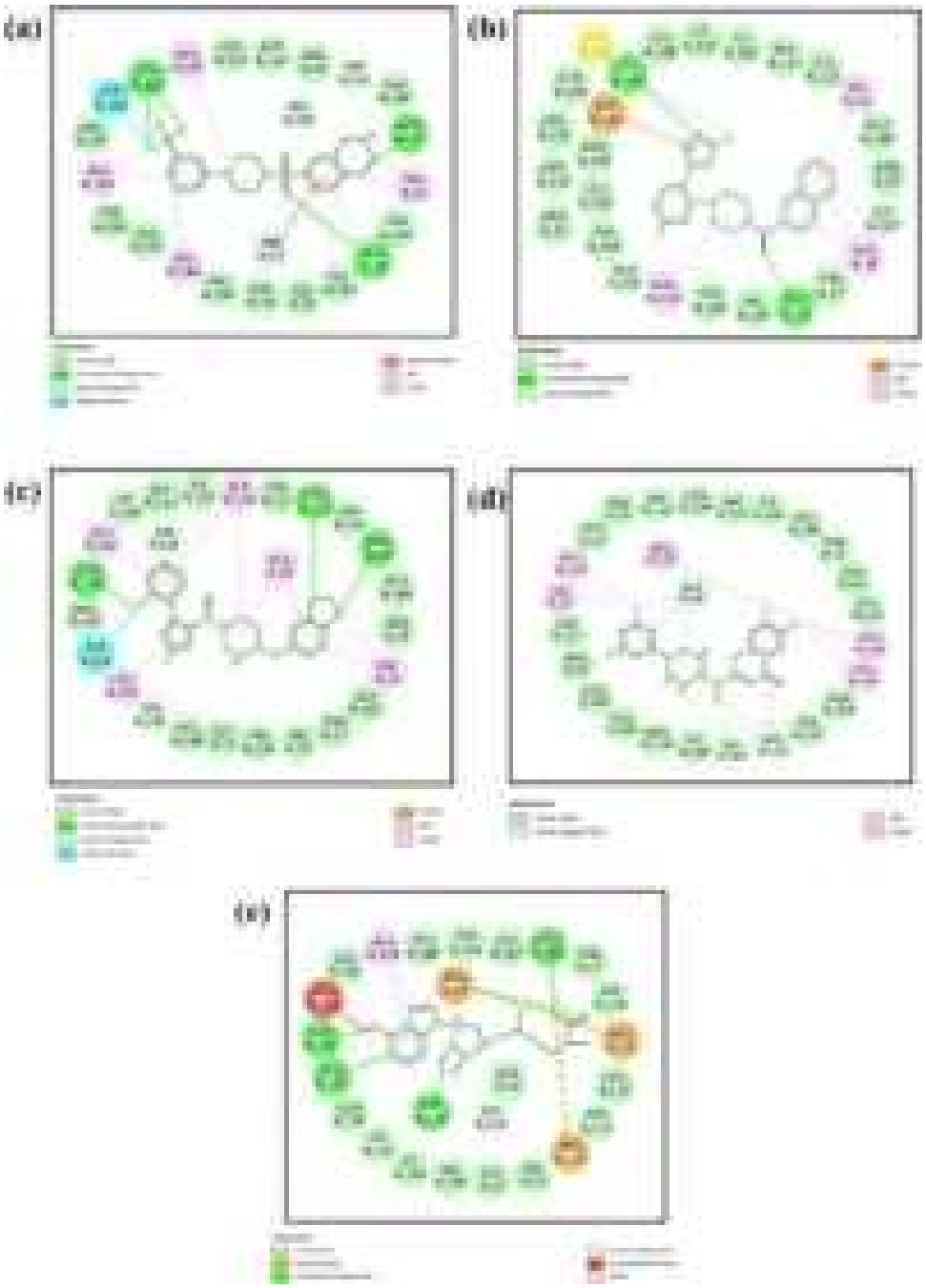

Fig. 2 The 2D structure of four select compounds in complex with the target protein **a** compound 1, **b** compound 2, **c** compound 3, **d** compound 4, and **e** control

RMSD and RMSF analysis

An RMSD analysis was employed to measure the stability of the protein–ligand complexes throughout a 200-ns simulation. Figure 4 illustrates an in-depth analysis of selected complexes using the protein component. The RMSD values of the protein–ligand complexes give vital insights into the conformational stability and dynamic behavior of these systems in a molecular situation as illustrated in Fig. 4. Compound 1 exhibited a consistent protein RMSD value of 4 Å throughout the simulation duration, indicating a stable interaction without significant conformational changes and the ligand RMSD value greater than or equal to 8 Å from the time frame of 100–200 ns simulation. However, from the start of the simulation to the 60 ns simulation, it exhibited minor fluctuation and from 60 to 100 the ligand RMSD value 4 Å was observed. Conversely, the complex of compound 2 exhibited a lower protein RMSD value of 2 Å, suggesting a more substantial maintenance of structural integrity, while the stable ligand RMSD of 2 Å throughout the simulation was observed. In contrast, the complex of Compound 3 exhibited a

Table 1 Intermolecular interaction of four selected compounds (a) compound 1, (b) compound 2, (c) compound 3, (d) compound 4, and (e) control.

S no.	Compound	H-Bond	Hydrophobic	Π–π stacking/π–π cation*
1	24349836	Ala^{18}, Arg^{87}, Leu^{162}	Leu^{113}, Asp^{114}, Arg^{25}, Glu^{186}, Tyr^{191}, Gly^{187}, Gly^{15}, Asp^{132}, Val^{136}, Gln^{250}, Tyr^{254}, Arg^{163}	Val^{21}, Ala^{110}, Leu^{188}, Leu^{192}
2	26616083	Gly^{15}, Leu^{162}	Asp^{132}, Leu^{188}, Leu^{113}, Arg^{25}, Gln^{133}, Gly^{112}, Tyr^{254}, Leu^{192}, Arg^{163}, Ile^{131}, Ile^{160}, Ser^{111}, Asp^{114}, Glu^{186}, Arg^{87}, Thr^{17}, Val^{136}, Tyr^{191}	Ala^{18}, Val^{21}, Ala^{110}
3	26648979	Arg^{87}, Leu^{113}, Gln^{133}	Arg^{163}, Ile^{160}, Gly^{112}, Ile^{131}, Ser^{111}, Asp^{114}, Glu^{186}, Arg^{25}, Gly^{187}, Thr^{17}, Val^{136}, Val^{14}, Gly^{15}, Leu^{188}	Ala^{18}, Val^{21}, Ala^{110}, Leu^{162}, Leu^{192}
4	26651264	–	Ala^{22}, Arg^{25}, Asp^{114}, Gln^{133}, Asp^{132}, Ile^{160}, Leu^{188}, Thr^{17}, Asp^{161}, Gly^{112}, Gln^{250}, Tyr^{191}, Ile^{108}, Arg^{116}, Glu^{186}, Leu^{109}, Arg^{87}, Ser^{111}	Val^{21}, Leu^{113}, Leu^{162}, Arg^{163}, Leu^{192}
5	Control	Asp^{132}, Asp^{161}, Leu^{162}, Glu^{186}	Leu^{192}, Leu^{188}, Tyr^{191}, Gly^{187}, Thr^{17}, Asp^{114}, Leu^{113}, Ser^{111}, Val^{21}, Gly^{15}, Val^{136}, Ile^{160}, Ile^{131}, Gln^{133}, Ala^{18}	Ala^{110}

higher protein RMSD value of 5 Å, implying a less stable protein–ligand interaction and the ligand RMSD value of equal to or greater than 8 Å was observed from the 125–200 ns simulation. From the beginning of the simulation to the 125 ns of simulation ligand exhibited the minor fluctuations. While, both Compound 4 and the control in complex with protein exhibited the protein RMSD values of less than 3 Å, indicating comparably stable conformations throughout the simulation period. While the ligand RMSD value range between 2 to a Å was observed in compound 4 with some fluctuation throughout the simulation, on the other hand, the ligand RMSD value of greater than 3 Å was observed in the control complex between 120 and 200 ns, while from start to 80 ns, the ligand RMSD value of less than 2 Å was observed. This analysis highlights the differential impacts of the compounds on the structural stability of the protein–ligand complexes.

In the comparative analysis of protein RMSF, selected compounds exhibited varying levels of dynamic behavior across specific amino acid residues as illustrated in Fig. 5. Compound 1 exhibited an RMSF value of 2.5 Å across the residue range of 225–250, indicating a moderate level of flexibility within this segment. Conversely, Compound 2 exhibits a higher degree of flexibility with a protein RMSF value of 3.5 Å across the residues 50–75. In contrast, Compound 3 was characterized by a reduced protein RMSF value of less than 2.5 Å, suggesting a more constrained dynamic behavior relative to Compounds 1 and 2. Compound 4, however, exhibited a protein RMSF value of less than 5.5 Å, indicating a broader range of molecular motion compared to the other compounds. In comparison, the control compound exhibited a protein RMSF value of 4.25 Å.

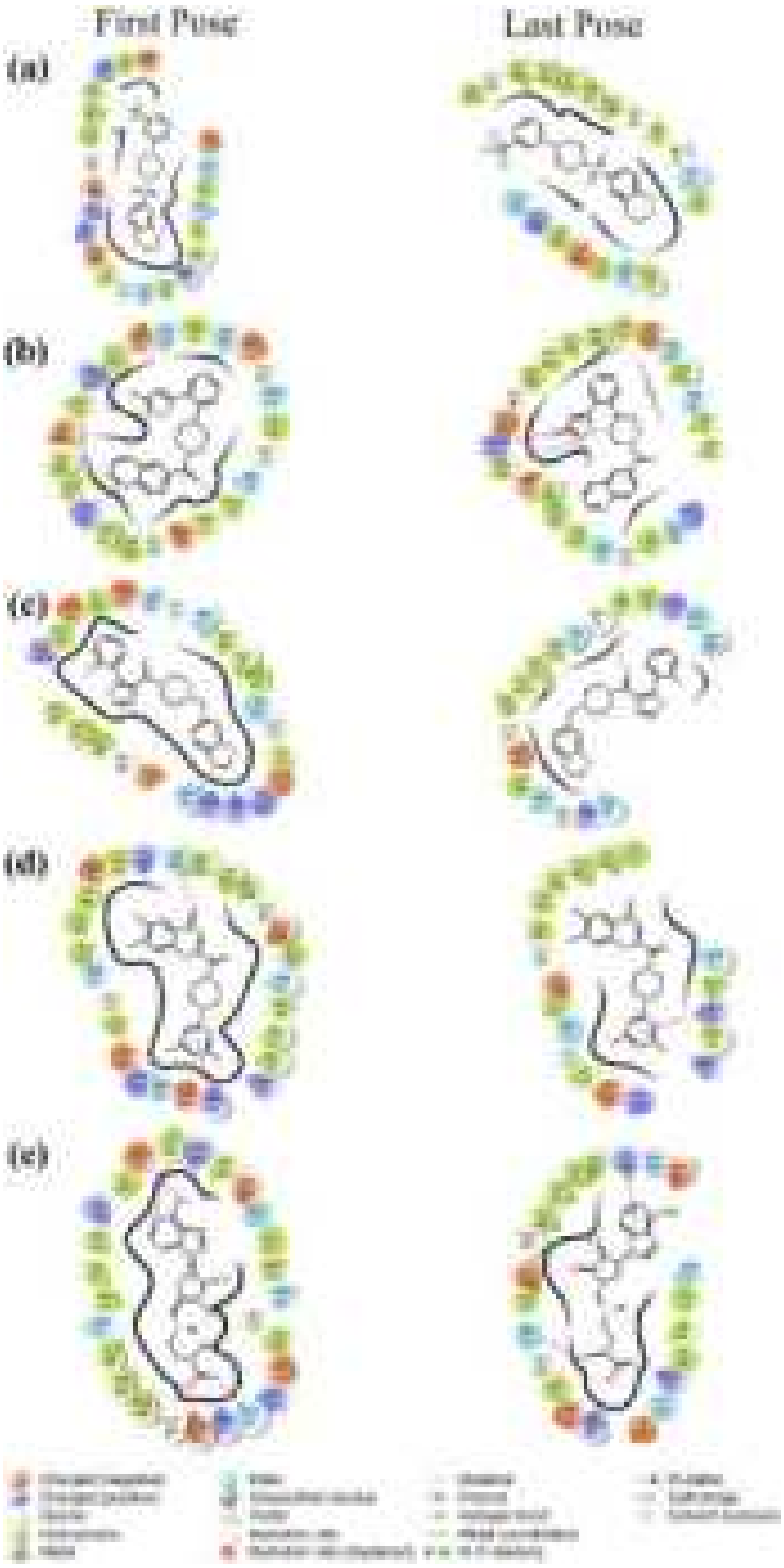

Fig. 3 2D interaction of first and last pose of three selected compounds in complex with the target protein four selected compounds **a** compound 1, **b** compound 2, **c** compound 3, **d** compound, and **e** control

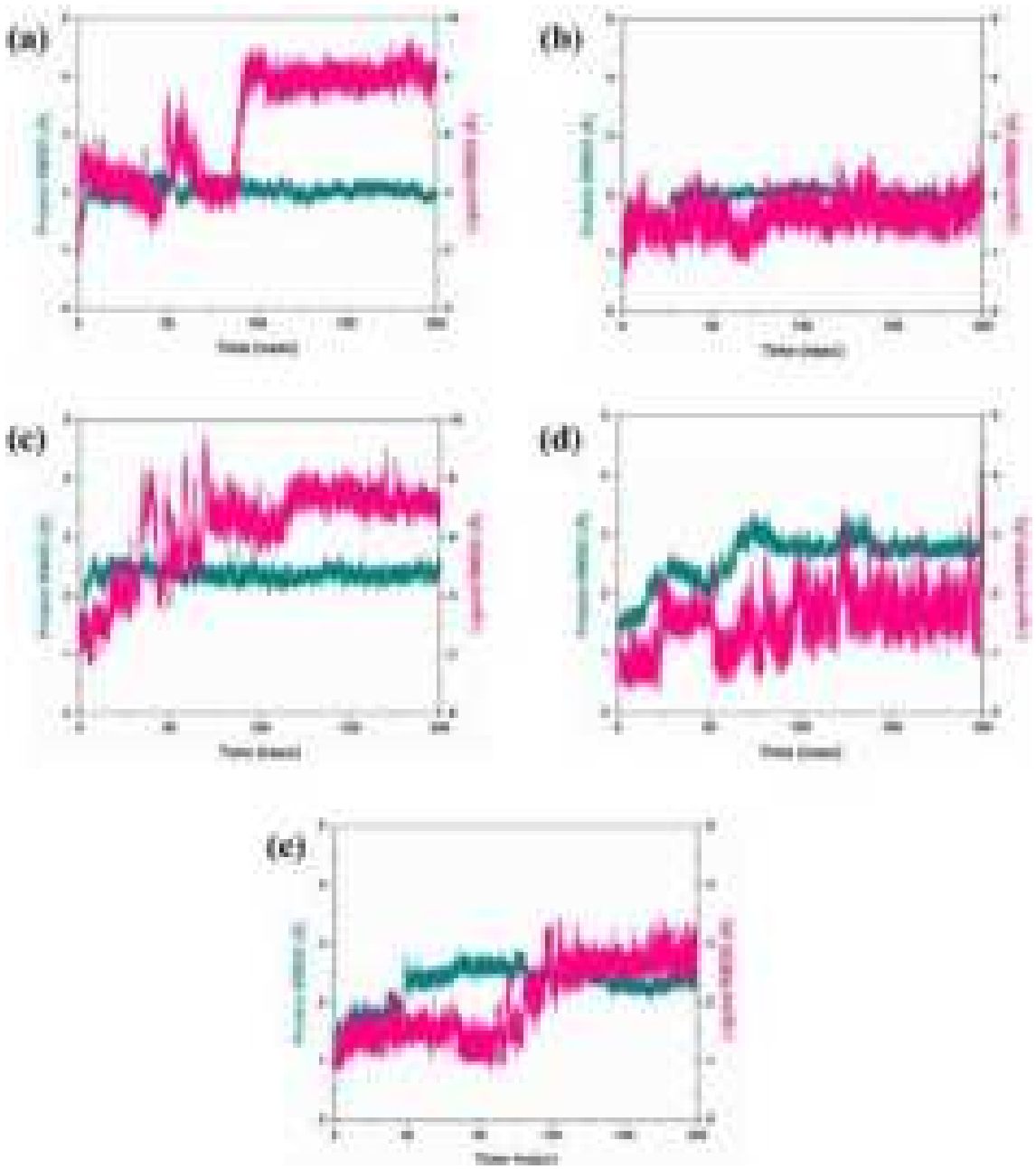

Fig. 4 RMSD analysis of selected compounds in complex with the target protein four selected compounds **a** compound 1, **b** compound 2, **c** compound 3, **d** compound, and **e** control. Here, the green color represents the protein while the pink color represents the ligand

Calculation of RG

The RG is used to calculate the connection between a protein's tertiary structure volume and its stability in biological systems [25]. A protein's larger radius of gyration indicates looser packing, as shown in Fig. S1.

Hydrogen bond analysis

We analyzed the formation of hydrogen bonds in molecular dynamics simulations that were done for 200 ns as illustrated in Fig. 6. Compound 1 exhibited the formation of a singular hydrogen bond, whereas Compound 2

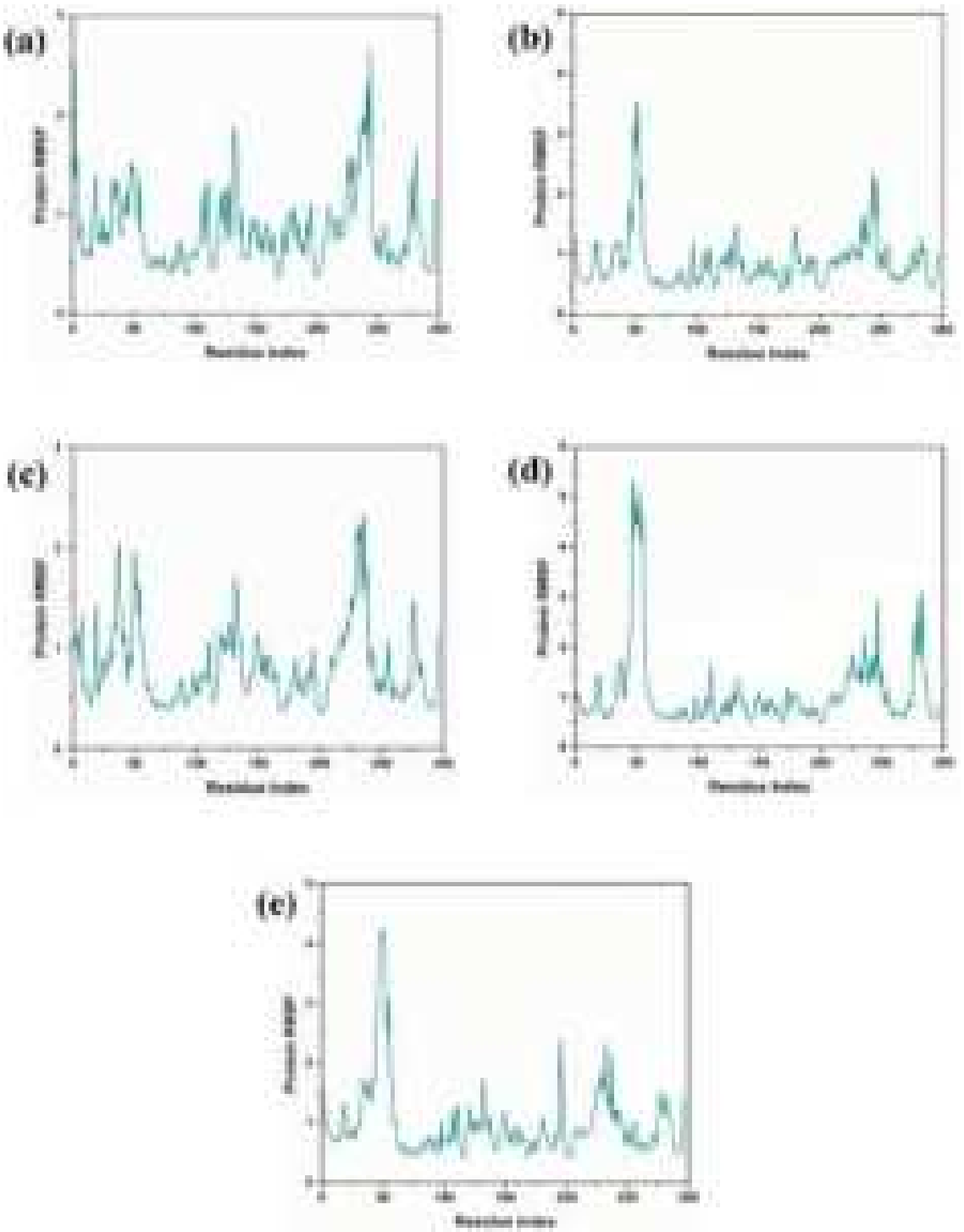

Fig. 5 RMSF analysis of selected compounds in complex with the target protein four selected compounds **a** compound 1, **b** compound 2, **c** compound 3, **d** compound, and **e** control

exhibited the formation of two to three hydrogen bonds. Moreover, the initial phase of the simulation revealed the formation of four bonds, which denotes a notable deviation in intermolecular interactions compared to the subsequent simulation period. Conversely, Compounds 3 and 4 each exhibited the formation of a single hydrogen bond, indicating a consistency in their hydrogen-bonding behavior. The control compound, in contrast, displayed a more complex hydrogen-bonding pattern, with the formation of six to

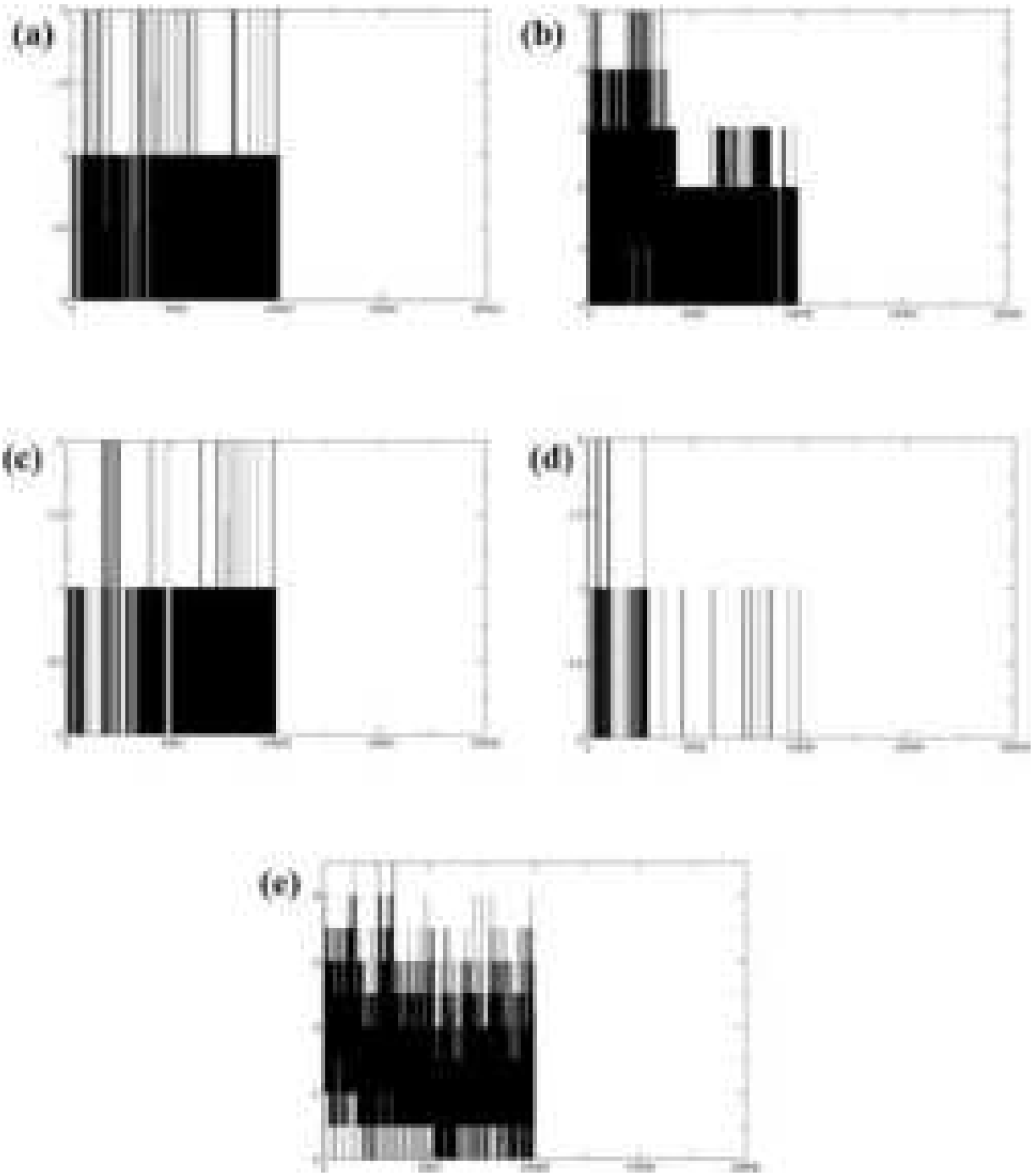

Fig. 6 Hydrogen bond analysis of selected compounds in complex with the target protein four selected compounds **a** compound 1, **b** compound 2, **c** compound 3, **d** compound, and **e** control

seven hydrogen bonds persisting throughout the entirety of the simulation period. This observation suggests a significantly higher stability and potential intermolecular interaction within the system facilitated by the control compound, as compared to Compounds 1, 2, 3, and 4.

MM/GBSA analysis

The binding free energy of the complex was calculated using the MM/GBSA approach. This approach analyzed the various constituents to ascertain their collective binding energy (ΔG). The compound 2 exhibited a ΔG value of

Table 2 MM-GBSA analysis of selected compounds in complex with the target protein four selected compounds (a) compound 1, (b) compound 2, (c) compound 3, (d) compound 4, and (e) control

Energy components/complexes	24349836	26616083	26648979	26651264	Control
Van der waal energy (ΔVDWAALS)	− 49.32 ± 3.29	− 59.68 ± 3.06	− 45.93 ± 1.87	− 54.90 ± 3.16	− 55.16 ± 2.27
Electrostatic energy (ΔEEL)	1.78 ± 2.61	− 19.84 ± 3.64	− 13.63 ± 2.62	− 5.48 ± 2.89	− 28.95 ± 12.77
Polar solvation energy (ΔEGB)	5.40 ± 2.14	29.55 ± 2.07	25.75 ± 2.74	25.98 ± 2.59	36.83 ± 11.84
Non-polar solvation energy (ΔESURF)	− 24.01 ± 1.50	− 21.02 ± 0.79	− 21.32 ± 2.15	− 14.45 ± 0.78	− 10.52 ± 0.52
Net gas phase energy (ΔGGAS)	− 47.54 ± 5.19	− 79.52 ± 6.71	− 59.56 ± 4.5	− 60.38 ± 6.06	− 84.12 ± 15.05
Net solvation energy (ΔGSOLV)	− 18.61 ± 3.65	8.53 ± 2.86	4.43 ± 4.89	11.53 ± 3.38	26.31 ± 12.36
ΔG_{total}	− 66.15 ± 29.56	− 70.98 ± 9.57	− 55.13 ± 9.39	− 48.85 ± 9.44	− 57.80 ± 27.42

− 70.98 ± 9.57 kcal/mol. The Gibbs free energy change (ΔG) for the molecule with compound 1 was determined to be − 66.15 ± 29.56 kcal/mol. The compound 3 has a ΔG value of − 55.13 ± 9.39 kcal/mol. The compound 4 had a ΔG value of − 48.85 ± 9.44 kcal/mol. Table 2 illustrates the ΔG value of the control compound, which was − 34.19 ± 36.98 kcal/mol. Moreover, the ΔG values of the tested compounds were similar to those of the control complex, suggesting a strong and sustained binding interaction with the target protein. The complexes being studied exhibited a robust and efficient binding relationship with the target protein, as evidenced by their high degree of similarity to the control complex. Reducing standard deviations improve the reliability and consistency of the estimated binding energies. The collective results of this research indicate that the compounds being examined have a strong attraction to the target protein, indicating that they are stable and effective ligands that impede their mode of operation.

RG-RMSD-based free energy landscape

The free energy field plays a crucial role in molecular dynamics simulations as it elucidates the distribution of energy and the conformational changes in biomolecular systems. The concept of the free energy landscape is crucial for comprehending biomolecular systems, as it provides a beneficial means of uncovering the thermodynamic and kinetic characteristics inherent in these intricate structures. This landscape depicts energy barriers, stable states, and pathways for transitioning between different molecular conformations. Valleys indicate stable states, whereas peaks represent energetic obstacles. Gaining insight into the thermodynamics and kinetics of a biomolecular system is essential for comprehending the intricate interactions, conformational alterations, and overall stability of the biomolecular complex. The RG study yielded insights into the protein-folding process. The RMSD analysis provides information into the dynamic stability of the complex. To construct the two-dimensional free energy landscape, a graphical was developed by projecting the RG onto the RMSD, as illustrated in Fig. 7.

This approach examined both complexes with ligands and their corresponding control group. These graphical representations aid in comprehending the energy consequences of changes in the shape of the compounds being studied. Moreover, two-dimensional projections offer a clear and detailed depiction of the dynamic conformational changes that take place throughout the simulation.

This structure allows the determination of a low-energy configuration that provides crucial insights into the energetically favorable states of the biochemical system. The occurrence of a deep blue area in the extended free energy landscape represents the most stable state. This phenomenon seems to have occurred repeatedly during the experiment when the protein structures reached their states of minimum energy. The dark blue areas are particularly noticeable in chemical groups. They demonstrate the formation of structures in situations with minimal energy. The complexes consistently exhibited energy minima, which were integral components of a broader free energy landscape, as indicated by the dark blue region.

It is important to mention that the minimal energy state, which serves as a reference point, was consistently determined to be 0 kJ/mol in all complexes. The analyzed chemical complexes' thermodynamic free energy landscape, including a control compound, provides accurate details about their molecular dynamics and stability characteristics. One notable characteristic of this environment is the existence of a consistently high energy state within a range of 16 to 17.5 kJ/mol among these complexes. The same energy threshold seen in all complexes indicates a possible uniformity in structural or functional characteristics, such as molecular interactions or stability. Furthermore, it is worth noting that all the complexes exhibit a stable conformation at energy levels below 2 kJ/mol, as evidenced by the presence of a dark blue color on the landscape. From the low-energy states, three stable configurations were identified and extracted. Subsequently, a superimposed structure was constructed using the initial configuration as the reference

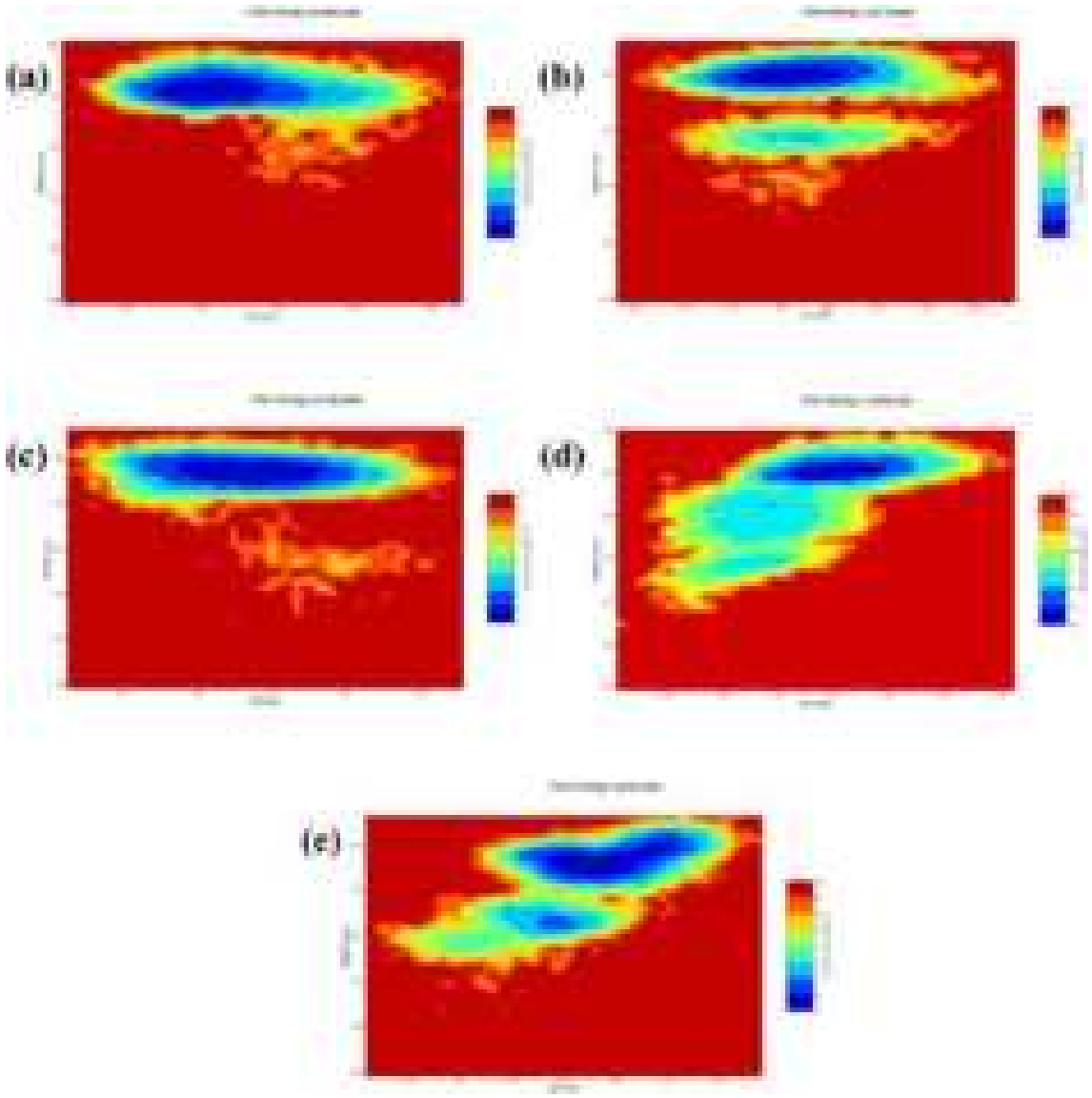

Fig. 7 RG-RMSD-based Free Energy Landscape analysis of selected compounds in complex with the target protein: four selected compounds **a** compound 1, **b** compound 2, **c** compound 3, **d** compound 4, and **e** control

point. Furthermore, overall RMSD values for the superimposed structures were calculated, as depicted in Fig. 8. The superimposed structure of compound 1 exhibited an overall RMSD of 0.583 Å, indicating the degree of deviation from the reference pose. Similarly, for compound 2, the overall RMSD value was observed to be 0.691 Å. The superimposed structure corresponding to compound 3 exhibited an overall RMSD of 0.630 Å, while that of compound 4 exhibited an overall RMSD of 0.577 Å. In comparison, the control compound's superimposed structure exhibited an overall RMSD value of 0.695 Å, illustrating the structural variations upon superposition relative to the reference pose.

Our study identified four Diverse-lib compounds (24349836, 26616083, 26648979, and 26651264) from a pool of 1500 candidates based on their binding energies, indicating a strong potential for interaction with the target protein [26]. Their binding energies were observed in a relatively close range, suggesting a potentially similar degree of affinity towards the ML2640c protein. Compound 24349836 and Compound 26616083 showed notably high negative binding energies, suggesting that they may form more stable complexes with ML2640c. While compounds 26648979 and 26651264, exhibited slightly lower binding energies, which may indicate a lesser but still significant potential to interact effectively with the target protein. The re-docking results reinforced the virtual screening findings, with all four compounds showing strong docking scores. The molecular interaction analysis revealed a detailed picture of

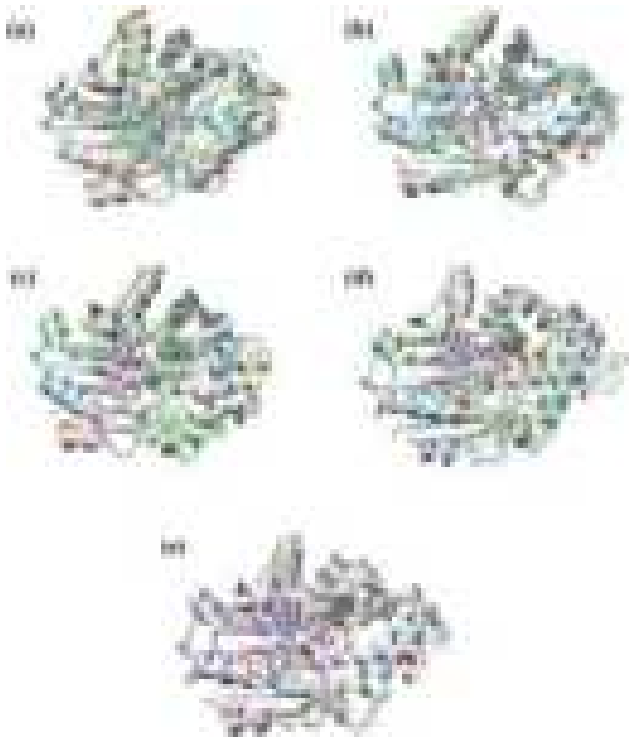

Fig. 8 Superimposition of FEL minima structures extracted from MD trajectories of each complex with initial MD pose: **a** compound 1, **b** compound 2, **c** compound 3, **d** compound 4, and **e** control

how each compound interacts with ML2640c [27]. Compound 24349836 exhibited a balanced mix of hydrogen bonds and hydrophobic interactions, suggesting a robust interaction mechanism with multiple anchor points on the protein. Compound 26616083 showed a significant number of hydrophobic interactions and π–π stacking, indicating a possible strong affinity through these non-covalent interactions. The compound 26648979 exhibited hydrogen bonds and a substantial number of π–π stacking interactions, which might contribute to its stable binding to the protein. Compound 26651264, despite not forming hydrogen bonds, formed hydrophobic and π–π stacking interactions, suggesting an alternative mode of strong interaction with ML2640c. Another work conducted on the ML2640c also discovered some common interactions, such as Ala110, Gly112, Asp132, Asp161, Leu162, Arg163, Glu186, Gly187, and Leu188, which support our findings [8]. The MD simulations provided insights into the dynamic behavior and stability of each compound-protein complex over time [21]. Compounds 24349836 showed a considerable degree of stability in their interactions with ML2640c, as evidenced by their RMSD values compared to compound 26616083 which exhibited slightly higher RMSD comparatively. This indicates that once bound, these compounds are likely to remain securely attached, potentially inhibiting the protein's function effectively. Compound 26648979, while stable, exhibited a slightly higher RMSD value, suggesting that it may undergo more significant conformational changes upon binding. This could affect its inhibitory effectiveness over time. Compound 26651264 exhibited a similar level of stability to the first two compounds, reinforcing its potential as a viable inhibitor despite its unique interaction pattern. The MM/GBSA calculations further quantified the binding affinities of the compounds to ML2640c. Compound 26616083 exhibited the most negative ΔG value, indicating the strongest binding affinity among the four compounds. This suggests that it could be the most potent inhibitor of ML2640c. Compound 24349836 also showed a strong binding affinity, reinforcing its potential as an effective inhibitor. While compounds 26648979 and 26651264 exhibited less negative ΔG values, presented significant binding affinities, suggesting that they could also effectively inhibit ML2640c. The comparative analysis suggests that while all four compounds have promising characteristics as potential inhibitors of ML2640c, differences in their binding energies, interaction patterns, and dynamic stabilities indicate varying levels of potential efficacy. Compound 26616083 stands out due to its strong binding affinity and stable interaction, making it a prime candidate for further experimental validation. However, the unique interaction profiles and stability of the other compounds also highlight the importance of considering a multi-faceted approach to therapeutic development, where this analysis emphasizes the nuanced differences between the compounds and suggests a path forward for their further investigation and potential development into therapeutic agents against leprosy treatment.

Conclusion

Our study embarked on a computational method to discover and analyze potential inhibitors of the ML2640c protein from *Mycobacterium leprae*, leveraging advanced computational methodologies including virtual screening, re-docking, molecular dynamics simulations, and free energy calculations. The identification of four compounds (24349836, 26616083, 26648979, and 26651264) highlights the potential of computational drug discovery in advancing our arsenal against leprosy, an ancient disease that continues to pose significant public health challenges worldwide. The comparative analysis of these compounds revealed their varying degrees of binding affinities and interaction mechanisms with the target protein, suggesting a nuanced landscape of potential therapeutic agents. Compound 26616083, in particular, emerged as a lead candidate due to its strong binding affinity and favorable interaction dynamics, presenting a promising candidate for further experimental validation and optimization. They underscore the transformative

potential of computational drug discovery in identifying therapeutics for infectious diseases. However, the journey from computational models to clinical applications is long and complex. The compounds identified in this study represent initial candidates that require further validation through in vitro and in vivo experiments to confirm their efficacy and safety. In addition, exploring the possibility of synergistic effects through combination therapies could further enhance their therapeutic potential. Our research demonstrates the critical role of computational drug discovery in identifying new therapeutic targets and compounds for leprosy treatment. As we move forward, a multidisciplinary approach, combining computational insights with experimental validation and clinical expertise, will be essential in translating these findings into tangible health benefits for those affected by leprosy. The implications of these findings not only contribute to ongoing efforts to combat leprosy but also exemplify the broader applicability of computational methods in addressing global health challenges.

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Author contributions R.B. and A.V.T. contributed towards conceptualization. A.V.T contributed towards supervision. R.B. performed all the experiments. R.B. contributed towards writing—original draft preparation. R.B. and A.V.T. contributed towards writing—review and editing.

Data availability No datasets were generated or analyzed during the current study.

Declarations

Conflict of interest The authors declare no conflict of interest.

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CONTENTS

ENVIRONMENTAL CONCERNS AND SUSTAINABLE DEVELOPMENT: ISSUES AND CHALLENGES FOR INDIA

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Abstract

The vast environment resources like air, land and water for our sustenance has in the pursuit of development and advancement destroyed the nature forever. When we speak of our Mother Earth it stands to serious consequences as the ecological balance is disturbed due to overuse or abuse of the natural resources. The consequences include global warming, sudden changes in the climate, acid rain, ozone layer depletion, extinction of wildlife, etc. In India rapid and unplanned expansion of urban has resulted in the degradation of urban environment. Ever deepening the problem of environmental research base of the issue. Growing awareness regarding legal responsibilities in regarding the environment, use of the media to increase awareness, introduction of environmental issues in mainstream education, encouraging public participation in environmental protection are some of the measures one can undertake for combating the perceived problems. While efforts are being made at the national and international level to protect our environment, it is also the responsibility of every citizen of India to save our environmental resources conservatively and prevent them from degradation. The issues and challenges before a developing country like India are immense but not only create environmental crises in natural hazardous. Despite all adversities India's endeavour has not only saved the country through advocacies but also led to the development of strong preventive solutions through awareness support globally as India stood like a lighthouse to the world through the troubled waters of environmental crises.

Key Words: Environment, awareness, ozone layer, conflict, preventive, pollution, sustainable development.

Introduction

The Earth is our abode and provides us with all the resources that are required for sustenance. The environment which comprises all the elements that affect the growth and development of all living species should be protected. But while meeting our ever growing needs and knowingly or unknowingly affect our environment. When we act against the capacity of the environment to regenerate itself, it results in environmental degradation. When we destroy the natural habitats as a corollary of urbanization our natural resources are depleted and we invite global warming. If we use our environmental resources beyond its limit of replacement, we may lose it forever. Therefore we need to act conscientiously and be concerned in preserving our environment. India being a populous country is facing tremendous challenge of environmental abuse. The issues and challenges before a developing country to ensure sustainable development amidst environmental crises is indeed herculean. Despite this India's endeavour has not only save the country through advocacies but also led to the development of strong preventive solutions through awareness support globally as India stood like a lighthouse to the world through the troubled waters of environmental crises.

Review of Related Literature

The need of the hour is to create awareness regarding environmental protection and motivate people to take action by preventing and eventually eradicating environmental disaster from this earth. The present study shall not only create awareness regarding our country's as well as global challenges related to environmental issues but also motivate proactive participation by fostering a sense of responsibility towards environment protection and being instrumental in bringing about positive changes in the environment.

Various stakeholders including individuals such as economists, ecosystem [illegible], ecologists, physicians, etc., emerging fields of study such as EcoHealth or Health ecology and various organizations studying how ecosystem changes affect human health and as a corollary performing yeoman service by understanding the problems have been brought into limelight for awareness and responsible participation to protect our abode the planet earth. For example a major factor responsible for the endangered wildlife is trade and commerce. CITES, an international treaty was thus introduced to protect wildlife and endangered species from becoming extinct. The study also reveals how the 'Chipko' movement led to the [illegible] of many anti-development camps.

The study exposes the ecosystem change created by human beings leading to deadly diseases such as SARS, COVID-19 which are not only dangerous but have baffled medical sciences.

Resorting to fossil fuel as a remedy for lack of proper energy resources by India leading to further [illegible] pressures on our land and the discovery of huge quantities of Lithium in Kashmir which will act as a great asset for developing and strengthening geopolitical relations through trade has been reviewed in the literature.

The study also reviews the work carried out by agencies like EPA, MATE, IEA, IPCC, etc. and specific laws for environmental protection which have been amended from time to time to ensure safety for preserving our natural resources and wildlife which are all a part of nature's cycle.

Objectives of the Study

1. The main objective of the study is to analyze the environmental concerns that pose crucial challenges for India.
2. To categorize and scrutinize issues responsible for causing air, water and soil pollution in India and on a global scale.
3. To identify the factors that can contribute to the sustainable development of India despite the adversities posed by the onslaught of climate change, global warming and attacks on the country due to geopolitical issues.
4. Introspection and consequently recommending proactive steps which can and has to be taken to arrest the effects of environmental degradation due to irresponsible human behavior, natural calamities or geopolitical onslaughts on the environment through virtual attacks on the country.

Research Methodology

The research problem scrutinizes whether the interventions of human beings in nature's cycle by their carrying out various activities in the course of life using natural resources creates long term impact on the environment leading to catastrophes. In order to get a better insight and explore the hypothesis a qualitative method of research has been used with in depth study of different features of the topic in thematic analysis and related literature to justify the objectives.

Main Content

What are the causes and effects of environmental degradation?

One of the major reasons for the misuse of environment in India is overpopulation mainly due to the exodus of people to different parts of India due to geographic liabilities or political insecurity. Creation of huge metropolitan cities due to industrialization with problems such as uncontrolled sewage and garbage disposal leads to environmental health hazards. Human intervention further includes deforestation. All these factors lead to water, air and land pollution. Noise as an environmental pollutant has serious consequences. Being exposed to consistently loud sounds can cause hypertension, hearing problems, ischemic heart disease, vertigo and insomnia. It can also create stress and stimulate aggression and anti-social behavior. Air pollution which denies us fresh oxygen is caused due to release of toxic chemicals into the atmosphere by industries and vehicles. Activities

Abstract

This article investigates the relative convergence of infant mortality rate (IMR) across the 15 major Indian states for the period 1987–2020. To test this hypothesis, this study applies Phillips and Sul's (2007) panel convergence test. Further, for the robustness of our findings, this study implements the extension of Phillips and Sul's relative club convergence test, which Kwak propounded in 2021. The results based on Phillips and Sul show divergence in IMR among the states; however, the existence of convergence when 15 states are grouped into different clubs. Four final clubs emerged based on the Kwak test, suggesting that each club has its unique transition path. One group is also identified, suggesting neither convergence nor divergence. From the policy perspective, it is important for the government to target reducing IMR by emphasising at the club level rather than focusing on all states together.

JEL Codes: I140, H75

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Self-reported Diabetes and Challenges in Its Management among Older Adults in Assam, India

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Abstract

This study examines the prevalence and management of diabetes among the older adults in Assam, India. This study utilizes the data from the first wave of the Longitudinal Ageing Study in India (LASI) conducted in 2017 – '18, covering 72,250 eligible individuals residing in a sample of 42,949 households surveyed. LASI adopted a multi-stage area probability cluster sampling design, a three-stage sampling design for rural areas; and a four-stage sampling design for urban areas. Those aged below 45 years are excluded from this study. Hence, the results are based on a representative sample of 2006 eligible individuals surveyed in the state of Assam.

Multivariate logistic regression analysis is used to study the association between socio-economic factors and prevalence of diabetes. Further, the risk prevalence of unhealthy behaviours among the diabetes patients is calculated to present a clear picture of the attitude towards diabetes management by the people of Assam. Findings confirm a high self-reported diabetes in the urban, educated, and richest sections but the prevalence was substantial among their remaining counterparts. Older adults with a parental history of diabetes were 6.3 times more likely to report than others. The majority of the diabetes patients (58 %) had hypertension. Among those with self-reported diabetes, 37 per cent was not under any diabetes medication, 11 per cent was not taking a special diabetic diet, 22 per cent was physically inactive, and 33 per cent was either overweight or obese. Policy-level interventions need to be strengthened further to counter the rural-urban disparity in access to diabetic medication, unfavourable dietary regimes, and physical activity levels observed among those with self-reported diabetes.

Key words: Diabetes, Older adults, Diabetes prevalence and management, Diabetes Comorbidities, LASI, Assam, India.

Introduction

Diabetes is a widespread health issue that affects a significant portion of the world's population, with type 2 diabetes accounting for 90 per cent of diabetes cases. The condition arises when the body either cannot effectively use the insulin produced or does not produce enough insulin. India, in particular, is facing an alarming prevalence of diabetes, with more than 74 million individuals

living with diabetes in 2021, and this figure is predicted to rise to 125 million in the next 24 years[1]. This has led to India being labelled as the "Diabetes Capital of the world."

The complications of diabetes including microvascular and macrovascular complications result in increased morbidity and mortality rates[2]. This is further compounded by the fact that diabetes often leads to other comorbidities[3]. According to the Non-Communicable Disease Risk Factor STEPS Survey-India, hypertension is the most prevalent comorbidity affecting 60 per cent of diabetes patients, followed by obesity (46%), dyslipidemia (36%), hypertriglyceridemia (30%), hypercholesterolemia (16%), cardiovascular disease (13%), stroke (6%), and chronic kidney disease (5%)[4]. Similarly, the Chennai Urban Rural Epidemiological Study reports that the prevalence of diabetic retinopathy, microalbuminuria, peripheral neuropathy, coronary artery disease, and peripheral vascular is 18 per cent, 27 per cent, 26 per cent, 11 per cent, and 6 per cent respectively[5-9]. However, proper disease management can delay the onset of these comorbidities.

Unfortunately, the DiabCare Asia study on diabetes control and complications in the Asian countries paints a grim picture of diabetes management in India, with approximately half of the diabetes patients having poor glycemic control and early incidence of type 2 diabetes[10]. Moreover, the prevalence and management of this uncontrolled epidemic in the north-eastern states of India including Assam, have not been subjected to substantive investigation due to the lack of epidemiological data[11]. Assam has an estimated population of 35 million in 2021 and accounts for 68 per cent of the population of north-eastern India[12].

Recent national survey-based estimates for the population aged 15 years and above in Assam reveal that 13 per cent of females and 16 per cent of males have high or very high blood sugar levels (>140 mg/dl) or are taking medicine to control their glycemic levels which is similar to the average situation in India[13]. However, this dataset is yet to be released, and researchers rely on reported diabetes data from other national surveys to examine the prevalence of diabetes among older adults in India. Using the Indian Diabetes Risk Score (IDRS), it is found that among the Longitudinal Aging Study in India (LASI) respondents in Assam, 10 per cent are at low risk, 64 per cent are at medium risk and 26 per cent are at high risk[14].

This study aims at analyzing the prevalence of self-reported diabetes in Assam and the challenges faced by diabetes patients in terms of comorbidity and management of the disease. The findings will add to the limited epidemiological data on diabetes in the north-eastern states of India and provide insights into the situation in Assam. By understanding the prevalence and management of diabetes in Assam, policymakers and healthcare providers can develop strategies to improve diabetes prevention, management, and care.

Methodology

The study uses data from the first wave of the Longitudinal Ageing Study in India (LASI) conducted in 2017 – '18, covering 72,250 eligible individuals residing in a sample of 42,949 households surveyed[15]. LASI adopted a multi-stage area probability cluster sampling design, a three-stage sampling design for rural areas, and a four-stage sampling design for urban areas. It is India's first nationally representative household survey to estimate the prevalence of chronic

diseases among older adults and the elderly population across the socioeconomic spectrum, nationwide as well as for states and union territories. All married and non-married men and women aged 45 and above, along with their spouses in selected households, were eligible to participate in the survey. LASI covered 2366 eligible persons residing in a sample of 1511 households in Assam. The researchers excluded the spouses aged below 45 years; hence, the results presented here are based on a representative sample of 2006 eligible individuals surveyed in Assam. Results presented here were obtained after applying state-specific sampling weights presented in the LASI data set.

The self-reported prevalence of nine types of chronic health conditions/diseases including diabetes, amongst the respondents, was assessed in LASI through the question, "Has any health professional ever diagnosed/told you that you have the following chronic conditions or diseases?" This information was used in the analysis to determine the risk of self-reported diabetes in the study population. The prevalence of self-reported diabetes was analyzed by these factors: age (45-49,50-54,55-59,60+), sex (male, female), place of residence (urban, rural), number of years of schooling (no education, <5 years, 5-10 years, 10+ years), employment status (currently working, not working), monthly per capita consumption expenditure (poorest, poor, middle, rich, richest), caste (Scheduled Tribe, Scheduled Caste, Other Backward Classes, others) and religion (Hindu, Others). Social groups represent the respondent's status in the social hierarchy, which continues to be predominant in India. The four commonly used social group categories in ascending order of social hierarchy and vulnerability are scheduled tribes, scheduled castes, other backward classes, and "others" or the rest of the population. Here the economic status is based on the monthly per-capita consumer expenditure (MPCE) variable available in the data set which is derived using the information on the expenditure incurred by the sample households on 40 food and non-food items. State-specific rural-urban adjusted MPCE quintiles were created to identify the household's economic status. Bivariate analysis is followed by a multivariate binary logistic regression analysis to understand the adjusted odds/risk of self-reported diabetes within these subgroups under study.

The prevalence of selected comorbidities and risky behaviors that contribute to poor management of blood sugar levels were examined for 145 cases in the sample with self-reported diabetes. These analyses were disaggregated by place of residence due to the unavailability of enough sample size and also due to urban disadvantage in the prevalence of diabetes in this subcontinent. A similar disaggregated analysis could not be performed for other variables due to scarcity in the number of sufficient self-reported diabetes cases in the LASI sample for Assam state in India.

Among those with self-reported diabetes, the rural-urban differences in associated comorbidities were examined using data from similar self-reported questions mentioned above. Comorbidities that we examined were hypertension, chronic heart disease (CHD), stroke, and high cholesterol. Based on comorbidity status, the self-reported diabetes cases were further classified as those with only diabetes, diabetes and hypertension, diabetes and CHD or stroke, diabetes and high cholesterol, and diabetes and more than one of these conditions.

The four vital risky behaviours among the self-reported diabetic patients examined were: non-medication for diabetes, not following special diet adherence to control diabetes, physical

inactivity, and overweight/obesity. Information on the risk of not continuing diabetes treatment was obtained from the survey question to diabetic patients on "If they were taking medicines for controlling diabetes?" This is seen as a proxy indicator for treatment continuity, even though a small share of patients will not require medication. The response to the survey question- "In order to control your diabetes, are you following a special diet?" was used to understand the risk of not following a special diet for controlling this disease. The risk of a sedentary lifestyle among cases with self-reported diabetes was judged based on their physical activity levels. Physically inactive were defined as those who did not perform at least 150 minutes of moderate-intensity physical activity throughout a week or 75 minutes of vigorous physical activity throughout a week. Body mass index (BMI) was used for measuring the risk of poor body composition among self-reported diabetes patients. Proportion over-weight (BMI≥ 25) and obese (BMI ≥30) were computed for the same.

The analysis was performed using the statistical software STATA 15.0. Results presented here were obtained after applying state-specific sampling weights presented in the LASI data set.

Findings

Table 1 presents the background characteristics of the population and the prevalence of self-reported diabetes in Assam, India, during the years 2017 - '18. This Table provides an overview of the demographic distribution and the burden of diabetes in the region. The data presented in Table 1 show the prevalence of diabetes among respondents according to their background characteristics. It confirms the established pattern that the likelihood of diabetes increases with age. For example, the prevalence of diabetes is 10 per cent for the 55-59 age group, and it increases to 8.8 per cent for those who are 60 or older. In contrast, the prevalence of diabetes is relatively lower for those in the 45-49 and 50-54 age groups, at 4.7 per cent and 7 per cent respectively.

The distribution of diabetes prevalence also indicates that men are more likely to be diabetic than women. Specifically, the data show that 8.8 per cent of men and 6.6 per cent of women are diabetic. Moreover, the likelihood of having diabetes increases with social status. The prevalence of diabetes is highest for those who have at least ten years of schooling, at 14.7 per cent, and for those who fall in the topmost mpce strata, at 12.2 per cent.

The data also reveals a significant difference in diabetes prevalence between urban and rural areas. The prevalence is 13.7 per cent among urban adults and 6.4 per cent among rural adults. In terms of religion, there is no apparent distinction in diabetes prevalence. However, there is a stark contrast among castes. The prevalence of diabetes is higher among individuals of Scheduled caste, at 13.1 per cent, compared to Scheduled Tribe, at 5.7 per cent, Other Backward Classes, at 6.9 per cent, and General, at 7.8 per cent.

Table 1

Background Characteristics of Population and Prevalence of Self-Reported Diabetes in Assam, India 2017 - '18

	Population characteristics		**Self-reported diabetes**
Characteristics	**Weighted cases (N)**	**distribution (%)**	**Prevalence (%)**

Age			
45-49	503	25.1	4.7 (3.1-7.2)
50-54	355	17.7	6.9 (4.4-10.5)
55-59	307	15.3	10.0 (6.7-14.6)
60+	841	41.9	8.8 (6.8-11.3)
Sex			
Male	944	47.0	8.8 (7.0-10.9)
Female	1062	53.0	6.6 (5.0-8.7)
Place of residence			
Rural	1660	82.8	6.4 (5.2-7.7)
Urban	346	17.3	13.7 (9.6-19.2)
Education			
No schooling	817	40.7	0.0 (2.9-6.2)
<5 years	317	15.8	9.5 (6.3-14.3)
5-9 years	496	24.7	6.5 (4.7-9.1)
10 + years	376	18.7	14.7 (11.0-19.3)
Social group			
Scheduled Caste	180	9.0	13.1 (7.7-21.4)
Scheduled Tribe	314	15.7	5.7 (3.3-9.9)
Other Backward Classes	791	39.5	6.9 (5.2-9.1)
None	720	35.9	7.8 (6.0-10.1)
Religion			
Others	1545	77.0	7.5 (6.1-9.2)
Hindu	461	23.0	8.1 (5.9-11.1)
Current working status			
Yes	954	47.5	6.1 (4.6-7.9)
No	1052	52.5	9.1 (7.2-11.3)
MPCE quintile			
Poorest	379	19.0	3.8 (2.3-6.4)
Poorer	396	19.8	7.9 (5.2-11.8)
Middle	405	20.3	7.3 (4.8-10.9)
Richer	423	21.1	7.0 (4.8-10.1)
Richest	397	19.9	12.2 (9.0-16.3)
Family history of diabetes			
yes (at least parent)	101	5.0	33.3 (23.2-45.2)
No	1905	95.0	6.3 (5.2-7.6)
Total	**2006**	**100.0**	**7.6 (6.4-9.1)**

Table 2 examines the relationship between the socio-economic factors and the likelihood of developing diabetes in the same population through a multivariate analysis. Table 2 helps in identifying the significant risk factors that contribute to the development of diabetes and can guide public health interventions. The results from a multivariate analysis examining the relationship between socioeconomic factors and the likelihood of developing diabetes are presented in Table

2. The study found that having at least one parent with diabetes increases an individual's odds of developing the disease by six times (adjusted odds ratio of 6.3, 95 per cent confidence interval [CI]: 3.6-11.0).
Regarding socioeconomic factors, individuals in the highest wealth quintile were found to have higher odds of being diabetic (adjusted odds ratio of 2.6, 95% CI: 1.2-5.6) compared to those in lower quintiles. Similarly, residing in urban areas (adjusted odds ratio of 2.0, 95% CI: 1.2-3.3) or having at least ten years of schooling (adjusted odds ratio of 2.7, 95% CI: 1.5-4.9) were associated with a two-fold increase in the likelihood of having diabetes.

The study did not find any significant impact of sex on the likelihood of being diabetic. However, in line with previous research, age was found to be directly proportional to the odds of having diabetes. Individuals aged 60 and above had higher odds (adjusted odds ratio of 2.2, 95% CI: 1.3-3.8) of having diabetes compared to younger individuals.

Table 2

Adjusted Odds Ratio from Multivariate Logistic Regression Analysis for Self-Reported Diabetes in Assam, India 2017 – '18

Adjusted odds ratio	
Characteristics	Odds ratio (95% CI)
Age	
45-49	1
50-54	1.53(0.80-2.92)
55-59	2.48(1.32-4.66)
60+	2.19(1.25-3.83)**
Sex	
Male	1
Female	1.50(0.92-2.44)
Place of residence	
Rural	1
Urban	2.00(1.21-3.31)**
Education	
No schooling	1
<5 years	2.07(1.10-3.90)**
5-9 years	1.34(0.75-2.39)
10 + years	2.71(1.49-4.92)**
Social group	
None	1
Scheduled Caste	3.16(1.50-6.67)**
Scheduled Tribe	1.30(0.61-2.77)
Other Backward Classes	1.64(0.94-2.85)
Religion	

Hindu	1
others	2.17(1.22-3.86)**
Current working status	
yes @	1
no	1.65(1.00-2.76)
MPCE quintile	
Poorest	1
Poorer	1.93(0.93-4.01)

Table 3 presents the prevalence of selected risky behavioural characteristics in diabetes patients in Assam, India, during the years 2017 - '18, categorized by urban and rural populations. This Table helps in identifying the differences in behaviour and lifestyle between urban and rural people that may contribute to the risk or management of diabetes progression; and can help in drafting targeted interventions for diabetes.

Table 3 presents a bivariate analysis that examines the relationship between diabetes management and place of residence. To gain insight into diabetes management, the study looked at factors such as adherence to diabetic medication and diet, frequency of physical activity, and body mass index (BMI). The results reveal a sharp disparity in adherence to medical regimens, with 44 per cent of rural diabetes patients reporting not taking regular antidiabetic medication compared to 19 per cent of their urban counterparts. Urban populations enjoy a slight advantage due to the easy availability of resources, as evidenced by 14.7 per cent of urban versus 13.6 per cent of rural respondents reporting not following a diabetic diet.

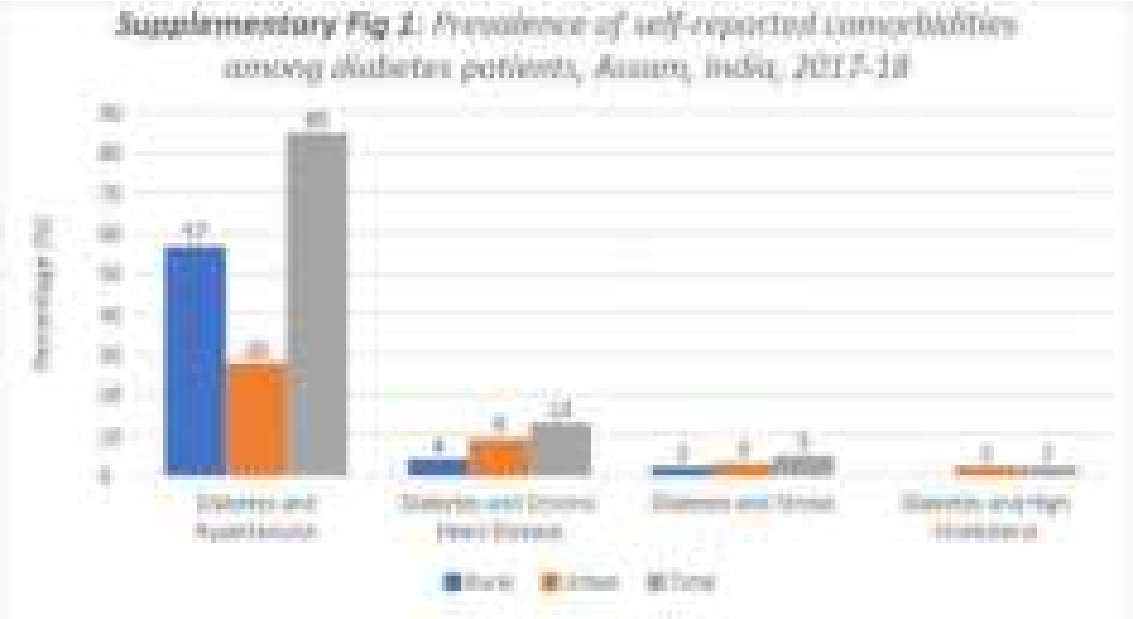
Table 3

Prevalence of Selected Risky Behavioural Characteristics in Diabetes Patients in Assam, India 2017-18

Not under medication for diabetes	**risk prevalence (%)**
Rural	44.0
Urban	19.7
Total	36.5
Not following any diabetes-related diet	
Rural	13.6
Urban	4.7
Total	10.9
Physically inactive (moderate/rigorous)	
Rural	18.9
Urban	28.8
Total	22.0
Overweight & obesity	
Rural	26.8
Urban	53.3
Total	33.2
Obesity	

Rural	5.9
Urban	1.5
Total	4.9

In addition to medication and diet, physical activity is equally crucial for regulating glucose levels in diabetic patients. Lifestyle and occupational differences between rural and urban diabetics are apparent, with 29 per cent of urban and 19 per cent of rural patients leading a sedentary lifestyle. Anthropometric measures, such as BMI, also follow the same trend, with almost half (53.3%) of urban diabetes cases having a BMI above the normal range compared to 26.8 per cent of rural respondents. Interestingly, rural diabetes patients report a higher rate of obesity, with 6 per cent falling within that range compared to 1.5 per cent of urban diabetes patients.



The supplementary figure provides a summary of the prevalence of comorbidities in individuals with diabetes in rural and urban areas. The differences in the percentages suggest that there may be disparities in the prevalence of comorbidities experienced by individuals with diabetes based on their place of residence. However, further research is necessary to understand the underlying factors contributing to these differences.

Discussion

Type 2 diabetes is a multifactorial disease caused due to the interplay of predisposed genetic makeup and environmental factors. Studies comparing Indians and European diabetic patients have found an ethnic variation of genetic factors that makes Indians with at least one diabetic parent more susceptible[16]. Moreover, the findings of this study are identical to CUPs and Viswanathan et al., which clearly showed that prevalence is higher for those with positive family history[17,18]. Further, these two studies also confirmed the "Double Gene dose effect" (both the parents are diabetic) for diabetes patients in India. Despite the empirical evidence suggesting a strong genetic role in diabetes incidence, it is worth noting that population gene pool shift occurs slowly, and the current diabetes epidemic can only be attributed to environmental changes.

Population belonging to the urban areas and upper socio-economic groups have a higher prevalence of diabetes. This is in line with the findings of the earlier studies, and the disparity can be attributed to the physical inactivity and adoption of the western dietary pattern[19-21]. The cause behind diabetes prevalence in the upper socio-economic groups of Assam can be compared with the epidemiological transition theory for developing countries mentioned by Omran AR, which states that in the developing regions, affluence is associated with a sedentary lifestyle and excess calorie consumption rather than better education and health awareness[22]. CUPS study also demonstrated the same factors to be one of the leading causes of increasing Insulin resistance syndrome among the urban population of Chennai[23].

The study exposes the large gaps in maintaining a diabetes-friendly lifestyle among diabetic patients. The nature of unevenness in access to diabetes treatment in this population is explicit, as more than one-third of the respondents reporting diabetes was not under any diabetic medication. The fact that the same was higher in the rural areas (44 %) than urban areas (20%) is a continuation of the rural-urban divide in coverage of health services in Assam as well as in India[13,15,24]. Every tenth diabetic patient (10%) did not follow any dietary restrictions to manage his/her raised blood sugar levels which is a matter of concern in rural than in urban populations. This could be considered as an indicator of the tip of the multiple challenges in following dietary restrictions recommended for diabetic patients, as the researchers of this study do not have any information from LASI on the data set on the periodicity, level of adherence to low-sugar diets, and kind of dietary diversity that is being followed by those reported to be following a special diet. In the current study, diabetes management is measured through the maintenance of a diabetic-specific diet, medical regimen, BMI, and the inclusion of physical activities in daily life. Place of residence plays an essential role in determining the availability of resources and flow of information. The impact of unverified health routines and health facility scarcity on poor diabetes management can be inferred from the urban-rural disparity[25]. Further, in assessing the inclusion of vigorous to moderate physical activities, rural areas have slightly more active individuals than urban areas[26]. The findings of this study state the same. It shows that the urban diabetic patients are better at following a diabetes diet and antidiabetic medications; on the other hand, the rural population is found to be comparatively more active on the physical exercise front.

More than one-fifth of diabetic patients led a sedentary lifestyle without adequate physical activities. One-third of the respondents reporting diabetes was either overweight or obese which also is an outcome of poor dietary practices and inadequate physical activity noted in this study. The risk of overweight and obesity is double among those with diabetes than the population in the corresponding age group in the Assam population (16 %). This shows the lack of interventions at the programme level as well as individual levels to promote a healthy body composition among the diabetic patient community. Here, urban diabetic patients were more likely to have a sedentary lifestyle and overweight/obese than their rural counterparts.

The above relationship between overweight/obesity and diabetes is bidirectional and confounded with many heterogeneous factors. Ramachandran et al.[27] and Huffman et al.[28] have found a positive association between diabetes and high BMI. Keeping BMI in the normal range is considered key to managing type 2 diabetes as it reduces the risk of microvascular complications[29,30]. The findings of the present study suggest that almost half of the urban and a

quarter of rural diabetic patients are at risk of developing hyperglycemia, hypertension, and hyperlipidemia due to above-normal BMI. Additionally, the current study illustrates the fact that a noticeable share of the diabetic patients also suffer from hypertension. Apart from that, no substantial comorbidity associations can be deduced due to limited data.

The study's major limitation is the use of self-reported diabetes data and hence, does not account for undiagnosed diabetes in the study population. The gaps in prevalence noted between various socio-economic groups will vary if there is a significant pattern in the prevalence of undiagnosed diabetes across these examined subgroups. LASI data set has only minimal information on access to medicines among the diabetic patients and their adherence to special diabetes diets. Hence, the researchers could only flag these critical issues noted in the population without examining them in detail. As mentioned earlier, further disaggregated analysis of comorbidity and challenges faced by diabetic patients in the management of diabetes could not be performed due to restrictions in the sample size.

The findings of this study advocate a multi-component approach to managing diabetes with an equal focus on a diet, physical activities and medicine. Also, the identification of high-risk groups is essential for optimizing the allocation of healthcare resources and the development of preventive strategies to minimize the associated morbidity and mortality.

Conclusion

The present study reveals the association between socio-economic characteristics and family anamnesis with the chance of developing diabetes. Assam is one of the states where a majority of the population is dependent on government health care services, and the limited focus on national health programmes on non-communicable diseases at the time of the survey period has contributed to poor access to diabetes medication[24]. The future depends on the implementation of the renewed National Health Mission that aims at providing comprehensive health care with a particular focus on NCDs through health and wellness centres across the country. Health programme managers in the state could use this as an effective platform to address the specific challenges in diabetes management brought out by the study relating to the access to diabetes medication, and advocacy requirement that is essential to bring about suitable changes in dietary behaviour and physical activities, for promoting the quality of life of those living with diabetes in India. Thus, from the results, it can be concluded that there is a need to spread awareness and knowledge on diabetes management, emphasis on following a diabetic diet, medical regimen, and regular physical activity.

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Availability of Trained Human Resources under the National Organ Transplant Programme at Tertiary Care Hospitals in Delhi: Opportunities and Challenges

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Abstract

National Organ Transplant Programme (NOTP) is a central scheme for Organ Transplantation in India that started in 2013. Under the programme, National Organ and Tissue Transplant Organization (NOTTO) functions as the centre for all activities for procuring and distributing organs and tissues in the country. The study objective was to assess the implementation of the NOTP at tertiary care government hospitals in Delhi under the specific category of availability and training of Human Resources under the programme. A descriptive study was conducted at four tertiary care hospitals in Delhi. Hospital personnel were interviewed. Semi-structured interview schedules were done and an observational checklist was filled. All qualitative data were analysed thematically. There was a need of sanction of more human resources to the Organ Transplant Department. Training of Transplant Coordinators by NOTTO was being regularly done. The Transplant Registry, and Networking with NOTTO and among the hospitals were efficient. The study concluded that NOTP is being efficiently implemented in Delhi with some gaps like over-burdened staff and deficient human resources.

Keywords: Organ Donation, Organ Transplantation, National Organ Transplant Programme, National Organ and Tissue Transplant Organization, Transplant Coordinators

Introduction

Organ transplantation is one of the most successful advances in modern medicine. Transplantation most often provides the only chance of survival for patients with end-stage disease. Even before the first transplant was performed, it was clear that organ transplantation could only be successful with a multidisciplinary approach. The history of organ transplantation has involved a series of breakthroughs in medicine that has influenced all aspects of health care[1]. Organ donation and transplantation have been the subject of extensive international interest at both governmental and professional levels. This interest has been driven by two main factors. First, the universal shortage of organs for transplantation and the wide international variation in donation and transplantation activity. Secondly, the need to ensure that all developments have a firm basis in legal and ethical practice with equity, quality, and safety at their core[2]. To streamline the organ donation and transplant process and stop organ commerce, the Government of India passed the Transplantation of Human Organs Act in 1994[3,4] which became effective in 1995. However, this law did not eradicate organ commerce. Organ commerce that was being practised

in the open before the law; was now being done with the help of false documentation. The concept of brain death was new to both the public and physicians, and there was a general lack of interest to promote this concept. From 1995 to 2000, there were only 35 hospitals that had attempted organ transplants from deceased donors, and of these, only a handful of hospitals in states like Tamil Nadu and Maharashtra have regularly engaged in the use of such donations[5,6]. In 2005, a national organ registry was established as a result of the efforts of the Indian Society of Organ Transplantation[7]. In 2008 (effective 2009), the Tamil Nadu state passed 10 government orders to facilitate the programme and defined all the procedures including the declaration of brain death and special cases (e.g., medico-legal situations, such as a road traffic accident, for which post-mortem procedures are required)[8]. This set forth the intent of the government to give a push to organ donation. In 2011, the act was amended, and this resulted in the formation of NOTTO, charged with the main objectives of promoting the use of organs from deceased donors, preventing commercial trade, and creating a national registry. To integrate organ donation into the process of end-of-life care, the Transplantation of Human Organs (Amendment) Act 2011[9] included a provision whereby patients and their families must be made aware of the "option to authorise or decline for the donation of human organs or tissues" of their next of kin as part of the standard intensive care unit (ICU) care. The deceased-donor organ donation rate in India is less than 1 per million, and NOTTO aims to increase the number of donations[10].

A large gap exists between the patients who require organ transplants and the available organ donors. There is a need to promote deceased organ donation. After only natural cardiac death, few tissues can be donated (like cornea, bone, skin) whereas after brain stem death, a person can donate many vital organs like kidneys, liver, heart, lungs, intestine and pancreas and tissues like corneas, skin, bones and heart valves etc[11]. Currently, India is facing issues and challenges for Organ Transplantation like high Burden of organ failure cases, poor availability of donors (demand Vs. supply gap), lack of awareness of the concept of Brain Stem Death, less number of Brain Stem Death certification by hospitals, inadequate infrastructure especially in Government sector institutions, lack of awareness and attitude towards organ donation, gaps in data reporting especially online entry by hospitals/ States in National Registry, high cost (especially for uninsured and poor), maintenance of standards in transplantation,[12] etc. The roles of registered organ/tissue transplant hospitals according to programme guidelines in terms of human resources are to train transplant coordinators, lab technicians and retrieval teams; to conduct training on Brain Stem death for doctors; and to conduct short orientation training for doctors, nurses and technicians[13].

Objectives

There were very less studies assessing the programme implementation. Hence, this study intends to

i) assess and evaluate the National Organ Transplant Programme at tertiary care government hospitals in Delhi under the specific category of availability; and
ii) analyse the training of Human Resources of various categories under this programme.

Methodology

The study design was descriptive in nature. The study was done at four government hospitals in Delhi, namely- All India Institute of Medical Sciences, Safdarjung Hospital, Dr. Ram Manohar Lohia Hospital and Institute of Liver and Biliary Sciences. 16 Hospital Transplant personnel (8 Transplant coordinators, 4 Nodal officers and 4 Transplant Specialists) were interviewed. Permission was taken from the Ministry of Health and Family Welfare (MoHFW), Government of India (GoI) for data collection from the above-mentioned hospitals. A semi-structured interview schedule questionnaire was developed. Secondary data were collected from records, reports produced by the concerned authorities and various published literature (articles, reports and research studies) and unpublished data in the form of observation. Websites of states, NOTTO/Hospitals were also referred. Previous annual reports of the programme were also referred to. The data collection for the study were done between January 2022 and April 2022. All qualitative data obtained through in-depth interviews with transplant personnel were analyzed thematically. Observation findings and secondary data collected were presented with the help of an appropriate table and thematic matrix (Table 1).

Table 1
Themes and Sub-themes for Thematic Analysis

Theme	Sub-Theme
Human Resource Availability and Training	1. Available versus Sanctioned Human Resource details 2. Training a. Induction training by NOTTO b. Regular periodic trainings by NOTTO c. Training by the hospital d. Duties performed by Transplant Coordinator in the hospital e. Duties performed by Nodal Officer in the hospital f. Duties performed by Transplant Specialist in the hospital g. The utilisation of training in performing duties h. Educational qualification of Transplant Coordinators i. Utilisation of educational qualification in performing duties j. Hurdles faced in accomplishing job responsibilities k. Recommendations by study participants for better implementation of the programme 3. Training of doctors 4. Training of nurses and paramedical staff

Findings

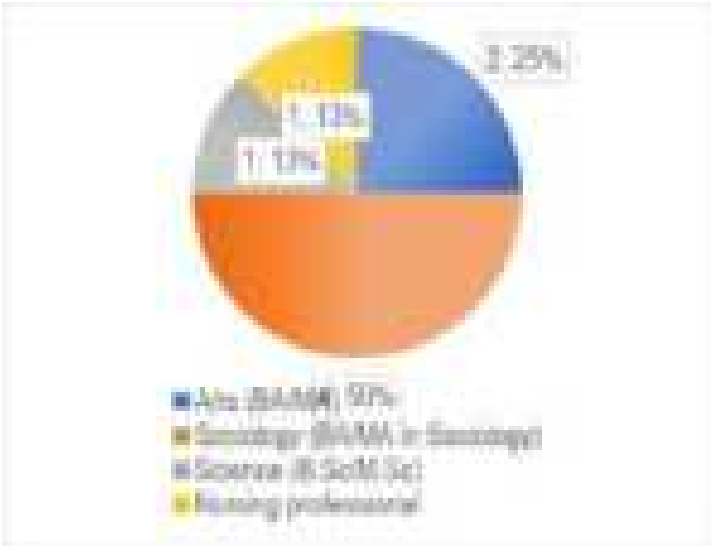
Figure 1 shows the total annual organ transplants in the study hospitals from 2001 to 2018. It clearly shows an improvement in the number of transplants after the 2011 amendment of the Transplantation of Human Organs and Tissues Act which provided the basis for the establishment of the National Organ Transplant Programme (NOTP) scheme and the National Organ and Tissue Transplant Organisation (NOTTO).

Figure 1
Total Number of Annual Organ Transplants in Study Hospitals from 2001 to 2018

Data source: Organ report, NOTTO. Available at: https://notto.gov.in/organreport.htm

It was found that the availability of human resources under the organ transplant department was compliant with the programme guidelines. The staff present was according to sanctioned strength in all the study institutes i.e. one Nodal Officer and two Transplant Coordinators. The transplant coordinators had different educational qualifications. As shown in Figure 2, most (N=4) transplant coordinators were graduates of Sociology and graduates of Arts (N=2). Some transplant coordinators were Science (N=1) and Nursing (N=1) graduates.

Figure 2
Educational Background of Transplant Coordinators (N=8)



The study participants responded that NOTTO conducts annually a one-week duration Transplant Co-ordinators Training course. NOTTO also conducts training courses for doctors,

nursing and paramedical professionals. NOTTO also conducted regular programmes, talks and workshops under GOI and in collaboration with various NGOs for organ donation awareness and organ retrieval and transplantation training. 7 out of 8 transplant coordinators had completed their induction training conducted by NOTTO at the time of the interview, the eighth transplant coordinator, being a recruit during the COVID-19 pandemic was going to attend the next training by NOTTO. All the study hospitals regularly conducted short training courses for nurses and paramedical staff in organ transplantation. In addition to trainings by NOTTO, AIIMS also conducted its own short training courses for resident doctors, transplant specialists and transplant coordinators along with training for nurses and paramedical staff.

The transplant coordinators performed various duties in the organ transplant department. They conducted daily rounds in the departments of Medicine, Surgery and ICUs to identify brain-dead patients and patients in critical condition for checking their organ transplant eligibility. After certification of brain death by the brain death certification committee; the transplant coordinators prepare for deceased organ transplantation. Transplant coordinators conducted counselling of relatives of the deceased patient for organ donation followed by taking consent for organ transplantation from the relatives of the deceased patient. They get legal affidavits signed by the deceased patient's relatives to prevent illegal organ trafficking. There is a hospital-based committee headed by the Director/Medical Superintendent of the institute that decides about the suitability of living organ donation based on the examination details and interview of the donor, proposed recipient and other family members. After approval for living organ donation, the transplant coordinators prepare the patient for living organ donation. The transplant coordinators get legal affidavits signed by the donor, recipient and relatives of the donor; and recipient stating that the transplantation is being done with the consent of all persons involved. The transplant coordinators also maintained organ transplant records in both physical and digital forms. Separate registers are maintained for the number of donors, deceased organ transplants and live organ transplants. They also maintained the hospital waiting list for organ transplantation for AIIMS and update it to NOTTO regularly for contribution to the regional organ transplant waiting list for Delhi NCR maintained by NOTTO. The transplant coordinators responded that they conducted various IEC activities. The transplant coordinators under the supervision of the nodal officer, annually organised National Organ Donation Day on 27th of November in all the study hospitals. They organized a poster exhibition comprising posters on organ donation awareness on National Organ Donation Day 2021. They conducted various outreach programmes for organ donation awareness. The transplant coordinators gave regular daily feedback to the nodal officer of the institute and weekly, monthly and annual feedback to NOTP Cell and NOTTO. They send monthly and annual reports to the nodal officer of the hospital, NOTP organ transplant cell and NOTTO. The nodal officers of the respective hospitals responded that they regularly supervised and monitored the staff in the transplant department. They also coordinated between hospitals in the Delhi NCR region for efficient compliance with the Delhi NCR transplant waiting list maintained by NOTTO.

Transplant specialists conducted organ retrieval and transplantation. They conducted pre-transplant and post-transplant recipient and donor clinical and biochemical workups. They also administered pre-transplant and post-transplant immunosuppressive therapy to transplant patients. The transplant specialists managed any complications if present post-transplantation like graft rejection etc. They conducted regular follow-ups of patients after the transplant procedure. The transplant coordinators felt that they were able to perform their duties effectively

because of the training skills taught to them in the training programmes conducted by NOTTO under the NOTP. The transplant coordinators were able to counsel the patients and their relatives about organ donation effectively by utilising the counselling skills taught in training programmes. The transplant personnel faced various hurdles in accomplishing their job responsibilities (Table 2) which included inadequate infrastructure for the organ transplant department (75%), feeling overburdened by duties (75%), less salary and number of leaves (50%) and lack of coordination between various departments (12.5%).

Table 2

Hurdles Faced in Accomplishing Job Responsibilities in All the Study Hospitals

S. No.	Hurdles faced	No. of Respondents (N=16)	*Percentage (%)
	Inadequate infrastructure for the organ transplant department	12	75%
2.	Overburdened by the roles and responsibilities assigned	12	75%
3.	Less salary	8	50%
4.	Less number of leaves	8	50%
5.	Lack of coordination between various departments	2	12.5%

*The transplant personnel gave multiple responses.

Figures in Table 3 reflects the transplant personnel's various recommendations for improving the implementation of the programme which included the recruitment of one more Transplant Coordinator (75%), improvement of infrastructure under the organ transplant department (75%), arrangement of incentives for the hospital employees for good work (50%), an increase in salary with regular experience-based increments (43.75%), availability of one driver on call (12.5%), recruitment of two types of transplant coordinators: one with a clinical background and the other with social work background (12.5%); and faster action by the brain death certification committee (6.25%).

Table 3

Recommendations by Transplant Personnel of All the Study Hospitals

S. No.	Recommendations	No. of Respondents (N=16)	*Percentage (%)
1.	Recruitment of one more Transplant coordinator	12	75%
2.	Improvement of infrastructure under the organ transplant department	12	75%
3.	Arrangement of incentives for the hospital employees for good work	8	50%
4.	An increase in salary with regular experience-based increments	7	43.75%
5.	Availability of one driver on call	2	12.5%
6.	Recruitment of two types of Transplant coordinators: One with a clinical background and the other with social work background.	2	12.5%
7.	Faster action by the brain death certification committee	1	6.25%

*The transplant personnel gave multiple responses.

Discussion

The human resources were according to the strength sanctioned under the programme guidelines in all the study hospitals. There was an apparent need to sanction more human resources under the organ transplant department in most of the study hospitals. A study done by Kute V et al. in 2020[14] found that the status of human resources is not up to the mark for programme implementation. All the nodal officers and the transplant coordinators regularly participated in the trainings and conferences organized by NOTTO. The same study also found that the NOTTO regularly conducts the transplant coordinator training course. AIIMS conducted regular short training courses for transplant coordinators. Other hospitals (3 out of 4) were not conducting their own training for the transplant coordinators. AIIMS regularly conducted short training courses for doctors in organ transplantation.

All the study hospitals regularly conducted short training courses for nurses and paramedical staff in organ transplantation. The transplant coordinators, nodal officers and transplant specialists of all the hospitals performed duties according to the guidelines of the programme. The transplant coordinators felt that they were able to perform their duties effectively because of the training skills taught to them in the training programmes conducted by NOTTO under the NOTP. They were able to counsel the patients and their relatives about organ donation effectively by utilizing the counselling skills taught in the training programmes. Figure 2 shows that the transplant coordinators had different educational qualifications. Sociology graduates felt that they were able to fulfil their duties in a better way as they could apply their skills better in counselling and motivating the donors.

A study by Singh NP and Kumar A in 2016[15] found that there was a lack of basic and essential medical infrastructure for organ transplants in most of the hospitals in India. A study by Mariappan M in 2017[16] found that there is inequity existing in the organ donation scenario in the country. The infrastructure in government and private hospitals to conduct transplantation needs to be strengthened. The concept of organ donation should reach the public and the role of various stakeholders is pivotal in this process. A study by Kute V et al. in 2020[14] found that there is poor infrastructure, especially in the government sector hospitals. The same study found that the NOTTO organizes awareness activities for the public. Social media tools like Twitter are used to increase awareness about organ donation and transplantation. This study had found that there is a need to increase IEC activities. Another study by Vasanthi R in 2020[17] found that NOTTO has, since its inception, been crucial in regulating and streamlining organ donation and transplantation activities; and maintains the National Registry. The procedure followed for the deceased and living organ retrieval and transplant process is similar in all the study hospitals. All the study hospitals were performing the procedures according to the standard guidelines under the National Organ Transplant Programme.

The strength of the study was that it was one of the few studies assessing the implementation of the National Organ Transplant Programme. The limitation was a relatively small sample size. A larger study sample could not be taken owing to time constraints.

Conclusion and Recommendations

This study assessed the implementation of the National Organ Transplant Programme at tertiary care hospitals in Delhi. There was a need to sanction more human resources under the programme for programme implementation. Regular trainings were conducted by NOTTO for Doctors, Transplant Coordinators and other healthcare workers. All the study hospitals regularly conducted short training courses for nurses and paramedical staff in organ transplantation. AIIMS conducted its own short training courses for Doctors and Transplant Coordinators along with training for nurses and paramedical staff.

Monthly and annual reports were regularly sent to NOTP Organ Transplant Cell and NOTTO. Regular feedback was given to NOTTO and NOTP Cell both by phone and in person. Each study hospital was maintaining its own transplant registry. A digitized waiting list for organ recipients was maintained by NOTTO in coordination with all the officials of NOTTO and participating institutions of Delhi, including Organ Transplant Cell officials. The procedure followed for the deceased and living organ retrieval and transplant process was similar in all the study hospitals. All the study hospitals were performing the procedures according to the standard guidelines under the National Organ Transplant Programme.

In conclusion, the National Organ Transplant Programme is being efficiently implemented in Delhi with some gaps like over-burdened staff, deficient human resources and inadequate infrastructures.

At the hospital-level, Electronic and Mass Media like TV, News Papers can be used for mass awareness among the public. Existing IEC activities should be expanded at a mass level as awareness in the community is low. There should be more sensitization of the public towards organ donation. For organ donation awareness activities, the Community Medicine department of each hospital can be involved. There can be faster action by the brain death certification committee. Discussions about donations should be a part of end-of-life care, when appropriate, and early involvement of transplant coordinators and counsellors should be ensured. At policy-level, there can be an arrangement of appreciation certificates and incentives for Doctors, Nurses and other coordinating staff for good work. One more Transplant Coordinator may be sanctioned for each hospital to strengthen the coordination within hospitals. There may be a provision for experience-based increments in salary. There should be an enhancement in funding grants for infrastructure and facility development. NGOs can also be involved in IEC activities more actively. A chapter on organ donation can be added to the syllabus for school students. Organizational support in the form of more transplant centres with good dialysis programmes, adequate staff and experienced members should be provided. Research should be promoted in the area of organ transplantation.

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Global Undernutrition Convergence: Evidence from Club Convergence

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Abstract

Being the most essential element for a healthy life, nutrition plays an important role in maintaining the health standard. Any deficiency in terms of nutrient intake is a leading risk factor of death and morbidities among infants, especially new-borns. This study investigates the undernutrition convergence globally by employing Philips and Sul club convergence test for the period 2001 to 2018. Results from Philips and Sul club convergence test shows that the evidence of overall convergence is not found rather selected countries cluster themselves into 3 clubs and one non-convergent group. This proves that selected countries are not converging to a single steady path; however, it revealed the existence of the club-specific steady state. The study recommends that club-specific policies need to be implemented to tackle the incidence of undernutrition.

Key words: Nutrition, Undernutrition, Club convergence.

Introduction

Being the most essential element for the healthy life nutrition plays an important role in maintaining the health standard (Barasi 2003)[1]. Nutrition is very crucial for the overall development of a human being; hence, efficiency and productivity of the labour force heavily depend on the balanced nutrition intake (Kim et. al., 2013)[2]. Having a diet with sufficient calories requirement of body is very essential for being healthy (Strauss, 1986)[3]. Any deficiency in terms of nutrients intake is a leading risk factor of death and morbidities especially among new-borns (Tomkins, 2000)[4] ([4]*If the variable is slowly moving towards the upward trend in a nonlinear way, then there would not be any cointegration between the series. This is considered by PS method.*) It is estimated that by eliminating under nutrition, 32 per cent of the world disease burden can be reduced (Ahmed et. al., 2012)[5]. National and International organizations started various programmes and policies to improve the nutrition availability to the most vulnerable groups of the world. But the problem of under nutrition is still persisting globally especially in the developing countries (Popkin et. al., 2012)[6]. Undernutrition occurs due to an imbalance in nutrition intake and the requirement of the body. Undernutrition affects every country of the world despite its geographical boundaries and socio-economic status. Hence, it has become a global issue in the recent years. Every country can experience undernutrition, but most susceptible are the developing and poor (under-developed) countries due to the challenge of poverty in these

countries. Undernutrition is the main hunger indicator used by the Food and Agriculture Organization (FAO).

According to World Health Organization (WHO), 11 per cent (820 million) of the world's population is taking lesser calories than what they require. It means they are undernutrition. As a result of poor nutrition intake, 22 per cent of children under 5 are stunted and around 697 (9 % of world population) million people are food insecure globally (Roser & Ritchie, 2019)[7]. According to the UN's 'depth of the food deficit' metric majority of the developing nations are under the food deficit. In other words, most of the developing countries had a food deficit of 200 kilocalories per person/day. Some of the Sub-Saharan African countries have a food deficit between 300-500 kilocalories per person/day (Van et. al. 2012)[8]. The consequences of undernutrition are manifold but the way to eliminate undernutrition is the availability of nutritious food to all the people around the world. This can happen by eradicating the prevalence of poverty especially from the developing regions of the world. Other factors in removing the undernutrition are compulsorily breastfeeding for the first 2 years of life, access to basic necessities for instance; healthcare, water, hygiene and sanitation, pregnant women's nutrition pattern etc.

International organizations continuously reaffirmed their agenda to eliminate undernutrition. The 1992 International conference on nutrition held in Rome adopted a world declaration of plan of action to eradicate undernutrition and hunger. Later in 2002, Rome Declaration on World Food Security and World Food Summit Plan of Action set a target of reducing hunger 50 percent by 2015. In 2004 FAO's council adopted the food for all to achieve food security and nutrition for all. In this order United Nation has adopted 8 development goals popularly known as millennium development goals in the year 1990 two of which are dedicated to improve the quality of life through eradicating hunger and reduced child mortality by 2015. Target was set to halve the proportion of people who suffer from poverty and hunger by 2015. Recently in 2016 united nation formulated sustainable development goals (SDGs) focused on nutrition to achieve by 2025. Collaboration between the International community and concerned governments of respective countries can help their people by ensuring equal access to quality food which will eventually boost their economic growth (Sachs 2012[9]; Soubbotina, 2004[10]). Inspection of programme and policies implemented by the government is needed to find whether the existing action plans are working or not.

Since the year 2000, world regions experienced substantial fall in undernutriton (Van et. al., 2012)[8]. An improvement in the nutritional intake is being recorded in the past decade (Müller & Krawinkel, 2005)[11]. Hunger has fallen from 14.8 per cent of people to 10.8 per cent between 2000 and 2018 (Otekunrin, et. al. 2019)[12]. Sub-Saharan Africa is an exception in a way that instead of taking numerous efforts by the world organization to reduce the prevalence of undernutrition & hunger for the region, undernutrition in terms of stunted children increased between 1990 to 2015. The International Food Policy Research Institute (IFPRI) formulated an index known as Global Hunger Index to measure the extent of hunger. In terms of GHI scores, Sub Saharan Africa and south Asia are the leading regions in terms of hunger hence prevalence of undernutrition is also highest in these regions. Although a significant improvement has been recorded in terms of elimination of hunger, however; undernutrition remains a serious problem in many developing countries. Apart from the negative consequences of undernutrition on human health, economy of the world is also adversely affected by this (Alderman, et. al., 2014; Headey, 2012)[13,14]. High prevalence of undernutrition causes poor growth and development on one hand

and enhances poverty on the other by effecting efficiency and productivity (Gupta & Mitra, 2004; Mehta & Shah, 2003)[15,16]. Furthermore, due to negative consequences of undernutrition on health, expenses incurred on seeking healthcare has also been increased which again become a cause of hunger and lower nutritious diet (World Health Organization, 2019)[17].

Data form various published sources shown that huge differentials are existed in terms of undernutrition between developed and developing countries (Abdullah, 2015)[18]. The burden of undernutrition is unacceptably high especially in developing regions of the world. More than hald of undernourished children live in South Asia. Nearly 479 million people is facing undernutrition in the region of Asia and the Pacific.

Though several studies are available on undernutrtion and its impact of socio-economic condition across countries by employing different methodologies but very little literature has been found on convergence issue. Existing literature (Ved & Menon 2012; Guriev & Vakulenko 2015; Klasen 2008; Haddad et. al. 1999; Ouyang et. al. 2019)[19-23] have investigated convergence in poverty, gender nutrition, urban nutrition but literature on undernutrition convergence is scanty. This study complements this research gap by investigating undernutrition convergence across the world.

Thus, the researchers of the current study have employed the concept of neo-classical growth convergence theory, which states that poor countries trace the growth path of rich nations in the long run. However, in reality this is not possible because each nation has its own steady path of transition. Hence, we relax this assumption of single steady state rather we assume that they require relative growth rates to trace a single steady path (Jones 1997; Evans & Karras 1996)[24,25]. This study applies the club convergence methodology propounded by Philips and Sul in 2007 to examine the above research objective i.e. whether the undernutrition in countries are converging or diverging over time across world.

Methodology

This research adopts the Philips and Sul club convergence (2007; hereafter PS)[26] test. PS method is more robust than neo-classical growth theory of convergence. In a way, the neoclassical theory says that the developing economies move faster than the developed economies in terms of their per capita income. Reasons for tracing developed nations faster are: developing nations imitate the production techniques, technology and institutions of highly advanced economies in the long run. Furthermore, PS test also resolve the problem of single steady state of transition. The neoclassical theory assumed that all the countries trace a single steady state which may not apply to those sections where huge diversity is persisting. PS test takes care of this issue and endogenously form the clubs of cross-sections based on the "nonlinear time-varying factor" in such a manner that each club will follow a unique steady transition path based on their relative growth trend. Thus, PS method is based on relative convergence and describes a series as non-stationary which is moderately converging considering individual heterogeneity. PS test provides the convergence of that series which has both stationary and non-stationary characteristics and that makes PS test better than panel unit root test. Altogether PS test takes care of the biasness comes from the mix of stationary and non-stationary misidentification in the panel. This method offers the basics of modelling transitional dynamics as well as long-run pattern and includes both the common and individual-specific components. Thus, the authors of this paper consider the Philips and Sul convergence test better in terms of effectiveness than panel unit regression model and co-integration test.

The researchers have used the annual data on undernutrition (UNT) for 162 countries provided by World Bank. World Bank provides data on prevalence of undernutrition in terms of percentage of population undernourished. The single factor model of PS can be shown as:

$$UNTit=it+it \quad (1)$$

Where i=1, 2, 3,4,…,15 (no of countries)
t=1987,1988,….,2018 (Time period).
δi = idiosyncratic distance between the systematic part of UNTit and common factor t.
t = Accumulated common behavior of UNTit of individual units. uit refers to the error term.

Equation 1 explains the progression of the UNTit with respect to the common factor by means of systematic element (i) and the error (uit).

UNTit is categorised into two parts: First- Systematic component (S_{it}) and Second- Transitory components (tit):

$$UNTit=Sit+tittt=itt, \quad \forall\ i,t \quad (3)$$

Where t = common steady path having both deterministic component and stochastic components.
it = idiosyncratic element (Time and Country-specific effects)
t = Share of the common Factor for each country).

Convergence follows the dynamic process (Philips and Sul, 2007)[26]. Hence, it in Equation (3) represents the transition paths. PS test does not focus on parametric form for t rather it factors out and focuses on it. To find out coefficients of it , structure restrictions must be imposed on δ_{it} and t. Hence, PS test assumes a semi-parametric form for it that help to conduct a formal test for convergence.

To estimate long-term convergence, PS test has suggested the below form that ignores the common component (t) from equation (3) by dividing the panel average:

$$hit=UNTit1Ni=1NUNTit=it\ 1Ni=1Nit \quad (4)$$

Where hit = Relative measure for the transition path with the panel average.

In the short run hit varies across the selected units, but attain convergence in the long run when $hit \rightarrow 1$ for all units (i), when $t \rightarrow \infty$. It can be achieved in the long term when the variance of the country of $hit \rightarrow 0$. The below assumption is required for algorithm club convergence in a semiparametric form including time-varying coefficients δit :

$$it =i +itit \quad (5)$$

Where it=iLtt, i>0, t≥1 and it is poorly dependent over t, and traces independent identically distributed (iid) (0, 1) over i. The function L(t) is gradually increasing and diverging at infinity (LT→∞ as t→∞). PS assumes the null hypothesis of convergence for all units (i) for the countries including a specific form of it: H0:i =δ,∀ i with a≥0. And the alternative hypothesis is: H1:i ≠δ,∀ i with a≥0 or a<0. Null hypothesis can be tested by following the below regression:

$$\log H1Ht - 2\log Lt = c + b\log t + ut \quad (6)$$

Where t=rT, rT+1,……, T and r>0.
Moreover, H1Ht show the countries variance.

Lt=log (t+1) is applied in Equation (5). Further, Ht=1Ni=1N(hit-1)2 and b=2. indicates the least square parameter of a. in case of null hypothesis logH1Ht diverge; whether a>0 or a=0. For testing convergence, one-sided t-test of the inequality, a≥0 using b might be useful. t- Statistic follows the "standard normal distribution asymptotically" that is created by the estimate b. PS has suggested that the null of convergence is accepted if the value of t-statistic is lower than the critical value -1.65. The speed of convergence can be calculated following the expression b = 2α (Phillips and Sul 2007, 2009)[26, 27].

Discussion

We have applied Philips and Sul club convergence method. Result shows that there is no evidence of overall convergence among the selected countries. -57.0766 is the log (t) regression value for the full sample which is lower than the critical value of -1.65, hence overall convergence hypothesis for the full sample is rejected in case of selected countries (Table 1).

Table1
Club Convergence Across Countries

Club	Countries	Coefficient	T-Value	Decision
Full Sample		-1.0318	-57.0766	Divergence
Club 1	| Chad | Haiti | Korea, Dem. People's Rep. | Lesotho | Liberia | | Madagascar | Venezuela, RB |	0.640	3.741	Club Convergence
Club 2	| Cabo Verde | Eswatini | Rwanda | Sierra Leone | Timor-Leste |	0.554	5.654	Club Convergence
Club 3	| Congo, Rep. | Iraq | Mozambique |	0.067	0.583	Club Convergence
Club 4	| Afghanistan | Angola | Botswana | Cote d'Ivoire | Ethiopia | | Gabon | Kenya | Nigeria | Sao Tome and Principe | | Solomon Islands | Tanzania | Togo |	0.678	6.810	Club Convergence

Club 5	| Bangladesh | Bolivia | Burkina Faso | Cambodia | El Salvador | | Guatemala | Honduras | Jamaica | Jordan | Malawi | Mauritania | | Mongolia | Namibia | Nicaragua | Philippines | Vanuatu |	0.360	3.420	Club Convergence
Club 6	| Belize | Cyprus | Dominica | Georgia | Mexico | New Caledonia | | Pakistan | Paraguay | Sudan |	0.816	4.493	Club Convergence
Club 7	| Albania | Argentina | Australia | Austria | Barbados | Belarus | | Belgium | Benin | Bosnia and Herzegovina | Brunei Darussalam | | Bulgaria | Canada | Chile | Colombia | Costa Rica | Cuba | | Czech Republic | Denmark | Dominican Republic | Ecuador | | Egypt, Arab Rep. | Estonia | Euro area | Fiji | Finland | France | | Gambia, The | Germany | Ghana | Greece | Guyana | | Hong Kong SAR, China | Hungary | Iceland | Indonesia | | Iran, Islamic Rep. | Ireland | Israel | Italy | Japan | | Korea, Rep. | Kuwait | Kyrgyz Republic | Latvia | Lebanon | | Lithuania | Luxembourg | Macao SAR, China | Malaysia | Malta |	0.280	3.120	Club Convergence

	| Mauritius | Montenegro | Morocco | Myanmar | Netherlands | | New Zealand | Norway | Oman | Panama | Poland | Portugal | | Romania | Russian Federation | Saudi Arabia | Senegal | Serbia | | Slovak Republic | Slovenia | Spain | Sri Lanka | | St. Vincent and the Grenadines | Suriname | Sweden | | Switzerland | Thailand | Trinidad and Tobago | Turkey | | Turkmenistan | Ukraine | United Kingdom | United States | | Vietnam |			
Club 8	| Cameroon | Croatia | Kiribati | Mali | Nepal | Peru | Samoa | | Tunisia | United Arab Emirates | Uruguay |	0.826	3.931	Club Convergence
Club 9	| Algeria | Azerbaijan | Brazil | China | Kazakhstan | Uzbekistan |	0.273	0.975	Club Convergence
Not convergent Group 10	| Armenia | India |	-3.687	-123.531	Neither convergence nor divergence

Club	**log (t) regression value**
Full Sample	-57.0766

This shows that the selected countries are not following a single steady path rather these countries merged and formed 10 clubs. According to Philips and Sul, in the first step of analysis we may not get the true number of clubs, thus to find out the true number of clubs and to find out the evidence of any merger of clubs log (t) regression is repeated again. Results presented in Table 2 (Annexure) shows the evidence of merger of clubs to large clubs. Final clubs are tabulated in table 3. Result shows that finally, we get 3 clubs and one group of 2 countries which is neither converge nor diverge. Club 1 includes 15 countries namely, Cabo Verde, Chad, Congo, Rep., Eswatini, Haiti, Iraq, Korea, Dem. People's Rep., Lesotho, Liberia, Madagascar, Mozambique, Rwanda, Sierra Leone, Timor-Leste, Venezuela, RB. These countries have highest incidence of undernutrition. A large number of countries in this club is from African continent

which is well known for their well spread food insecurity (Lopriore C & Muehlhoff E 2003)[28]. Demographic, socio-economic and agro-ecological characteristics of the region often to be blamed for poor nutrition condition of the children in this region (Anand & Ravallion 1993)[29]. Moreover, rapid population growth and desertification has affected food production, access and availability. Poverty and unemployment are the other determinants of poor nutritional qualities in the countries of this club (Mamabolo et. al. 2005)[30]. Higher Income inequality is persisting in these countries consequently, lower human development leading to higher undernutrition (Adeleye et. al. 2020; Mukherjee et. al. 2019)[31,32]. 37 countries namely Afghanistan, Angola, Bangladesh, Belize, Bolivia, Botswana, Burkina Faso, Cambodia, Cote d'Ivoire, Cyprus, Dominica, El Salvador, Ethiopia, Gabon, Georgia, Guatemala, Honduras, Jamaica, Jordan, Kenya, Malawi, Mauritania, Mexico, Mongolia, Namibia, New Caledonia, Nicaragua, Nigeria, Pakistan, Paraguay, Philippines, Sao Tome and Principe, Solomon Islands, Sudan, Tanzania, Togo, Vanuatu formed the club 2. These countries have recorded highest undernutrition incidence but that is lower as compared to the club 1 countries. The economy of these countries is of developing in nature consequently higher population growth, lower per capita income, lower human development, lower employment opportunity leads higher undernutrition in this group of countries (Kennedy, 2002; Anand & Ravallion, 1993; Smith & Haddad, 2000; Madanat, et. al., 2008)[33,27,34,35].

Table 2
Results of Merger of Clubs

Club Merger	Coefficient	T-Value
Club 1+2	0.073	0.861
Club 2+3	0.482	5.179
Club 3+4	0.236	4.074
Club 4+5	0.452	5.243
Club 5+6	0.089	1.100
Club 6+7	0.094	1.320
Club 7+8	0.246	2.983
Club 8+9	0.024	0.285
Club 9+10	-2.838	-20.538

A total of 98 countries namely, Albania, Algeria, Argentina, Australia, Austria, Azerbaijan, Barbados, Belarus, Belgium, Benin, Bosnia and Herzegovina, Brazil, Brunei Darussalam, Bulgaria, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., Estonia, Euro area, Fiji, Finland, France, Gambia, The, Germany, Ghana, Greece, Guyana, Hong Kong SAR, China, Hungary, Iceland, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Japan, Kazakhstan, Kiribati, Korea, Rep., Kuwait, Kyrgyz Republic, Latvia, Lebanon, Lithuania, Luxembourg, Macao SAR, China, Malaysia, Mali, Malta, Mauritius, Montenegro, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Norway, Oman, Panama, Peru, Poland, Portugal, Romania, Russian Federation, Samoa, Saudi Arabia, Senegal, Serbia, Slovak Republic, Slovenia, Spain, Sri Lanka, St. Vincent and the Grenadines, Suriname, Sweden, Switzerland, Thailand, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vietnam are included in club 3. Club 3 countries are the developed countries with high HDI index as compared to the countries listed in club 1 and club 2 (Crafts, 1997)[36]. Higher per capita income, lowest income inequality, advanced healthcare facilities are some of the

reasons for better nutritional qualities in the countries of this club (Dabla-Norris et. al. 2015; Diaz-Bonilla et. al. 2000; Verma & Usmani 2019)[37-39].

A non-convergent group of 2 countries namely Armenia and India were also found during the analysis. These countries do not club with any of the groups. These two countries need further exploration to understand their distinctiveness.

Table 3
Final Club

Club	**Countries**	**Coefficient**	**Log(t)**	**Decision**
Club 1	| Cabo Verde | Chad | Congo, Rep. | Eswatini | Haiti | Iraq | | Korea, Dem. People's Rep. | Lesotho | Liberia | Madagascar | | Mozambique | Rwanda | Sierra Leone | Timor-Leste | | Venezuela, RB |	-0.043	-0.585	Divergence
Club 2	| Afghanistan | Angola | Bangladesh | Belize | Bolivia | | Botswana | Burkina Faso | Cambodia | Cote d'Ivoire | Cyprus | | Dominica | El Salvador | Ethiopia | Gabon | Georgia | | Guatemala | Honduras | Jamaica | Jordan | Kenya | Malawi | | Mauritania | Mexico | Mongolia | Namibia | New Caledonia | | Nicaragua | Nigeria | Pakistan | Paraguay | Philippines | | Sao Tome and Principe | Solomon Islands | Sudan | Tanzania | | Togo | Vanuatu |	0.177	2.600	Cub Converge
Club 3	| Albania | Algeria | Argentina | Australia | Austria | | Azerbaijan | Barbados | Belarus | Belgium | Benin |	0.109	1.578	Cub Converge

	| Bosnia and Herzegovina | Brazil | Brunei Darussalam | | Bulgaria | Cameroon | Canada | Chile | China | Colombia | | Costa Rica | Croatia | Cuba | Czech Republic | Denmark | | Dominican Republic | Ecuador | Egypt, Arab Rep. | Estonia | | Euro area | Fiji | Finland | France | Gambia, The | Germany | | Ghana | Greece | Guyana | Hong Kong SAR, China | Hungary | | Iceland | Indonesia | Iran, Islamic Rep. | Ireland | Israel | | Italy | Japan | Kazakhstan | Kiribati | Korea, Rep. | Kuwait | | Kyrgyz Republic | Latvia | Lebanon | Lithuania | Luxembourg | | Macao SAR, China | Malaysia | Mali | Malta | Mauritius | | Montenegro | Morocco | Myanmar | Nepal | Netherlands | | New Zealand | Norway | Oman | Panama | Peru | Poland | Portugal | | Romania | Russian Federation | Samoa | Saudi Arabia | Senegal | | Serbia | Slovak Republic | Slovenia | Spain | Sri Lanka | | St. Vincent and the Grenadines | Suriname | Sweden | | Switzerland | Thailand | Trinidad and Tobago | Tunisia |			

	| Turkey | Turkmenistan | Ukraine | United Arab Emirates | | United Kingdom | United States | Uruguay | Uzbekistan | | Vietnam |			
Not convergent Group 4	| Armenia | India |	-3.687	-123.531	Neither convergence nor divergence

Conclusion

The main aim of this study was to investigate the convergence hypothesis of undernutrition globally from 2001 to 2018. To do so this study employed the Philips and Sul (2007)[26] convergence method. Our result showed that there is no evidence of overall convergence in terms of undernutrition rather it shows multiple clubs of similar convergence pattern. This means that selected countries are not converging to a single group instead they followed a club specific steady state path after clustering themselves. The clusters observe somewhat similar growth pattern which is reflected in their clubbing pattern depending on undernutrition, except Armenia and India.

The result of the present study offers the following policy recommendations: First, countries lie in club 1 and club 2 should revise their programmes and policies to ensure the food safety for all. Second, results found that some of the developing countries like Sri Lanka, Nepal, Myanmar and Thailand etc. are catching up the countries where human development is high and undernutrition is on moderate level but these countries have to make adequate effort to sustain the same level of undernutrition. Third, club-specific programmes and policies should be taken into consideration to resolve the problem of undernutrition convergence in the long run.

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Knowledge, Attitude and Practice of Contraception among Adolescents in Bangladesh

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Abstract

A cross-sectional study was conducted to assess the knowledge, attitude and practice of contraception among the adolescents in Bangladesh. The authors used the Bangladesh Adolescent Health and Wellbeing Survey (BAHWS) 2019 – '20 conducted by the National Institute of Population Research and Training (NIPORT). Data were collected in five phases, with each phase taking about four weeks to complete, that started on 25 July 2019 and completed on 10 January 2020. Knowledge, attitude and practice of contraception among 4926 ever-married females, 7800 unmarried females and 5523 unmarried male adolescents aged 15-19 from 67093 households were evaluated from the findings of the successfully interviewed respondents. Three types of individual questionnaires (ever-married female adolescents, unmarried female adolescents, and unmarried male adolescents) were piloted before data collection began. The researchers used descriptive statistics for data analysis.

The contraceptive prevalence rate among currently married female adolescents ages 15-19 years was 56 per cent. Modern method use was 51 per cent, and traditional method use was 5 per cent. The pill was by far the most widely used method (33%), followed by condoms (9%) and injectable (7%). Among contraceptive method non-users, 38 per cent said that they want to have children, while 26 per cent said that their husband stays elsewhere or abroad, and they thus have no need for a contraceptive method. Overall, more unmarried male adolescents (84%) and unmarried female adolescents (75%) knew of at least one of the three common contraceptive methods (oral pill, condom, and emergency contraceptive pill). Knowledge of the pill was higher among females (72%) than males (61%), but the opposite was true for knowledge of condoms and ECP (only 40% of females knew about condoms compared to 82% of males; ECP was known by 9% of females, compared to 19% of males). The study highlights the need to empower the adolescents with the information and self-efficacy to make and act on their decisions on use of contraceptives and communication programmes for unmarried adolescents should be strengthened to arrest the trend towards unwanted pregnancy.

Key words: Family planning, contraception, knowledge, practice.

Introduction

Adolescence is the phase of life between childhood and adulthood, from 10 to 19 years. It is a unique stage of human development and an important time for laying the foundations of good

health. Adolescents experience rapid physical, cognitive and psychosocial growth. This affects how they feel, think, make decisions, and interact with the world around them[1]. Of the estimated 1.2 billion adolescents worldwide, many have missed out on health services that consider their specific needs. Over 2000 adolescents die every day, mainly from preventable causes[2].

Contraception means the use of drugs, devices, or surgery to prevent pregnancy. There are many different types of contraception. These include barrier methods to keep sperm from fertilizing the egg, hormone methods, intrauterine devices (IUDs), and surgery to close the fallopian tubes in women or close off the two tubes that carry sperm out of the testicles in men; also called birth control[3]. Comprehensive sexuality education and condom promotion and distribution can contribute to prevent unintended pregnancy and STIs including HIV. Enrolling and keeping adolescents in school can contribute to a range of positive health outcomes[4]. One in 20 adolescents worldwide contracts a curable sexually transmitted infection each year, and each day, over 6500 adolescents and young people aged 10–24 are infected with HIV. In 2020, there were 1.7 million adolescents living with HIV worldwide, of whom 88 per cent live in sub-Saharan Africa. Adolescents account for 11 per cent of new HIV infections. In 2020, there were 1,50,000 new HIV infections among adolescents, more than three quarters of which were among adolescent girls[5].

As of 2019, adolescents aged 15–19 years in low and middle-income countries (LMICs) had an estimated 21 million pregnancies each year, of which approximately 50 per cent were unintended resulting an estimated 12 million births[6]. Based on 2019 data, 55 per cent of unintended pregnancies among adolescent girls aged 15–19 years end in abortions which are often unsafe in LMICs[6].

Contraceptives are not easily accessible to adolescents in many places. Even when adolescents can obtain contraceptives, they may lack the agency or the resources to pay for them, knowledge on where to obtain them and how to correctly use them. They may face stigma when trying to obtain contraceptives. Further, they are often at higher risk of discontinuing use due to side effects, and due to changing life circumstances and reproductive intentions. Restrictive laws and policies regarding the provision of contraceptives based on age or marital status pose an important barrier to the provision and uptake of contraceptives among adolescents. This is often combined with health worker bias and/or lack of willingness to acknowledge adolescents' sexual health needs[6].

The Government of Bangladesh (GoB) is committed to ensure adolescent-friendly Family Planning and Reproductive Health services, and supporting adolescents to engage in healthy behaviours from a very young age. The GoB has developed the National Strategy for Adolescent Health 2017-2030 to meet the health needs of this critical population[7]. The 4th HPNSP has recognized the importance of addressing adolescents in order to improve their health and also to achieve a demographic dividend, in line with the country's commitment to meet the SDGs by 2030[8].

Because of the young age-structure of Bangladesh's population, the reproductive attitude and behaviour of teenagers are likely to have an important impact on overall reproductive health, demographic and social outcome. Adolescent sex and exposure to the risk of pregnancy has

attracted considerable research attention to understand its magnitude; and address it as a problem. These facts warrant an investigation into the knowledge and attitude of this age-group regarding fertility control and contraception.

Methodology

A cross-sectional study was conducted in Bangladesh. The researchers used the *Bangladesh Adolescent Health and Wellbeing Survey (BAHWS) 2019–'20* conducted by National Institute of Population Research and Training (NIPORT). Data were collected in five phases, with each phase taking about four weeks to complete, that started on 25 July 2019 and was completed on 10 January 2020. The study was to evaluate the knowledge, attitude and practice of contraception among the total of 4926 ever-married females, 7800 unmarried females and 5523 unmarried male adolescents aged 15-19 years. All the respondents were successfully interviewed from the 67093 households using three types of individual questionnaires (ever-married female adolescents, unmarried female adolescents, and unmarried male adolescents) that were piloted before the data collection began. The authors used descriptive statistics for data analysis.

The inclusion criteria: For contraceptive use; contraceptive prevalence rate and the percentage of currently married female adolescents who used any contraceptive method were included. Sample respondents included the currently married female adolescents aged 15-19 years. Modern contraceptive methods included female and male sterilization, implants, intrauterine devices (IUDs), injectable, oral contraceptive pills, and male condoms.

Source of Modern Contraceptive Methods: Information on the place from where the modern contraceptive method that was currently being used was obtained from the sample respondents. Sample respondents were currently married female adolescents aged 15-19 years who were currently using a modern contraceptive method.

Knowledge of Contraceptive Methods: Spontaneous knowledge: Respondent who spontaneously mentioned that she/he heard of the oral pill, condom, or emergency contraceptive pills (ECP). Prompted knowledge: If the respondent reported that she/he heard of the oral pill, condom, or ECP after the method was described to them. Sample respondents were unmarried females and unmarried male adolescents aged 15-19 years.

The sample for BAHWS 2019-'20 is nationally representative and includes adolescents aged 15-19 years residing in non-institutional dwelling units. The main sampling goal of the survey was to provide estimates of primary indicators related to adolescent health and wellbeing at the national, urban/rural, and regional levels in Bangladesh. Indicators were estimated separately for adolescents in three groups: ever-married females, unmarried females, and unmarried males. The urban/rural classification we used follows that of the Bangladesh Population and Housing Census 2011; the three regions were defined and stratified as: Eastern (Chattogram and Sylhet Divisions), Central (Dhaka, Mymensingh, and Barishal Divisions), and Western (Rangpur, Rajshahi, and Khulna Divisions). Sixteen sample strata were formed, from which the sample was selected separately.

The survey was based on a two-stage stratified sample of households which involved sampling of primary sampling units (PSUs), and sampling of households. Once the lists of PSUs were prepared, PSUs, households, and adolescents were selected from each stratum.

Variables were knowledge, attitude, and practice of students regarding family planning and contraception. Descriptive statistics was used for data analysis. The collected data were analyzed with regard to the information given by the subjects according to the set questionnaire items and the analyzed data are presented in the following tables.

Findings

Seventy-two per cent of the unmarried female adolescents were aware of the pill; 35 per cent responded spontaneously and 37 per cent mentioned a particular method after prompting. In contrast, 40 per cent of the females had heard of condoms as a family planning method, 28 per cent responded after prompting and 12 per cent mentioned a contraceptive method spontaneously. A small proportion of unmarried female adolescents had heard of ECP (9%) (Table 2). A large majority of unmarried male adolescents (82%) knew of condoms as a family planning method followed by the oral pill (61%). Unmarried male adolescents were more knowledgeable about ECP (19%) as compared to the females of the same age group.

Figure 4 reflects that less than half (48%) of unmarried females and one-quarter (25%) of unmarried males mentioned the public sector as a sources of contraceptive methods. In contrast, 61 per cent of unmarried females and more than three-quarters (76%) of unmarried males mentioned the private medical sector as a source of contraceptive methods. Pharmacy or drug store which is part of the private medical sector was mentioned by a majority of females (53%) and males (66%) adolescents (data not shown).

Thirty-eight per cent of the currently married female adolescents who were not using any family planning method reported that they wanted to have children at the time of the survey. Only 6 per cent stated that their husband or others were opposed to using a contraceptive method, and an additional 6 per cent stated that they thought that contraceptive use interfered with normal physiological processes (Table 1).

Nearly two-in-three contraceptive users (64%) obtained their methods from the private medical sector, mostly from a pharmacy or drug store (Figure 2). About one-in-ten users (9%) received their methods from their husband, and one-in-twenty (5%) received methods from other sources (a shop or friends/relatives). Nearly one-in-five users (19%) obtained their methods from the public sector, and only 3 per cent of users obtained their methods from non-governmental organizations (NGOs) (Figure 2 and Table 3). The source of modern contraceptive methods varied to a great extent by the specific method. Long-acting methods, such as implants were mostly obtained from a public sector facility (77%), while 20 per cent of the users obtained implants from the private medical sector. Nearly 40 per cent of the injectable users obtained the method from a pharmacy/drug store and 38 per cent obtained it from the public sector. In contrast, 68 per cent of the pill users and 64 per cent of the male condom users obtained their method from a pharmacy or drug store (Table 3).

The contraceptive prevalence rate among the currently married female adolescents aged 15-19 years was 56 per cent. Modern method use was 51 per cent, and traditional method use was 5 per cent (Figure 1) The pill was by far the most widely used method (33%), followed by condoms (9%) and injectables (7%). Modern method use was the highest in the Western region (58%), followed by the Central region (52%) and the lowest in the Eastern region (34%). The variation of overall method use by education and wealth quintile was not pronounced.

Figure 1
Percentage of Currently Married Female Adolescents Aged 15-19 Years Currently Using a Contraceptive Method in Bangladesh, 2019-'20

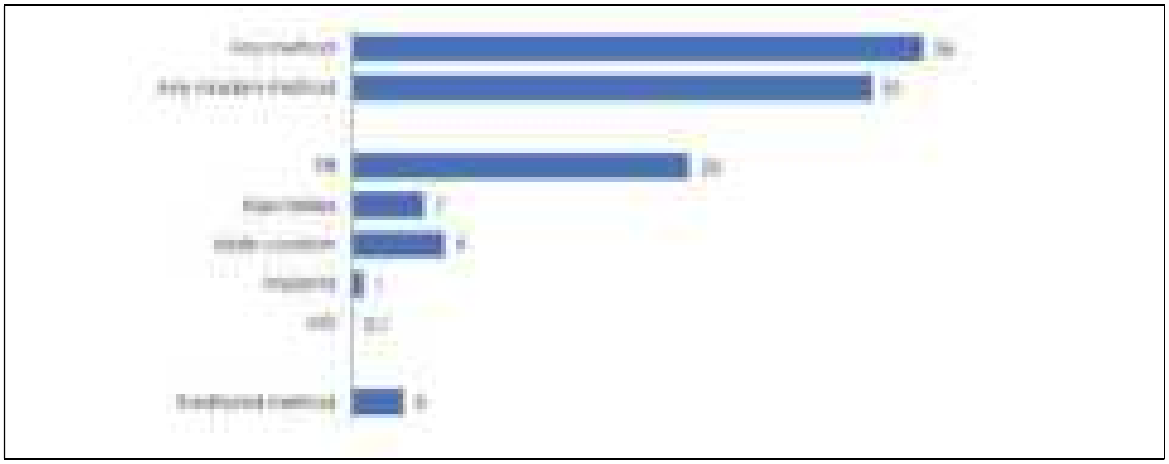

Figure 2
Per cent of Currently Married Female Adolescents Aged 15-19 Years Currently Using a Modern Method of Contraception by the Most Recent Source in Bangladesh, 2019-'20

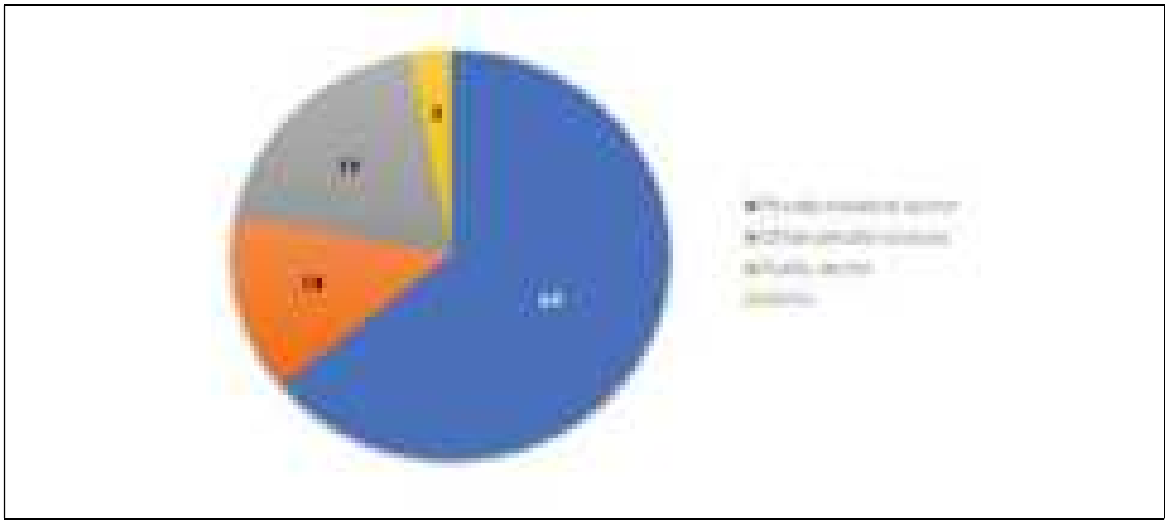

Figure 3
Percentage of Unmarried Adolescents Aged 15-19 Years Who Had Heard of Oral Pill, Condom or Emergency Contraception Pill in Bangladesh, 2019-'20

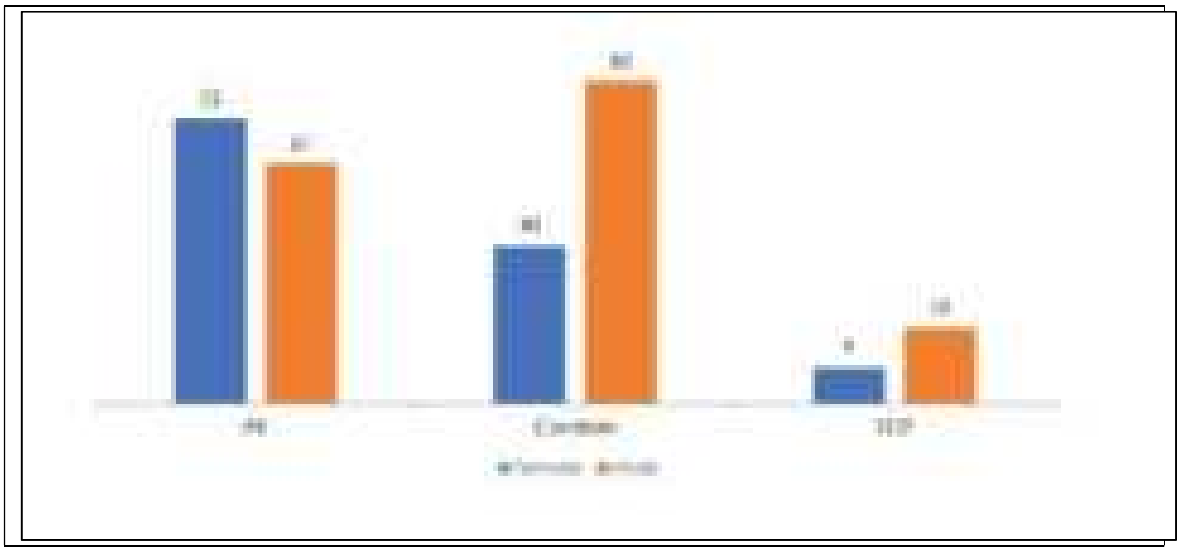

Figure 4
Percentage of Unmarried Adolescents' Knowledge on Sources of Modern Contraceptive Methods among Those Who Have Heard of Contraceptive Methods in Bangladesh, 2019-'20

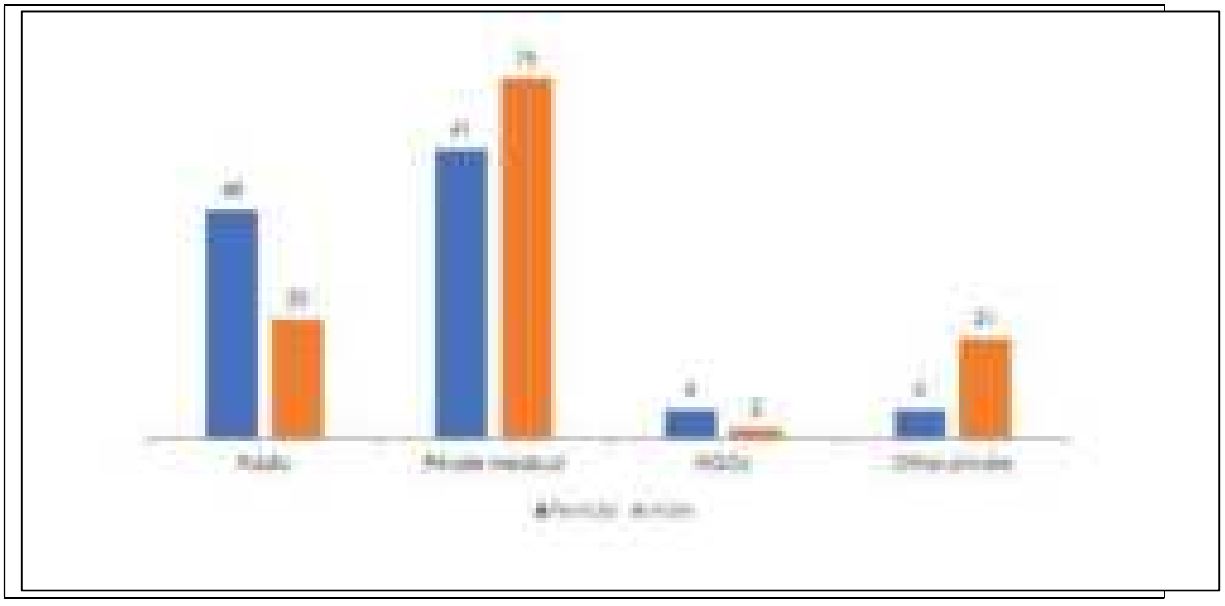

Table 1

Percentage of Currently Married Female Adolescents Aged 15-19 Years Who Are Not Using Any Contraceptive Methods by Reasons Stated in Bangladesh, 2019-'20

Reasons	Percentage
General health concern/side effects	01.5
Difficulty in having sex	00.6
Interfered with normal physiological process/do not like methods	06.2
Husband/others opposed	05.9
Social stigma/religious prohibition	00.4
want children now	38.0
Husband stays elsewhere/abroad	26.0
Other reasons	21.4
Number of Adolescents	**2,110**

Table 2

Percentage of Awareness of Family Planning Method Among Unmarried Female and Male Adolescents Aged 15-19 Years in Bangladesh, 2019-'20

Background Characteristics	Spontaneous Prompted	Heard about				Number of Adolescents
		Pill	Condom	ECP	At least one of the three methods	
Unmarried Females	Overall	71.8	39.7	09.3	74.5	7,800
	Spontaneous	35.0	11.8	01.3		
	Prompted	36.8	28.0	08.0		
Unmarried Males	Overall	60.6	82.1	19.4	84.1	5,523
	Spontaneous	23.6	31.6	03.5		
	Prompted	37.0	50.5	16.0		

Table 03

Percentage Distribution of Currently Married Female Adolescents Aged 15-19 Years Who Used Modern Methods by the Recent Source in Bangladesh, 2019-'20

Source	Pill	Injectable	Male Condom	Implants	All Modern Methods
Public Sector	**16.0**	**37.5**	**07.1**	**77.2**	**19.2**
Medical College hospital/district hospital	00.0	00.6	00.0	06.4	00.3
MCWC	00.0	01.1	00.3	14.4	00.6
Upazila health complex	01.5	05.1	00.5	47.7	03.1
UH & family welfare center	01.6	00.7	00.9	08.7	01.6
Satellite clinic/EPI out reach	01.1	09.8	00.0	00.0	02.0
Community Clinic	03.9	09.8	00.8	00.0	04.0
Government field worker	08.0	10.4	04.6	00.0	07.5
Private medical sector	**68.6**	**50.3**	**64.1**	**20.1**	**63.9**
Private medical college hospital/clinic	00.1	01.4	00.3	10.6	00.6
Qualified doctor's chamber	00.4	03.7	00.0	03.1	00.9
Non-qualified doctor's chamber	00.5	05.9	00.0	00.0	01.1
Pharmacy/Drug store	67.6	39.4	63.9	06.3	61.3

NGO sector	**01.5**	**11.3**	**1.7**	**02.7**	**02.9**
NGO static clinic	00.3	02.9	00.2	01.6	00.6
NGO satellite clinic	00.2	02.6	00.7	01.1	00.6
NGO depot holder	00.1	01.1	00.0	00.0	00.2
NGO field worker	00.9	04.8	00.7	00.0	01.4
Other private	**13.9**	**00.9**	**27.1**	**00.0**	**14.1**
Shop	01.7	00.0	03.9	00.0	01.8
Friend/relative	02.0	00.3	00.4	00.0	01.4
Husband	09.6	00.0	16.7	00.0	09.3
Other private	00.6	00.5	06.1	00.0	01.6
Total	**100**	**100**	**100**	**100**	**100**
Number of adolescents	**1585**	**321**	**430**	**69**	**2407**

Table 4

Percentage Distribution of Currently Married Female Adolescents Aged 15-19 by Contraceptive Method Currently Used with Background Characteristics in Bangladesh, 2019-'20

Background Characteristics	Any methods	Any modern methods	Any traditional	Not currently using	Number of adolescents
Age					
15-17	55.6	50.1	05.5	44.4	2,107
18-19	56.4	51.1	05.3	43.6	2,692
Residence					
Urban	56.8	51.0	05.8	43.2	1,111
Rural	55.8	50.6	05.2	44.2	3,688
Region					
Western	63.6	57.9	05.6	36.4	1,959
Central	57.1	51.7	05.3	42.9	1,889
Eastern	38.4	33.7	04.8	61.6	950
Educational attainment					
Primary incomplete	56.8	51.4	05.4	43.2	557
primary complete	53.4	50.2	03.3	46.6	423
secondary incomplete	57.1	51.9	05.2	42.9	2,629
secondary complete or higher	54.2	47.8	06.4	45.8	1,190
Wealth Quantile					
Lowest	56.5	50.9	05.6	43.5	917
secondary	57.3	53.2	04.1	42.7	1,040
Middle	56.5	49.8	06.6	43.5	1,106
Fourth	55.2	50.4	04.7	44.8	1,019
Highest	54.1	48.4	05.8	45.9	715
Total	**56.0**	**50.7**	**05.4**	**44.0**	**4,799**
Note: If more than one methods is used, only the most effective methods is considered in this tabulation.					
includes a few cases with no education.					

Discussion

An analysis of the figures of the Census 2022 shows that the highest number of the population belongs to the age group of 15-19 Years (10.03%)[9]. Fifty-nine per cent of the women age 20–24 years marry before 18 years. Between 2011 and 2014, the percentage declined from 65 per cent to 59 per cent; and has remained stable over the last 3 years. Twenty-eight per cent of the teenagers had initiated child bearing. Teenage childbearing declined slightly between 2014 and 2017 from 31 from 65 per cent to 28 from 65 per cent[10]. This study on the knowledge, attitude and practice of contraception among adolescent in Bangladesh emphasises on describing the family planning method is crucial to impart knowledge of the method among unmarried adolescents. In all the cases, more adolescents reported knowing of the contraceptive method when it was described than those who reported knowing it spontaneously. The most widely reported source of contraceptive methods by unmarried adolescents aged 15-19 years was the private medical sector followed by the public sector. The NGO sector was the least reported source. Over one-in-four (25%) of the married female respondents reported that their husbands stayed elsewhere or were abroad; so they did not require to use a method. More than one-in-five (20%) did not use any contraceptive method due to other reasons. There was no clear association of overall contraceptive use (any or modern methods) with education but injectables and male condom use were associated with education. For example, injectables use sharply declined with education and in contrast, male condom uses sharply increased with education.

Conclusion

The study highlights that knowledge and awareness do not always lead to a positive attitude towards the use of contraceptives. Although in the present study, the actual number of sexually active unmarried male and female were not known, there appears to be a need for continuing education about sexuality and contraception. Also there is a need to motivate the youth for effective and appropriate use of contraceptives, and arrest the trend towards unwanted pregnancy and increase in population. Most married female adolescents who used a contraceptive method, obtained it from a pharmacy. Obtaining methods from pharmacies or from friends and relatives limits the range and quality of FP information and counseling that can be provided; and potentially limits the methods choices. Ensuring access to adolescent-friendly services and comprehensive information on FP options will enable adolescents making a fully informed choice to meet their fertility preferences in ways tailored to their life stages and circumstances. The National Plan of Action for Adolescent Health Strategy 2017-2030 aims at promoting age-appropriate comprehensive sexuality education. This should include comprehensive education on contraceptive methods and where to obtain them in order to address the current knowledge gaps, and further recommendations for platforms to reach adolescents, both married and unmarried, with complete information on FP.

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A Systematic Review of Screen Time and Adolescent Mental Health in India during the COVID-19 Pandemic

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Abstract

The COVID-19 pandemic and resulting lockdowns have had a significant impact on global mental health, accompanied by an increased screen time on electronic devices. In India, where a large adolescent population exists, approximately 75 per cent of the internet-using teenagers had experienced excessive screen time due to the pandemic. Thus, it is vital to examine the effects of prolonged screen time on the mental well-being of Indian adolescents during the COVID-19 restrictions. This comprehensive review analyses the various studies conducted on Indian adolescents, following a systematic approach that searches electronic databases for relevant studies published between March 2020 and August 2022. The findings demonstrate a growing trend of screen time amongst the Indian adolescents, leading to potential health issues such as depression, anxiety, gaming addiction, decreased quality of life, physical and sleep problems, increased risk of myopia, social connectedness, emotional wellness, social isolation, and cognitive impairment. To fully comprehend the impact of excessive screen time on their mental health, it is essential to consider additional COVID-19-related factors like cyberbullying, domestic violence, sexual harassment, and work-from-home arrangements. Further, quantitative research is necessary to enhance the understanding of the influence of these variables on mental health during the pandemic.

Key words: COVID-19, Adolescent, Mental health, Digital technology, Screen time, Quality life

Introduction

The COVID-19 pandemic, declared a public health emergency by the World Health Organization (WHO) in January 2020, has had widespread impacts on physical and mental health globally[1]. In India, with over 1.34 billion people, the government imposed a 55-day lockdown beginning on 25 March 2020, to manage spread of the virus[2].

The pandemic and associated vulnerabilities, including lockdowns and financial crises, are expected to increase mental health issues and self-destructive behavior[3]. Studies conducted during the previous pandemics such as the 2014 Ebola outbreak and the 2009 H1N1 outbreak, found that the general population reported an increased anxiety and depression[4,5]. Similarly, during the COVID-19 pandemic, many studies reported poor self-rated health, poor sleep quality, higher perceived stress load, previous distressful life events, lack of psychological preparedness,

and severe health issues like pneumonia, all of which increase the risk of depression and anxiety[6-12].

The pandemic's impact is not limited to adults only as children and adolescents have also been affected directly or indirectly by the pandemic's measures such as lockdowns[13]. Expanded screen time, stressed family relations, or inactive life at home present additional challenges to adolescents' emotional wellness. Moreover, prolonged exposure to screens can cause mechanical eye strain, myopia, and obesity, and is related to poor sleep and mental disorders[14-18].

While some studies have reported positive or no relationship between screen time and mental well-being among the adolescents[18], excessive screen time is associated with a range of adverse mental health outcomes such as psychological problems, low emotional stability, and greater risk for depression or anxiety. Moreover, excessive time spent on online activities can lead to addictive behaviours and certain mental disorders.

In conclusion, the COVID-19 pandemic has had significant impacts on physical and mental health globally. While the pandemic's impact on mental health is expected to continue for years, it is essential to consider the impact on children and adolescents who are also affected by prolonged screen time, disrupted social relationships, and other challenges. The current study is important for investigating the impact of increased screen time on the mental health of adolescents during the pandemic. Therefore, it is important to investigate the relationship between screen time and adolescent mental health during the pandemic. The study is particularly relevant in the Indian context where the pandemic has had a significant impact on adolescent mental health. India is one of the world's most populous countries, and it has experienced a rapid increase in internet penetration and smartphone use in the recent years, making it an ideal setting to investigate the relationship between screen time and mental health among the adolescents. Overall, the study aims at providing important insights into the relationship between screen time and adolescent mental health during the pandemic in India which could be used for framing and formulating public health policies and interventions to mitigate the negative effects of the pandemic on their mental health.

Methodology

This systematic review was conducted based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement[20]. It helped collect and analyze data from the past studies and evaluate the results. The protocol of this systematic review was registered in the prospective international register of systematic reviews (PROSPERO) database (ID: CRD42022306125).

Eligibility criteria: The following section describes the inclusion and exclusion criteria:

Population: Adolescents ranging from 18 to 21 years old. (Late adolescence is the transition between childhood and adulthood, the time to test boundaries, break dependency ties, and build new identities) were included in the study. It also included those adolescents who were exposed to COVID-19 lockdown in India.

Interventions/exposures: All the studies that reported screen time usage during COVID-19 or studies that reported associations between any mental and physical health outcomes (psychological impact, mental impact, physical health, screen time/technological impact, behavioural impacts) and screen time during COVID-19 in India.

Review of literatures: Articles published between march 2020 to August 2022 were reviewed. Studies exploring mental or physical health outcomes using screen time and its consequences in the context of COVID-19 amongst the adolescents were reoffered.

Outcomes: The earlier studies had reported the mean screen time (in either hours or minutes/week) before and during the COVID-19 pandemic; associations between any mental health outcome or both physical and mental health outcomes, and screen time during the COVID-19 pandemic.

Exclusion criteria: The review of literatures excluded the conference proceedings and abstracts; studies those included adolescents <18 and >21 or those which adolescents who were not exposed to COVID-19 lockdown; and the studies that focussed only on physical health outcomes of the adolescents.

Search strategy: To find the past researches for this review article, the authors searched individual studies with original data including grey literatures like editorials, academic databases including Scopus, PubMed, Science Direct, CINAHL, Cochrane, Google Scholar, Scielo, and ProQuest for previous studies published between March 2020 and August 2022 (major lockdown period). A systematic search was conducted by the two authors. Titles and abstracts of the remaining studies were independently screened for inclusion. They used the combinations of the following search terms: screen time, social media, technology, connectedness, belonging, loneliness, in India, Adolescent, physical activity, psychosocial wellbeing, identity, self-concept, adolescence, Twitter, Instagram, and Facebook.

Selection process: The researchers reviewed the titles and abstracts of the articles and excluded those who did not meet the eligibility criteria, involve mentoring, and the search terms that were not in the scope of the review. Then, the researchers independently screened the titles and abstracts of all articles retrieved, and they compared their choice of articles. In case of disagreement, consensus on which articles to screen the full text was reached by discussion. Again in any case of disagreement, they had consensus on inclusion or exclusion by discussion; and, if necessary, thee consulted a third expert reviewer.

Data collection process: Data from each study were extracted in a standardized form including characteristics of the subjects, and the study findings. Study sources included the name of the first author's year of publication. Meanwhile, the characteristics of each study referred to study design, population type, age of the sample, sample size, and location of the study. Every article was carefully read and two review authors extracted data independently recorded on an Excel sheet.

Table 1

Keywords Used in Each Search Engine

Search engine	Keywords
Scopus	*(adolescent) OR (late-adolescent) AND (screentime OR digital AND media OR digital AND technology) AND (mental AND health) AND (covid*) AND (India) AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020)) AND (LIMIT-TO (SUBJAREA , "PSYC")) AND (LIMIT-TO (AFFILCOUNTRY , "India"))*
Pub med	*((((((covid 19) AND (mental health)) OR (wellbeing)) AND (screen time)) OR (digital technology)) AND (adolescent) OR (college students)) AND (India)*
Web of Science	*((TI= (covid*mental health screen time adolescent* India)) AND AB= (covid*mental health screen time late adolescent* India)) AND PY=(2020-2021)*
Google Scholar	*screen time OR digital technology AND mental health OR well-being AND adolescent OR late adolescent OR college students AND covid 19 AND India*
Science Direct	

Study Risk of Bias Assessment

The Newcastle-Ottawa Scale (NOS)[21] was used to assess the quality of the studies included. This tool was modified for cohort and case-control studies and adapted for cross-sectional studies. The unclear design studies were assessed according to the prospective cohort NOS. To enhance the validity of this review, the authors only comprised primary studies with the acceptable display quality. The reviewers independently rated all the components of the studies, and results were corroborated, with discrepancies resolved through discussion. The three dimensions of this scale are selection, comparability, and outcome. With a maximum of five stars to be given, the selection domain has four criteria that evaluate the sample's representativeness, sample size, the number of non-respondents, and the indications of the exposure. One category in the comparability domain, with a maximum rating of two stars, evaluates whether confounding factors are considered. With a maximum rating of three stars, the final domain of outcomes has two categories that evaluate the result and the appropriate use of statistical tests. Except for the evaluation of exposure and assessment of the result which both have a maximum score of two stars, all categories are eligible for only one star.

Table 2

Quality Assessment of the Included Studies Using the Newcastle Ottawa scale

Study	Sample representativeness	Sample size	Non-response rate	Exposure definition	Adjustment for confounders	Assessment of the outcome	Statistical test	Score (0-10)
Majumdar et al., 2020	1	1	1	2	0	2	1	8
Akulwar-Tajane et al., 2021	1	0	1	1	0	1	2	6
Arora et al., 2021	1	1	1	2	0	1	1	7
Akulwar-Tajane et al., 2021	1	1	0	2	0	2	1	7
Pandya & Lodha, 2021	1	1	1	1	0	2	1	7
Singh & Balhara, 2021	0	1	1	2	2	1	1	8
Gupta et al., 2021	1	1	1	2	0	1	1	7
Kattula et al., 2021	1	1	1	2	1	1	1	8
Balhara et al., 2022	1	1	0	2	2	2	1	9
Ganesh et al., 2022	1	1	0	2	1	1	1	7

Findings

The literature search was done using the key-words listed in Table 1. The authors found 1556 records in the database search. After the removal of duplicates, a total of 983 records were excluded at the full-text screening stage; 42 full-text documents were reviewed; and finally, 10 articles met the criteria for inclusion[22-31]. Later, they searched the documents that cited any of the originally included databases, and the references of the initiative included studies. However, no extra article that fulfilled the inclusion criteria was found in these searches. According to the PRISMA statement, the flow of our study selection is presented in Fig. 1.[20]

Figure 1

PRISMA 2020 Flow Diagram Describing the Study Selection Process

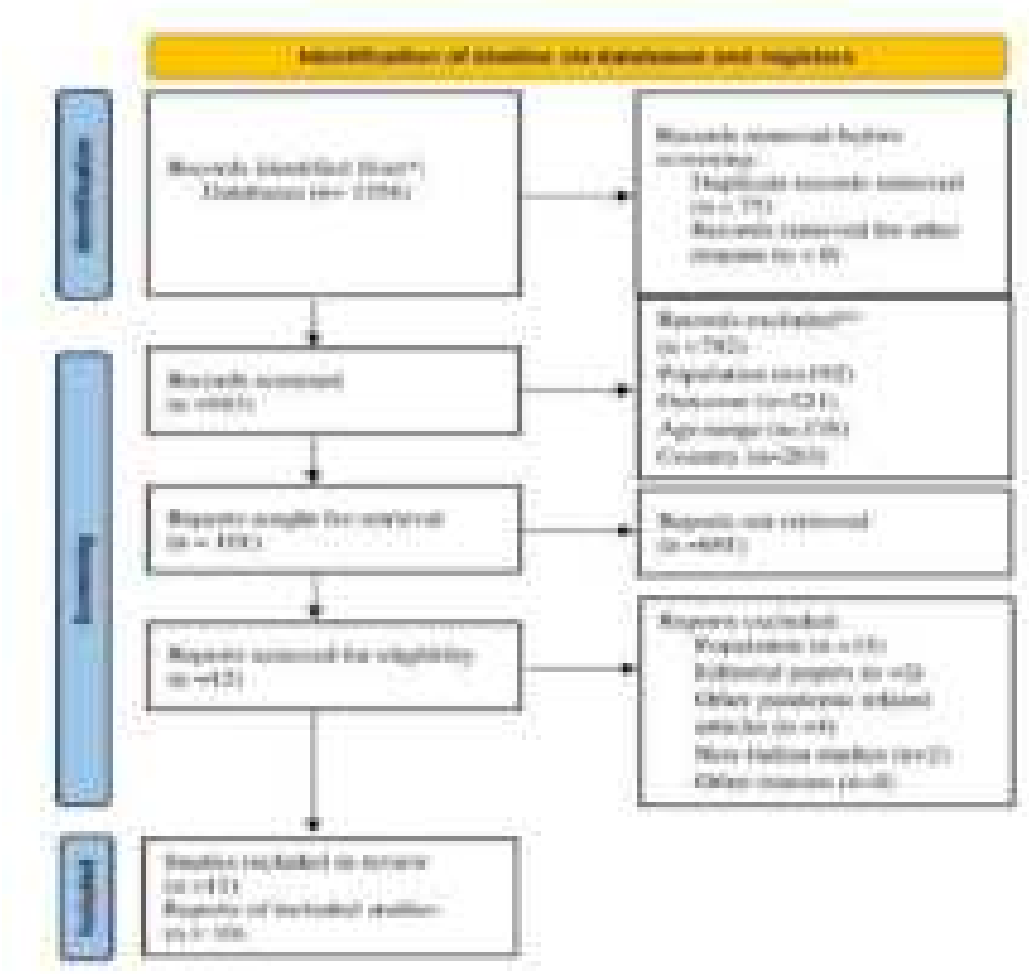

Table 3

Summary of Baseline Characteristics and Findings of Studies Included

Lead Author (Year)	Study design	Population, Age	Sample size	Aims and objectives	Findings
Majumdar, 2020	Qualitative design	University undergraduate students, 18-21	325	To explore the impact of the lockdown – home confinement and social distancing – caused by the COVID-19 pandemic on well-being and lifestyle behaviours, particularly mental and physical health, depressive status, sleep quality, somatic complaints, and digital use.	The study of 325 undergraduate and postgraduate university students confirms, students spent a significantly ($p < .001$) greater duration of time on their cell phone both before (3.04 hours/day) and during (5.23 hours/day) the lockdown and drastically as compared to desktop/laptop or television use. The study showed an interesting association; increased cell phones use among students was negatively correlated with sleep duration ($r = -0.60$); Increased total screen time among the respondents was associated with higher depressive symptomatology; CES-D score was found to be positively associated with screen time among students ($r = 0.26$). The study revealed that Excessive screen time appears to have had a detrimental effect on health by severely affecting sleep patterns and duration.
Akulwar-Tajane, 2021	Cross-sectional qualitative study	Students, 18-21	150	To identify technology use in regards to the person's screen time and its impact on sleep and the mediating effect of physical exercise.	A total number of 150 psychotherapy students completed forms were analysed. 94.7% students' screen time use had increased during the lockdown. 43.3% of student participants spent more than 6 hours on digital devices on a daily basis.73.3% of the population agreed that screen time did affect their sleeping pattern during the lockdown. The study revealed that screen time has increased during the lockdown and to ha affected students' sleep patterns and sleep quality along with a new occurrence of sleep problems in lockdown. Also, mental and physical health issues have been reported. Along with changes in circadian rhythm, lifestyle influences from increasing access.
Kumar Arora, 2021	Cross-sectional, explanatory, online survey study	College students, 18-21	500	To assess the impact of screen time and physical activity on the level of cognitive loss in college students in India.	The highest percentage of college students (43%) had more than six hours of screen time. Subjects having more screen time also revealed a higher cognitive failure questionnaire score (56.19+20.07). Subjects who completed exercises for more than 29 minutes per day were found to have the lowest cognitive failure score (44.31+22.34). A decrease in physical activity also

					accompanies the increased screen usage thereby impacting the mental health of college students leading to cognitive failure.
Akulwar-Tajane, 2021	Cross-sectional qualitative study	Physiotherapy students, 18-21	150	To explore how access to screens, such as smartphones, tablets, and computers, can act as a distraction potential and play a role in studying experiences. Taking into consideration the mediating effect of sleep patterns and mental health of students on learning abilities.	For 94.7% students' screen time use had increased during the lockdown, the extent of the increase being moderate (51-75%) or high (>75%) for nearly two-thirds of the population. 43.3% of student participants spent more than 6 hours on digital devices daily. 56.7% of the students opined that smartphone use was problematic as screen usage has affected their academic performance. The study revealed that distracting students from study-related tasks and excessive hours spent in front of the screen also have a major effect on one's sleep and can affect one's physical and mental well-being.
Pandya, 2021	Systematic review	Children, Youth, 18-21	-	To comprehend the virtual social connectedness, excessive use of digital technology, and its consequences and suggest strategies to maintain healthy use of digital technology.	Screen time has increased drastically during COVID-19. Overall digital device usage increased by 5 h, giving a plunge to screen time up to 17.5 h per day for heavy users and an average of 30 h per week for non-heavy users. The study reported 8.8 h of screen time among younger adults and 5.2 h among the elderly (>65 years old), presenting concerns among these. However, there are mixed consequences of prolonged screen time use and blurred understanding between healthy and unhealthy social connectedness over digital media. A large number of original studies indicate excessive screen time has adverse health effects in long run such as physical health symptoms like eye strain, sleep disturbance, carpal tunnel syndrome, and neck pain as well as mental health problems ranging from difficulties in concentration and obsession to diagnosable mental illness such as anxiety, depression, and attention-deficit hyperactivity disorder.
Singh, 2021	Review study	Adolescent 18-21	-	To rethink the concept of "screen time" in the context of the COVID-19 situation.	The concerns about excessive screen time among children and adolescents pertain to two main health domains. First, an increase in screen time can harm physical health, cause sleep problems and increase the risk of myopia. Second, excessive screen time can also lead to adverse psychological consequences. Using screens while gaming, accessing social media, and watching online streaming services can be associated with behavioural addictions such as gaming disorder.

Gupta, 2021	Cross-sectional survey	College students 18-21	210	To determine the impact of increased screen usage on psychological and physical health during COVID-19 among Indian Students.	A statistically significant difference in time duration spent on screen before and during COVID was observed (t= 19.96; p<0.01). The bulk of them was spending more than 3 hours on screen for study purposes during COVID. The physical health issue which was faced the most due to increased screen usage during COVID, the majority of people reported neck pain (63.3%), eye problems (59.04%), headaches (56.19 %), and backache (29.52 %). 69.9% responded they felt anxious due to over-screen usage whereas 48.8 % responded lack of confidence as a major issue faced by them followed by panic disorder (24.8 %), depression (23.3 %), while 5.2 % responded to other problems which included lack of concentration, feeling agitated, and irritated due to over screen usage.
Kattula, 2021	Cross-sectional study	College students 18-20	232	The study aimed to assess OTT platform use among college students and its associations with increased screen time, mental well-being, COVID-19 related anxiety and personality traits.	Around 80% of the participants reported streaming videos for entertainment was an important reason for the increase in screen time. The change in screen time following the COVID-19 pandemic was a median increase of 240 (120-300) minutes per day. The study found students with high OTT platform use had scored significantly lower on the scale score representing the trait of conscientiousness. Further, those with problematic OTT platform use had poorer mental well-being. The psychological effects of binge-watching reported a significantly greater level of depressive symptoms in those who binge-watched videos. Also, watching videos is a way to reduce or cope with symptoms of anxiety and depression rather than a source of causing or perpetuating emotional difficulties in them.
Balhara, 2022	Descriptive cross-sectional study	College students 18-21	128	The study aimed to assess the gaming behaviour of college students and its association with stress due to the COVID-19 pandemic and the situation consequent to the public health measures instituted.	About half (50.8%) of the participants reported that their gaming behavior had increased, whereas 14.6% reported a decrease in their gaming during the lockdown period. Those with increased gaming had significantly greater chances of experiencing moderate-or-severe anxiety as compared to those who did not increase gaming. In binary logistic regression analysis, hours of gaming per day (OR 1.75 [1.29–2.36]), an increase in gaming due to examination-related stress (OR 4.96 [1.12–21.98]), and belief that gaming helped manage stress (OR 4.27 [1.65–11.04]), were found to be independently associated with gaming behaviour during the lockdown period. An increase in the amount of time spent on gaming would likely reduce the time available for

					other life activities such as personal care, exercise, and communication with others. This pattern of gaming could be detrimental to their physical and mental well-being.
Ganesh, 2022	Cross-sectional study	Medical and engineering students 18-21	731	The current study aimed to assess the relationship between screen time and mental well-being among students. also, attempted to explore the impact of educational and recreational screen time on the mental well-being of students.	The daily total screen time across different devices among the study participants was 540 min (median value, Interquartile range (IQR) = 390.0–720.0) and 540 min (median value, IQR = 420.0–720.0) for weekdays and weekends, respectively. Overall, the students who participated in the study reported a median score of 52 (IQR: 36–68) on the WHO well-being index. About 46.8% (n = 342) of participants scored less than 50% cut-off score on the WHO-5 well-being index (i.e., suggestive of poor mental well-being). During the COVID-19 pandemic, physical inactivity was found to have an association with mental health problems such as anxiety and depression in participants. Increased screen time use predominantly to access social media for non-communication purposes was associated with a higher risk of poor mental well-being.

Of the 10 studies, three were qualitative studies[22,29,30]. Five were cross-sectional studies[23,24,25,28,31] and two were review studies[26,27]. The overview of the baseline study characteristics is given in Table 3.

The researchers used the Newcastle-Ottawa Scale (NOS) to assess the risk of bias for each incorporated study. They considered the high quality of the articles based on each NOS score (moderate and high). An overview of these assessments is depicted in Table 2.

A study by Majumdar et al.[22] uncovered an interesting association that increased cell phone use among students was negatively correlated with sleep duration (r = −0.60) whereas among the office workers, increased use of desktop/laptops was negatively correlated with sleep duration (r = −0.90). Increased screen time among the respondents was associated with higher depressive symptomatology; CES-D (The Center for Epidemiological Studies-Depression Scale) score was entirely associated with screen time among students (r = 0.26) and office time workers. This is also consistent with the discovery that healthy sleeping habits, timing, and patterns are associated with improved mental health and a lower depression score.

Akulwar-Tajane et al.[23] showed that the screen-based digital devices and media use have significantly increased during the COVID-19 pandemic lockdown amongst the Physiotherapy students and provided scientific evidence for its negative impact on sleep. From the study, 94.7 per cent of the students' screen time use had increased during the lockdown. 43.3 per cent of the student participants spent more than 6 hours on digital devices daily. 73.3 per cent of the population agreed that screen time did affect their sleeping pattern during the lockdown. 64 per cent of the students encountered sleeping problems. 52 per cent of the people admitted that excessive screen use had affected their sleep quality. 65.3 per cent of the students were found participating in physical exercises regularly, out of which 65.27 per cent reported decreased sleeping complaints. The study revealed that using screens can have a severe impact on one's mental and physical health, in addition to disrupting the sleep cycle. These mental health conditions (20%) also include a lack of motivation and academic pressures (6%).

The Akulwar-Tajane et al.[25] study also revealed that 84.7 per cent of students could not perform study-related activities optimally as per their academic capacity. 56.7% of the population also agreed that excessive screen time hindered their ability to perform academically well. The study found that excessive screen use keeps students from completing their academic work and negatively impacts their sleep and overall physical and mental health.

Kumar Arora et al.[24] found that the highest percentage of college students (43%) had more than six hours of screen time. Subjects having a higher screen time also demonstrated a higher cognitive failure questionnaire score (56.19+20.07). Subjects who performed exercises for more than 29 minutes per day were found to have the lowest cognitive failure score (44.31+22.34). Along with increased screen time comes a decline in physical exercise, which affects college students' mental health and impairs their ability to think clearly.

Pandya and Lodha[26] showed the virtual social connectedness, excessive use of digital technology, and its consequences and suggested strategies to maintain healthy use of digital technology. Results reveal that screen time has increased drastically during COVID-19. However,

there are mixed consequences of prolonged screen time use and blurred understanding between healthy and unhealthy social connectedness over the digital media. According to a wide number of original studies, excessive screen time has negative health impacts over the long term including physical symptoms like eye strain, sleep disturbance, carpal tunnel syndrome, and neck discomfort as well as mental health issues including memory problems, obsessions, and diagnosable mental illnesses like anxiety, depression, and attention-deficit hyperactivity disorder. The suggestions for negative implications on (physical and) mental health warrant a strict need for inculcating healthy digital habits, especially knowing that digital technology is here to stay and grow with time.

According to Singh & Balhara[27], concerns regarding excessive screen time among children and adolescents are related to two essential health categories. The first way that increasing screen time might impair physical health is through sleep issues and an increased chance of myopia. Second, excessive screen time can also lead to adverse psychological consequences. They were using screens while gaming, accessing social media, and watching online streaming services can be associated with behavioural addictions such as gaming disorder.

Gupta et al.[28] showed a statistically significant disparity between the screen time spent before and during COVID-19 ($t= 19.96$; $p<0.01$). Similarly, a statistically significant positive correlation was found between screen usage time during the COVID-19 pandemic with backache (0.62), neck pain (0.71), headache (0.50), weight gain (0.52), and mental health (0.40). 69.9 per cent of the respondents said they felt anxious because of excessive screen time while 48.8 per cent cited lack of confidence as a critical concern, followed by panic disorder (24.8%) and depression (23.3%), and 5.2 per cent mentioned additional issues like inability to concentrate, feeling upset, and angered. The study found a positive association between screen time and physical and psychological health during COVID-19 among the Indian students.

Kattula et al.[29] found that most of the participants (n=216, 93%) regularly used OTT platforms. Approximately 80 per cent of the participants stated that watching streaming videos for fun was a significant factor in their increased screen usage. The Problematic Over the Top Platform Use Item list (POTTPUI) score was positively connected with the COVID-19-related anxiety scale score ($r=0.148$, $p=0.024$) and significantly inversely correlated with the WHO well-being index score ($r=-0.314$, p0.001). The study discovered that problematic OTT use was connected with paid OTT platform subscriptions and poor mental health, whereas conscientiousness's personality characteristic appeared to protect against problematic OTT use.

Balhara et al.[30] explored the changes in gaming habits among college students within the COVID-19 context. Half of the participants (50.8%) claimed that their gaming activity had grown, while 14.6 per cent claimed it had decreased during the lockdown. The time available for other daily activities like self-care, exercise, and social interaction would presumably decrease as game time increased. Their physical and emotional health may suffer from their gaming habits. This study does not prove that higher gaming during lockdown is associated with mild, moderate, or severe depression. They also expressed a more substantial agreement than students who did not enhance their gaming habit with the notion that gaming assisted in reducing stress due to the COVID-19 pandemic and the associated public health measures such as lockdown, quarantine, and social isolation.

Ganesh et al.[31] found that total screen time was noticeably more significant for students with poor mental health. On the WHO well-being measure, the students who participated in the study reported a median score of 52 (IQR: 36-68). On the WHO-5 well-being index, 46.8 per cent of the participants (n = 342) scored below the 50 per cent cut-off which suggests poor mental well-being. Physical inactivity was linked to mental health issues like anxiety and depression during the COVID-19 pandemic. An increased risk of poor mental health was linked to increased screen usage, mainly when it was used to access social media for non-communicational purposes.

Discussion

The digital age has brought about a sea change in the lives of children and adolescents. It has provided an avenue for further educational opportunities and easy access to information, knowledge, and communication. At the same span, there are concerns about the harms caused by the excessive use of digital technology. With the rise of the novel coronavirus (COVID-19) pandemic crisis, the world has been facing unprecedented times[32]. The beginning of December 2019 gripped the world as a whole, causing the pandemic situation[33] COVID-19-generated lockdown introduced the concept of a "new normal" as a measure of prevention and protection, necessitating children and adolescents to stay at home for educational and recreational purposes. Digitalization impacted children's play, learning, the construction of social relationships, and overall development. Although several studies have tried to elucidate how screen time affects mental health, the extent of how far adolescents' mental health is concerned is unknown. This systematic review included studies showing that screen time and COVID-19 impact adolescents' mental health.

The systematic review mainly collected pieces of evidence from the Indian adolescent population. According to research, increased screen time has been shown to affect both physical and mental health negatively. According to our research, the most frequent effects were sleep difficulties, decreased physical activity, anxiety, and depression. Adolescents' symptoms of depression and anxiety increased noticeably and significantly throughout the lockout compared to rates seen before the lockdown.[22,26,28,29] Cognitive failures, decreased academic performance, lack of concentration, gaming disorder, and poor well-being are additional outcomes that appear to be linked to the COVID-19 lockdown associated with screen time[24-27,31] The literature on screen time reflects both the pros and cons of screen time on (mental) health.

Screen time in excess appears to have negatively impacted sleep quality and duration which in turn, seems to have harmed health. Restrictions on access and isolation in the house resulted in less physical activity and more screen time, which may have significantly contributed to the disruption of sleep patterns. According to a study, the respondents' mid-sleep time curve flattened and shifted toward the right, indicating that more people went to bed later and woke up later during lockdown than they did before lockdown.[22] Furthermore, another study adds to the expanding body of literature emphasizing the connections between screen use and various outcomes, including sleep. The study clarifies that physical activity may be a modifying factor affecting sleep patterns. Most of the exercising participants reportedly felt positive effects due to their physical activity.[23] Also, using a phone or other screen right before bed will prevent you from getting enough rest. Inducing psychophysiological arousal and disrupting sleep might result from gazing at a bright screen while also consuming emotionally upsetting violent, or fast-paced

content in the form of movies or video games. It has been demonstrated that exposure to blue light or electromagnetic radiation after dark from various digital screens such as smartphones, can retard or inhibit the pineal gland's generation of melatonin and lead to sleep disorders owing to disruptions in circadian rhythm. These sleep abnormalities, in turn, have been related to physical health concerns and poor psychosocial functioning, including reduced academic achievement.[27]

According to a study, screen use, sleep quality, and academic achievement are all negatively correlated. The study found that during the COVID-19 lockdown, 84.7 per cent of the students could not complete academic tasks to their fullest potential.

They mentioned the following issues in addition to those covered below: lack of focus and concentration (60.7%), lack of motivation to study, etc. 56.7 per cent of the students felt that using a smartphone was problematic because using a screen had a negative impact on their academic performance.[25] One of the studies revealed that students who spent more time on screens had higher CFQ (cognitive failure questionnaire) scores which indicated a higher likelihood of cognitive failure. The subjects with the longest screen time- more than 6 hours a day, had the highest CFQ scores, whereas those with the shortest- between one and three hours a day, had the lowest CFQ scores.[24] In contrast, it was discovered that a longer exercise period was directly connected to a decline in cognitive failure.

The lowest CFQ scores were found in those who regularly exercised for longer than 29 minutes, indicating a lower chance of cognitive failure.[24] The literature on screen time reflects both the advantages and disadvantages of screen time for (mental) health. If COVID-19 had only been around for a short time, perhaps digital technology would have a positive impact on day-to-day life. However, the prolonged pandemic has made using digital technology a threat to people's physical and mental health.[26] Excessive screen time has negative long-term health effects, including physical symptoms like eye problems, sleep disturbance, carpal tunnel syndrome, and neck pain, as well as mental health problems like concentration issues, obsessions, and diagnosable mental illnesses like anxiety, depression, and attention-deficit hyperactivity disorder.[26-28] Sleep issues and a higher incidence of myopia are the two main detrimental effects of screen time on children's and adolescents' physical health.[27,30] According to a study's findings, spending more time in front of a screen significantly negatively influences one's physical and mental health. Students frequently have backache, neck pain, and headaches, among other physical health issues. However, students report anxiety as the most common mental health problem[28] Poor mental health was linked to using screens more frequently overall. Different sorts of screen time might relate differently to adolescents' mental health. An increased risk of poor mental health was linked to increased screen usage, particularly when it was used to access social media for non-communicational purposes.

Additionally, it was shown that people's lack of physical activity was linked to mental health issues like anxiety and depression during the COVID-19 pandemic.[28,31] A study found that those who used OTT platforms problematically had worse mental health. The psychological consequences of binge-watching revealed noticeably higher depressive symptoms in those who did so.[29] In that study, the OTT consumption behaviour was not linked to COVID-19-related anxiety. We have a similar observation in a study that revealed anxiety associated with COVID-19 was unrelated to

an increase in gaming behaviour.[30] This study fills a gap in the body of knowledge regarding how the COVID-19 pandemic affected gaming habits. During the COVID-19, the majority of college students increased their gaming activity. It was linked to test-related stress and the notion that gaming reduces stress.[30]

Studies revealed that screen time is mediative, with both positive and negative effects on mental health. Perhaps, digital technology offered a forum to deal with psychological reactions fuelled by COVID-19 if it were for a shorter period. However, the protracted period of the pandemic has led the use of digital technology to the pinnacle of a hazard to people's physical and mental health. Literacy about digital practices and parental supervision of children's digital practices needs attention. The pathological use of digital games among youth is disturbing. Critical to note is that digital patterns must be balanced with non-connected activities. It is essential to be aware of the absolutes where one can depend on digital devices for comfort and betterment versus where one needs to pause and disconnect.

Conclusion

Prolonged screen time has been linked to various adverse effects on health including mental health, as suggested by numerous studies. In India, it is essential to re-examine the recommendations on screen time for children and adolescents. However, screen time is a complex concept, and simply limiting the total time spent looking at screens may not be enough. It is advisable to consider other factors when making changes such as the type of screen time, the potential for behavioural problems, and privacy-related concerns like cyberbullying.

Future studies should focus on exploring optimal cut-offs for screen time and delve deeper into the contents and contexts of screen-time use among the children and adolescents at different developmental stages. While digitalization is the future, individuals must be empowered to make informed decisions based on scientific information to mitigate the negative impacts of prolonged screen time. Encouraging healthy digital habits is crucial in the light of the global trend towards digitalization. To promote healthy habits, we can aim at educating students on the negative effects of excessive screen time and encourage better bedtime routines. Additionally, we will limit screen use for academic purposes, providing alternative sources and solutions. We will also educate students on the importance of physical activity, especially during lockdowns which is crucial for maintaining good health and wellbeing. The present research contributes valuable scientific knowledge to the impact of long-term lockdowns on health and wellbeing as well as to the development of effective preventive measures. With the insights gained from this study, we strive to create a healthier digital environment and promote well-being among children and adolescents.

Recommendations

Based on the findings of this study, there are several implications for practice that can promote healthier digital habits and reduce the negative effects of prolonged screen time on children and adolescents. Firstly, educators and parents must be made aware of the adverse effects of prolonged screen time; and they must be educated on strategies to limit and monitor children's screen time. This could include setting guidelines and restrictions on screen time, encouraging

alternative activities like outdoor play or reading, and monitoring children's screen use. Secondly, there is a need to incorporate other attributes besides total screen time spent while making recommendations on screen time. These attributes could include the type of screen time, contents and contexts of screen use, and privacy-related issues like cyberbullying. Thirdly, physical activity should be promoted amongst the children and adolescents, especially during lockdowns. This could include encouraging outdoor activities, setting up virtual exercise classes, and providing opportunities for physical activity during remote learning. Fourthly, educators and parents should promote healthy bedtime routines to ensure that children get enough sleep, which is crucial for their physical and mental well-being. Finally, there is a need for ongoing research to explore the optimal cut-offs for screen time based on the type of screen time, the rise of behavioural problems, and privacy-related issues like cyberbullying. This will ensure that future recommendations on screen time are evidence-based and effective in promoting healthy digital habits among children and adolescents.

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Global Undernutrition Convergence: Evidence from Club Convergence

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Abstract

Being the most essential element for a healthy life, nutrition plays an important role in maintaining the health standard. Any deficiency in terms of nutrient intake is a leading risk factor of death and morbidities among infants, especially new-borns. This study investigates the undernutrition convergence globally by employing Philips and Sul club convergence test for the period 2001 to 2018. Results from Philips and Sul club convergence test shows that the evidence of overall convergence is not found rather selected countries cluster themselves into 3 clubs and one non-convergent group. This proves that selected countries are not converging to a single steady path; however, it revealed the existence of the club-specific steady state. The study recommends that club-specific policies need to be implemented to tackle the incidence of undernutrition.

Key words: Nutrition, Undernutrition, Club convergence.

Introduction

Being the most essential element for the healthy life nutrition plays an important role in maintaining the health standard (Barasi 2003)[1]. Nutrition is very crucial for the overall development of a human being; hence, efficiency and productivity of the labour force heavily depend on the balanced nutrition intake (Kim et. al., 2013)[2]. Having a diet with sufficient calories requirement of body is very essential for being healthy (Strauss, 1986)[3]. Any deficiency in terms of nutrients intake is a leading risk factor of death and morbidities especially among new-borns (Tomkins, 2000)[4] ([4]*If the variable is slowly moving towards the upward trend in a nonlinear way, then there would not be any cointegration between the series. This is considered by PS method.*) It is estimated that by eliminating under nutrition, 32 per cent of the world disease burden can be reduced (Ahmed et. al., 2012)[5]. National and International organizations started various programmes and policies to improve the nutrition availability to the most vulnerable groups of the world. But the problem of under nutrition is still persisting globally especially in the developing countries (Popkin et. al., 2012)[6]. Undernutrition occurs due to an imbalance in nutrition intake and the requirement of the body. Undernutrition affects every country of the world despite its geographical boundaries and socio-economic status. Hence, it has become a global issue in the recent years. Every country can experience undernutrition, but most susceptible are the developing and poor (under-developed) countries due to the challenge of poverty in these

countries. Undernutrition is the main hunger indicator used by the Food and Agriculture Organization (FAO).

According to World Health Organization (WHO), 11 per cent (820 million) of the world's population is taking lesser calories than what they require. It means they are undernutrition. As a result of poor nutrition intake, 22 per cent of children under 5 are stunted and around 697 (9 % of world population) million people are food insecure globally (Roser & Ritchie, 2019)[7]. According to the UN's 'depth of the food deficit' metric majority of the developing nations are under the food deficit. In other words, most of the developing countries had a food deficit of 200 kilocalories per person/day. Some of the Sub-Saharan African countries have a food deficit between 300-500 kilocalories per person/day (Van et. al. 2012)[8]. The consequences of undernutrition are manifold but the way to eliminate undernutrition is the availability of nutritious food to all the people around the world. This can happen by eradicating the prevalence of poverty especially from the developing regions of the world. Other factors in removing the undernutrition are compulsorily breastfeeding for the first 2 years of life, access to basic necessities for instance; healthcare, water, hygiene and sanitation, pregnant women's nutrition pattern etc.

International organizations continuously reaffirmed their agenda to eliminate undernutrition. The 1992 International conference on nutrition held in Rome adopted a world declaration of plan of action to eradicate undernutrition and hunger. Later in 2002, Rome Declaration on World Food Security and World Food Summit Plan of Action set a target of reducing hunger 50 percent by 2015. In 2004 FAO's council adopted the food for all to achieve food security and nutrition for all. In this order United Nation has adopted 8 development goals popularly known as millennium development goals in the year 1990 two of which are dedicated to improve the quality of life through eradicating hunger and reduced child mortality by 2015. Target was set to halve the proportion of people who suffer from poverty and hunger by 2015. Recently in 2016 united nation formulated sustainable development goals (SDGs) focused on nutrition to achieve by 2025. Collaboration between the International community and concerned governments of respective countries can help their people by ensuring equal access to quality food which will eventually boost their economic growth (Sachs 2012[9]; Soubbotina, 2004[10]). Inspection of programme and policies implemented by the government is needed to find whether the existing action plans are working or not.

Since the year 2000, world regions experienced substantial fall in undernutriton (Van et. al., 2012)[8]. An improvement in the nutritional intake is being recorded in the past decade (Müller & Krawinkel, 2005)[11]. Hunger has fallen from 14.8 per cent of people to 10.8 per cent between 2000 and 2018 (Otekunrin, et. al. 2019)[12]. Sub-Saharan Africa is an exception in a way that instead of taking numerous efforts by the world organization to reduce the prevalence of undernutrition & hunger for the region, undernutrition in terms of stunted children increased between 1990 to 2015. The International Food Policy Research Institute (IFPRI) formulated an index known as Global Hunger Index to measure the extent of hunger. In terms of GHI scores, Sub Saharan Africa and south Asia are the leading regions in terms of hunger hence prevalence of undernutrition is also highest in these regions. Although a significant improvement has been recorded in terms of elimination of hunger, however; undernutrition remains a serious problem in many developing countries. Apart from the negative consequences of undernutrition on human health, economy of the world is also adversely affected by this (Alderman, et. al., 2014; Headey, 2012)[13,14]. High prevalence of undernutrition causes poor growth and development on one hand

and enhances poverty on the other by effecting efficiency and productivity (Gupta & Mitra, 2004; Mehta & Shah, 2003)[15,16]. Furthermore, due to negative consequences of undernutrition on health, expenses incurred on seeking healthcare has also been increased which again become a cause of hunger and lower nutritious diet (World Health Organization, 2019)[17].

Data form various published sources shown that huge differentials are existed in terms of undernutrition between developed and developing countries (Abdullah, 2015)[18]. The burden of undernutrition is unacceptably high especially in developing regions of the world. More than hald of undernourished children live in South Asia. Nearly 479 million people is facing undernutrition in the region of Asia and the Pacific.

Though several studies are available on undernutrtion and its impact of socio-economic condition across countries by employing different methodologies but very little literature has been found on convergence issue. Existing literature (Ved & Menon 2012; Guriev & Vakulenko 2015; Klasen 2008; Haddad et. al. 1999; Ouyang et. al. 2019)[19-23] have investigated convergence in poverty, gender nutrition, urban nutrition but literature on undernutrition convergence is scanty. This study complements this research gap by investigating undernutrition convergence across the world.

Thus, the researchers of the current study have employed the concept of neo-classical growth convergence theory, which states that poor countries trace the growth path of rich nations in the long run. However, in reality this is not possible because each nation has its own steady path of transition. Hence, we relax this assumption of single steady state rather we assume that they require relative growth rates to trace a single steady path (Jones 1997; Evans & Karras 1996)[24,25]. This study applies the club convergence methodology propounded by Philips and Sul in 2007 to examine the above research objective i.e. whether the undernutrition in countries are converging or diverging over time across world.

Methodology

This research adopts the Philips and Sul club convergence (2007; hereafter PS)[26] test. PS method is more robust than neo-classical growth theory of convergence. In a way, the neoclassical theory says that the developing economies move faster than the developed economies in terms of their per capita income. Reasons for tracing developed nations faster are: developing nations imitate the production techniques, technology and institutions of highly advanced economies in the long run. Furthermore, PS test also resolve the problem of single steady state of transition. The neoclassical theory assumed that all the countries trace a single steady state which may not apply to those sections where huge diversity is persisting. PS test takes care of this issue and endogenously form the clubs of cross-sections based on the "nonlinear time-varying factor" in such a manner that each club will follow a unique steady transition path based on their relative growth trend. Thus, PS method is based on relative convergence and describes a series as non-stationary which is moderately converging considering individual heterogeneity. PS test provides the convergence of that series which has both stationary and non-stationary characteristics and that makes PS test better than panel unit root test. Altogether PS test takes care of the biasness comes from the mix of stationary and non-stationary misidentification in the panel. This method offers the basics of modelling transitional dynamics as well as long-run pattern and includes both the common and individual-specific components. Thus, the authors of this paper consider the Philips and Sul convergence test better in terms of effectiveness than panel unit regression model and co-integration test.

The researchers have used the annual data on undernutrition (UNT) for 162 countries provided by World Bank. World Bank provides data on prevalence of undernutrition in terms of percentage of population undernourished. The single factor model of PS can be shown as:

$$UNTit=it+it \quad (1)$$

Where i=1, 2, 3,4,…,15 (no of countries)
t=1987,1988,….,2018 (Time period).
δi = idiosyncratic distance between the systematic part of UNTit and common factor t.
t = Accumulated common behavior of UNTit of individual units. uit refers to the error term.

Equation 1 explains the progression of the UNTit with respect to the common factor by means of systematic element (i) and the error (uit).

UNTit is categorised into two parts: First- Systematic component (S_{it}) and Second- Transitory components (tit):

$$UNTit=Sit+tittt=itt, \quad \forall\ i,t \quad (3)$$

Where t = common steady path having both deterministic component and stochastic components.
it = idiosyncratic element (Time and Country-specific effects)
t = Share of the common Factor for each country).

Convergence follows the dynamic process (Philips and Sul, 2007)[26]. Hence, it in Equation (3) represents the transition paths. PS test does not focus on parametric form for t rather it factors out and focuses on it. To find out coefficients of it , structure restrictions must be imposed on δ_{it} and t. Hence, PS test assumes a semi-parametric form for it that help to conduct a formal test for convergence.

To estimate long-term convergence, PS test has suggested the below form that ignores the common component (t) from equation (3) by dividing the panel average:

$$hit=UNTit1Ni=1NUNTit=it\ 1Ni=1Nit \quad (4)$$

Where hit = Relative measure for the transition path with the panel average.

In the short run hit varies across the selected units, but attain convergence in the long run when $hit \rightarrow 1$ for all units (i), when $t \rightarrow \infty$. It can be achieved in the long term when the variance of the country of $hit \rightarrow 0$. The below assumption is required for algorithm club convergence in a semiparametric form including time-varying coefficients δit :

$$it =i +itit \quad (5)$$

Where it=iLtt, i>0, t≥1 and it is poorly dependent over t, and traces independent identically distributed (iid) (0, 1) over i. The function L(t) is gradually increasing and diverging at infinity (LT→∞ as t→∞). PS assumes the null hypothesis of convergence for all units (i) for the countries including a specific form of it: H0:i =δ,∀ i with a≥0. And the alternative hypothesis is: H1:i ≠δ,∀ i with a≥0 or a<0. Null hypothesis can be tested by following the below regression:

$$\log H1Ht - 2\log Lt = c + b\log t + ut \quad (6)$$

Where t=rT, rT+1,……, T and r>0.
Moreover, H1Ht show the countries variance.

Lt=log (t+1) is applied in Equation (5). Further, Ht=1Ni=1N(hit-1)2 and b=2. indicates the least square parameter of a. in case of null hypothesis logH1Ht diverge; whether a>0 or a=0. For testing convergence, one-sided t-test of the inequality, a≥0 using b might be useful. t- Statistic follows the "standard normal distribution asymptotically" that is created by the estimate b. PS has suggested that the null of convergence is accepted if the value of t-statistic is lower than the critical value -1.65. The speed of convergence can be calculated following the expression b = 2α (Phillips and Sul 2007, 2009)[26, 27].

Discussion

We have applied Philips and Sul club convergence method. Result shows that there is no evidence of overall convergence among the selected countries. -57.0766 is the log (t) regression value for the full sample which is lower than the critical value of -1.65, hence overall convergence hypothesis for the full sample is rejected in case of selected countries (Table 1).

Table1
Club Convergence Across Countries

Club	Countries	Coefficient	T-Value	Decision
Full Sample		-1.0318	-57.0766	Divergence
Club 1	| Chad | Haiti | Korea, Dem. People's Rep. | Lesotho | Liberia | | Madagascar | Venezuela, RB |	0.640	3.741	Club Convergence
Club 2	| Cabo Verde | Eswatini | Rwanda | Sierra Leone | Timor-Leste |	0.554	5.654	Club Convergence
Club 3	| Congo, Rep. | Iraq | Mozambique |	0.067	0.583	Club Convergence
Club 4	| Afghanistan | Angola | Botswana | Cote d'Ivoire | Ethiopia | | Gabon | Kenya | Nigeria | Sao Tome and Principe | | Solomon Islands | Tanzania | Togo |	0.678	6.810	Club Convergence

Club 5	| Bangladesh | Bolivia | Burkina Faso | Cambodia | El Salvador | | Guatemala | Honduras | Jamaica | Jordan | Malawi | Mauritania | | Mongolia | Namibia | Nicaragua | Philippines | Vanuatu |	0.360	3.420	Club Convergence
Club 6	| Belize | Cyprus | Dominica | Georgia | Mexico | New Caledonia | | Pakistan | Paraguay | Sudan |	0.816	4.493	Club Convergence
Club 7	| Albania | Argentina | Australia | Austria | Barbados | Belarus | | Belgium | Benin | Bosnia and Herzegovina | Brunei Darussalam | | Bulgaria | Canada | Chile | Colombia | Costa Rica | Cuba | | Czech Republic | Denmark | Dominican Republic | Ecuador | | Egypt, Arab Rep. | Estonia | Euro area | Fiji | Finland | France | | Gambia, The | Germany | Ghana | Greece | Guyana | | Hong Kong SAR, China | Hungary | Iceland | Indonesia | | Iran, Islamic Rep. | Ireland | Israel | Italy | Japan | | Korea, Rep. | Kuwait | Kyrgyz Republic | Latvia | Lebanon | | Lithuania | Luxembourg | Macao SAR, China | Malaysia | Malta |	0.280	3.120	Club Convergence

	| Mauritius | Montenegro | Morocco | Myanmar | Netherlands | | New Zealand | Norway | Oman | Panama | Poland | Portugal | | Romania | Russian Federation | Saudi Arabia | Senegal | Serbia | | Slovak Republic | Slovenia | Spain | Sri Lanka | | St. Vincent and the Grenadines | Suriname | Sweden | | Switzerland | Thailand | Trinidad and Tobago | Turkey | | Turkmenistan | Ukraine | United Kingdom | United States | | Vietnam |			
Club 8	| Cameroon | Croatia | Kiribati | Mali | Nepal | Peru | Samoa | | Tunisia | United Arab Emirates | Uruguay |	0.826	3.931	Club Convergence
Club 9	| Algeria | Azerbaijan | Brazil | China | Kazakhstan | Uzbekistan |	0.273	0.975	Club Convergence
Not convergent Group 10	| Armenia | India |	-3.687	-123.531	Neither convergence nor divergence

Club	**log (t) regression value**
Full Sample	-57.0766

This shows that the selected countries are not following a single steady path rather these countries merged and formed 10 clubs. According to Philips and Sul, in the first step of analysis we may not get the true number of clubs, thus to find out the true number of clubs and to find out the evidence of any merger of clubs log (t) regression is repeated again. Results presented in Table 2 (Annexure) shows the evidence of merger of clubs to large clubs. Final clubs are tabulated in table 3. Result shows that finally, we get 3 clubs and one group of 2 countries which is neither converge nor diverge. Club 1 includes 15 countries namely, Cabo Verde, Chad, Congo, Rep., Eswatini, Haiti, Iraq, Korea, Dem. People's Rep., Lesotho, Liberia, Madagascar, Mozambique, Rwanda, Sierra Leone, Timor-Leste, Venezuela, RB. These countries have highest incidence of undernutrition. A large number of countries in this club is from African continent

which is well known for their well spread food insecurity (Lopriore C & Muehlhoff E 2003)[28]. Demographic, socio-economic and agro-ecological characteristics of the region often to be blamed for poor nutrition condition of the children in this region (Anand & Ravallion 1993)[29]. Moreover, rapid population growth and desertification has affected food production, access and availability. Poverty and unemployment are the other determinants of poor nutritional qualities in the countries of this club (Mamabolo et. al. 2005)[30]. Higher Income inequality is persisting in these countries consequently, lower human development leading to higher undernutrition (Adeleye et. al. 2020; Mukherjee et. al. 2019)[31,32]. 37 countries namely Afghanistan, Angola, Bangladesh, Belize, Bolivia, Botswana, Burkina Faso, Cambodia, Cote d'Ivoire, Cyprus, Dominica, El Salvador, Ethiopia, Gabon, Georgia, Guatemala, Honduras, Jamaica, Jordan, Kenya, Malawi, Mauritania, Mexico, Mongolia, Namibia, New Caledonia, Nicaragua, Nigeria, Pakistan, Paraguay, Philippines, Sao Tome and Principe, Solomon Islands, Sudan, Tanzania, Togo, Vanuatu formed the club 2. These countries have recorded highest undernutrition incidence but that is lower as compared to the club 1 countries. The economy of these countries is of developing in nature consequently higher population growth, lower per capita income, lower human development, lower employment opportunity leads higher undernutrition in this group of countries (Kennedy, 2002; Anand & Ravallion, 1993; Smith & Haddad, 2000; Madanat, et. al., 2008)[33,27,34,35].

Table 2
Results of Merger of Clubs

Club Merger	Coefficient	T-Value
Club 1+2	0.073	0.861
Club 2+3	0.482	5.179
Club 3+4	0.236	4.074
Club 4+5	0.452	5.243
Club 5+6	0.089	1.100
Club 6+7	0.094	1.320
Club 7+8	0.246	2.983
Club 8+9	0.024	0.285
Club 9+10	-2.838	-20.538

A total of 98 countries namely, Albania, Algeria, Argentina, Australia, Austria, Azerbaijan, Barbados, Belarus, Belgium, Benin, Bosnia and Herzegovina, Brazil, Brunei Darussalam, Bulgaria, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Arab Rep., Estonia, Euro area, Fiji, Finland, France, Gambia, The, Germany, Ghana, Greece, Guyana, Hong Kong SAR, China, Hungary, Iceland, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Japan, Kazakhstan, Kiribati, Korea, Rep., Kuwait, Kyrgyz Republic, Latvia, Lebanon, Lithuania, Luxembourg, Macao SAR, China, Malaysia, Mali, Malta, Mauritius, Montenegro, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Norway, Oman, Panama, Peru, Poland, Portugal, Romania, Russian Federation, Samoa, Saudi Arabia, Senegal, Serbia, Slovak Republic, Slovenia, Spain, Sri Lanka, St. Vincent and the Grenadines, Suriname, Sweden, Switzerland, Thailand, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Uzbekistan, Vietnam are included in club 3. Club 3 countries are the developed countries with high HDI index as compared to the countries listed in club 1 and club 2 (Crafts, 1997)[36]. Higher per capita income, lowest income inequality, advanced healthcare facilities are some of the

reasons for better nutritional qualities in the countries of this club (Dabla-Norris et. al. 2015; Diaz-Bonilla et. al. 2000; Verma & Usmani 2019)[37-39].

A non-convergent group of 2 countries namely Armenia and India were also found during the analysis. These countries do not club with any of the groups. These two countries need further exploration to understand their distinctiveness.

Table 3
Final Club

Club	**Countries**	**Coefficient**	**Log(t)**	**Decision**
Club 1	| Cabo Verde | Chad | Congo, Rep. | Eswatini | Haiti | Iraq | | Korea, Dem. People's Rep. | Lesotho | Liberia | Madagascar | | Mozambique | Rwanda | Sierra Leone | Timor-Leste | | Venezuela, RB |	-0.043	-0.585	Divergence
Club 2	| Afghanistan | Angola | Bangladesh | Belize | Bolivia | | Botswana | Burkina Faso | Cambodia | Cote d'Ivoire | Cyprus | | Dominica | El Salvador | Ethiopia | Gabon | Georgia | | Guatemala | Honduras | Jamaica | Jordan | Kenya | Malawi | | Mauritania | Mexico | Mongolia | Namibia | New Caledonia | | Nicaragua | Nigeria | Pakistan | Paraguay | Philippines | | Sao Tome and Principe | Solomon Islands | Sudan | Tanzania | | Togo | Vanuatu |	0.177	2.600	Cub Converge
Club 3	| Albania | Algeria | Argentina | Australia | Austria | | Azerbaijan | Barbados | Belarus | Belgium | Benin |	0.109	1.578	Cub Converge

	| Bosnia and Herzegovina | Brazil | Brunei Darussalam | | Bulgaria | Cameroon | Canada | Chile | China | Colombia | | Costa Rica | Croatia | Cuba | Czech Republic | Denmark | | Dominican Republic | Ecuador | Egypt, Arab Rep. | Estonia | | Euro area | Fiji | Finland | France | Gambia, The | Germany | | Ghana | Greece | Guyana | Hong Kong SAR, China | Hungary | | Iceland | Indonesia | Iran, Islamic Rep. | Ireland | Israel | | Italy | Japan | Kazakhstan | Kiribati | Korea, Rep. | Kuwait | | Kyrgyz Republic | Latvia | Lebanon | Lithuania | Luxembourg | | Macao SAR, China | Malaysia | Mali | Malta | Mauritius | | Montenegro | Morocco | Myanmar | Nepal | Netherlands | | New Zealand | Norway | Oman | Panama | Peru | Poland | Portugal | | Romania | Russian Federation | Samoa | Saudi Arabia | Senegal | | Serbia | Slovak Republic | Slovenia | Spain | Sri Lanka | | St. Vincent and the Grenadines | Suriname | Sweden | | Switzerland | Thailand | Trinidad and Tobago | Tunisia |			

	| Turkey | Turkmenistan | Ukraine | United Arab Emirates | | United Kingdom | United States | Uruguay | Uzbekistan | | Vietnam |			
Not convergent Group 4	| Armenia | India |	-3.687	-123.531	Neither convergence nor divergence

Conclusion

The main aim of this study was to investigate the convergence hypothesis of undernutrition globally from 2001 to 2018. To do so this study employed the Philips and Sul (2007)[26] convergence method. Our result showed that there is no evidence of overall convergence in terms of undernutrition rather it shows multiple clubs of similar convergence pattern. This means that selected countries are not converging to a single group instead they followed a club specific steady state path after clustering themselves. The clusters observe somewhat similar growth pattern which is reflected in their clubbing pattern depending on undernutrition, except Armenia and India.

The result of the present study offers the following policy recommendations: First, countries lie in club 1 and club 2 should revise their programmes and policies to ensure the food safety for all. Second, results found that some of the developing countries like Sri Lanka, Nepal, Myanmar and Thailand etc. are catching up the countries where human development is high and undernutrition is on moderate level but these countries have to make adequate effort to sustain the same level of undernutrition. Third, club-specific programmes and policies should be taken into consideration to resolve the problem of undernutrition convergence in the long run.

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इतिहासाचार्य वि. का. राजवाडे मंडळ, धुळे
या संस्थेचे त्रैमासिक

|| संशोधक ||

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विशेष सूचना : [illegible]
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अक्षरजुळणी : [illegible]

ONE WORLD FAMILY - THE CLARION CALL OF THE ART OF LIVING

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Research Scholar
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ABSTRACT :

(Received 2015)

The Sanskrit phrase *Vasudhaiva Kutumbakam* that translates as 'One World Family' appears in the sixth chapter of the Hitopadesha and has a basis in the Samskrit tradition. According to the Vedic tradition, all living beings are perceived as a single family which implies an interconnected universe with a unifying principle behind the apparent diversity in the universe. The mission of *Vasudhaiva Kutumbakam* is the rich and ancient approach that encompasses the political, social, ecological, economic, cultural and spiritual dimensions and perceptions that *Samskrit* Approximate can bring about the transformation envisaged in the Vedic Upanishad. Responding to this clarion call with a great fervor is a mesmerizing personality - Parampujya Sri Sri Ravishankarji - the founder of the World Wide Art of Living Movement. An ambassador for global peace, he is an epitome of unconditional love, tolerance, divinity, peace and bliss. This paper explores how the Art of Living plays a pivotal role in bringing about a wave of unity, harmony, and interconnectedness, ultimately working towards the goal of a 'One World Family'.

KEY WORDS: *Vasudhaiva Kutumbakam*, oneness, Global Interfaith, Art of Living, peace

INTRODUCTION

The ancient Indian philosophy *Vasudhaiva Kutumbakam* encompasses the view of a global village where all individuals, regardless of their nationality, race, or religion, are considered part of the same human family. One world is affected today with issues that have caused the whole spheres by our existence. As a result, like that a mutilate has arisen in the forefront with the clarion call of *Vasudhaiva Kutumbakam*, the founder of the world wide Art of Living Movement Sri Sri Ravi Shankarji a name synonymous with peace, compassion and unconditional love with a less significant most cosmic, late responsible citizens. Each one's contribution serves as the foundation for fostering positive relationships and contributing to the betterment of society.

Sri Sri Ravi Shankarji believes strongly in the dictum 'Love Makes the World' and truly so as one hundred and eight countries have joined hands through the Art of Living Movement to fulfill his dream of *Vasudhaiva Kutumbakam* in the vast tapestry of human existence, the essence of life lies in understanding the interconnectedness of all beings and embracing the profound philosophy of *Vasudhaiva Kutumbakam*, which translates to "the world is one family." The Art of Living, in its deepest sense, encompasses not only the pursuit of individual happiness but also the cultivation of empathy and a sense of universal belonging.

CONCLUSION :

REFERENCES

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Samshodhan Dnyan Vichar Pratisthan's
Dr. Shripati Shastri Research Institute of Social Sciences

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Purple Prairie and Politics : A Study of Salman Rushdie's Midnight's Children, Nayantara Sahgal's Rich Like Us, Rohinton Mistry's A Fine Balance, Upamanyu Chatterjee's English, August and Kiran Desai's The Inheritance of Loss

- Dr. Ashalata Purohit

The present study is about Purple Prairie and Politics in a regional way to examine real concerns and a need for a new vision for the political system. The study portrays the interdependency and involvement of the common man although he is indirectly or unknowingly the victim. Every thought his right of adult franchise politicized, the voice of the common man is independent and it also exists largely democratic. Common man suffers no matter who rules him. He becomes a pawn under every government whether it is monarchy or democracy.

People suffer due to the political events and turmoil and politics is an indispensable part of human life. The novels taken up for the selection of analysis in this study are Salman Rushdie's Midnight's Children (1981), Nayantara Sahgal's Rich like us (1985), Rohintonmistry's A Fine Balance (1995), Upamanyu Chatterjee's English, August (1988) and Kiran Desai's The Inheritance of Loss (2006) which deal with political themes. The novelists are concerned with the impact of politics on human lives.

The study portrays the sufferings and humiliation of the masses at various levels i.e. physical, economic, social and psychological. The time span of the selected novels is mostly from the late sixties to early eighties which cover the major and memorable political and social events like national Emergency wars with Pakistan, China and Bangladesh, encroachment of Assam like Indira Gandhi, Naxalite movement in the North - Eastern state, functioning of bureaucracy and illegal immigration.

Vasai-Kulkarn (Chemistry) Poona College of Arts, Science & Commerce, Pune

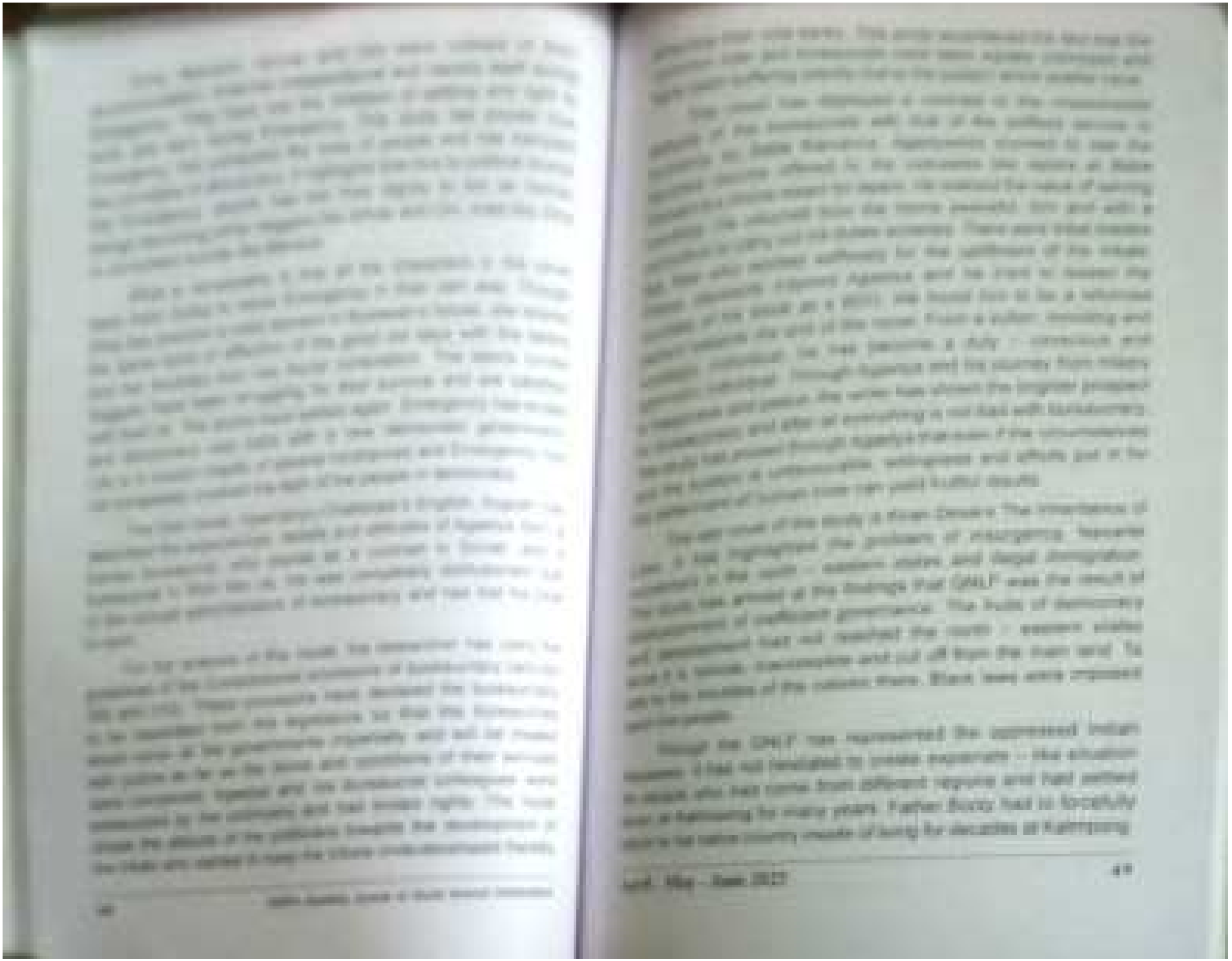
population of more than five hundred thirteen million people with their problems and distressing experiences which can be more strength, talent and merit to survive there. The people have their religious and the creation of Supreme Power is great and its effects on the masses. The time span is chosen for the study as it signifies the end of one political era where one generation of rulers who were freedom fighters was replaced by the next generation of rulers. Rajiv's death has ended an era in Indian politics paving way for the dynastical rule in Indian democracy.

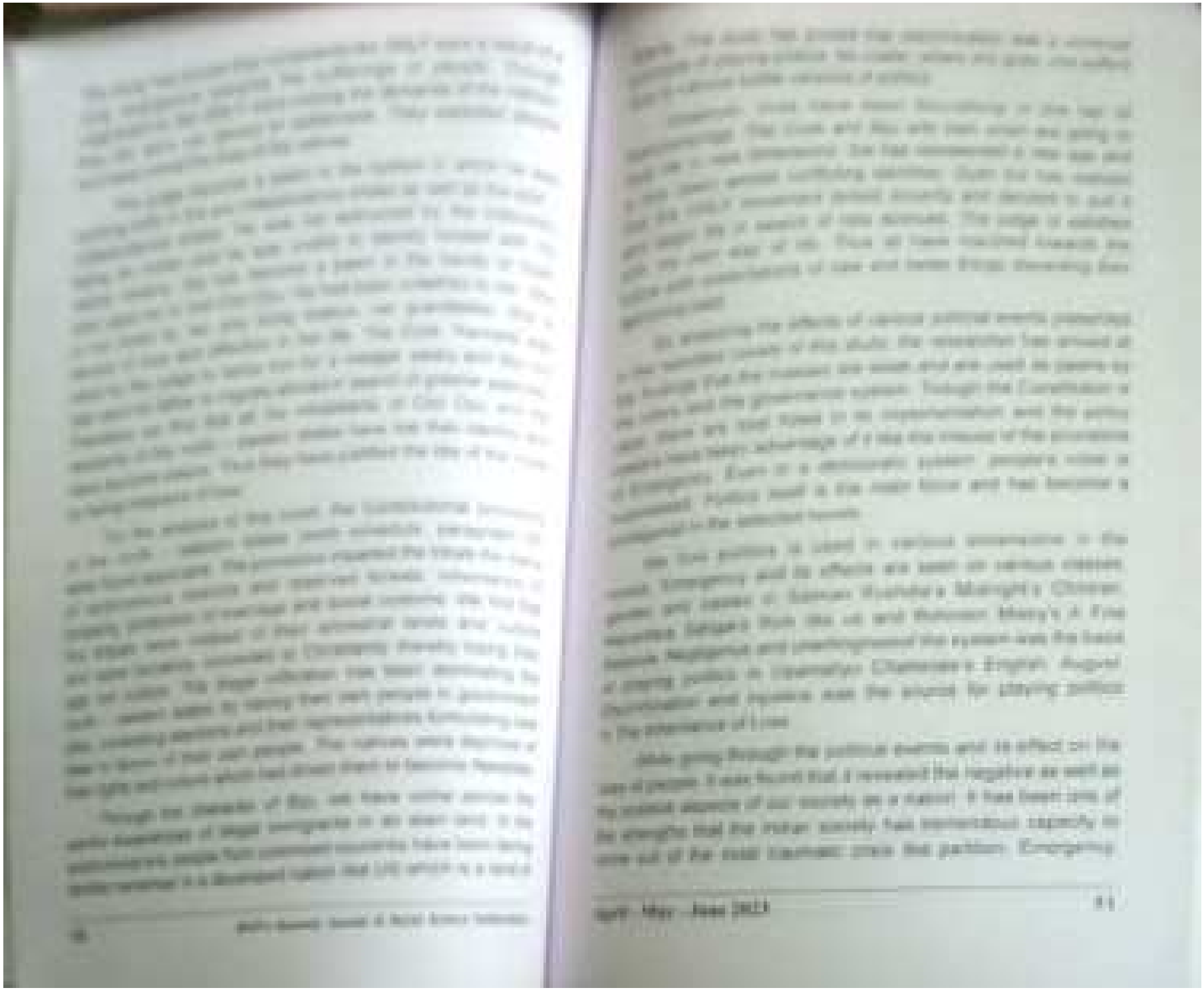
Along with a broad time span, the research geographically covers the State, continents India, America and Europe and mainly deals with Mumbai, Bangladesh, Pakistan, Madhya Pradesh, Delhi and the rural interiors of India. This wide geographical scope shows how people suffer universally and are controlled by the political system.

The special contribution of the study is that it has applied various relevant Constitutional provisions to the selected works of literature and has analysed the effects of the alteration of democratic principles and provisions.

The study has put forth the methodology for the analysis of the selected novels which is using the relevant Constitutional provisions as a framework. For this purpose, the Constitutional provisions that have like the Directive Principles, Fundamental rights, the basic provisions of bureaucracy, provisions for the Backward castes and special provisions for Scheduled Castes and Tribes and Laws.

As the study has dealt with the theme of how politics makes a need of innocent people, it also measures the attitude of the rulers or the heads of particulars which has benefitted the rulers. It shows the disparity between theory and practice. The benefit of the law is taken care of rather than the common welfare of the masses.





foreign aggression etc. This capacity to rise again after a setback has kept the Indian society breathing inspite of constant attacks for over two thousand years. This is because of the psychological toughness as well as the flexibility on the part of the society. Also the strong will of the people has led to the survival of democracy enduring several setbacks endangering its existence.

One finds politics has been governing the lives of people irrespective of caste, class, religion or gender. Everyone has been suffering due to politics and at the same time is a part and parcel of politics.

The political system is always instable since no man made system can be perfect as the political framework needs to change to suit the growing and varying needs of the people. After all people are at the centre of governance. The flexibility of the political system with welfare of the people at its centre can only ensure the survival of a healthy and vibrant democracy.

(This is the synopsis of the PhD thesis submitted to the S. P. Pune University)

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Articles

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THE COST OF MATERIALISTIC LIFESTYLE: MONEY, MIND AND MORALITY

[illegible] Sahu Sayyad
Assistant Professor of English, Poona College of Arts, Science and Commerce Camp, Pune - [illegible]

Abstract:
Wealth accumulation and wealth creation are human specific activities as all human beings [illegible] human beings act and interact in the context and conclusions of their economic standing in the [illegible] and culture. The majority, if not all, are inclined to think that to be well, one first has to be [illegible] good life begins arguably, according to many of us, after considerable success in having more [illegible] and/or having more than others. Such a materialistic outlook and the ensuing [illegible] [illegible] moral problems but are being seen as major pursuits of life. There are many [illegible] this upheaval, but the most pressing one is the desire to live life according to the standards [illegible] 'bad' and bad society, not by the ideals set by our inward spirit. The present paper aims to [illegible] human desire of amassing riches 'mindlessly.' The story 'The Fisherman and the Businessman' attributed to Paulo Coelho (b. 1947), a Brazilian writer and lyricist famous worldwide for his novel "The Alchemist". It takes up for study and analysis to validate the arguments made in the paper.

Keywords:
Materialism, Existential Vacuum, Ethical Criticism, Moral Values

Introduction:
Materialism refers to a societal trend where the pursuit of material possessions and wealth has become the primary goal of many individuals. This tendency is fuelled by the consumerist culture that [illegible] modern society, where people are bombarded with advertisements and messages that encourage [illegible] to acquire more and more goods (Shrum, Chaplin, [illegible] and [illegible]). The following [illegible] is very poignant in this case:

> "Newspaper headlines exalt the local lottery winner. Get-rich-quick books climb to the top of best-seller lists. Multicolored ads flash on Web pages. Celebrities on television [illegible] from sport utility vehicles to mascara. Although they differ in form, each of these [illegible] essentially proclaims "Happiness can be found at the mall, on the Internet, or in the catalogue" (Kasser p. 1)

While there is nothing inherently wrong with wanting to improve one's quality of life or to possess material objects, materialistic aspirations extended to the level of society can have negative consequences for both individuals and society as a whole.

A materialistic lifestyle is characterised by a strong focus on accumulating material possessions and wealth as a measure of success and happiness. In this type of lifestyle, the pursuit of money, status and material goods takes priority over other aspects of life, such as relationships, personal growth, and well-being. Individuals who adhere to a materialistic lifestyle often measure their self-worth and the worth of others based on their possessions and financial standing (Kasser). However, while material possessions can provide temporary satisfaction and pleasure, they do not necessarily lead to long-term happiness or fulfillment. There is a growing body of study that suggests that people whose values are centred on the accumulation of riches or material items are at a higher risk of dissatisfaction, including anxiety, depression, low self-esteem, and relationship issues - regardless of age, income, or culture (Burroughs and Rindfleisch; Kasser).

Outline of the Story in Question:
In the story *The Fisherman and The Businessman*, a businessman advises a fisherman to work harder, catch more fish, and reinvest his profits to grow his business. The fisherman, however, is [illegible]

[1] [illegible]

[illegible] life, spending time with his family, and enjoying the company of his friends. The businessman [illegible] that the fisherman's approach to life is not about [illegible], but rather about [illegible] [illegible] truly matters in life.

An Interpretation

[illegible] businessman in a small village having no business of his own (?) so sitting idly by the beach [illegible] [illegible] call about the "existential vacuum" (Frankl) the modern society has been undergoing [illegible] the emergence of capitalism. Being one of the major characters in the story, the reader knows [illegible] where he comes from, why he is at the shore, or whether he is at shore by chance. Besides [illegible] "PhD in Business Management" degree, the reader knows nothing about his business. [illegible] [illegible] he is a successful businessman or not. He hails a fisherman at shore who is on his way back [illegible] catching "quite a big fish". The businessman was quite "impressed" by the fisherman's "big" [illegible] is a "short while", a very interesting and insightful information about the character of the [illegible]. The fisherman is skilled at his work and is satisfied with the life he lives. He says:

> "I usually wake up early in the morning, go out to sea and catch a few fish, then go back and play with my kids. In the afternoon, I take a nap with my wife, and evening comes, I join my buddies in the village for a drink — we play guitar, sing and dance throughout the night."

The fisherman is content with having enough food to feed his family and friends and time to enjoy [illegible] company of his loved ones. The businessman pays no heed to the fisherman's [illegible] [illegible] [illegible] people with strong materialistic tendencies as the ability or willingness to consider the [illegible] [illegible] of such money-minded people decreases degree by degree due to excessive materialism [illegible] (Kasser p. 69-72).

Wondering at why the fisherman does not "stay longer at sea and catch more", the businessman readily [illegible] his "help" to the fisherman, though the fisherman asked for none. Such a help from a businessman in the age of capitalism can never be assessed in terms of cooperation but in terms of [illegible] as a businessman. He suggests him to spend more time at sea, fishing more so as to have [illegible] life by growing his fishing job into a business empire with a headquarter set up in a city along [illegible] several branches at various locations distributing fishes. After listening to this plan of the businessman, the fisherman asks a simple question, "And after that?". The businessman says:

> "After that, you can finally retire, you can move to a house by the fishing village, wake up early in the morning, catch a few fish, then return home to play with kids, have a nice afternoon nap with your wife, and when evening comes, you can join your buddies for a drink, play the guitar, sing and dance throughout the night!"

The businessman ends up telling him to live the life the fisherman was always already living. So, the [illegible] to make the fisherman postpone living his life "meaningfully". And this sounds alarming [illegible] [illegible] [illegible] the matter of materialistic life. Are we trained to be dissatisfied with what we have [illegible]? The loss of meaning in modern society has allowed the tools of reason and science to be deployed [illegible] and cynical manner against humanity.

[illegible] to have more than one currently has is arguably triggered by people surrounding us physically and virtually. Craving for 'stuffs' which are expensive, brands, status-symbols, and image-builders [illegible] [illegible] and accelerated also by [illegible] of media. Consequently, one can never have [illegible] [illegible] others having more. Thus, one's struggles for money-acquisition do not stop even after [illegible] levels of income. Having more money is associated with fame and recognition, [illegible] fame and recognition is a hallmark of success. So, the passion for being successful [illegible] [illegible], work harder, and carry overload at the expense of freedom, interpersonal relationships, and [illegible] bliss.

[illegible] the story, the businessman suggests the fisherman to increase his "buying power" by expanding his [illegible], and [illegible] on fishing more, possibly by being away or absent for some time from people [illegible]. This arrangement of fishing more and thereby having more in life – a [illegible] called "affluenza" [illegible] have caused him to feel insecure in terms of living his life and loving his people. So, the [illegible]

of the story in question is that material success and wealth are not the only measures of a meaningful and fulfilling life. It reminds us to take time to appreciate life's simple pleasures, to spend time with loved ones, and to prioritize our values and passions. Ultimately, it is up to each individual to decide what is most important in life and to pursue it with intention and purpose. "Socrates died as we [illegible] drink."

Conclusion:

Money in itself has no intrinsic morality. It is a piece of paper, a piece of gold, a series of digits in an electronic account. It is our level of desire for money and what we do with it that determines the morality of money. According to the New York Times personal finance columnist MP Dunleavey, the key to living a life of actual prosperity is confronting 'what seems to match your realistic needs' [illegible]. Every nation has plenty of resources to keep its people housed, fed and mobile, but the people [illegible] suffer economic injustice as if we can not save anything except money. [illegible] the poor, but we have money to fund a war. Unless an "ethical perspective" is adopted in [illegible] measure of a financially successful life and monitoring our lifestyle, desires to have more and more material goods in life will put a heavy burden on our sense of contentment. In this light of the argument it is a truism that "Materialism causes unhappiness, and unhappiness causes materialism". People who prioritize material possessions and wealth are less happy and more anxious than those who focus on non-materialistic values like personal growth, community involvement, and spirituality. Materialism has been linked to a range of negative psychological outcomes, including lower self-esteem, higher levels of depression and anxiety, and increased feelings of social isolation. Materialistic individuals tend to spend more money than they can afford, often in an attempt to keep up with others or to acquire status symbols. This can lead to financial problems, such as credit card debt, and can cause stress and strain on personal relationships. The pursuit of material possessions often results in increased consumption, which can have negative environmental consequences, such as resource depletion, pollution, and climate change. Materialism is closely linked to social status and inequality. The pursuit of wealth and status often results in the widening gap between the rich and the poor, which can lead to social unrest and conflict. This culture can be harmful as it promotes the idea that happiness and success can be achieved through the acquisition of material possessions, rather than through meaningful experiences, relationships, and personal growth. To sum up, the adverse effects of materialism [illegible] are vast and complex. By prioritizing non-materialistic values, such as personal growth, community involvement, and spiritual fulfillment, we can create a more sustainable and fulfilling society. In his speech *Beyond Vietnam: A Time to Break the Silence* (1967), Martin Luther King Jr. appeals to his audience which is still relevant and assailing materialisation:

> "We must rapidly begin the shift from a thing-oriented society to a person-oriented society. When machines and computers, profit motives and property rights, are considered more important than people, the giant triplets of racism, extreme materialism and militarism are incapable of being conquered."

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DYSTOPIAN LITERATURE AND THE 'EXISTENTIAL VACUUM': AN ETHICAL CRITIQUE

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Abstract:
The present paper delves into the profound relationship between dystopian literature and the concept 'existential vacuum', as elucidated by Victor Frankl, exploring how dystopian narratives reflect and critique societal values, norms, and ethical frameworks. By analysing key dystopian serves as a lens through which to examine ethical dilemmas and existential crises. By scrutinizing the exemplary (popular) novels in the genre of dystopian literature, the study aims to unravel the ethical underpinnings inherent in these narratives, delving into questions of human agency, moral responsibility, and societal structures, by shedding light on the ethical implications embedded in these fictional worlds while offering insight into how these narratives challenge readers to reflect on their own values and choices in the face of oppressive systems and existential crises. By engaging with the ethical critiques woven into dystopian literature, this research contributes to a nuanced understanding of how these narratives challenge conventional ethical paradigms and prompt reflection on contemporary ethical dilemmas and societal trajectories. The core concern of this research paper is to highlight the importance of reading dystopian literature by employing 'Ethical Criticism' as a lens, and the aim is to see whether indispensability of 'ethical coexistence' can be proven in the time when its sustainability appears to be in question.

Keywords:
Existential Vacuum, Ethical Criticism, Dystopian Literature, Ethics of Coexistence, Literature Teaching

Introduction

Something is rotten in the state of Denmark.

Dystopian literature has long served as a powerful medium for exploring the darker facets of human nature, societal structures, and ethical dilemmas. Within the realm of dystopian narratives, a recurring theme emerges—the 'existential vacuum'—a concept that encapsulates the profound sense of emptiness, purposelessness, and disconnection experienced by individuals in oppressive and dehumanizing societies. Conducting an ethical critique of how these narratives illuminate the ethical implications of societal decay, loss of individual agency, and moral ambiguity is no doubt essential for fostering a deeper understanding of the complex dynamics at play within contemporary society and for prompting meaningful dialogue towards addressing these pressing ethical concerns. Dystopian literature evokes the existential dread and moral quandaries faced by individuals in worlds governed by oppressive regimes and technological advancements. By critically examining the 'existential vacuum' within dystopian

narratives, the genre's role in fostering ethical awareness and prompting readers to contemplate their own roles in shaping a more just and humane future can be highlighted.

The History and Nature of 'Dystopian Literature'

The term 'dystopia' derives from 'utopia', introduced by Thomas More in 1516, critiquing societal flaws through an idealized fictional society embodying communist principles. 'Dystopia', coined by J.S. Mill, is commonly misunderstood as the direct antithesis of 'eutopia', implying a negative or 'bad' place. Dystopian fiction typically portrays nightmarish scenarios as reflections or critiques of existing societal norms, emphasizing a connection to reality rather than depicting wholly separate worlds. (Norledge 2-4) Ealy dystopias often depicted a negative condition caused by an excess of utopian zeal, challenging the assumption that all dystopias are anti-utopian (Claeys 284); some grew out of trends towards dictatorship, economic monopoly, and environmental collapse.

Dystopian fiction frequently depicts societies marked by oppression, suffering, or significant deterioration, serving as a warning against contemporary societal norms and tendencies. A resurgence of the genre occurred in the 1980s, termed the 'dystopian turn,' influenced by critical utopianism and prevailing socio-political circumstances. Canonical dystopian works such as *Brave New World* and *Nineteen Eighty-Four* have been extensively analysed for their portrayal of dystopian societies and their enduring impact on the genre.

Literary dystopias serve as reflections of the adverse effects of authoritarian regimes and the societal implications of technological advancement, drawing inspiration from the turbulent events of the 20th century, including World Wars and the emergence of totalitarian regimes. These narratives trace their origins to earlier anti-utopian literature, with thematic elements discernible in the works of authors such as Swift and Wells.

The shift from utopias to dystopias in the late 19th century signalled a move from idealized portrayals to cautionary tales about societal imperfections. The continued relevance of dystopian themes today implies parallels between fictional and real-world societies, notably evident in pervasive technological surveillance and control.

When examining recent scholarly contributions in the field of dystopian studies, from a comprehensive perspective, the following assumptions receive significant validation:

1. Centralised control is a hallmark of dystopian societies, where power is typically held by a totalitarian government, a technocratic elite, or a dictatorial figure, leading to the suppression of individual freedoms and autonomy.
2. Dystopian narratives often feature a backdrop of environmental degradation, technological control, or societal collapse, which contributes to the setting's bleakness and the character's sense of entrapment and despair.
3. Propaganda is used as a tool to manipulate and control the populace, with information, independent thought, and freedom of expression being restricted or altered to maintain the status quo of the ruling entity.
4. Social stratification is pronounced, with a clear division between the ruling class and the oppressed, often leading to a protagonist who questions or rebels against the established order, thus illustrating the dangers of a society that values conformity over diversity.
5. Despite the bleak outlook, dystopian novels serve as a warning and a platform for critique, reflecting contemporary societal fears and serving as a mirror to potential future outcomes if current trends are taken to their extremes.

The History and Nature of the Concept 'Existential Vacuum':

He who has a why to live can bear with almost any how. (Frankl 9)

'Existential Vacuum' refers to a condition of feeling purposeless and meaningless in life. a concept rooted in existentialist philosophy and psychology, particularly associated with work of the Austrian psychiatrist and a Holocaust survivor Victor Frankl who founded gotherapy' – the third Viennese school of psychoanalysis. Individuals undergoing a profound e of emptiness, purposelessness, and disconnection 'lack the awareness of a meaning worth ng for' (Frankl 111). And this *perceived* absence/loss of (ultimate) meaning can lead to lings of emptiness and a sense of drifting through life without a clear goal or sense of filment, because if meaning is what we desire, then the lack of it will certainly create a hole 'vacuum'. Frankl defines it in his memoir *Man's Search for Meaning*:

> *The existential vacuum is a widespread phenomenon of the twentieth century. . . . Man . . . sometimes . . . does not even know what he wishes to do. Instead, he either wishes to do what other people do (conformism) or he does what other people wish him to do (totalitarianism).* (Frankl 111)

is loss is due to a loss of instinctual security (the loss of animal instincts) and diminishing ditions (the erosion of traditional societal structures) (Frankl 111), leading to lack of clear havioural directives for humans. This condition results in a tendency towards conformism or bmission to totalitarian dictates, as individuals struggle with decision-making in the absence innate or societal guidance. Consequently, individuals are confronted with the necessity of aking choices and seeking meaning. Unlike many contemporaries, some thinkers like Victor ankl maintain that life does hold meaning even in the face of this vacuum. In his book *Man's arch for Meaning*, Frankl emphasized that man can transcend his circumstances because man s a 'will to meaning' (a fundamental motivational force in every human being that makes em to seek and to strive to find meaning in their life). He emphasized that meaning can be und in diverse aspects such as relationships, creative pursuits, and the ability to confront and ercome life's challenges. It means meaning can be found through the attitude one takes wards unavoidable suffering, suggesting that even in the face of adversity, individuals can scover a profound sense of purpose.

he idea that 'to live is to suffer and to survive is to find meaning in the suffering' (Frankl 9) emed pertinent at the time when the discourse such as 'all existing things are born for no ason, continue through weakness and die by accident…It is meaningless that we are born; it meaningless that we die' (Freedman 125-140) was shaking the confidence of traditional rtainties. The issue of life's meaning became prominent in modern times mainly as a result f the rise of existentialist thinking and the fall of traditional certainties. It can be inferred ithout surprise from Jonathan L. Freedman's book that individuals are more willing to discuss timate sexual topics than they are about matters concerning the meaning of life. Victor rankl's writing and his life advocates against nihilism – a philosophical viewpoint that argues fe has no intrinsic meaning or value – which is nothing but 'a symptom of the mass neurosis' Frankl 132). Frankl proclaims:

> .. *there is a danger inherent in the teaching of man's "nothingness", the theory that man is nothing but the result of biological, psychological and sociological conditions, or the product of heredity and environment. Such a view of man makes a neurotic believe ... that he is the pawn and victim of outer influences or inner circumstances.* (Frankl 132)

rankl contends that every individual possesses the liberty to transform themselves at any given oment, highlighting the inherent human ability to transcend adverse circumstances and volve beyond them:

> *Man is capable of changing the world for the better if possible, and of changing himself for the better if necessary.* (Frankl 132)

Dystopian Literature and Existential Vacuum: At a Crossroads

Dystopian literature often portrays a society where individuals (discernibly, the dystopian protagonists) grapple with a profound sense of meaninglessness, reflecting the concept of the 'existential vacuum' as a central theme, where characters are shown to lack a sense of purpose and direction in their lives. These characters who experience an 'existential vacuum' seek to fill the void with surrogate activities, manifesting a 'will to power' or 'will to pleasure' as substitutes for the frustrated 'will to meaning'. Indeed, it is a recurring theme in dystopian narratives where dehumanizing systems of power or hedonism thwart the individual's search for meaning. The 'existential vacuum' serves as a thematic device to critique societal structures, ethical frameworks, and the consequences of unchecked power dynamics. It prompts readers to contemplate the ethical implications of living in environments devoid of genuine human connection and moral guidance, where the absence of opportunities for self-transcendence and authentic meaning-making – noological dimension of human existence (Frankl 106-111) – can lead to widespread existential despair.

Moreover, the 'existential vacuum' in dystopian literature underscores the genre's capacity to provoke introspection and critical reflection on contemporary issues such as freedom, alienation, and the impact of technological advancements on human existence. By portraying characters grappling with this vacuum, dystopian works challenge readers to confront their own values and choices in the face of existential dilemmas, ultimately emphasizing the importance of ethical awareness and individual responsibility in shaping societal futures.

By presenting extreme scenarios where the existential vacuum is exacerbated, the key dystopian works published between 1891 and 1949, including Jerome's *The New Utopia* (1891), Wells's *The Sleeper Awakes* (1899), Zamyatin's *We* (1924) , Huxley's *Brave New World* (1932), and Orwell's *Nineteen Eighty-Four* (1949) serve as a cautionary tale, warning of the potential consequences of a society that fails to address the human need for meaning.

In this way, the study of dystopian literature in the context of Franklian ideas can be established and consolidated under the following considerations:

1. Dystopian literature often portrays a world where societal structures have failed to provide individuals with meaning, reflecting Frankl's concept of 'Existential Vacuum', a state where life lacks clear purpose or direction. The societies depicted have either eroded or subverted traditional sources of meaning such as reason, religion, and faith in individual purpose.
2. Frankl's logotherapy posits that the search for meaning is a primary human drive, which dystopian settings challenge by depicting societies that suppress or ignore this intrinsic quest.
3. Dystopian works often explore the consequences of a society's collective surrender to authoritarianism or nihilism, mirroring existentialist concerns with un-authenticity and the loss of individual meaning-giving agency.
4. The existential vacuum in dystopian literature can be seen as a critique of reductionist views that diminish human experience to mere biological, psychological, or sociological conditioning, as opposed to Frankl's view of humans transcending these conditions
5. The portrayal of characters in dystopian literature who resist oppressive regimes and seek personal meaning aligns with Frankl's notion of the 'will to meaning' and the potential for spiritual freedom even in constrained circumstances.

The therapeutic approach of logotherapy could be seen as an ethical response to the existential vacuum, as it emphasizes the human capacity to transcend suffering through the discovery of personal meaning.

'Dystopia' through the lens of Ethical Criticism: The Road Not (or Less) Taken

Ethical literary criticism is concerned with analysing the potential moral effects of literature on readers and assessing how these effects occur, recognizing that narratives influence readers' moral character and judgments. It operates under the premise that literature is not merely an aesthetic artifact but also a medium that engages with moral questions and can shape the moral sensibilities of individuals.

Ethical literary criticism is not about censoring or prescribing moral lessons but about engaging with the text to understand its moral dimensions and the implications for readers and society. It rejects the notion that literature is morally neutral and instead posits that all literary works dealing with human relations have inherent moral aspects that can be evaluated. Ethical critics strive to balance the artistic craft with ethical content, recognizing that the process of writing and the honesty of narrative development are themselves moral acts.

Ethical literary criticism matters because it helps readers see, understand, and appreciate the ways in which literature invites them into specific ways of feeling, thinking, and judging, thereby exerting an influence on their hearts and minds. (George 56) It confronts the avoidance of moral discussions in literary criticism, which has been prevalent since Plato.

In broader sense, ethical literary criticism is an approach that emphasizes the moral dimensions of literature, focusing on how texts communicate ethical concerns and universal values to readers, often highlighting the role of literature in enhancing vital awareness through imaginative engagement. The ethical turn in literary criticism has seen a resurgence, with a renewed focus on the engagement with crises that are serious in nature and ethical in function, reflecting a tradition where moral considerations were central to human endeavours.
Dystopian narratives often depict societies where ethical decay is prevalent, reflecting a loss of belief in absolute good and evil, which is intertwined with hedonism and power worship (Claeys 440). The rise and maintenance of totalitarian regimes in the dystopian narratives exploit the absence of moral absolutes to justify oppressive actions and their reigns. Dystopian authors use the setting of a morally bankrupt world to examine the psychological effects on individuals, who struggle with the implications of their actions in a society devoid of ethical guidance. No doubt, the decay of ethical standards and/or the absence of moral frameworks often leads society to dystopian ends. The genre serves as a critique of societies that prioritize collective or functional ends over humanistic and individual values, thereby prompting reflections on the ethical implications of sacrificing individuality for the sake of societal stability or progress.

Dystopian protagonists often embody ethical resistance, either as individuals who intuitively sense societal wrongs and embark on a quest to challenge or escape the oppressive system, embodying the hope for change and the potential for resistance against authoritarian regimes. Another archetype is the high-ranking insider who gradually becomes aware of the dystopian society's corruption and either seeks to reform it or to dismantle it entirely, highlighting the ethical awakening and moral struggle within the narrative. Dystopian protagonists are often portrayed as ethical beacons, whose actions and decisions reflect larger moral questions about freedom, autonomy, and the value of human life within the constraints of their oppressive worlds.
Through their resistance and defiance, these character challenge readers to consider the ethical implications of conformity, surveillance, and the loss of privacy in their own lives, as well as in the fictional dystopian settings.

Conclusion

Standing at the brink of an uncertain future in a rapidly changing world, fostering ethical discourse emerges as crucial for building a just, sustainable, and inclusive society. It's argued that promoting ethical dialogues across various domains is essential for instilling a collective

commitment to ethical principles and advancing towards a positive future. Neglecting the ethical dimensions of literature can lead to shallow engagement, missing out on its potential for personal and societal moral development. Ignoring ethical considerations in literary analysis risks reducing complex narratives to mere aesthetic objects, potentially perpetuating harmful ideologies and reinforcing existing power structures within literary traditions.

Without ethical criticism, literature education risks focusing solely on textual aesthetics or politics, neglecting the inquiry into the lives and behaviours of others, which is essential for developing relational understanding and empathy.

A literature curriculum that overlooks ethical dimensions may fail to encourage students to make practical connections to the real world, limiting their engagement with larger questions about justice, humanity, suffering, and the nature of evil.

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Rabindranath Tagore's Concept of Religion

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Abstract- This research paper describes Rabindranath Tagore's concept of Religion along with various influences on his mind viz. Maha Rishi (his father) Baul singers, Hinduism, Buddhism, Christianity and Islam. Though he was thoroughly immersed in Indian philosophy. He had never been narrow minded. He used to accept the changes, his lucidity and straightforwardness about his philosophy of life is discussed in this paper. All the influences are perceived in a sequential frame work so that we can recognize and distinguish various important points of his transition. His concept of religion is discussed here with close penetration.

In Valmiki Pratibha, the Goddesses Sarasvati has come down to melt the heart of cruel robber and to bless him with the power of music. In the same way his play 'Malini' is full with religious thoughts as the protagonist wanted to spread the message of Buddhism in the whole country. 'Chitra' is the play, wholly based on the great religious epic 'Mahabharata'. The play 'Chandlika' has criticized the contemporary existing prejudice, which was prevailing in the name of religion and caste. The play 'Shyama' witnesses the terrible consequences, if someone follows his or her whims, power and physical gratification without thinking of consequences. The researcher has explained Tagore's message of serenity, tranquility and unity of all religions with the help of his plays. And it explores the basic themes like 'God and human soul', 'God and nature', 'nature and human soul' and 'individual and humanity'. It explores Tagore's aim that to convert religious orthodoxy of myths into spirituality. It also describes his image of God in his epoch-making work 'Gitanjali', and his idea of 'Jivan-Devata'. He wanted to reach man to the highest level, to the zenith that is the 'Divinization of Man'. He believed that human being and Divinity do not belong to two different orders, they are just like two sides of the same coin.

Keywords- concept of religion, straightforwardness, philosophy, existing prejudice, God and human soul, individual and humanity, religious orthodoxy, Divinization of Man, spirituality, mischievousness, innermost faith, unambiguity.

1. INTRODUCTION

Religion can be defined as a belief on someone whom we have not yet seen still we cherish faith in Him. An innermost faith, whom we ever try to communicate with the help of prayer. This prayer is like water that keeps the roots of faith alive. It is the essence of culture where we get assurance that we are safe and protected from wickedness. Religion is something that which we call perpetual and eternal. We all human being and each and every living thing eventually are subject to perish. But if something is everlasting, which will never end, is nothing else but God, the Almighty, Who is an endless phenomenon. Religion is the perception of that which surpasses the limitations of reason and scientific knowledge.

Religion protects us like a safeguard and holds all of us together in a pervading unity. Without religion the world would have been mayhem of utter havoc, anarchy and pandemonium. Without this faith nothing could have been ever born and nothing would have ever remain alive. Because of this belief we can perpetually get protected and prevail over the fear of mischievousness and fear of death. We must say that after getting tied with religion the meaning of death changes from negative to positive and death becomes a gateway to Heaven.

The aim of religion is to elevate human being from physical plane and to make them work on higher level that is spiritual. For that it gives the complete rule of life and law of man's living. Though we human being can survive without being religious but with religion we can get control over ourselves. Because of religion we restrain ourselves from doing wrong deeds. As we have a certain kind of awe and a veneration that God who is omnipresent. He is always there, who can punish us for this, and we prevent ourselves from doing anything wrong. Without religion we will spend the whole life as it is. But when we are in, we step up with spiritual and intellectual progress.

Some people misinterpret religion with customs, rituals, traditions and even festivals. These things are nothing but the practices that are followed by our ancestors. Actually Religion has two aspects inner and outer. From inner point of view it is a real faith in God. It is an inmost spiritual experience of giving ourselves completely to an unrevealed faith. From an outer point of view it is an expression of belief in religious institutions by following traditions and customs.

But without performing any of the customs and without following any creeds and doctrines we can be a nice devotee and we can be a true religious person. By following practices and taboos we go through uncertainties and apprehensions. Whereas religion is something that gives us assurance, reliability and faith. Religion is actually a positive and clear attitude of life that is full of straightforwardness and unambiguity. It enables us to live life with balance, concord and unanimity within ourselves and with society.

The most esteemed Indian thinkers of 20th century are Balgangadhar Tilak, Mahatma Gandhi, Sri Aurobondo, Sarwapalli Radhakrishnan and Rabindranath Tagore, all are of the view that man should improve his status, he should develop his physical world and materialistic world but at the same time he should always take out some time to develop in himself spiritual values. It is immensely important to develop thoroughly, physically, intellectually and spiritually.

2. VARIOUS INFLUENCES ON TAGORE'S MIND

Particularly Rabindranath Tagore's attitude towards religion is something outstanding and different from others. For his idea of religion is the 'religion of the whole race of mankind'. He was largely inspired by '*Upanishads'*, '*Bhagvatgita',* his father 'Maharishi', 'Baul-Singer', 'Vaishnvism', 'Brahmo Samaj', 'Christianity', 'Buddhism', 'monotheistic ideology of Islam' and 'liberal national outlook that gives utmost importance to humanity'. He has developed encouraging affirmations towards humanity.

One of the great and long-lasting influences on Tagore's mind is his father. He came to inherit right from his very birth a deep religious vision because of his close alliance with his father Maharishi at Jorasanko home. He believed that the ideas of '*Vedas'* and '*Upanishads'* were proliferated and prospered as an indispensable part of cultural heritage.

His father Debendranath, who had agreed on the fact that there should be a particular source book on which the reformed religion of Brahmos could be based. When we examine his father's life we can understand the cause that compelled him to renounce his home. We can also come to know the spiritual gains that he made which rationalize his renunciation from worldly life. He was a very strict and sincere yet he had never been a conformist kind of man. He even kept himself away from all the rituals of Bengalis. He travelled out empty handed and gave up everything including his customs, traditions and his habits. Even the strict social conventions could not hold him back. It was his own will and his own spiritual thirst that led him to this spiritual path.

This path was born out of the inborn and inherent nature of his soul. Having got rid of all the other paths, he had found that path for himself. On the course of his journey he had to put up with much agonies, afflictions and social mistreat but that did not demoralize him. He was of the view that God is the Lord of the universe. He wants it in this way. It is His wish that He connects to us only individually. He himself helped us to build an invulnerable individuality that can hold out against all attacks from all quarters. It is within this flawless and unblemished isolation that He has decided the spot where the two of us will meet.

Maharishi was of the view that religion is a natural light. Just as natural light comes to us naturally without making efforts so also religion. It reaches to human being effortlessly. It is true and eternal, we are only supposed to seek God and adequately stir our heart. We cannot do anything else just as we cannot produce daylight similarly religion cannot be acquired through human efforts. In order to deliver his thoughts Maharishi took the help of 'Brahmo Samaj', which became the second most influence on his youngest son.

Rabindranath Tagore also had a great impact of 'monotheistic ideology of Islam'. He firmly believed that God is only one. He had made us, created us then why we are following castes, untouchability, idol worship and multiple Gods. We all are His production so we all are same. Like his father he also took the help of Brahmo Samaj to preach all these things and firmly opposed 'Sati Pratha' which was the most abominable

act of contemporary India. He taught that true religion cannot be personal, regional, appropriated by caste and colour. True religion is common to all and equal to all. In every religion there are lots of misconceptions and miscomprehensions that should be removed and Rabindranath Tagore has learnt it from his father, who being founding member of Brahmo Samaj did the same. He left most influential mark on his youngest son Rabindranath. Rabindranath Tagore was very much inspired by 'Baul Singers' of Bengal in particular. They are the travelling saints in India, they go on travelling all around the country, helping and serving mankind. They do not believe in any of the religious institution nor do they enter in any of the place of worship in order to perform religious rites and ceremonies. They have a strong belief in the 'love for humanity' and they do it by self-sacrificing duties. He found ultimate comfort with the songs of Baul singers who used to spectacle their thoughts with their songs. They are open-minded and free thinkers. According to them, the belief in God is not in constituting a formal expression of reverence to a Deity, but the faith in God is 'to serve humanity'.

Rabindranath Tagore came personally in contact with 'Baul Singers' in 'Shailedah Period'. Where he met 'Lalan Fakir', who used to create his own poetry, Rabindranath liked to spend time with him, talking to him, listening his stories and his self-created songs. Lalan fakir did not believe in God but that does not mean he rejected Divinity. He believed in Godhood but that God exist in human-being. If one wants to make God happy he should take care of those who are deprived and dispossessed of everything. As human being are created by God, by making His creature happy we can make Him happy. The same idea seemed acceptable to Rabindranath Tagore. He named the idea 'Jivan-Devata', his lord of life.

Apart from that he had a great impact of 'Nirguni saints of North India' and 'the Godly love of Vaishnav poets', that is 'Vaishnavism', 'Sufism', 'the hymn of Mirabai', 'Tulsidas' and 'mystic songs of Kabir' have influenced him to the great extent. Rabindranath Tagore is the first person who has added literary value to all these primitive sources of Indian tradition. Some of their poems and songs have been translated by Tagore himself.

Let us see the influence of various religions on Tagore. All these borrowed religious theories enabled him are decorate and transform his own thoughts.

3. INFLUENCE OF 'HINDUISM'

Let us see what Upanishads says about God. According to '*Upanishads'* whatever is apparent in this world confirms the presence of Divinity. Each and everything in this world, including every human being, trees, seas, sky, planets, and mountains manifest His existence. We find various similarities between the Tagore's concept of religion and the ancient sagacity of '*Upanishads'* and '*Bhagvatgeeta*'. These similarities transcend the gap of at least three thousand years, yet they seem to be adjacent and apparent.

4. INFLUENCE OF 'BUDDHISM'

The second most influential religion for Rabindranath Tagore is 'Buddhism'. It is Buddha's moral and spiritual teaching that have made a great impact on his mind. His views about religion, humanism and internationalism, his predominance on endless love, compassion, pity and his refusal of negative attitude, anger, and hatred are all inspired by Buddha's preaching.

5. INFLUENCE OF 'CHRISTANITY'

One more influential religion for Tagore is 'Christianity'. He picked all the beautiful and positive things from all religions, and gifted the world his 'ideology' which was based on those positive things. According to the sacred writing of Christianity contained in the '*Bible'*, 'when God was born as a man with his own choice he took upon himself the responsibility of the sins that we people had committed and a crown of thorn upon his head, representing his suffering. One who endures penance and misery in life, he is very close to God'.

6. INFLUENCE OF 'ISLAM'

Tagore had been very much influenced with 'Monotheistic Ideology' of Islam. He believed that God is only One. He always refused paganism. Islam affirms that God is Infinite, human being are finite this is the difference between God and any living creature. God has made the world and He has created the time. In the whole universe only one thing that will remain forever and ever, He is God. He has infinite time, His time has no limits.

7. CONCLUSION

To conclude, it can be said that a thorough study of Rabindranath Tagore and his selected plays bring to light that his eloquently written work offers philosophical perceptions of life. It also lucidly displays its various influences that molded his virtuosity. The virtuosity that is able to influence not only Indian education and literature but also Indian minds.

Rabindranath Tagore's work has fascinated not only his country and his continent but also the whole world. If we consider him as a writer of our country only, we are not judging his brilliance rightly. He has written for the anguish, longing and hankering of all humanity, for he has a vision of the whole world. In his life time he became a heroic figure with his unchallengeable opinion. With his encouraging and magnificent imagination, he articulates his coherent, spontaneous and lofty thoughts which are unparalleled and relevant even today. Though there is abundant writing available on his political, social, and literary viewpoint but his religious views and his thoughts on love are not that accessible. When we see his writings with religious perspective, it seems some of his thoughts remained neglected. We are here going to speculate on the same, with the reference of contemporary Hinduism and image of God, and his own chronological modification of religious thoughts and philosophical thoughts.

Religion is something that which we call innermost spiritual experience, this experience is so powerful that one surrenders himself to the unknown reality that reality claims about the existence of God. It is a belief on that Almighty that He is there and He will be there for us, with us ever and ever. This belief is so powerful that it can transcend the human reason and scientific knowledge.

8. FINDINGS

We can sum up the main features of Rabindranath Tagore's writings based on critical evaluation.

- He was such an exceptional man who could shower down his exceptional creative imagination on the whole world.
- He was the one who is bestowed with multiple merits.
- He was both intensely oriented with Indian established thoughts and encouraged with modernistic sensibility.
- He was a messenger of love and peace as he expresses his views on universal love.
- His writings are far ahead of his time.
- He sheds illumination and fondness on his age which will remain till ages to come and exposed unidentified perspective of thought.
- He worked like a mediator between human being and Divine.
- His brilliance modified and augmented whatever he touched.
- His thoughts are worth soothing heart and even the soul of humanity.
- He made fertile almost all literary fields and ventured to explore some unrevealed and unknown fields.
- His vision about man's destiny was flawless and firm.

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The Life and Legacy of Rabindranath Tagore

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Abstract- *The present study unfolds the making of Rabindranath Tagore. It examines various atmosphere and inspirations that influenced Tagore's personality and the impact of British rule that molded him. It also unfolds how English language had been introduced and proliferated in India. It elaborates various literary genres of English Literature that initiated and evolved in India. It examines contemporary Indian English Writings and studies the effects of various incidents like, First World War, Jallianwala-Bagh massacre, Partition of Bengal, Mahatma Gandhi's non co-operation Movement and Second World War. Some significant social reformers and freedom fighters who had also contributed in the progress of English language are discussed in this paper. The modification of British rule in education, the untiring efforts of Indian reformers, and the genuine interest shown by Indians these are the few significant things which gave birth to the English language and literature in India, all are elaborated here.*

Keywords: Legacy, atmosphere and inspirations, proliferated, First World War, Jallianwala- Bagh massacre, Partition of Bengal, Mahatma Gandhi, superstitions.

1.1. INTRODUCTION

S.T. Coleridge had once gave an epithet to Shakespeare as 'Myriad Minded', this seems to be more eminently suitable to Rabindranath Tagore, whose whole life was replete with ceaseless and uninterrupted flow of inventiveness. His inventions were incessant and full of creativity. Asia's first Nobel Laureate was a multi-faceted personality, a musician, a painter, a poet, a dramatist, a novelist, a literary critic and what not. There is scarcely any literary form that he had not tried and turned in to gold. This much was not enough for the multi-faceted personality that he could also find time to set up his own kind of academy at Shantiniketan. This subsequently became a renowned Vishwa-Bharti University, where pupils from different parts of the world come to flourish their careers.

Rabindranath Tagore is the first man who had gained the distinguished place for our country in the world literary scene. The Nobel Prize was just the beginning of his long and successful career, where there was so much more is about to come. His fertile and dynamic literary career extended over a period of 65 years. He composed perhaps the largest number of lyrics ever attempted by any poet. He had achieved and gave to this country in one life what requires centuries, if someone else wants to achieve. That is how he is called unparalleled and matchless. He contemplated, wrote, travelled and talked persistently and tirelessly. He has been the supreme inspiration to millions of modern India, and he will ever be an inspiration for Indian youth in the years to come. One of his well-known critics Mohit K. Roy asserts,

> *"He was a poet in the traditional Indian sense of the word, a kavi, a seer, an intermediary between the human and the divine. His genius enriched whatever he touched. Like the sun after which he was named, he shed light and warmth on his age, vitalized the mental and moral soil of his land, revealed unknown horizons of thought and spanned the arc that divides the East from the West."* [1]

1.2. ATMOSPHERE AND INSPIRATIONS OF RABINDRANATH TAGORE

Rabindranath Tagore was fortunately blessed with the wonderful atmosphere. As among the modern Indian languages, Bengali poetry and prose fiction got a great beginning by his predecessors, like Madhusudhan Dutt, Ishwar Chandra Vidyasagar and Bankim Chandra Chatterjee. They brought him an amazing atmosphere as they all where his inspirations. It was as if the atmosphere of expectation and hope, where he participated enthusiastically. He started composing rhymes from his childhood and soon his enthusiasm and determination brought fruits and his work in prose and verse had started to appear in print.

A visit to England followed and the English Romantics, like Keats, Shelley, Wordsworth and the great Victorians, like Tennyson, Browning exercised a strong and powerful influence on him. He idolized also Sir Thomas Browne and Shakespeare. He was not an extra-ordinary systematic reader but like Shakespeare he used to read haphazardly, without any proper plan. He made the capital use of whatever came on his way. He wrote about 7000 lines before he was eighteen.

Moreover his upbringing was in an atmosphere of artistic distinction of the family of Tagore, manifested by sophisticated aesthetic sense, patriotic sentiments and artistic outlook. The intricate arrangements for learning Bengali, English and Sanskrit at home trained his sensibility at very early age. Though there were number of obstacles too, in his self-expression. As he was subjected for some years, the inflexibilities and rigidities of the school discipline which was very stifling. He lost his mother at very young age, thus deprived from the emotional support, but still his inspirations were able to make him a great personality.

As in his father he found a serious but a pleasant personality and Bauthakurani [2] was just like a blessing for him. She fulfilled his inner psychological needs and gave him back that emotional support back. She was just like a mother for him, fulfilling all those necessities, as a child he was craving for. Her selfless affection touched him and this leads to make him a realistic man and a great literary figure. His artistic disposition and poetic heart began to unfold slowly and he could able to write masterpieces at that very young age. Bauthakurani had a profound and deep love for literature; she inspired and provoked him to write. She helped him by criticizing and correcting him. She had created an atmosphere of artistic expectancy which made a positive effect on his mind. He memorize her by saying,

> *"My sister-in-law was a great lover of literature. She did not read simply to kill time, but the Bengali books. She read filled her whole mind"* [3]

It is because of this atmosphere that Rabindranath Tagore became a most outstanding of the Indian poets in English, and because of '*Gitanjali'* that he won recognition as a poet on the global scale as a 'Nobel Laureate'. If an overview is taken on him as a great poet, we will find his genius. If we compare the contemporary traditions and his poetry, there are bhakti songs in Indian tradition, Vaishnav poets, Shiva poets, who seek God as a child seeks his mother, as a lover seeks his beloved. It shows the inter connection between the poet and the Eternal, the lover and the beloved, wife and husband, servant and master etc. The human body is the temple of the soul, the human soul is the temple of God. His creative passion is rightly revealed by a critic in his own words:

> *"Rabindranath Tagore's poetic output justifies Shelley's prophetic dictum; 'Poets are the unacknowledged legislators of the world'. He is a world poet and a class by himself. His melodies have enthralled not only his country or the orient but also the entire world."* [4]

The important aspect of his poetry is the amalgamation of humanistic essence and spirituality. He was deeply concerned with Indian classical thoughts and at the same time he was equally a modernistic in his sensibility. Thus, there is the fusion of ancient and modernistic sensibility in his poetry. He was a man who touched the kindred points of heaven and earth and coordinated in himself the best of the East and the West. One of his distinguished critic states,

> *"Rabindranath is essentially a poet, and like any other poet he has a philosophy of life. There is a great difference between Tagore and other poets. And this difference is conspicuous in his philosophy of life."* [5]

His non-conformism was very fundamental and reliable that made him a fearless critic of social practices and dogmas. On the other hand, romantic fascination and magnetism of modernism fail to attract him. His grand-father's spirit of enterprise, and his father's spiritual compassion created in him artistic sensibility. He augmented every genre of literature as an impatient experimenter and a modernizer of every field of literature. If we analyze the contemporary work, we find that lots of poetry was written in English after independence. Poets wrote it with constant efforts to achieve modernity. They used to derive modern techniques from T.S. Eliot, W.H. Auden, Dylan Thomas. They were having some exceptional qualities like, speculative approach and pursuit for ingenuity and originality. They stressed on individualism and always tried their best to reject all that is conventional. Rabindranath on the other hand was handling in a very unique way as he was a great poet of talent and he had the habit of handling things in a different way.

1.3. IMPACT OF BRITISH RULE IN INDIA

In Modern Bengali Literature, the second half of the nineteenth century is recognized as 'Bankim era'[6] and the first half of the twentieth century is recognized as 'The Age of Tagore'. Towards the end of nineteenth century, people have started to become conscious about British rule in India and where getting involved in political movements. The reason behind their awareness is the political debate and criticism on British government. This is the reason how Indian Association became so potent with the help of multitudes of Indians.

In the beginning when the Indian National Congress came into existence, the educated Indians started to visit its annual session out of consideration to the British government. At that time the middle class and the general public were not affected by these political movements. But soon the Congress had gone through some notable changes which affected and took under its fold multitudes of Indians. The Ganpati and Shivaji festivals in Bombay stimulated anti-English feeling. The anti-British feeling was also generated in Bangal. Now the general public has started to understand the true intention of British.

They had been planning to divide and weaken the fundamentalist Hindu youths and a decision was taken to divide Bengal in two executive sectors. So that they can create antagonism and hostility. Indians were already guessing Britisher's intentions, and were quite sure about their purpose behind the strategy. Finally they stood up as a single person after the announcement of partition of Bengal by Lord Curzon. Along with general public the artists, dramatists, poets etc. took part in the movement under the guidance of Rabindranath Tagore, Lokmanya Tilak, Lala Lajpat Ray, Bipin Chandra pal and Aurobindo Ghose. These great leaders rejuvenated the organization with their invaluable support. In this regards Mohit K Roy observes,

> *"It was the movement which created atmosphere of heat, patriotism and indiscrete actions as well as unabashed greed that finally frustrate the movement."* [7]

The British in a bid to frustrate and discourage the national movement tried to dissociate the Muslims from the movement by publicizing separate electoral rules for them. But when it could not restrain the national movement Morley, the state secretary and Minto, the governor general made some changes in the Indian administration. But people could understand their plan; they could not be misled by this pure deception.

The First World War broke out in 1914 and the Indians helped the British in every possible way, with a hope to get something better. But instead received an abominable 'Rowlat Act' and the dreadful massacre of vulnerable masses at Jallianwala Bagh: Rabindranath in a letter to Lord Chelmsford the viceroy of India demonstrated his intolerable exasperation and renounced his 'knighthood' in protest.

In 1919 Montague Chelmsford proclaimed administrative reforms, but by 1920, under the guidance of Mahatma Gandhi the non-co-operation movement assumed huge proportion. In 1927 Simon commission, for effecting some administrative changes, was formed. Three round table conference was held in England but that was of no use. Gandhiji went on a hunger strike. In this context a life-long Tagore scholar Sabyasachi Bhattacharya states,

> *"Till the appearance of Mahatma Gandhi in Indian politics, there was no agenda even remotely like this before the nationalist leadership"* [8]

In 1938, Second World War broke out and the Indians again helped the British. The cataclysm of war, its annihilation and decimation of value led the country further down to demolition. These are the drawbacks of British rule in India. Let us analyze what is the positive side and what they gave to India and how this colonial world plays an important part in transfiguration of Tagore. Sabyasachi Bhattacharya points out,

> *"Tagore believed that his sensibilities were shaped by 'three movements, all of which were revolutionary'- those associated with Rammohan Roy who opened up the mind to new ideas, Bankim Chandra Chatterjee who 'aroused our literature from age long sleep', and the national spirit which taught people to assert their own cultural personality. At this confluence of three movements, Tagore says, he sought guidance for my own self-expression in my own standard of judgement."*[9]

People started to look at the past as something we should change. They have developed new inclination and perspective towards the days that were coming ahead. They have started thinking everything rationally, with reasons, with the help of upcoming scientific research; they have started criticizing superstitious beliefs. Furthermore at that time, we observe some changes took place in social sphere as a result of the colonial exploitation of British imperialist. Likewise there was a complete break in the economic growth of the country, due to pandemic disease following poverty and starvation were making their way. The media voice was suppressed that leads to the lack of global connectivity.

Bankim Chandra Chatterjee and Rajaram Mohan Roy are the most influential spirits in making an inspiring man like Rabindranath Tagore. They made him assertive, who could question against the dogmas and superstitions prevailing in the country. They were literary activist, who wrote what they felt to make people realize what is happening. They understood the need of English education. As it could be helpful as well as it can give progressive outlook to the people. As a result they emphasized on education through the medium of English so that it can bring about logical thinking and liberal attitude in India. This is how the English education got its roots firm.

Thus three things proved most significant for adopting and encouraging English language in India.

- The modification of British rule in education.
- The untiring and determined efforts of Indian reformers.
- The genuine concern and interest shown by Indians.

1.4. SUMMING UP

This paper is introduces us with various factors responsible in making and changing the personality of Tagore. It also unfolds various things like the atmosphere and inspirations which motivated Rabindranath Tagore to become a great personality. It discloses the impact of British rule in India. It also deals with the initiation and development of English language, before independence and after independence.

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THE ANGLO FRENCH SAGA: WAR AND DIPLOMACY IN 17TH AND 18TH CENTURY

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ABSTRACT*- Britain and France have largely influenced European history and warfare in early modern and modern times. This is not being said with the intention of belittling other powers such as Germany (formerly Prussia), Spain or Austria- Hungary but on international scale well until the outbreak of the First World War in 1914 the two countries vied for supremacy and ruled over 35% of land surface. It was natural that they must have clashed at various intervals to assert their dominance. Now close business and trading- partners still the British and French reflect disdain for each other's cultural traits. France strongly feels that modern United Kingdom (read Britain) is more or less an American vassal while the British nurture the notion that the French have not yet grown up and adjusted to the present world reality which is highly Anglo-Saxon influenced. The article revisits some turbulent times when the two nations crossed swords with each other and what has been the leftover of that legacy.*

Keywords: Britain, France. Louis XIV, Battle, Spain, Hapsburgs, Bourbon, Protestant, Roman Catholic, Dutch, Treaty.

Europe of today appears to be the most cohesive and stable of all continents. Virtually all countries from Greece to Portugal, from Italy to Sweden, from Poland to France and United Kingdom, Ireland and Iceland (the island nations) seem to have shed the baggage of hostility and war and have integrated their people with others to better reflect continent's unity and diversity. Culturally a visitor would not find much difference in art and architecture if he/she visits Vienna, Zurich, Milan, Budapest, Madrid, Brussels, Amsterdam, Paris, London or Rome. Great Britain's exit from the European Union has given Germany and France more room to call shots in one of the oldest and perhaps most flexible cultural, economic and political blocks of our world.

The two major European countries (before the unification of Italy and Germany) which exercised considerable influence on both Europe and the world were Britain and France. The two nations are also close neighbours- the coast of Calais in France being just 20 miles (32 km) from Dover in England (also known as Strait of Dover). Both Britain and France once formed a part of Julius Caesar's Roman Empire. While France remained (and still) a Roman Catholic country, Britain severed its ties with the Papacy in 16th century when Tudor monarch Henry VIII established the Church of England. In both these countries since then the plight of the minorities (Protestants or Huguenots as they were known in France and Catholics in Britain) had been miserable and it was not until 1829 when the Catholic Emancipation Act was passed in the parliament of the United Kingdom that Roman Catholics got relief while in France the Protestants achieved the same in 1789 when the Declaration of the Rights of Man and of the Citizen was proclaimed which also marks the outbreak of the French Revolution.

The outbreak of the 100 Years' War in Europe (1338-1453) actually started the rivalry between the two countries which are separated by the English Channel. This war also inspired English and French nationalism. As war it was, it also saw for the first time the dominance of heavy cavalry and significant use of artillery which it has been said also precipitated the creation of the first standing armies in western Europe, ever since the days of the western Roman Empire. From this war only heralded the concept of stronger national identities and the need for a centralized power.[1] Relations between England and France are often portrayed as a history of at best of mutual suspicion and open hostility. The Battle of Agincourt (1415) in which ragtag English army of Henry V routed the French is one such long-lived trope that has persisted through history.[2] A particularly heroic figure that etches in our mind is of French peasant girl- Joan of Arc who was canonized as a saint in 1920.

The first major war concerned with the subject is Nine Years War (1688-97), also known as War of the

[1] Francois Guizot, *The History of Civilization in Europe; translated by William Hazlitt,* Indiana, USA, 1846, pp. 204-5.
[2] *The Conversation,* 17.09.2019.

League of Augsburg which pitted France against a coalition of nations including Britain. Louis XIV of France (1638-1715) can be considered to be the first French king who desired territorial expansion of his country and in the pursuit of same followed an aggressive foreign policy. Ever since the Thirty Years War' came to an end, France had consolidated its position as Europe's foremost military power. Louis XIV was fortunate enough that French foreign policy was shrewdly and carefully moulded by Cardinal Armand Jean du Plessis de Richelieu, who laid the ground for royal absolutism in France. It was his' mechanism that eventually led to fading away of the Hapsburgs and set the stage for French prestige. However, Louis pushed France to extreme in his enterprise.

The Holy Roman Empire was under serious threat from the Ottomans who were threatening to overrun all of central Europe from the south. Louis had aided this Ottoman drive. When Ottomans were besieging Vienna in 1683, Louis completely overlooked his fellow Christian rulers.[3] Although the Turks didn't succeed in their mission but Louis's fortunes were on the rise as he was able to secure a cluster of territories, thereby enlarging his dominion. However, the revocation of the Edict of Nantes[4] by the French monarch in 1685 opened the box of troubles for him. Protestants left France en masse for England, Germany, Switzerland and other countries and tales of their brutal treatment by the French state soon ended the goodwill which the French were enjoying in the Dutch Republic and as many French Protestants were traders too- their exodus severely impacted Franco-Dutch trade.[4]

In 1688-89 Great Britain underwent Glorious Revolution and James II (reigned 1685-88) abdicated to France. James's son-in-law William III of Orange (1650-1722), Stadtholder of the Dutch Republic[5] and his wife Mary II were declared as joint sovereigns of England. William III had not forgotten Louis' aggressive overtures in his country and with resources of English nation at his disposal he found the time and condition ripe to put brakes on French territorial advancement. Historically Britain always tried to avoid large-scale mobilization of troops on European mainland. This they tried to offset by aligning themselves with one or more continental powers whose interests clashed with that of its enemies, most notably France. Louis XIV's support to the Jacobite uprising[6], undertaken by James II created a strong anti-Catholic and anti-French sentiment in England. William III whose own country was passing through a tumultuous period convinced the officials that war was a must against France and to maintain a balance of power in Europe.

Meanwhile France under Louis was seriously contemplating invasion of England and at the same time an attack on Namur, a city and municipality in Belgium[7] (the country than formed a part of Spanish Netherlands). The French did attacked Namur, the city fell, but the citadel held out until 30 June 1692. At the Battle of Steenkirk (then a village in Belgium) on 3 August 1692, a joint attack of English-Scottish-Dutch-German forces was timely repulsed as more French reinforcements arrived and William's advance halted. Surprisingly both sides claimed victory- the French for repulsing the Allied attack and Allies for saving Liege[8], from not allowing it to meet the same fate as Namur. Yet as the historians have opined, considering the nature of late 17th century warfare this was of little or no consequence.[9] The much-desired invasion of England ended in a failure as there was no proper coordination and British naval forces demonstrated their superiority over the French. The Battle of La Hogue (1692) is chiefly remembered in this respect when French ships were set on fire. The subsequent

[3] John B Wolf, *The Emergence of the Great Powers: 1685-1715*, Harper & Row, New York, 1962, p.53. [4] The Edict of Nantes promulgated by King Henry IV of France on April 13, 1598 gave Huguenots (Protestants as they were known in France) many religious liberties and full civil rights and also allowed for the establishment of a special court, *Chamber de l'Edit*, comprising both Protestants and Catholics for the settlement of any dispute arising between them.

[4] John Miller, *James II; A study in kingship*, Methuen, 1978, p.144.

[5] Stadtholder referred to the title used by the official to maintain peace and provincial order in the early Dutch Republic and at various intervals he also became *de facto* head of state.

[6] The Jacobites were the supporters of exiled Stuart monarch James II. They wanted to restore Roman Catholicism in England under James II and his descendants.

[7] Belgium became an independent nation only in 1830.

[8] Liege is a major city in Wallonia region of Belgium.

[9] John A Lynn, *The Wars of Louis XIV:1667-1714*, Routledge, 1999, p.227.

years proved tough and difficult for France as there had been a severe harvest failure in the country which led to famine and an estimated 2 million deaths in 1694.[10] The French monarch however cared little. His military adventurism continued and though the French forces won battles at Heidelberg, Marsaglia, Charleroi and others but the hardships generated by the crises of 1693 considerably put pressure on country's resources and the Allies too didn't budge. France's fortunes were on the downslide after 1695 and in 1697 by the Treaty of Ryswick[11] peace was reached. Neither France emerged defeated nor Allies emerged vulnerable from this.

The last major conflict where France and Britain were on the opposite sides during the reign of Louis XIV was War of the Spanish Succession (1701-14). Here the underlying principle was the same- Britain chiefly desired that the thrones of Spanish Hapsburgs and French Bourbons should not be united as it would upset the balance of power in Europe thereby
France being emerging by far as the strongest (and threatening) power of Europe.[13] Spain

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although no more powerful on the continent as it was once, yet its overseas empire had remained intact and included possessions in Italy, Spanish Netherlands, the Philippines and the Americas. As Louis accepted his grandson as the sovereign of two thrones the stage was set for a renewed conflict and the Grand Alliance being reformed in 1701. The Peace at Ryswick had therefore proved inconclusive. To quote James Falkner that, "War of Spanish Succession established the principle that dynastic rights were secondary to maintaining the balance of power between different countries."

In this conflict only the brilliance of John Churchill, popularly known as the Duke of Marlborough[12] came to the fore. England declared war on France on 4 May 1702 and Duke of Marlborough was given command of the English, Dutch and hired German forces and he was successful in his enterprise against the enemy. It was in recognition of this that Queen Anne proclaimed him a duke. His victories at Blenheim[15] (2 August 1704) and Ramillies (23 May 1706) are considered to be amongst the greatest in European military history before Napoleon appeared on the scene. Blenheim effectively dislodged Bavaria from the Franco-Spanish alliance and Louis XIV's hopes of an early victory were dashed. Ramillies proved another significant milestone for the allies as Franco-Spanish-Bavarian forces again tasted defeat and in greater numbers. Fewer than 3,000 were dead on the Allied side while some 20,000 casualties took place amongst their opponents. The French saw their worst debacle at Ramillies and Allies were able to capture town after town in the Spanish Netherlands. Marlborough's two subsequent victories- Oudenaarde (1708) and Malpalquet (1709) gave further success to the Britain and its allies as the French lost towns in the Spanish Netherlands (Belgium) which they had taken in 1707. The Battle of Malpalquet however became a saving grace for France- although the forces of the Grand Alliance[13] had claimed victory yet they suffered huge losses (doubled as compared to the French) and French forces were able to withdraw in good order. It was considered to be one of the bloodiest battles of the 18th century.[14]

The Peace of Utrecht (also known as Treaty of Utrecht) brought this saga of Spanish Succession to a close. The ultimate objective for which Britain fought in this war was realized- the thrones of France

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[10] William Doyle, *Short Oxford History of France-Old Regime France,* OUP, 2001, p.184.

[11] The Treaty of Ryswick or Rijswijk was signed between 20 September and 30 October 1697 which effectively ended Nine Years' War between France and the Allies. Ryswick is a city near The Hague, Netherlands. [13] When Charles II, king of Spain died in 1700 he had left his throne to Philip of Anjou, a grandson of Louis XIV. He succeeded Charles as Philip V of Spain on 16 November but this was acceptable to Britain and allies only if he renounced his claim to the French throne.

[12] The Duke of Marlborough (1650-1722) was an English statesman and soldier who was instrumental in securing James II on the English throne and also subsequently leading to his ouster in the Glorious Revolution. [15] The Battle of Blenheim resulted in the victory of Allies led by Duke of Marlborough and effectively prevented French and Bavarian armies from taking Vienna.

[13] The Grand Alliance was constituted on 20 December 1689 between England, the Dutch Republic and the Holy Roman Empire against France and its allies. The Duke of Marlborough led Grand Alliance to victory in four most important battles in the War of the Spanish Succession namely- Blenheim, Ramillies, Oudernaarde and Malplaquet.

[14] The Battle of Malplaquet was fought on 11 September 1709 between a French army commanded by the Duke of Villars and a Grand Alliance led by the Duke of Marlborough. The losses suffered by allied forces in this battle has led some historians to opine that Malplaquet was a French strategic victory since by saving his army and preventing an invasion of France, Villars enabled Louis to negotiate far better peace terms in 1713 than those available in 1709.

and Spain were never to be combined. Britain acquired Gibraltar and Menorca and trade concessions in the Americas and replaced the Dutch as the leading maritime and commercial power in Europe. This became possible because Louis XIV consistently followed an aggressive policy towards the Dutch which soaked up their resources. So, it can be fairly said that Britain benefited immensely from Louis's adventures in the Netherlands. The French though successful in getting Philip of Anjou as heir to the Spanish throne; however, were financially exhausted. The Holy Roman Empire continued to get fragmented; with

Prussia, Bavaria and Saxony increasingly acting as independent states. Peace of Utrecht was not to the liking of Spain which had lost territories in Italy. Not surprisingly a new war broke out- War of the Quadruple Alliance in 1718 where Spain was the instigator. It went on for two years and interestingly here the British and French interests converged as they wished to stop the expansion of Russian and Spanish power. This alliance between Britain and France was carried on from 1716 to 1731.

Here we can see that enmity and hostility between the two countries which earnestly began during the Hundred Years' War, went on consistently till the early 18th century. This is the suffice for this paper although both Britain and France fought each other with profound disdain till the first decade of the nineteenth century- a period identified with the outcome of the French Revolution and Napoleon. The two countries remained at peace from 1716-31 for their own territorial interests which seem threatened by Spain and Russia. Louis XIV has been considered to be the most colourful monarch in French history and it was his ambitions which Britain effectively wanted to check or put a stop to, that heightened struggle between the two countries to a great extent. Both William III and Louis had been unscrupulous in their mechanisms and plans. The Seven Years War (1756-63) and Anglo-French War (1778-83) saw a renewed and global struggle for dominance between the two countries yet in these conflicts the scale tilted in favour of Britain and France lost its colonial possessions in India and the Caribbean – the only saving grace for the French however was its support to the United States which resulted in its independence from the British in 1776. So this has led Simms Brendan to opine that, "The Bourbon War (as the Anglo-French war is also known as) helped secure American independence and bring an end to the first British Empire but turned out to be detrimental to the French crown."[15] Perhaps the biggest debacle the French committed was the recall of Francois Dupleix, the French Governor of India to France in 1754. It is still debatable that if Dupleix had been allowed a free hand in his mechanisms by the French government it would have been impossible for the British to succeed in India. Robert Clive could have met his match only in Dupleix. In the war of 1778-83 it is recalled with special interest, a series of naval battles fought between Admirals- Edward Hughes of England and Pierre Andre de Suffren of France. The French were desperate to displace Britain from her Indian territories.[16]

The clashes between the two major European powers in the Carribean, the United States and Spain's desperate entry on French side to reclaim Gibraltar in 1779 is a reflection of European superimposition on the world.

To sum up, a close working relationship was achieved between the two countries effectively only in 1904 (hundred years after Napoleon had declared himself as Emperor of the French) when *Entente Cordiale* (Cordial Agreement) which was a series of agreements between the two nations was put into effect on 8 April. Yet throughout the 20th century and in present times too there has been a display of a sense of uneasiness and suspicion occasionally. Tom McTague says that despite standing shoulder to shoulder against the Nazis in September 1939, the fall of France in June 1940 revived old rancour. Winston Churchill took the decision to bomb the French navy at Mers-El-Kebir (a port on Algeria's north-west Mediterranean coast) on 8 July 1940, killing 1,297 servicemen, because he didn't trust French promises to keep the fleet from German lands. The fallout caused the two countries to break off diplomatic

[15] Simms Brendan, *Three Victories and Defeat: The Rise and Fall of the First British Empire, 1714-83*, New York, 2007, pp.615-18.
[16] Alfred T Mahan, *The Influence of Sea Power upon History, 1660-1783*, New York, 1957, p.416.

relations until 1944.[17] Charles de Gaulle in his Presidency withdrew France from the NATO and didn't allow Britain to became member of the European Economic Community (now European Union). De Gaulle earnestly believed that Britain would not go along with his vision of Western Europe which should be strategically independent of United States' influence. It is worth mentioning that since 1990s Britain has largely toed American line on most foreign policy issues, France has kept itself a little disconnected with Anglo-American world-view.

George Bush's decision to invade Iraq in 2003, in which Prime Minister Tony Blair was 'more than willing' partner was met with extreme reluctance and disdain by France. But the baggage of extreme and open hostility is certainly over between London and Paris. Britain's exit from the European Union has given France and Germany more room to shape European foreign policy and as the largest and most robust economies in the organization, more leverage in formulating economic policies. France has chartered a tumultuous course since the Hundred Years War and when relations with England were getting warmer, the defeat at the hands of Prussia in 1870 (Franco-Prussian War) placed before it a new rival. The ongoing Ukrainian crises has once again brought the two countries closer and while Britain still doesn't mind being Uncle Sam's sidekick, France wants to charter a new course which is Europe-centric and thus wants to work closely with Germany. But this might not be easy when NATO is a living entity and an increasingly aggressive Russia is threatening Europe's eastern frontiers.

[17] *The Conversation*, 17.9.2019

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Ultraviolet and visible light active photothermal copper bismuth oxide nanostructures for solar steam generation

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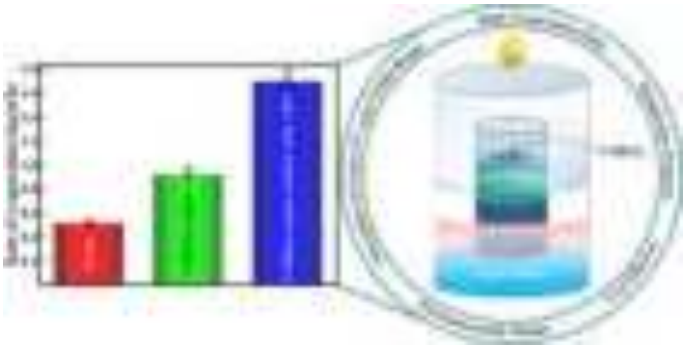
HIGHLIGHTS

- Synthesis of economical and environmentally benign $CuBi_2O_4$ microspheres by hydrothermal method
- $CuBi_2O_4$ formation by the assembly of 1D nanorods
- Absorption in the entire ultraviolet and visible range
- Real-time desalination of salty water consisting of 3.5, 10, and 20 wt% salt content

GRAPHICAL ABSTRACT



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ABSTRACT

The $CuBi_2O_4$ (CBO) microspheres comprising 1D nanostructures crystallized in a tetragonal crystal system with *P4/ncc* space group. The Cu and Bi ions in the CBO photothermal harvesters remained in stoichiometric 2+ and 3+ oxidation states, respectively. The CBO showed excellent absorption in the entire ultra-violet (UV) and visible spectrum, covering the prominent solar spectrum. The CBO microsphere formed by assembling 1D CBO nanorods possessed a specific surface area of 1.45 m^2/g, and the temperature-dependent contact angle of water over CBO surface decreases upon increasing temperature, making it an excellent choice in solar steam generation (SSG) process. Thus, the presence of CBO-loaded cellulose paper at the air-water interface has demonstrated three times accelerated evaporation rate of 1.7 kg/m^2h. Notably, the CBO-loaded cellulose paper delivered high stability with no change in evaporation rate even after consecutive cycles. The CBO exposed to the natural sunlight in the customized desalination setup provided >50 % CR/ER ratio for the salinity of 3.5, 10, and 20 wt % salty waters.

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Our findings establish that CBO is a highly desirable photo-material for SSG and has the potential to act as a solar light harvester for photovoltaic systems.

1. Introduction

The growing population and modernization of society have intensified the water shortage issues creating a severe global challenge. Since the oceans cover 75 % surface of the planet earth, the industrial and scientific community needs to put effort into finding a quick, affordable, and effective water desalination method to combat the problem of a global water crisis. Trapping of solar energy to achieve efficient light–to–heat conversion is turning as an attempt towards the environment-friendly green transition of water purification processes for overcoming clean water shortage. Solar steam generation (SSG) is a feasible and ecologically friendly approach that allows light-absorbing photo-thermal materials to produce localized heating at the air-water interface, thereby expediting the evaporation rate [1]. SSG, a simple water evaporation process benefiting renewable energy sources, is an environment-friendly water treatment process not only limited to seawater desalination but also helpful in wastewater treatment [2–4], sterilization [5,6], and electricity generation using electrokinetic effect [7,8], etc. The SSG systems primarily consist of porous floating (such as wood, paper, gauze, aerogels, polystyrene foam, etc.) and photothermal materials (such as nitrogen-doped graphene quantum dots [9], candle soot [10], carbon fiber [11], gold nanoparticles [12], platinum nanoparticles [13], silver nanoparticles [14], polypyrrole [15], polyvinyl alcohol [16], TiO_2 [17], MoS_2 [18], Fe_3O_4 [19], etc.), which harness sunlight and accelerates the evaporation rate by generating local heating at the air-water interface, akin to plant transpiration and human sweating. Therefore, the overall performance of the SSG system crucially hinges on photo-thermal conversion achieved by the photo-thermal material at the air-water interface. Consequently, apart from finding new photothermal materials with high thermal stability, broad absorbance, and minimum heat losses, the emphasis is also driven towards regulating the heat exchange from the surrounding environment [20–22].

Initially, gold nanoparticles were claimed to transform light into heat when illuminated by a specific laser [23]. Because of the wide absorption spectrum and accessibility, various carbon-based materials involving carbon black, graphene, and carbon nanotubes have subsequently received prominence [22]. Yang et al. [24] designed a graphene foam that resembles a 3D cross-linked honeycomb in order to attain an evaporation rate of 1.30 kg/m^2h. However, the carbon based-materials suffer from hydrophobicity; hence, several surface modifications or treatment with organic solvent is crucial in achieving high evaporation rates [25–29]. Additionally, several photo-thermal materials have been developed, such as polymers [30], metal oxides [20], metallic plasmonic materials [31], metal carbides (MXenes) [32], metal dichalcogenides [33], and metal-organic frameworks (MOFs) [34], etc. Tan et al. [30] developed hybrid hydrogels from polyvinyl alcohol (PVA) and silica aerogel microparticles to produce a flexible and self-floating photo-absorber at the air/water interface for quick SSG with an evaporation rate of 1.83 kg/m^2h. Recently, plasmonic wood has been prepared by decorating plasmonic nanoparticles on a porous matrix of wood to absorb a wide wavelength range and perform an efficient SSG system [31]. The capacity to perform photo-thermal conversion was enhanced by employing organic chromophores as bridging ligands in a metal-organic framework, resulting in an SSG performance with an evaporation rate of 2.05 kg/m^2h [34]. However, among the identified photo-thermal materials, environmentally benign metal oxide semiconductors have shown practical promise owing to their abundance, ease of synthesis, nanostructure tunability, reproducibility, high photo-thermal conversion efficiency, long stability, and antibacterial activity [18,20,35]. The SSG performance of metal oxide semiconductors nanostructures can be further bolstered by designing and developing metal oxide semiconductors that can absorb a broad visible spectrum. Magnetically recoverable Fe_3O_4 decorated on TiO_2 nanoparticles has shown solar-assisted recyclable SSG performance [19]. Nevertheless, TiO_2 demands the conversion into black titania or addition polymers like polypyrrole and polydopamine or carbon to absorb the complete visible range for SSG [17,36,37]. Likewise, WO_x, Fe_3O_4, and CoO_x demand the incorporation of defects or the addition of carbon nanostructures for complete spectral absorption for effective SSG [6,38,39]. Metal oxides having semiconducting nature show a photo-thermal effect due to photo-generated electron-hole pair and subsequent non-radiative relaxation. Unfortunately, most of the metal oxide semiconductors have wide band gap and absorb only in the UV region. On scrutinizing various metal oxide semiconductors, spinel structured (kusachiite) copper bismuth oxide ($CuBi_2O_4$ or CBO) with a tetragonal crystal system comprising an arrangement of $[CuO_4]^{6-}$ along the c-axis with detached Bi^{3+} ions, is abundant and non-toxic showing wide visible range absorption, recently investigated for application in solar cells, solar-driven water splitting, photocatalysis, and antimicrobial activity [40–44]. Along with the wide absorption range, CBO has a high molar extinction coefficient close to the IR region, the ability to kill drug-resistant bacteria upon illumination, and good photo-thermal conversion efficiency [45]. Also, it is a low-cost and earth-abundant material that shows good chemical stability, shape/morphology control with minimal processing, and better photostability [46,47]. Although CBO shows the antibacterial property that can contribute towards the high purity and biosafety of water, it has not been explored for solar thermal water desalination application.

Therefore, herein, for the first time, we present CBO microspheres of 1D nanowires for clean water production from environmentally friendly solar steam generation. The porous CBO microspheres comprising of 1D nanorods synthesized by hydrothermal technique exhibited excellent photothermal SSG performance owing to the broad absorption in the ultra-violet and visible spectrum range harvesting >50 % of the solar spectrum. Moreover, the CBO ink can be coated over several membranes, and the high porosity of the CBO microspheres can enable capillary forces to assist steam generation and reduce salt accumulation. The CBO coated over cellulose paper as floaters reduce heat loss to the bulk solution and has the potential to produce clean and safe water in an environmentally friendly and economical way in remote areas (Fig. 1). The well-defined crystallinity, morphology, and stoichiometric oxidation states of the CBO microspheres delivered a highly stable evaporation rate of ~1.7 kg/m^2h, which is comparable to other well-studied photo-thermal materials.

2. Experimental details

2.1. Synthesis of CBO microspheres comprising 1D nanorods

Initially, 50 mM bismuth (III) nitrate pentahydrate ($Bi(NO_3)_3{\cdot}5H_2O$; Merck) and 25 mM copper (II) nitrate trihydrate ($Cu(NO_3)_2{\cdot}3H_2O$; Merck) was dissolved independently in 2 M Nitic Acid (HNO_3) solution and DI water, respectively, for 30 min, to obtain clear solutions of the Bi^{3+} and Cu^{2+} precursor. The stirring was continued while adding 2 M sodium hydroxide (NaOH; Sisco Research Labs Pvt.) solution dropwise to gain sky-blue color to these transparent reaction mixtures. The

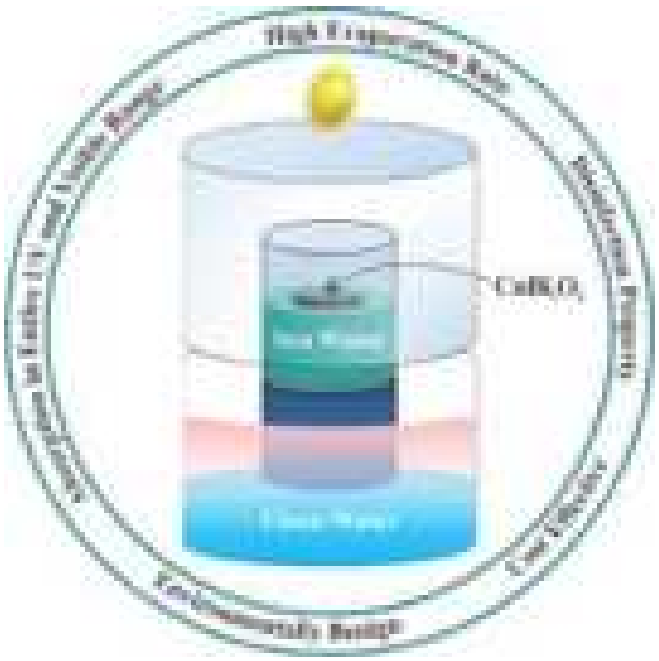

Fig. 1. Schematic of clean water production from solar steam generation using CBO microspheres.

resulting reaction mixture was loaded into an autoclave with a Teflon liner and subjected to a hydrothermal procedure. The autoclave reactions were carried at 120 °C for 5 h. After natural cooling, the precipitate was filtered through centrifugation and repeatedly rinsed with DI water and ethanol. The as-synthesized wet product was dried at 120 °C overnight and further annealed at 550 °C for 5 h to gain CBO powder, and characterized to understand the structural, morphological, surface, elemental, and optoelectronic properties using X-ray diffraction (XRD, Empyrean, Malvern-Panalytical, $\lambda = 1.5406$ Å), Field Emission Scanning Electron Microscopy (FESEM, JEOL, JSM-7610 F Plus), automated gas sorption analyzer (Quantchrome Autosorb iQ2), X-ray photoelectron spectroscopy (XPS, Thermo Scientific Inc. K-alpha), and UV–Vis spectrophotometer (DRS, UV-2600, Shimadzu). The temperature-dependent interfacial contact of the CBO and water was measured using a drop-shape analyzer (KRUSS, DSA25). For all the contact angle measurements, the CBO microspheres were coated over the silicon wafer to negate the effect of the surface roughness of the underlying substrate.

2.2. Solar steam generation experiment

The homogenous ink of CBO photothermal material was prepared by dissolving and sonicating 100 mg of catalyst in a mixture of the solvent containing 3 mL of DI water and 1.9 mL of ethanol. Further, 0.1 mL 5 % Nafion solution was added to this ink and continued to sonicate for another 20 min. Finally, it was drop cast over cellulose paper (radius 1.5 cm) and allowed to dry overnight at room temperature to gain the SSG

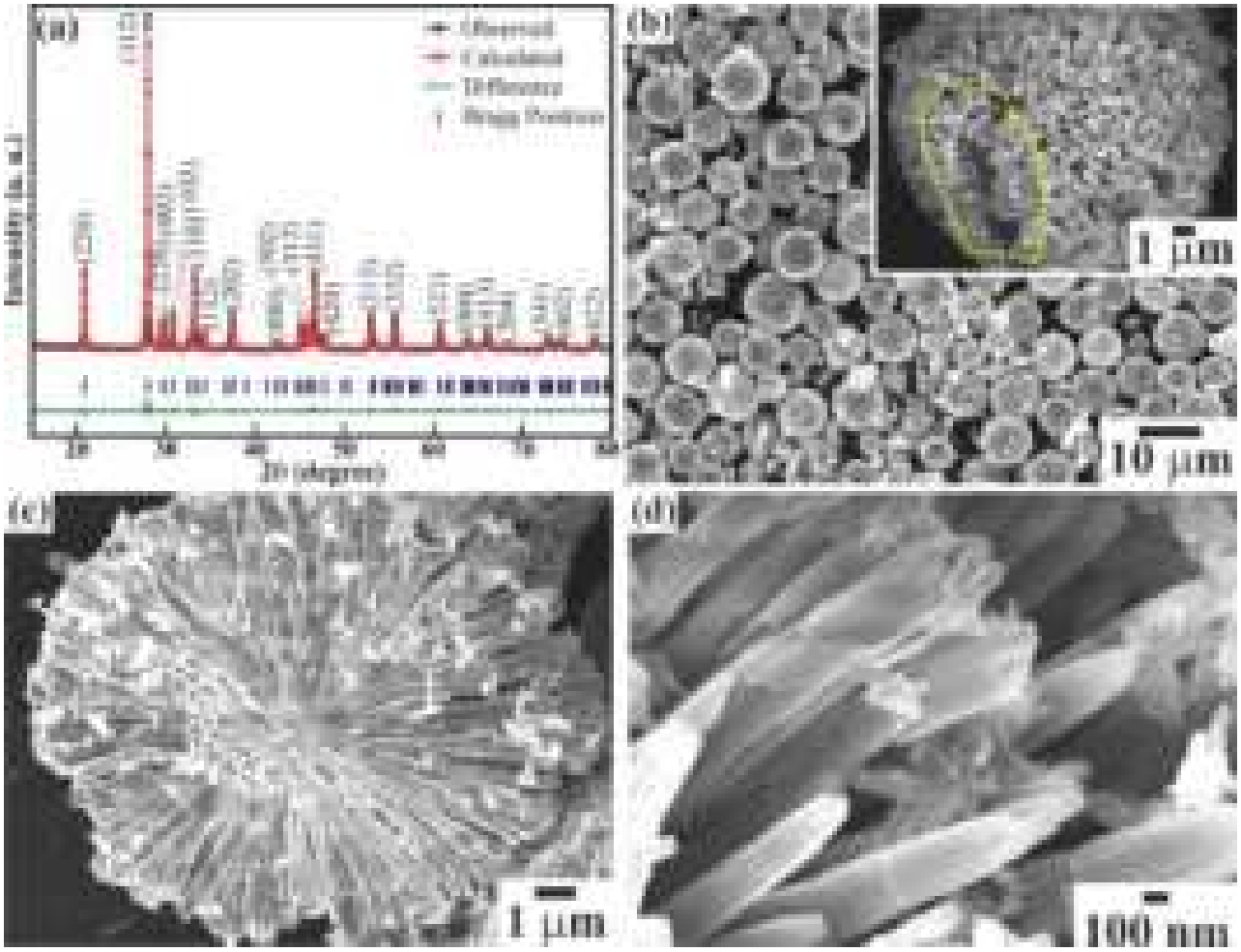

Fig. 2. (a) Rietveld refinement of X-ray diffractogram of CBO photo-thermal harvesters. FESEM images of (b) CBO microspheres with the (c) centric growth of (d) 1D CBO nanorods. Yellow dotted lines in the inset of (b) depict the porous nature of CBO microspheres.

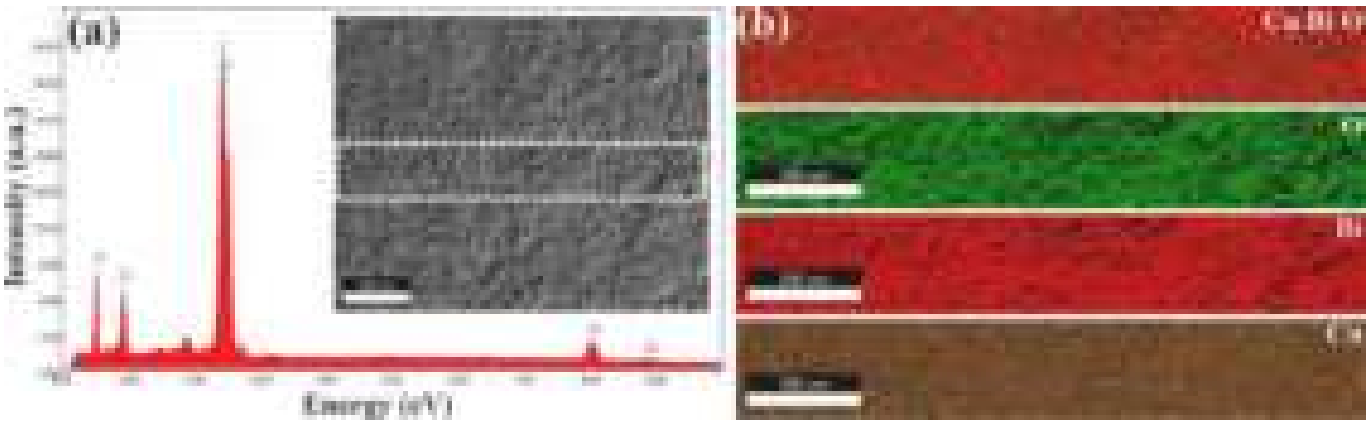

Fig. 3. EDS (a) line spectra and (b) mapping of CBO microspheres. The dotted line on the FESEM image in inset shows the area of EDS mapping.

floaters of CBO. The cellulose paper employed to understand the photothermal harvesting efficiency of the CBO microspheres is susceptible to minimal stress and strain, which hinders its mechanical probing and, therein, investigation of the mechanical properties of CBO microspheres. Nevertheless, the developed CBO ink can be coated over other possible membranes during device application, which is not included in the present manuscript. SSG process was performed under a Xenon Lamp (300 W) illumination as simulated sunlight. The measurement of weight change due to evaporation by SSG was performed at an interval of 10 min in a 50 mL beaker filled with 40 mL water placed on an electronic weight balance of 0.1 mg accuracy. The change in temperature, with and without CBO-coated cellulose paper floated at the air-water interface, in real-time through light-to-heat conversion was measured using a thermal imaging IR camera (FLIR TG 165X). The evaporation rate was calculated from Eq. (1)

$$Evaporation\ rate = \frac{dm}{S \cdot dt} \tag{1}$$

where dm is the weight change under light illumination, S is the surface area of photo-thermal material under illumination, and dt is the time of light illumination under which evaporation occurs. Specifically, the difference in water weight for cellulose paper and the bare water surface was also recorded for comparison. Further, the recyclability of the CBO-coated cellulose paper was tested for five consecutive cycles. The CBO-coated cellulose paper was floated over fresh water under illumination for 60 min during each cycle and the evaporation rate was evaluated. The CBO-coated cellulose paper was extracted and dried naturally during each consecutive cycle. The salinity studies were performed on salt water prepared by dissolving the required weight percentage of salt in DI water and finding the initial and final salt concentration after desalination.

3. Results and discussions

The Rietveld refinement of the X-ray diffractogram of the CBO photothermal harvester (Fig. 2(a)) indicates its well-defined crystallinity. The well indexing of all observed XRD peaks corresponding to ICSD No. 1006030 revealed the tetragonal crystalline nature with the *P4/ncc* space group of CBO. The value of R_{WP}, R_{EXP}, GoF, and R_P of CBO are 8.72, 4.88, 1.78, and 7.38, respectively. The estimated parameters (lattice) a = b = 8.510 Å and c = 5.812 Å are akin to the literature. The surface morphology of these tetragonal crystalline CBO represents (Fig. 2(b)) the formation of uniform and porous CBO microspheres consisting of 1D CBO nanorods. The cross-section image of these microspheres indicates the nucleation of 1D nanorods at the center and growth to an outward direction shaping the microspheres (Fig. 2(c)). The high magnification FESEM image (Fig. 2(d)) on the surface of the CBO microspheres shows discrete 1D CBO nanorods of ~120 nm diameter with clearly visible textural boundaries. Unlike hydrothermally synthesized CBO microspheres reported in the literature [48], in the present process, the CBO microspheres are formed with distinct 1D nanorods. Moreover, to achieve well-defined porosity in the CBO microspheres, the molar ratio of the metal precursors is varied; however, such changes in the molar ratio affected the stoichiometry and produced impure phases [49]. In the present study, highly porous CBO microspheres formed with centric growth and assembly of 1D nanorods can assist in higher localized heating at the air-water interface when used for the SSG process. To account for the distribution of the constituent elements in the CBO microspheres, the elemental EDS mapping performed is shown in Fig. 3. The uniform distribution of the Cu, Bi, and O elements over a defined scanning area is illustrated with brown, red, and green colors, respectively, showed their existence without the inclusion of any other foreign elements.

Fig. 4 shows the high-resolution XPS spectra representing the oxidation states and electronic structure of O(1s), Bi(4f), and Cu(2p) core levels of the CBO photo-thermal harvester. To accurately identify the features of O(1s), Bi(4f), and Cu(2p) core levels, the XPS spectra are deconvoluted with the Voigt function in Shirley background. The XPS spectrum of Cu(2p) core levels (Fig. 4(a)) shows two distinctive peaks of $Cu(2p_{3/2})$ and $Cu(2p_{1/2})$ at the binding energies (BE) of 931.83 (≡a) and 951.72 (≡b) eV, respectively, with energy difference of 19.89 eV, which are accompanied by concomitant satellite peaks at 941.44 (≡a′) and 963.14 (≡b′) eV, respectively. This signifies that the CBO photo-thermal harvester comprises of Cu in the 2+ oxidation state. Likewise, the Bi(4f) spectra representing two peaks are deconvoluted into 4 discrete peaks located at BE of 157.81 (≡c), 163.08 (≡d) 158.65 (≡c′), and 163.86 (≡d′) eV representing $Bi^{3+}(4f_{7/2})$, $Bi^{3+}(4f_{5/2})$, $Bi^{4+}(4f_{7/2})$, and $Bi^{4+}(4f_{5/2})$, respectively (Fig. 4(b)). However, the intensity of the $Bi^{4+}(4f_{7/2})$ and $Bi^{4+}(4f_{5/2})$ peaks are much smaller, indicating the insignificant existence of Bi^{4+}. Moreover, the energy difference between $Bi^{4+}(4f_{7/2})$ and $Bi^{4+}(4f_{5/2})$ is of 5.27 eV. This ascertains the existence of the 3+ oxidation state of Bi in the CBO photo-thermal harvester. Fig. 4(c) shows a single distinct O(1 s) peak at a BE of 528.72 eV for the CBO photothermal harvester [50–52]. Moreover, the ratio of Cu, Bi, and O elements evaluated from the deconvoluted XPS spectra of Cu(2p), Bi(4f), and O(1s) core levels is 1.02, 1.92, and 4, respectively (i.e., Cu:Bi:

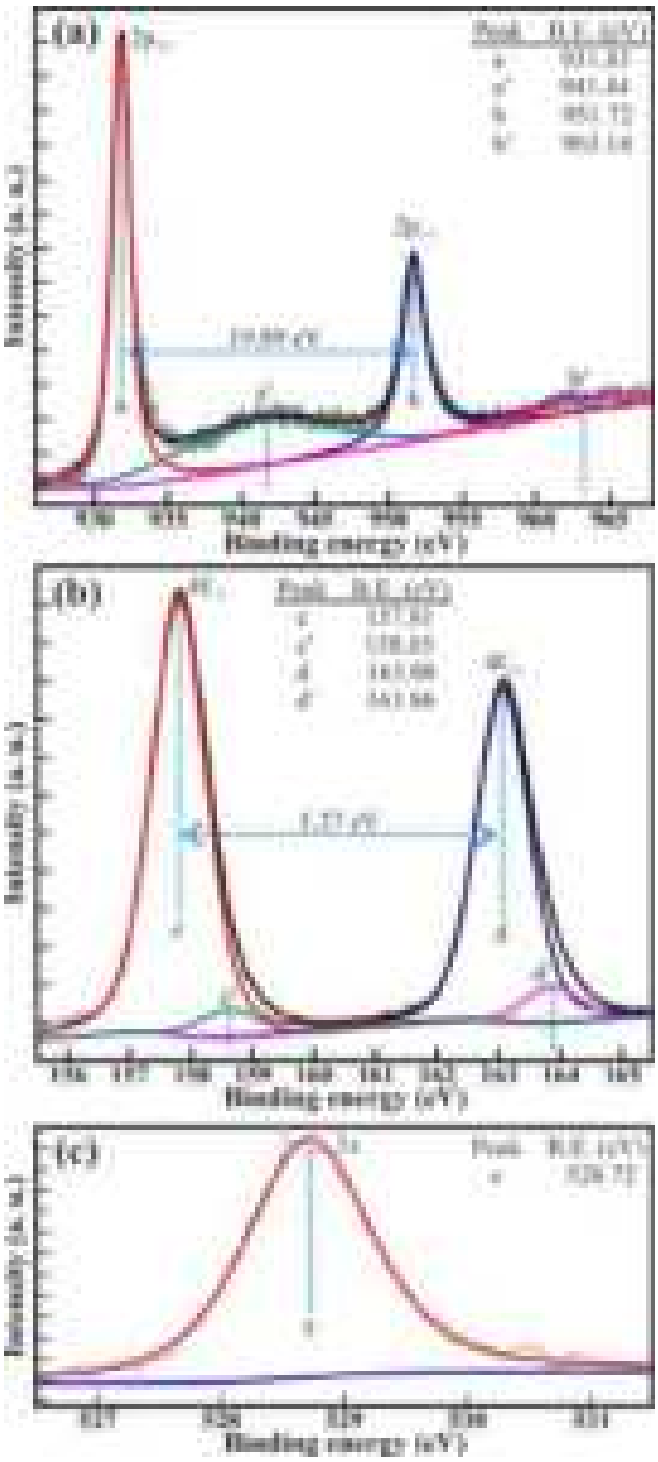

Fig. 4. High resolution XPS spectra of (a) Cu(2p), (b) Bi(4f), and (c) O(1s) of CBO photo-thermal harvester. Shirley background and Voigt function were used to deconvolute the XPS spectra.

O::1.02:1.92:4). Overall, the XPS analysis corroborates the stoichiometric existence of Cu^{2+}, Bi^{3+}, and O^{2-} in the 1D CBO microspheres consisting of nanorods.

The excellent absorbance in the 200 to 2000 nm wavelength range (Fig. 5(a)) shows the suitability of CBO for conversion of the incident photon to heat via photogeneration and relaxation of electrons and holes. Contrary to the metal oxides such as defective WO_x, TiO_2, Fe_3O_4, and CoO_x employed for SSG [53], the CBO microspheres consisting of nanorods have virtually absorbed the complete UV and Visible spectrum representing its potential as SSG. Moreover, a bandgap of ~1.5 eV estimated for the CBO photo-thermal harvester using the Tauc's plot (inset of Fig. 5(a)) revealed its competitiveness in photogeneration and $e^- - h^+$ relaxation for heat generation under solar illumination. Further, the BET adsorption-desorption isotherms (Fig. 5(b)) with N_2 were recorded to estimate the specific-surface-area and distribution of pore size (inset of Fig. 5(b)) in CBO microspheres comprising 1D nanorods. The distinct loop of type IV isotherm observed for the CBO indicates its porous nature. The specific surface area, pore diameter (average), and pore volume (total) of 1.45 m^2/g, 3.393 nm, and 0.0291 cc/g were obtained due to the evolution of 1D CBO nanorods in an outward direction to form microspheres. The porous CBO microspheres of 1D nanorods offer a higher specific surface area, ensuring the scattering of incident photons/radiation, resulting in larger $e^- - h^+$ photogeneration/relaxation enhances the localized heating at the air/water interface during the SSG process and boosts the evaporation process.

The CBO harvester-loaded cellulose paper was set to float over the liquid surface to irradiate with a xenon lamp (300 W), as shown in Fig. 6 (a), and the subsequent changes in the temperature and mass of water were recorded to study the efficacy of the CBO catalyst in SSG process. The change in temperature as a function of time in the presence of plain cellulose paper and CBO-loaded cellulose (CBO/cellulose) paper under illumination is shown in Fig. 6(b). It is observed that surface temperature linearly increases for the initial 30 min of illumination and remains stable afterward. Under illumination, the CBO/cellulose-based SSG device gained a surface temperature from ~28.9 °C to ~37.6 °C in 30 min, whereas it remained approximately unchanged (~27.9 °C to ~29.3 °C) with only cellulose-based SSG device. The steady-state surface temperature of ~37.6 °C achieved from the CBO SSG device is better than that produced from pristine TiO_2 (i.e., 36.2 °C in ~120 min) [53], and comparable to black titania/graphene oxide films (i.e., 40.6 °C in ~15 min) [37], and TiO_2/Cotton/polypyrrole/polydopamine (i.e., 47.7 °C in ~10 min) [36]. The enhanced photogeneration of electrons through the scattering process and subsequent relaxation in the porous CBO microspheres of 1D nanorods have assisted in accelerating the photo-thermal conversion process, which is a prime requirement for water evaporation. Furthermore, the thermal images recorded at the water-air interface for plain and CBO-loaded cellulose paper at the initial stage (0 min) and 30 min of irradiation, presented in Fig. 6(c and d), respectively, exhibit an efficient interfacial heat generation due to conversion of light energy to heat energy in the presence of nanostructured CBO, which expedite the evaporation rate.

The variation in mass change of water with respect to illumination time for plain water, plain cellulose paper, and CBO-loaded cellulose paper is shown in Fig. 7(a). After 90 min of illumination, the highest change in water mass of 2.5 kg/m^2 was observed for the CBO/cellulose due to steam generation. In comparison, it was ~1 and ~0.5 kg/m^2 for plain cellulose paper and water, respectively. Further, the rate of water evaporation to generate steam was significantly higher for the CBO/cellulose (i.e., ~1.7 kg/m^2h) than the plain water (~0.5 kg/m^2 h) and pure cellulose paper (i.e., ~0.9 kg/m^2 h) (Fig. 7(b)). These analyses represent the excellent capability of the CBO photothermal harvester in the SSG process. Further, an excellent photo-thermal harvester should also possess long-term stability and recyclability. Therefore, the CBO-loaded cellulose paper was used with fresh water for 5 consecutive cycles (60 min each) to generate steam. The corresponding evaporation rate calculated for each cycle is shown in Fig. 7(c). The CBO-loaded cellulose paper retained its evaporation rate at ~1.7 kg/m^2 h even after 5 consecutive cycles. The observed results are comparable with other metal oxide photothermal materials such as TiO_2, Fe_3O_4, ZnO, and MoO_{3-x} [16,54].

The temperature-dependent variation of the mean contact angle of the water over the surface of the CBO photothermal harvester was measured to understand the temperature effect on the water interaction with the CBO microspheres. The mean contact angle at the water/CBO

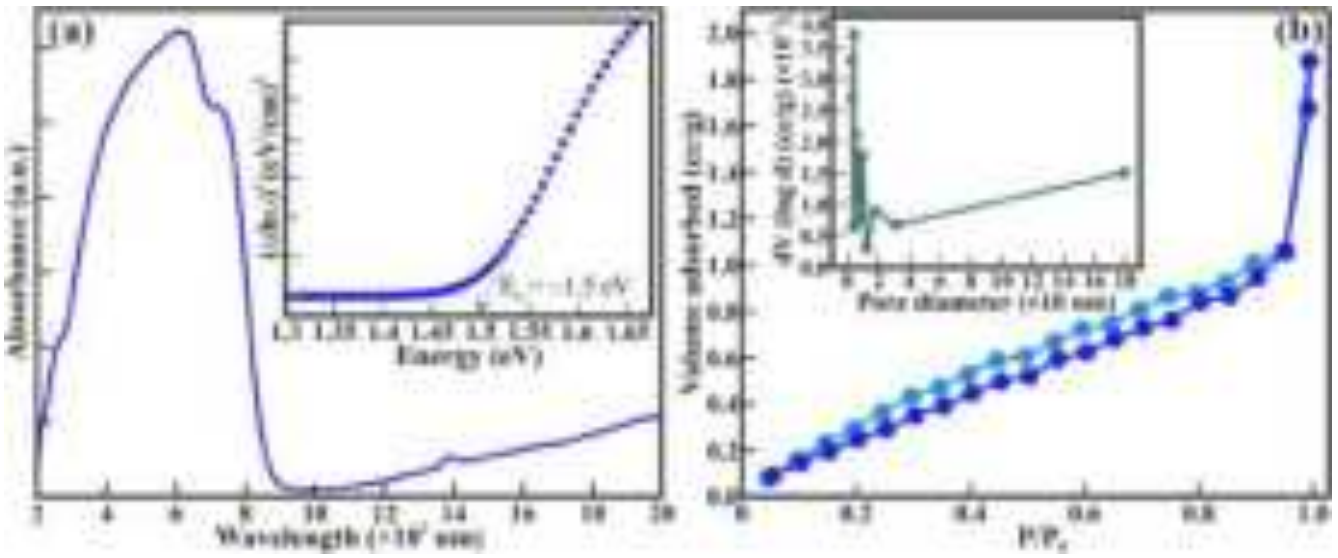

Fig. 5. (a) Absorbance and (b) BET adsorption-desorption isotherms of CBO photo-thermal harvester. The respective inset shows bandgap estimation from the corresponding Tauc plot and the BJH pore size distribution of CBO.

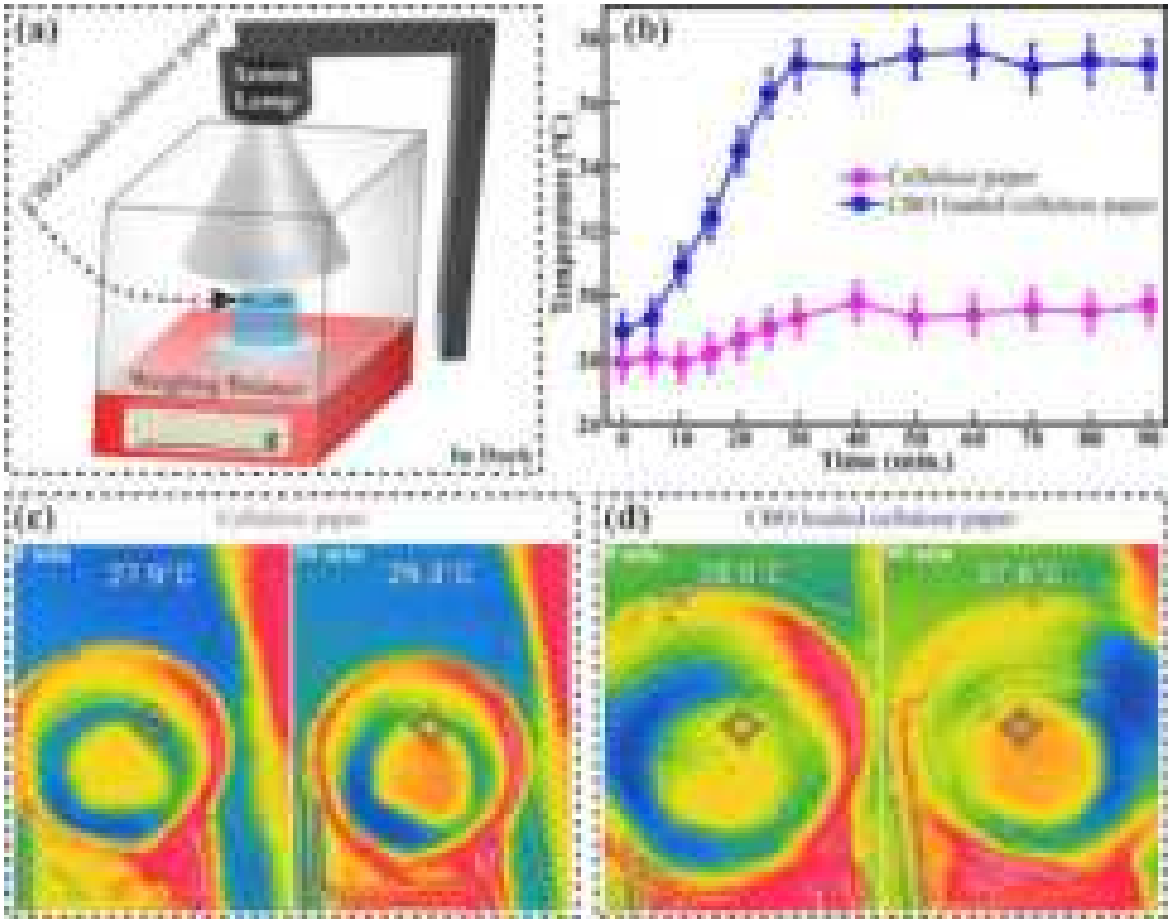

Fig. 6. (a) Schematic of SSG measurement setup. (b) Time-dependent temperature variation at the water-air interface of plain and CBO-loaded cellulose paper. Thermal images at the water-air interface of (c) plain and (d) CBO-loaded cellulose paper at the initial stage and 30 min of irradiation.

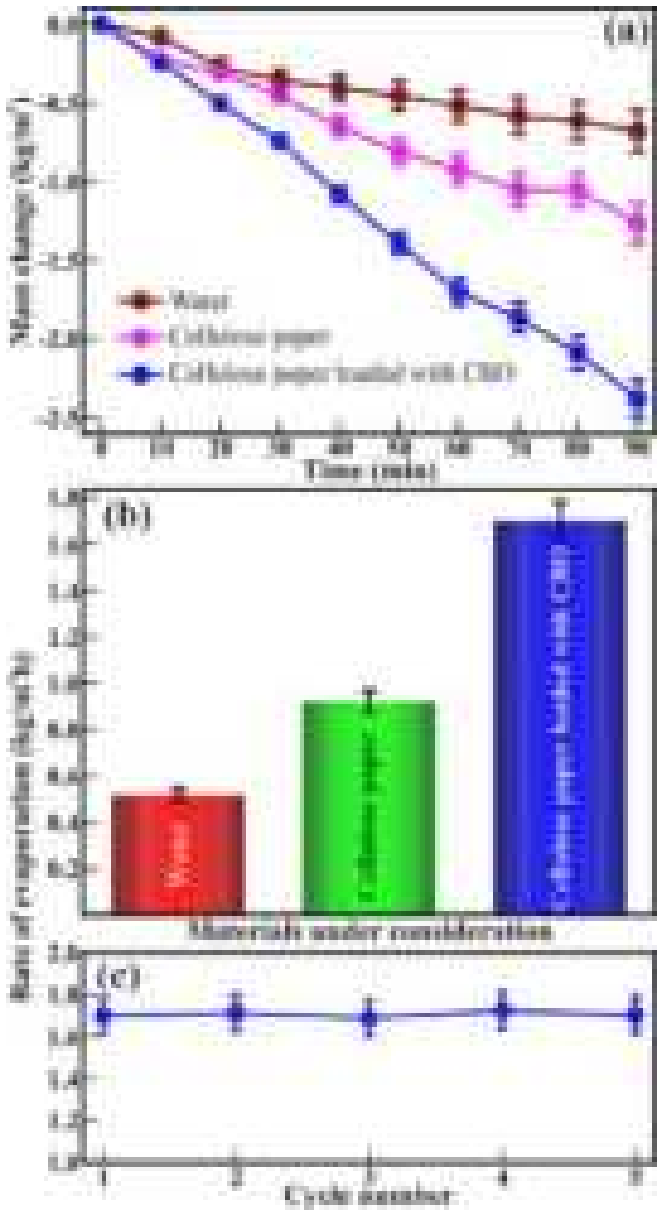

Fig. 7. (a) Time-dependent mass change of water, cellulose paper over water, and CBO loaded cellulose paper over water and respective (b) rate of evaporation. (c) Variation in evaporation rate for CBO-loaded cellulose paper over water with consecutively repeated cycles.

interface was measured in the ambient after loading CBO ink over a silicon wafer (Fig. 8). The steady decrease in the mean contact angle of water over the CBO surface is observed with the rise in the surface temperature of the CBO photo-thermal harvesters. A mean contact angle of ~75° observed at a temperature of 28 °C had reduced to ~45° when the temperature was raised to 40 °C. The inversely proportional behavior of contact angle concerning the temperature indicates an enhanced wettability of the CBO surface by water. The wettability indicating more water spread over photo-thermal material allows covering the maximum surface area of CBO during photo-thermal conversion at higher temperatures, significantly benefiting the SSG process. Overall, the increased hydrophilicity of CBO photo-thermal harvesters with a rising temperature has benefited the evaporation process, suggesting CBO as a promising photo-thermal material for SSG application.

Further, an outdoor experiment was conducted to analyse the performance of the CBO under direct sunlight in the SSG process. The evaporation rate of >1.32 kg/m^{2}h for the pure water was evaluated for each consecutive hour with respect to outdoor light intensity (Fig. 9(a)). The clean water collection rate (CR) from salty water was estimated from a customized solar steam collection setup (Fig. 9(b)) exposed under direct sunlight from 11:00 am to 12:00 noon in the ambient outdoor condition in the presence of CBO. A wet cotton cloth was wrapped around the outer bottom beaker to achieve dual fold benefit, i.e., to enhance the collection rate and to avoid condensed water droplets on the top up-side of the down beaker, allowing light to fall on CBO loaded cellulose paper. The photographs of the engineered setup are shown in Fig. 9(c), along with the top and bottom beakers without and with the condensed water. The evaporation rate (ER) of 1.585, 1.472, and 1.326 kg/m^{2}h was calculated for salty water with a salinity of 3.5, 10, and 20 wt%, respectively (Fig. 9(d)). However, the highest clean water CR of 0.825 kg/m^{2}h was achieved with 3.5 wt% salinity, followed by 10 wt% (0.760 kg/m^{2}h) and 20 wt% (0.679 kg/m^{2}h). Furthermore, >50 % of the CR/ER ratio was observed for salinity of 3.5, 10, and 20 wt% (Fig. 9(e)) with negligible variation of ~3 % with an increase in salinity. However, the difference in the rate of evaporation and collection primarily can be further boosted with better thermal management. Additionally, the salt concentration was increased, and the salinity of the collected water following an outdoor experiment was measured. The salinity of the collected water drastically reduced compared to the initial salty water, as shown in Fig. 9(f). The difference in the total dissolved salt (TDS) between the initial and desalinated solutions was analyzed by measuring their conductivity [55]. The TDS of the salty water consists of 20 wt% salt concentration was reduced from 200,799 mg/L to 179 mg/L after desalinating, indicating the desalination capabilities of the CBO. Considering that evaporation occurs at the air-water interface, long-term evaporation can lead to salt accumulation and clogging of the pores. Therefore, the surface morphology and the elemental analysis of the CBO-coated cellulose paper were performed after the salinity tests in 20 wt% salt concentration (Fig. 10). The FESEM micrograph of the CBO-coated cellulose paper illustrated the presence of discrete NaCl crystals over the CBO microspheres consisting of nanorods (Fig. 10(a)), and it is verified by EDS elemental analysis (Fig. 10(b)). The constituent Cu, Bi, and O elements of the CBO microspheres and Na and Cl elements of the salt solution were detected. However, the sparse distribution of NaCl crystals avoided complete clogging of the pores, eventually assisting steam generation. Nevertheless, prolonged desalination can increase salt accumulation, but the CBO-coated cellulose floaters can be washed (with DI water), dried, and reused in accordance with the reusability presented in Fig. 7(c). These results show that the CBO photothermal harvester achieves reasonable evaporation rates.

4. Conclusions

In conclusion, we have presented CBO microspheres comprising 1D nanorods for a stable and efficient SSG process. The hydrothermally synthesized porous CBO microspheres crystallized in a tetragonal crystal system with *P4/ncc* space group in stoichiometric oxidation states of Cu^{2+} and Bi^{3+}. The porous CBO microspheres possessing a specific surface of 1.45 m^2/g showed complete absorption in UV and Visible range. The temperature-dependent contact angle measurements showed that the mean contact angle of water at the interface increases with increasing the surface temperature of the CBO/cellulose photothermal harvester. The water temperature raised from ~28 °C to ~38 °C in 30 min under xenon light illumination in the presence of CBO/cellulose

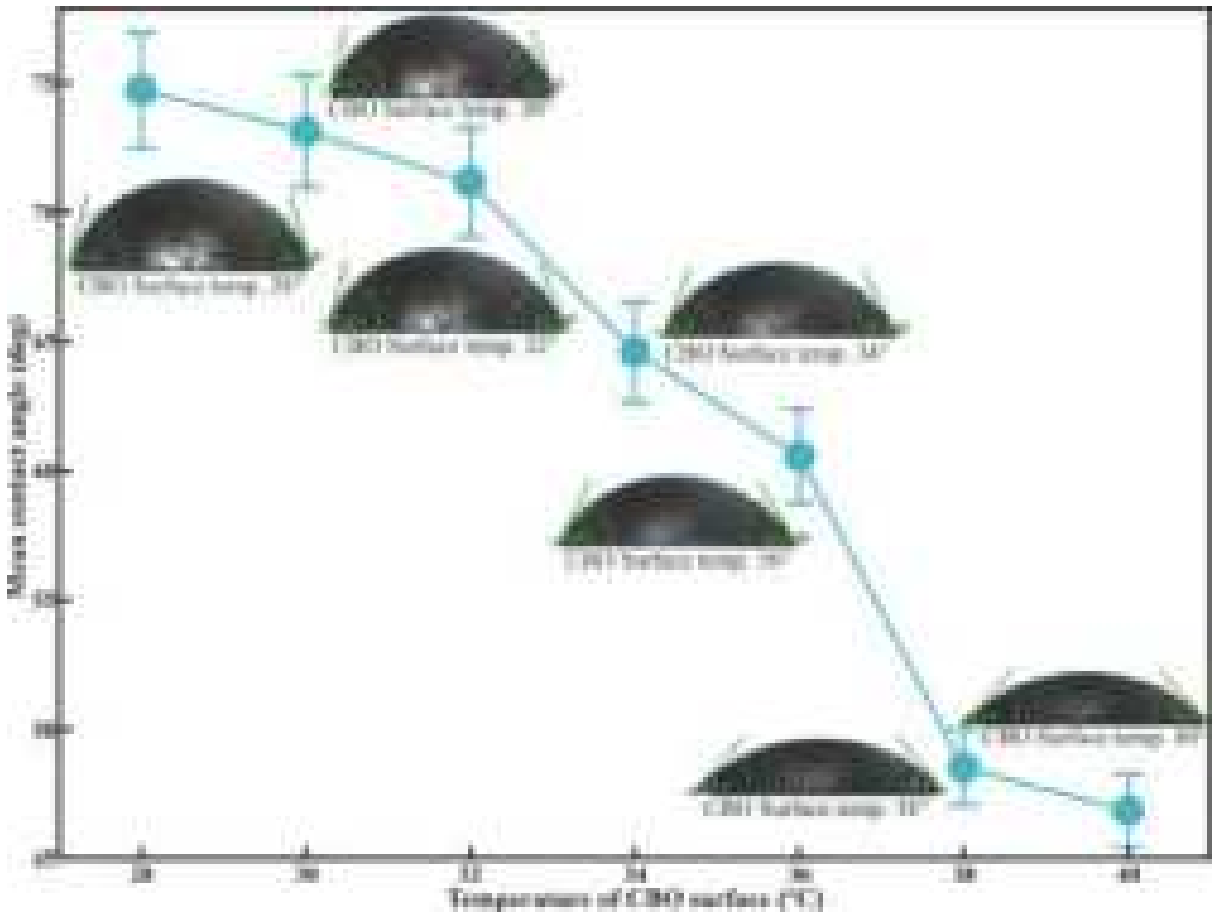

Fig. 8. Temperature-dependent mean contact angle of water interaction over the surface of CBO photo-thermal harvester. The inset shows the representative image of the water/CBO interface from >15 measurements performed for each temperature.

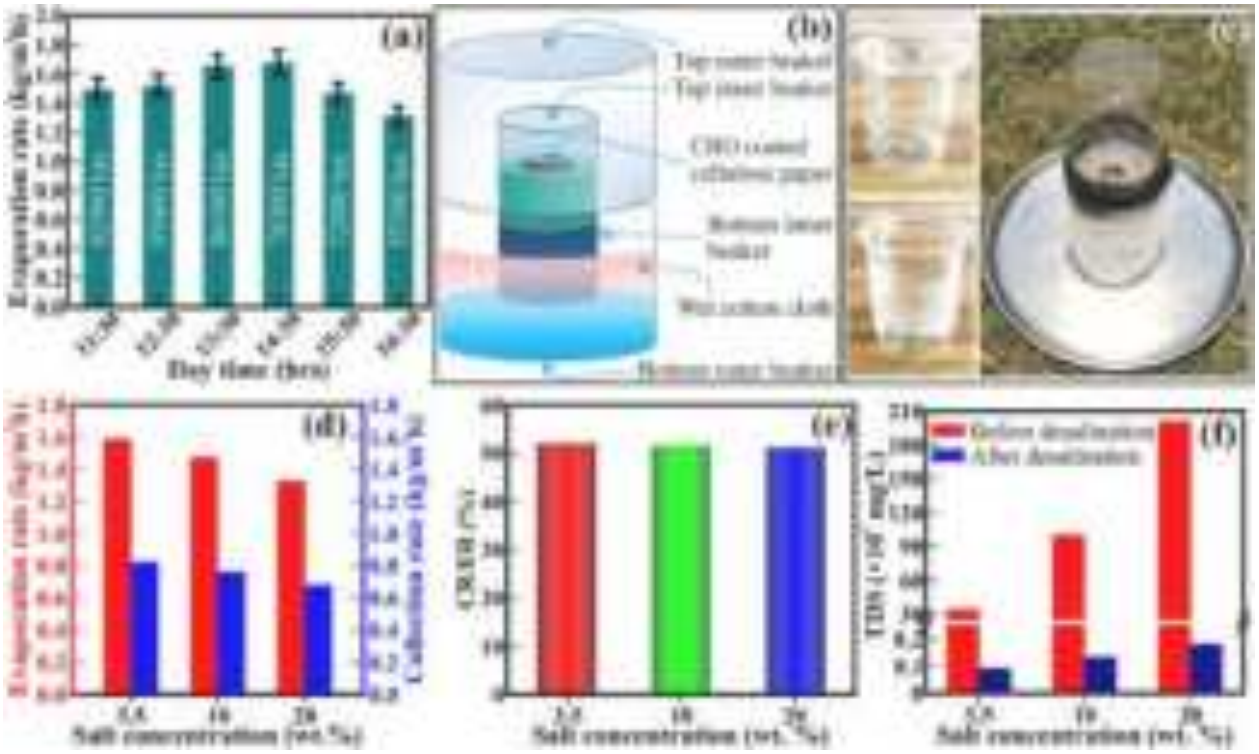

Fig. 9. (a) Evaporation rate during outdoor experiment. (b) Schematic of customized solar steam collection setup and (c) photograph of real-time steam collection experimental setup. (d) Evaporation rate and clean water collection rate, (e) ER/CR ratio, and (f) TDS (ppm) for various salt concentrations.

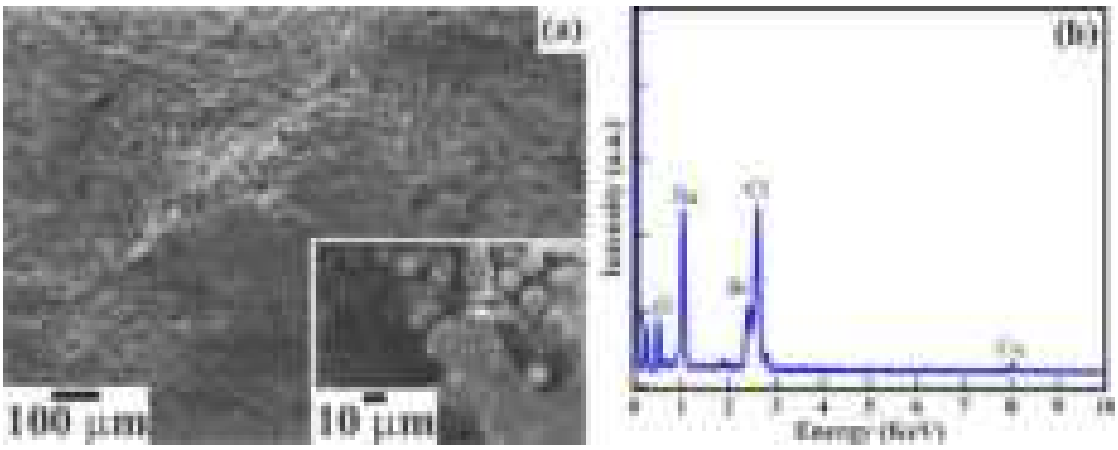

Fig. 10. (a) FESEM micrograph and (b) EDS spectra of CBO-coated cellulose paper collected after the salinity tests in 20 wt% salt concentration.

paper. The CBO-loaded cellulose paper also showed the highest mass change (−2.5 kg/m^2) and evaporation rate (~1.7 kg/m^2 h) compared to water and plain cellulose paper. Notably, the CBO-loaded cellulose paper delivered high stability even after consecutive cycles. The CBO exposed to the natural sunlight in the customized desalination setup provided evaporation rate of ~1.6 to 1.3 kg/m^2 h, clean water collection rate of 0.8 to 0.7 kg/m^2 h, and >50 % CR/ER ratio for the salinity of 3.5, 10 and 20 wt% salty waters.

CRediT authorship contribution statement

We have not used AI and AI-assisted technologies in the writing process of this manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Infrared active narrow bandgap Ni doped $LaFeO_3$ nanoparticles for desalination and decontamination of water leveraging interfacial solar steam generation

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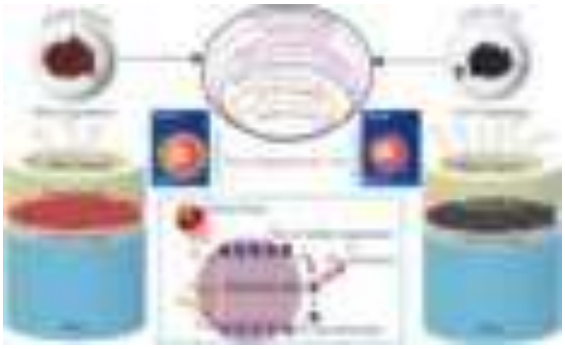
HIGHLIGHTS

- High absorbance due to creation of intra-band gap states provided superior activity towards the SSG.
- ~50.4 °C rise in surface temperature for NLFO5.
- Real-time desalination of 3.5 wt% salt water.
- RhB and MB dye separation under direct sunlight.
- Drastic decrement in salt concentration after SSG as confirmed from AAS.

GRAPHICAL ABSTRACT



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ABSTRACT

Photothermal Ni-doped $LaFeO_3$ (NLFO) ($LaFe_{1-x}Ni_xO_3$, x = 0, 0.2, 0.3, 0.4, and 0.5) microspheres composed of nanoparticles synthesized by hydrothermal method are utilized for interfacial solar steam generation (ISSG) of salty and contaminated water. The orthorhombic (*pnma*) to rhombohedral ($R\bar{3}c$) phase transition of $LaFeO_3$ (LFO) at morphotropic phase boundary (MPB) flattens the free energy profile, and high absorbance in the 800–2000 nm Vis-NIR region arises due to the creation of intra-band gap states are accountable for superior activity towards the ISSG for desalination. The La, Ni, and Fe possess the oxidation states of 3+, 2+, and 3+/4+, respectively, showing successful doping of Ni^{2+} at the Fe^{3+} sites that produce lattice distortion at La/FeO_6 octahedra. $LaFe_{0.5}Ni_{0.5}O_3$ (NLFO5) sample exhibits surface temperature of 50.4 °C due to heat localization and produces evaporation flux of 2.89 kg/m^2h under IR illumination at the air-water interface. Importantly, NLFO5 loaded cellulose paper shows good repeatability and cyclic stability for 10 consecutive cycles under IR illumination and equivalent evaporation flux of 2.4 kg/m^2h under direct sunlight illumination. Moreover, 3.5 wt%

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saline water shows a drastic decrement in ion concentration after ISSG, as confirmed by atomic absorption spectroscopy. Furthermore, NLFO5 possesses good evaporation flux of 2.27 and 2.20 kg/m^{2}h for water contaminated with RhB and MB organic dye. Our results propose the NLFO as distinguished photothermal material for ISSG application and wastewater purification by means of evaporation.

1. Introduction

Nowadays, scarcity and supply of fresh water have become a growing challenge for the world, causing the loss of millions of lives yearly around the globe. To meet the demand for freshwater, many technologies have been adopted in recent years, including dye removal from wastewater [1] and seawater desalination using the interfacial solar steam generation (ISSG) process [2], which are mainly targeted because of their commercial use. Photothermal desalination and/or photocatalytic organic dye removal under abundantly available sunlight, without producing chemical waste usually infeasible in other traditional methods, have emerged as cost-effective, sustainable, and environment friendly methods to produce clean water [3]. Therefore, ISSG, for altogether desalinating the saline and organic dye contaminated wastewater, shall remove the salt and dye contaminants under sunlight and condense into pure drinkable water. ISSG system can work efficiently for clean water supply in any region if it harvests the whole solar spectrum and converts into heat easily and quickly. Photothermal material, a key component of the ISSG system to convert solar energy into heat for water evaporation, is expected to possess broadband light absorption, high solar-to-thermal conversion efficiency, water transportation, and low specific heat capacity. At the same time, it should be cost-effective, stable, recyclable, and easy to scale up [3]. Among various evaporation modes of ISSG, interfacial and isolation evaporation modes are recognized to be better in terms of less energy losses and high evaporation flux [4]. However, hunting for materials with remarkable photothermal and photocatalytic properties is still going on in the quest to advance the ISSG or solar-driven evaporation of seawater or wastewater via interfacial evaporation mode.

Initially, researchers explored the plasmonic material, including nanoparticles of Au, Ag, and Cu noble metal, where localized surface plasmon resonance (LSPR) plays major role in heating [5]. The absorption spectrum of plasmonic material is confined to the 400–2500 nm range, providing an excellent evaporation flux for the ISSG process [6]. Furthermore, the scientific community started hunting for various carbon-based solar absorbing photothermal materials, such as graphene, carbon nanotubes, hybrids of carbons, etc., which have performed well for ISSG application [7]. Likewise, semiconducting metal oxides viz. TiO_2 [8], ZnO [9], and Fe_2O_3 [10] are also utilized, but the ISSG performance is limited to the UV region and further needs to be improved with strategies like the creation of surface disorder, defects, and oxygen vacancy [11]. Moreover, polymers of thiophene (PTh), aniline (PANI), and pyrole (PPy) provide effective solar-to-steam conversion without complex steps but still suffer from stability, recyclability, and scalability [12]. Therefore, nanostructured morphologies of photothermal materials having low bandgap, structural stability, and high surface area are desirable in ISSG to increase the evaporation flux by harvesting the whole solar spectrum [13]. Perovskite oxides (i.e., ABO_3 compounds) are attracting considerable attention due to their rich physicochemical properties, strong photothermal and photocatalytic response, tunable crystal structure, and the existence of various valence states helpful in enhancing optical properties [14]. Nevertheless, the reports in the literature on perovskite oxides for ISSG application are mostly limited to the $SrCoO_3$ (SCO), [15], $LaNiO_3$ (LNO) [16], $LaCoO_3$ (LCO) [16], Sr-doped LCO [17], and the composite of Sr-doped LCO and Ti_3C_2 MXene [18]. SCO provided evaporation flux of 2.13 kg/m^{2}h and 1.45 kg/m^{2}h when loaded with Ppy and Nickel Foam (NF), respectively [15,19]. Among the perovskite oxides, lanthanum-based oxides, i.e., $LaMO_3$ (M = Fe, Ni, Co, Mn, Sr, etc.) in the pristine or composite form, found suitable for wide variety of applications, including photocatalysis, supercapacitors, batteries, fuel cells, and solar cells [20–22], are explored in search of better evaporation flux for interfacial ISSG (i.e., 2.3 kg/m^{2}h and 1.4 kg/m^{2}h for LNO and LCO, respectively) [16]. Moreover, metal doping is also explored to improve the evaporation flux in ISSG. The Sr doping in LCO provided an evaporation flux of 1.67 kg/m^{2}h ($La_{0.7}Sr_{0.3}CoO_3$) [23] and 2.45 kg/m^{2}h ($La_{0.5}Sr_{0.5}CoO_3$) [17] after scavenging in Polyvinyl Alcohol (PVA) and Chitosan (CS) polymer. Nevertheless, Sr-doped LCO (i.e., $La_{0.9}Sr_{0.1}CoO_3$) mixed with Ti_3C_2 Mxene limited the evaporation flux to 1.40 kg/m^{2}h [18]. However, to the best of our knowledge, the Ni-doped $LaFeO_3$ (NLFO) has not been thoroughly explored for applications in photo-assisted ISSG despite the fact that Ni doping at the Fe sites in $LaFeO_3$ (LFO) has improved the catalyst activity for CO_2 methanation [24], electrocatalytic oxygen evaluation [25], photocatalytic dye degradation [26], hydrogen production [27], and gas sensing [28].

Moreover, there is a decisive linkage between the nanostructure morphologies (in terms of dimensionality, surface-to-volume ratio, and morphology) and solar-to-heat energy conversion efficiency (absorption range, photo-thermal conversion). However, the entire focus was on developing materials with broad absorption range being solar spectrum consisting of ~51 % Ultraviolet-Visible (UV–Vis) and ~49 % infrared (IR) light. Particularly, designing IR-absorbing photothermal materials that cover the NIR region of the solar spectrum is beneficial to improving salt rejection and water condensation efficiency [29]. Additionally, clouds can block visible light, but the NIR wavelength range (i.e., 0.7 to 3 μm) being long wavelength can pass easily through most tiny droplets (size <3 μm) [30]. Despite these facts, specifically, metal oxide based NIR absorbing photothermal materials have yet remained unexplored for the ISSG process. Therefore, it is essential to develop low-cost, easily processable, highly stable, photothermally efficient, salt-resistive, and high steam generating metal oxide evaporator under IR illumination. As $LaNiO_3$ (LNO) offers broadband absorption [22], it is expected to significantly modify the bandgap after Ni doping at the B site in LFO and facilitate efficient light absorption, which can lead to significant improvement in the ISSG, making it a better photothermal material. Moreover, LFO and NLFO exhibit a stable crystal structure, tunable band gap due to doping, excellent ionic and electronic conductivity, thermal stability [31], and environment friendliness [1], making them suitable candidates for excellent ISSG performance in desalination applications. Moreover, with the increase in Ni doping in LFO (Ni:Fe::1:1; $LaFe_{0.5}Ni_{0.5}O_3$), the trap energy states created within the band gap of LFO may act as intermediate energy levels for trapping of electrons and further generating the energy in the form of heat or phonons [3]. This heat causes a rise in surface temperature and assists in a faster rate of evaporation, which is ascribed to the defect-level assisted recombination for an excellent ISSG process.

Therefore, in the present work, we report NLFO microspheres consisting of nanoparticles synthesized via hydrothermal route as an efficient material for ISSG of saline and organic dye (Rhodamine B (RhB) and Methylene Blue (MB)) contaminated water. Interestingly, NLFO has shown excellent light absorption in the wavelength region of 800–2000 nm. Consequently, NLFO, with high absorption in the IR wavelength region, needs to be explored to understand the IR illuminated evaporation process in ISSG applications. The rise in surface temperature due to solar-to-heat conversion, evaporation flux, and mass loss during the ISSG process was studied under IR lamp (150 W). The trap energy states created within the band gap of LFO after Ni doping may act as intermediate energy levels for trapping electrons and further generating

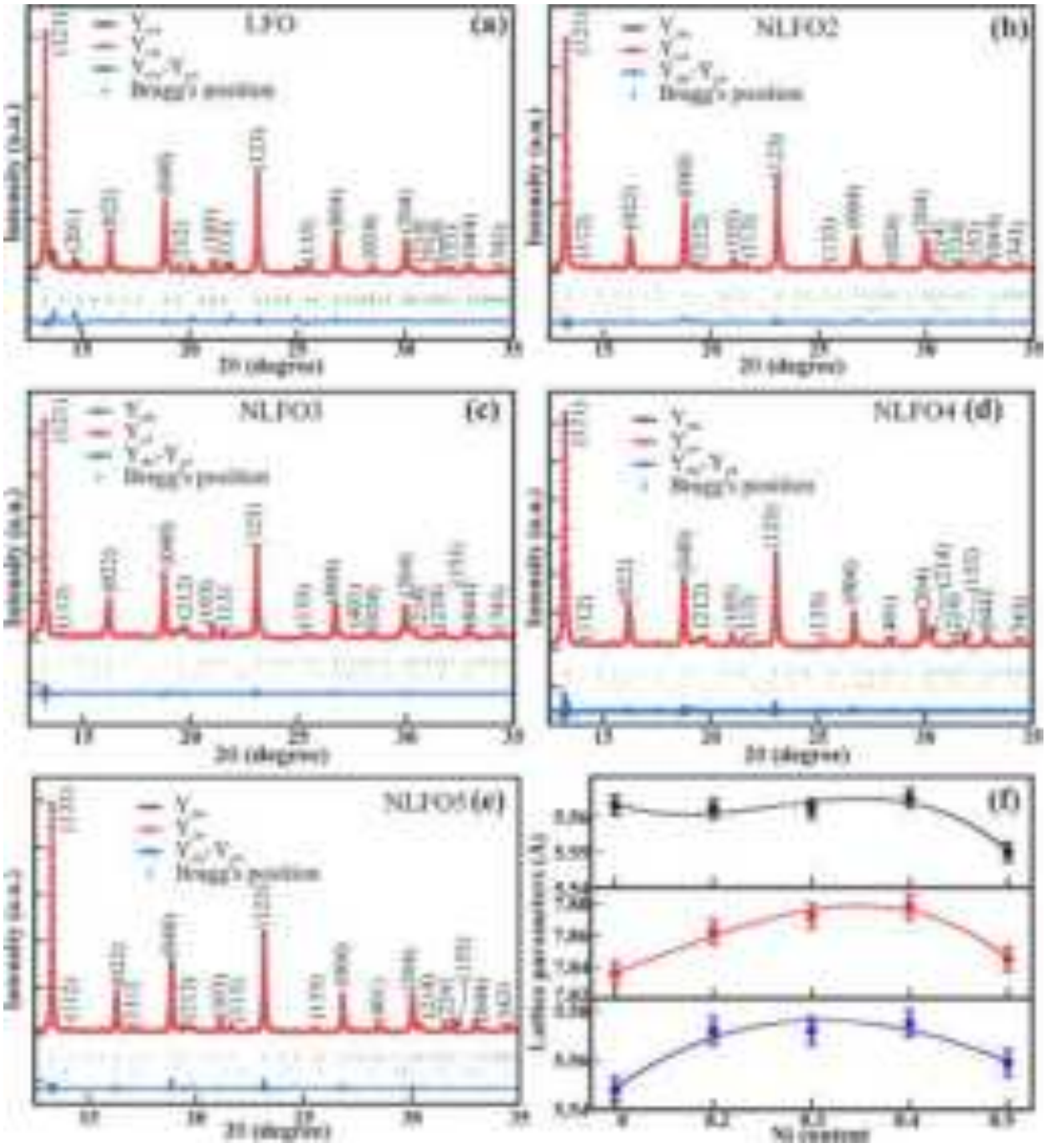

Fig. 1. Rietveld refined XRD spectra of (a) LFO, (b) NLFO2, (c) NLFO3, (d) NLFO4, and (e) NLFO5 samples, and (f) lattice parameter variation evaluated with respect to Ni doping.

energy in the form of heat or phonons. This heat causes a rise in surface temperature, assisting the faster rate of evaporation. An in-depth study on the Ni doping effect on LFO microspheres reported here can promote IR light absorbing metal oxide based photothermal evaporators for ISSG technology.

2. Experimental

2.1. Synthesis and characterization of NLFO

The LFO and NLFO perovskite were synthesized using the hydrothermal method. The stoichiometric nitrates solution of La (La $(NO_3)_3{\cdot}6H_2O$, 99.999 %, SRL chemicals), Fe ($Fe(NO_3)_3.9H_2O$, >99 %, Sigma Aldrich), and Ni ($Ni(NO_3)_3.6H_2O$, 99.999 %, Sigma Aldrich) was prepared in DI water and mixed under continuous stirring, in which separately prepared citric acid ($C_6H_8O_7$; 99.5 %, SRL Chemicals) solution was added dropwise and continued stirring to gain homogenous solution. This solution was transferred to a Teflon liner and autoclaved for 12 h at 180 °C. After that, it was centrifuged/washed in DI water/ethanol multiple times and dried in a hot air oven at 100 °C for 12 h. Thus collected powder was annealed at 800 °C for 2 h to obtain the $LaFe_{1-x}Ni_xO_3$ (where, x = 0, 0.2, 0.3, 0.4, and 0.5) perovskites. The different amount of Ni doped LFO are identified as NLFO2 (≡ x = 0.2), NLFO3 (≡ x = 0.3), NLFO4 (≡ x = 0.4) and NLFO5 (≡ x = 0.5) in the present work.

The crystal structure and lattice parameters of NLFO were analyzed

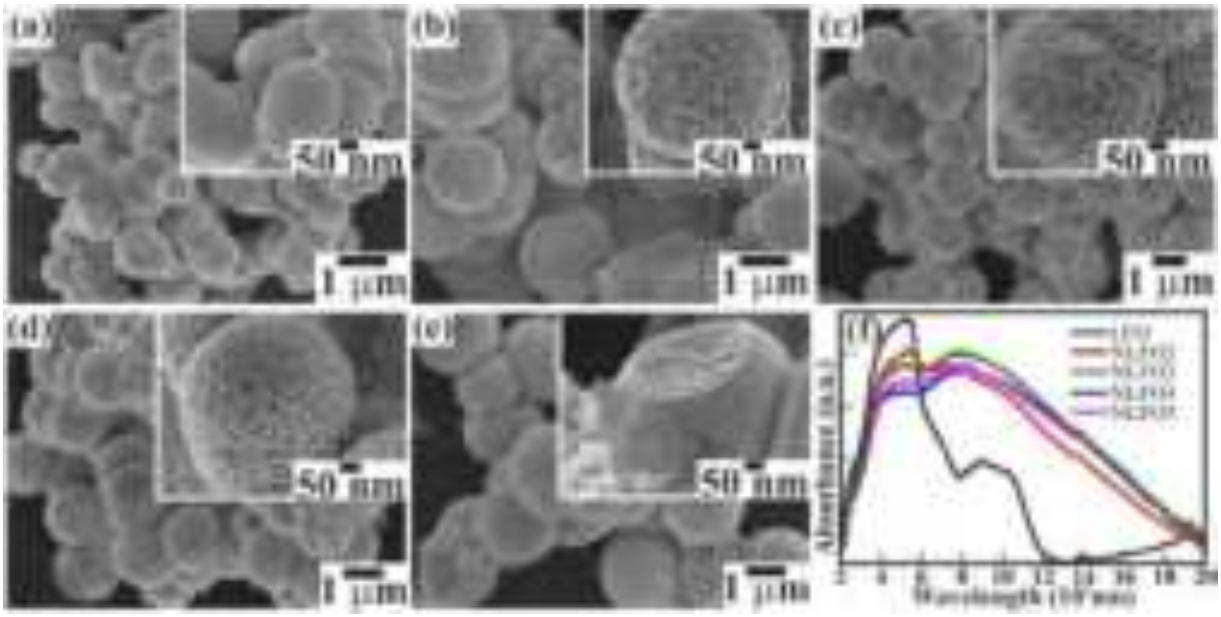

Fig. 2. FESEM images of (a) LFO, (b) NLFO2, (c) NLFO3, (d) NLFO4, and (e) NLFO5. (f) UV–Visible-NIR absorption spectra of pristine and Ni-doped LFO microsphere composed of nanoparticles.

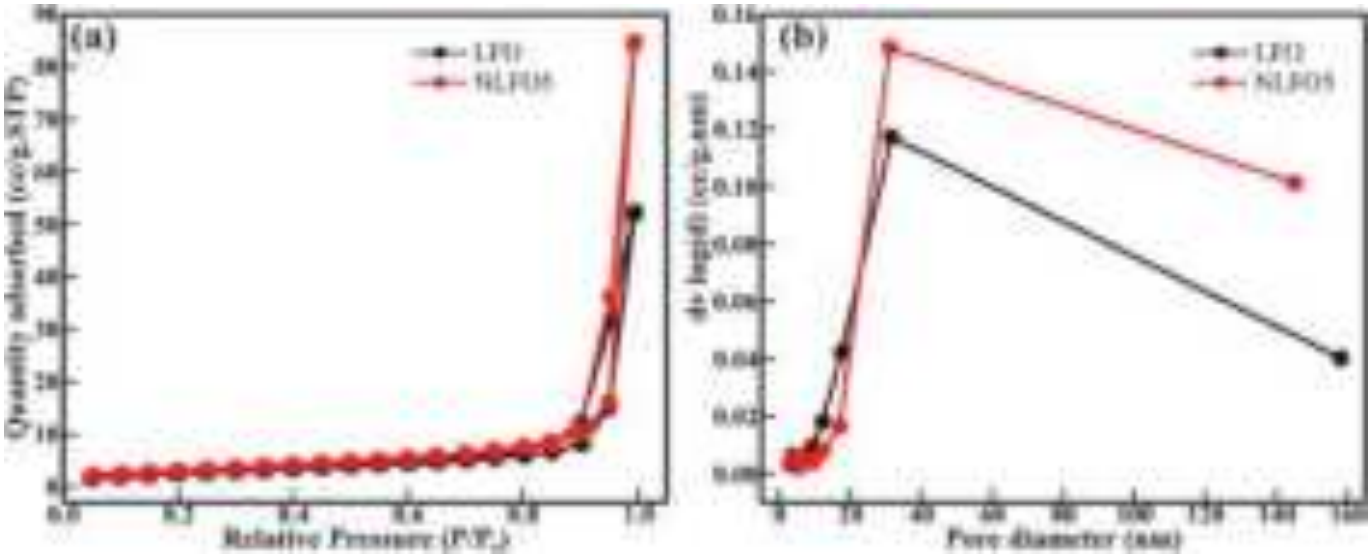

Fig. 3. (a) N_2 adsorption-desorption isotherm, and (b) BJH pore size distribution for LFO and NLFO5 samples.

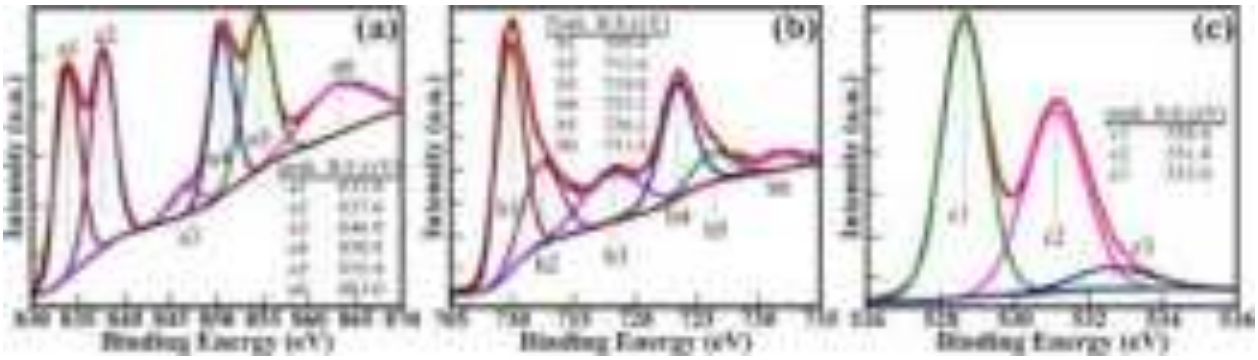

Fig. 4. High resolution XPS spectra of (a) La(3d) and Ni(2p), (b) Fe(2p), and (c) O(1s) core levels of NLFO5 sample.

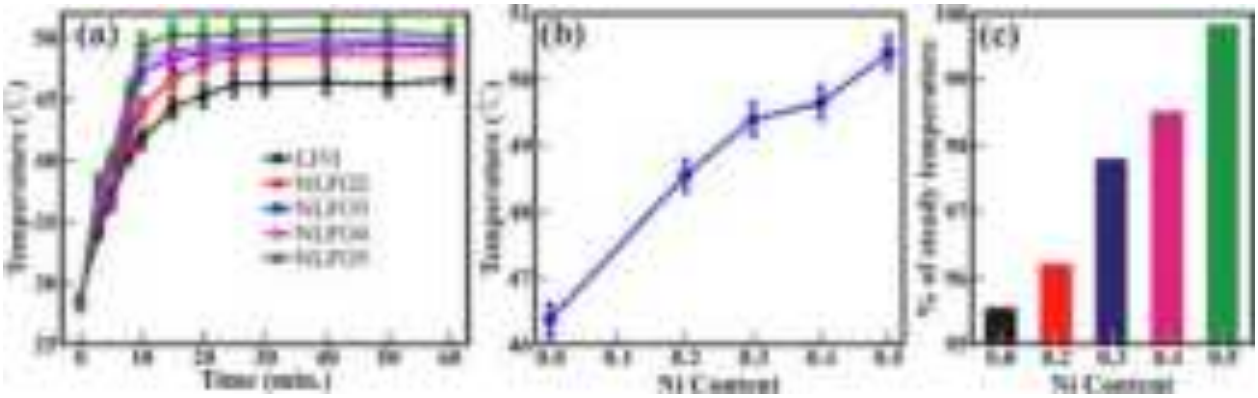

Fig. 5. Thermal measurements for pristine and Ni-doped LFO samples under IR light illumination. (a) Time dependent variation in the surface temperature at water-air interface, (b) Steady state temperature variation at 25 min., and (c) Histogram representing percentage of steady state temperature observed at 15 min. to understand effect of Ni concentration.

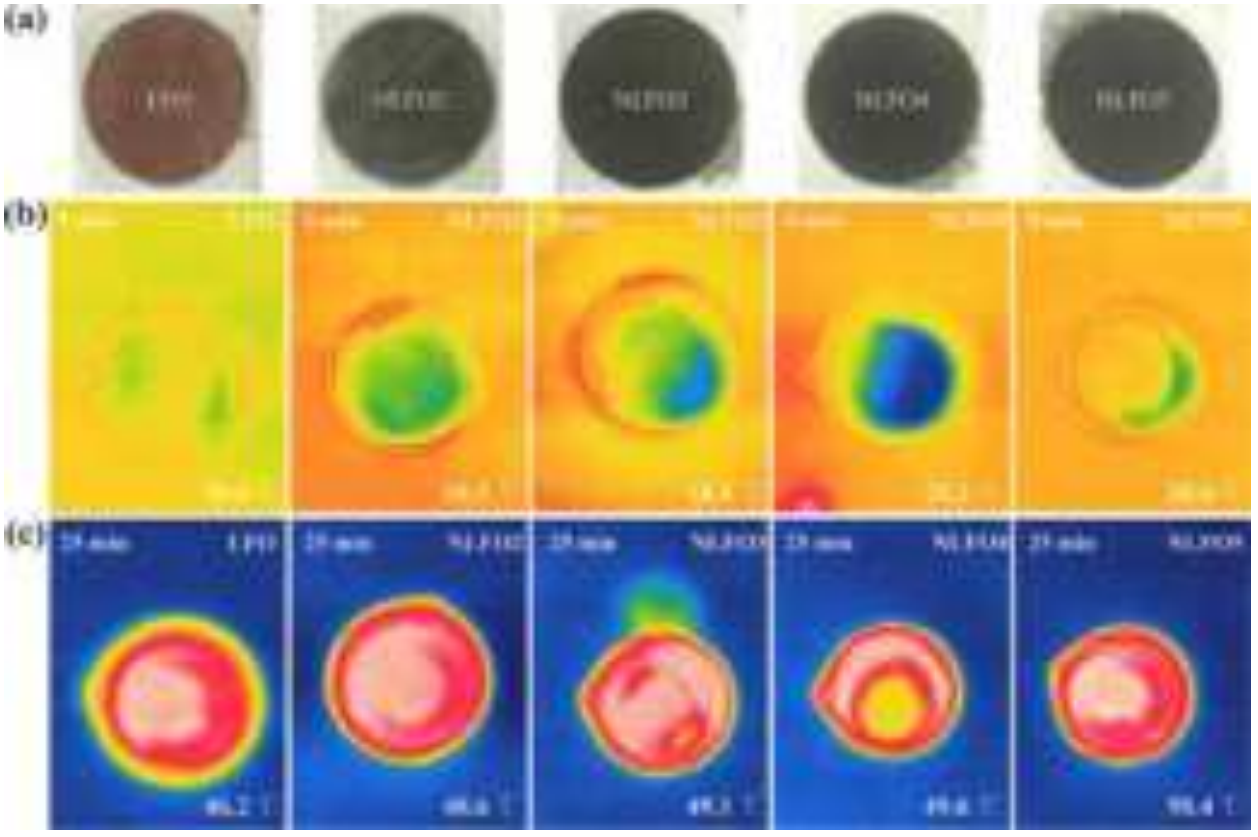

Fig. 6. (a) Optical images and respective thermal images captured by IR camera (b) immediately after irradiation (0 min.) and (c) after attaining steady state temperature (25 min.) for various pristine and Ni-doped LFO samples.

from a synchrotron source ($\lambda = 0.71$ Å) of X-rays at Beamline-11, Indus-2, Raja Ramanna Centre for Advanced Technology (RRCAT) Indore, India. The oxidation state and electronic properties of all NLFO samples were recognized from X-ray photoelectron spectroscopy (XPS, Thermo Scientific Inc. Al-kα). The surface morphological features and optical properties were examined from a field emission scanning electron microscope (FESEM, JEOL JSM-7610 F Plus) and diffuse reflectance spectra recorded on UV–Visible spectrophotometer (JASCO V-670, Japan), respectively. The surface area and pore size distribution of LFO and NLFO5 samples were estimated with nitrogen (N_2) adsorption-desorption isotherm using Brunauer–Emmett–Teller (BET) and Barrett-Joyner-Halenda (BJH) methods in an automated gas sorption analyzer (Quantchrome Autosorb iQ2). The temperature dependent contact angle measurements were performed using a drop drop-shape analyzer (KRUSS, DSA25) equipped with the controlled heating arrangement. The salt concentration (ppm) of 3.5 wt% saline water and condensed pure water after ISSG was measured utilizing atomic absorption spectroscopy (AAS) (CHEMITO AA 201) to understand the ISSG effect on the water purity.

2.2. Interfacial solar steam generation measurements

To prepare the ISSG device, initially, hydrothermally synthesized 40 mg powder of LFO and NLFO were dispersed in 250 ml DI water by ultrasonication for 60 min to achieve the homogeneous aqueous (aq.) suspension. Afterward, this aq. suspension was deposited on cellulose

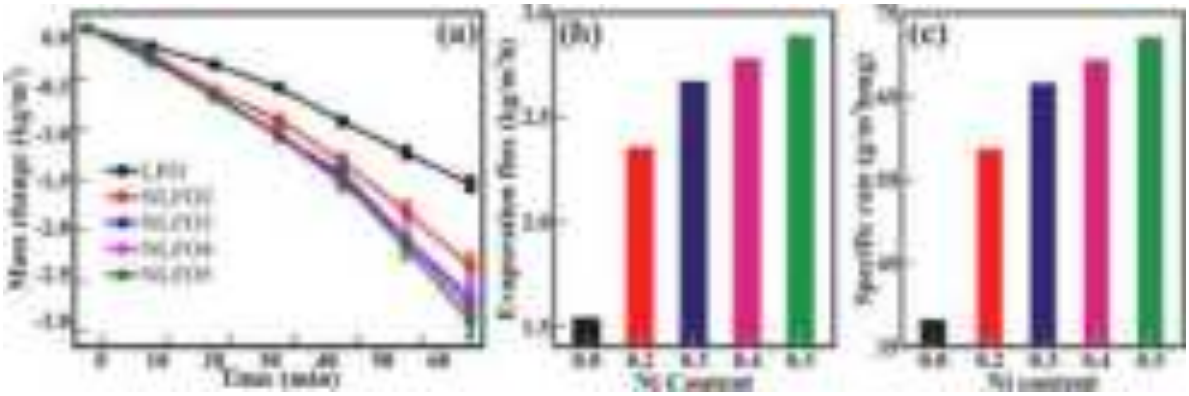

Fig. 7. (a) Time dependent mass change of water, and histogram representing (b) evaporation flux, and (c) specific rate of water evaporation for pristine and Ni-doped LFO microspheres comprising of nanoparticles.

Table 1
Comparative ISSG performance of various photothermal materials.

Photothermal material	Substrate	Evaporation		Ref.
		Duration (h)	Flux (kg/m^2h)	
Carbon paper	PVA Hydrogel	1	2.6	[43]
$Ti_3C_2T_x$/rGO/MoS_2	Polystyrene	1	1.33	[45]
$SrCoO_3$@NF	PU foam	1	1.45	[15]
$La_{0.7}Sr_{0.3}CoO_3$	Polyethylene foam	1	1.67	[23]
$La_{0.5}Sr_{0.5}CoO_3$/PVA/CS	Hydrogel	1	2.45	[17]
$LaNiO_3$	Cellulose membrane	1	2.3	[16]
$LaCoO_3$			1.4	
Cu_3SnS_4	Wood	1	1.35	[46]
Bionic Mushroom	Wooden Strip	1	1.67	[44]
Ti_3C_2/$La_{0.9}Sr_{0.1}CoO_3$	Polypropylene	1	1	[18]
$SrCoO_3$@ppy	PU foam	1	2.13	[19]
λ-Ti3O5	Porous hydrogel	–	6.09	[50]
RGO	NIPAM aerogel	1	4.0	[51]
CAP aerogel	–	–	5.368	[52]
$LaFe_{0.5}Ni_{0.5}O_3$	Cellulose membrane	1	2.89 (@IR light) 2.4 (@sunlight)	Present work

filter paper (radius 1.5 cm) through the process of vacuum filtration and further dried at room temperature for 12 h. The LFO or NLFO coated cellulose filter paper was allowed to float on the surface of the water (Fig. S1). Then the device is illuminated with the IR lamp, simulated sunlight, and direct sunlight during the desalination process. The ISSG process was performed under a Murphy IR lamp (150 W), and mass change during the water evaporation was measured using a weighing balance with 0.1 mg accuracy. Additionally, the ISSG process was also investigated under direct sunlight and simulated sunlight by the Newport LED solar simulator. The change in temperature at the water surface due to the photothermal effect of ISSG device at the air-water interface was measured using a thermal imaging IR camera (FLIR TG 165x). The evaporation flux (E_r) and specific water production rate are calculated using the formula [2]

$$E_r = \frac{dm}{Sdt} \tag{1}$$

$$\text{Specific rate} = \frac{E_r}{Weight} \tag{2}$$

where dm is the weight change due to light exposure, S is the surface area of photothermal material under light exposure, and dt is the light exposure time at which water evaporation occurs.

3. Results and discussion

To analyze the phase and purity of the sample, the synchrotron XRD was performed on LFO and NLFO samples. Fig. 1 illustrates the XRD spectra of LFO and NLFO samples on which Rietveld refinement was performed using Fullprof software to gain the goodness of fit parameters. The goodness of fit parameters (R_p, R_{wp}, R_{exp}, and GOF) for all LFO/NLFO samples are listed in Table S1. For LFO, all the peaks are well indexed and match with the orthorhombic $LaFeO_3$ phase with space group of *pnma*. (ICSD card No. 01-082-1958) along with few impurity peaks assigned to La_2O_3 of cubic phase (Space group: $p\bar{3}$m1, ICSD card: 1531452) (Fig. 1(a)). With the increase in Ni doping, the impurity peaks of La_2O_3 start disappearing, and the highest intensity (121) peak of LFO located at $2\theta = 13.2°$ shifted towards the lower angle (Fig. 1(b–d)) might be due to the lattice distortion of Fe/NiO_6 octahedra; hence the lattice parameters increased up to NLFO4 samples despite of retaining orthorhombic crystal structure (Fig. 1(f)). However, with the increase in Ni doping at the B site in LFO to 50 % (Ni:Fe::1:1; $LaFe_{0.5}Ni_{0.5}O_3$), the phase transition from orthorhombic (LFO, space group of *pnma*) to rhombohedral (LNO, space group of $R\bar{3}c$) [32,33] and the decrease in lattice parameters (Fig. 1(f)) have been noticed, exhibiting phase transformation at the morphotropic phase boundary (MPB) and indicating giant response to less external stimuli. The enhancement in ISSG property is assigned to the flattening of the free energy profile across the boundary where two different phases coexist in the doped material [34].

The reaction between metal nitrate at the optimized time and temperature offered microsphere-like morphology consisting of a number of interconnected nanoparticles for all synthesized samples (Fig. 2). The pristine LFO microsphere of <0.8 μm average diameter with a relatively smooth outer surface consists of compact nanoparticles of <52.91 nm average diameter (Fig. 2(a)). The smooth surfaced LFO microspheres have gained a relatively rough outer surface with increased Ni doping (Fig. 2(b–e)). The diameter of the microsphere and nanoparticles in it remained in the range of 1.45 to 2.63 μm and 44 to 95 nm, respectively, for the increase in the Ni doping concentration. The well-separated distinct nanoparticles forming porous microsphere morphology evolved with the increase in Ni doping. Hence, the average size/diameter of the microspheres has relatively increased compared to pristine LFO. However, NLFO5 microspheres made up of distinct nanoparticles with clearly visible textural boundaries protruding outwards offered porous morphology deep inside the structure, providing more active sites for the exciton pair to produce localized heat as compared to other NLFO microspheres (Fig. 2(e)). Further, to evaluate the absorption capacity and analyze the effect of Ni doping on the optical properties of LFO, UV–visible spectra recorded in the wavelength range of 200 to

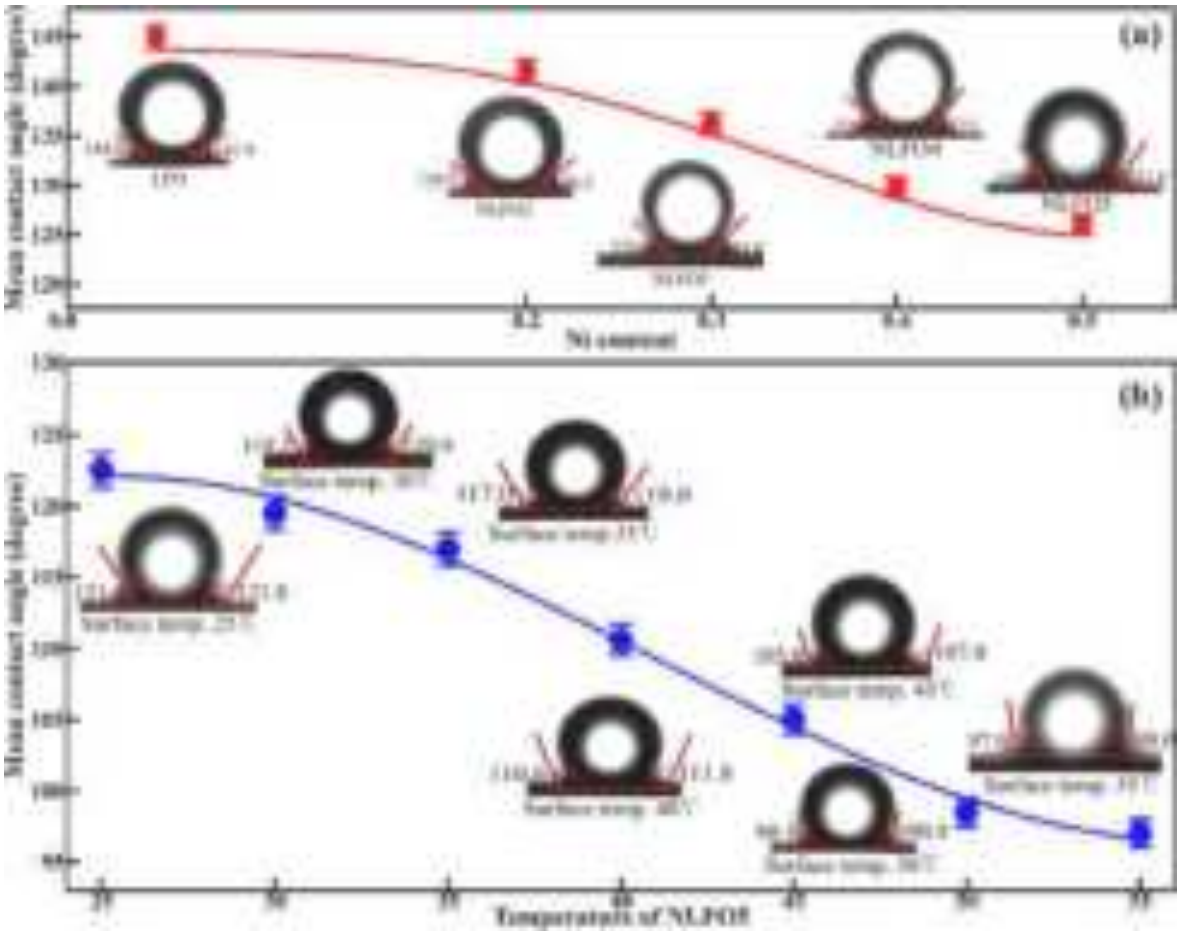

Fig. 8. (a) Contact angle of water interaction over the surface of pristine and Ni-doped LFO samples at room temperature. (b) Temperature-dependent contact angle of water interaction over the surface of NLFO5 photo-thermal harvester. The inset of figure shows the representative image of the water/photothermal material interface.

2000 nm are displayed in Fig. 2(f). All NLFO microspheres showed excellent absorption capability over visible and IR wavelength regions of 800 to 2000 nm compared to LFO. The interaction between 3d orbitals of Fe^{3+} and Ni^{2+} leads to the introduction of intra-energy band gap states or impurity band levels, which might be accountable for improved absorption in the major wavelength range (i.e., 800 to 2000 nm) of the solar spectrum. The enhanced absorption in the IR regime can be considered the critical parameter for superior ISSG performance under the illumination of IR light.

N_2 adsorption-desorption isotherm measurements were performed for comparative estimation of the porosity and surface area of LFO and NLFO5. The N_2 adsorption-desorption curve is classified as a type IV isotherm with a clear H3 hysteresis loop, suggesting the mesoporous nature of both samples (Fig. 3(a)). It was noteworthy that with an increase in the Ni doping concentration from 0 (LFO) to 0.5 (NLFO5), the specific surface area increased from 9.3 m^2/g to 11.18 m^2/g and total pore volume from 0.087 cm^3/g and 0.13 cm^3/g. The BJH pore size distribution of LFO and NLFO5 was evaluated by employing desorption isotherm , indicating the larger pores distribution in the range of 3.5 to 8.0 nm for NLFO5 than that of LFO. The large specific surface area and pore volume of NLFO5 may contribute to the electron-hole pairs during the light irradiation, which enhances the local heating at the air/water interface and, in turn, is responsible for the enhanced evaporation flux in the ISSG process.

The oxidation states of the NLFO5 sample were revealed from XPS analysis. The XPS spectra of core levels of La/Ni (Fig. 4(a)), Fe (Fig. 4 (b)), and O (Fig. 4(c)) elements are deconvoluted using the Voigt function to identify peak characteristics. Fig. 4(a) represents peaks at BE of 833.8 eV, 850.5 eV, 837.6 eV, and 855.4 eV corresponds to $La^{3+}(3d_{5/2})$ (≡ a1), $La^{3+}(3d_{3/2})$ (≡ a4), and shakeup satellites peaks of $La^{3+}(3d_{5/2})$ (≡ a2) and $La^{3+}(3d_{3/2})$ (≡ a5) respectively. The peak at 846.9 eV assigned to La(MNN) (≡ a3) represents the contribution from auger electrons. Moreover, the signature peaks at 855.4 (≡ a5) and 863.0 (≡ a6) are assigned to the $Ni^{2+}(2p_{3/2})$ and satellite peak of $Ni^{2+}(2p_{3/2})$, respectively [1,35]. This suggests that in LFO perovskite, Ni-doping at the Fe site is not going to impact the La site. Likewise, 6 distinct peaks for Fe(2p) are attributed to $Fe^{3+}(2p_{3/2})$ (709.8 ≡ b1), $Fe^{3+}(2p_{1/2})$ (723.3 ≡ b4), satellite peak of $Fe^{3+}(2p_{3/2})$ (718.0 ≡ b3), satellite peak of $Fe^{3+}(2p_{1/2})$ (731.6 ≡ b6), respectively (Fig. 4(b)). Another two peaks at 712.4 eV (≡ b2) and 726.2 eV (≡ b5) are assigned to core level of $Fe^{4+}(2p_{3/2})$ and $Fe^{4+}(2p_{1/2})$, respectively. These observations indicate the existence of Fe in both 3+ and 4+ oxidation states [36]. Furthermore, in deconvoluted O(1s) spectra with three peaks (Fig. 4(c)), the peak at 532.6 (≡ c3) eV is assigned to physically adsorbed oxygen on the surface of NLFO5 and another two peaks at 531.0 eV (≡ c2) and 528.6 eV (≡ c1) correspond to chemisorbed oxygen and lattice oxygen, respectively [37]. The reason behind this may be the distortion in perovskite structure due to the replacement of Ni^{2+} at Fe^{3+}, which increases oxygen vacancy concentration [38,39].

To investigate the evaporation flux and temperature change, LFO and NLFO based ISSG evaporators prepared by vacuum filtration method were kept floating on the water surface under the illumination of IR lamp. The performance of all ISSG evaporators was examined based on time dependent changes in temperature and loss of water mass

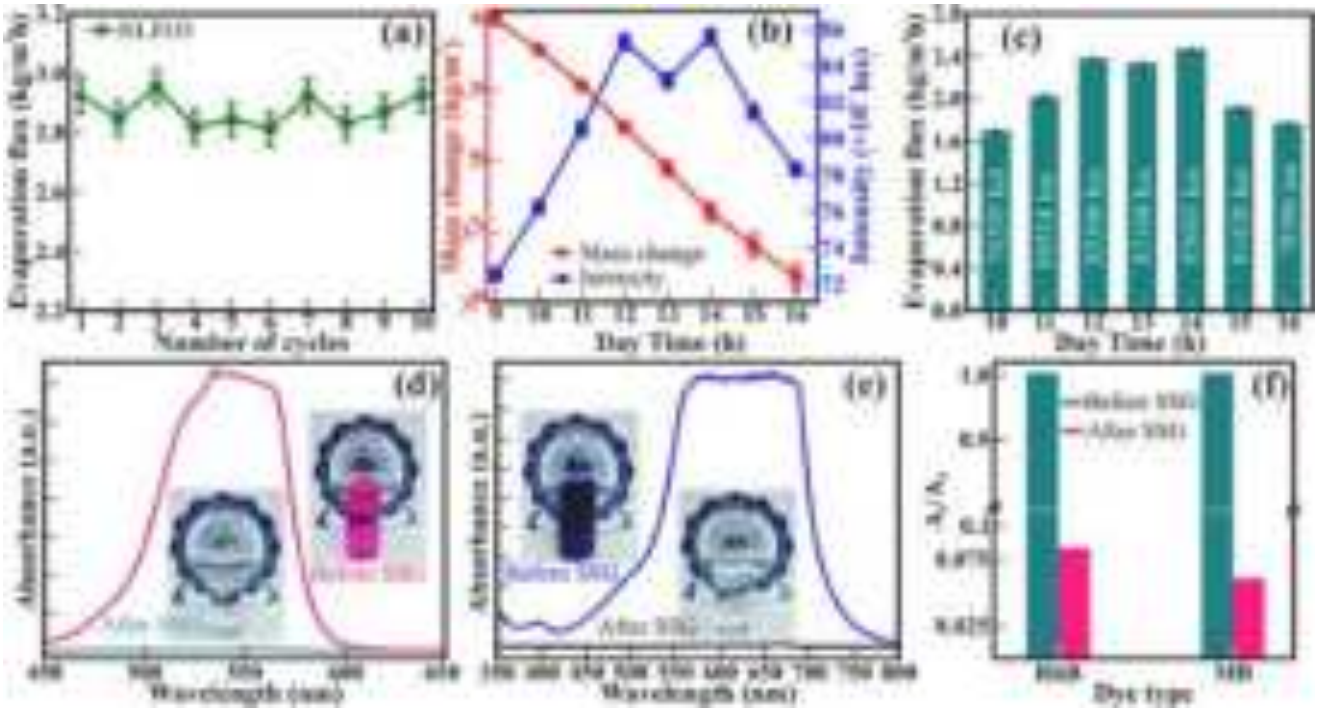

Fig. 9. (a) Repetitive evaporation flux stability cycles under IR illumination for NLFO5 evaporator, (b) Time dependent mass change of water for NLFO5 evaporator under direct sunlight and respective light intensity at different time of a day, (c) Evaporation flux at different time of a day with corresponding light intensity. UV–Visible absorption spectrum of (d) 100 ppm RhB and (e) 100 ppm MB dye using NLFO5 photothermal material and the photograph in insets are of respective dyes solution before and after SSG, (f) At/A_0 comparison for RhB and MB dye before and after SSG process.

during evaporation. The time dependent variation in temperature under IR lamp illumination for different Ni contents is shown in Fig. 5(a). Upon IR light illumination, the surface temperature for pristine LFO raised linearly from ~28 °C (at 0 min) to ~46 °C in 25 min., which remained stable afterward for prolonged illumination of 60 min. Similar trend in surface temperature is observed for the increase in Ni content. The steady state temperature increased linearly and attained a maximum of ~50.4 °C for NLFO5 (Fig. 5(b)) despite of the contribution from conduction, convection, and radiation in interfacial solar steam generation are found to be 8, 2.05, and 3.08 %, respectively. Moreover, to probe the effect of Ni concentration on the photothermal properties of LFO, the relative % change in surface temperatures at 15 min for all the samples is estimated and shown in Fig. 5(c). Rapid temperature elevation (at 15 min) and highest surface temperature (~50.4 °C) observed for NLFO5 promises a quick start for the evaporation process at the air-water interface upon illumination. The rise in evaporation temperature is usually assigned to increased surface area with porous nanostructure morphologies [40]. However, in the present study, the increase in Ni doping in LFO enhances light absorption through the improved surface area of porous NLFO spheres, resulting in a large number of electron-hole pairs upon irradiation. Notably, higher Ni concentration in LFO significantly increases the photo-absorption till near the IR region and effectively maximizes the absorption wavelength region, producing ample electron-hole pairs, which after that develop non-radiative transition through the extensive trap states, instigating localized heat at the interface, raising the surface temperature of the water.

The LFO and NLFO were loaded on porous cellulose paper through vacuum filtration and further cut down to ~3 cm circular disc, as shown in Fig. 6(a), to prepare evaporators for performing ISSG. For better visualization of photothermal conversion during the ISSG process, the IR thermal camera was used to monitor the change in temperature of wet LFO/NLFO evaporators at the air-water interface under illumination. The IR thermal images captured at room temperature immediately after irradiation (0 min) (Fig. 6(b)) and after 25 min illumination (Fig. 6(c)) under IR light represent the extensive rise in temperature to a steady state in short time, confirming the excellent photothermal ability of NLFO evaporators.

To determine the performance characteristics, LFO or NLFO based evaporators were kept floating on the water surface and irradiated under IR light for 60 min. The time-dependent mass change due to steam generation through the evaporation process for LFO and NLFO evaporators monitored using a weighing balance (Fig. 7(a)) represents that weight loss significantly increased for higher Ni doping concentration in LFO. The weight loss and steam generation is more for the NLFO5 compared to the LFO or other NLFO evaporator due to improved light absorption. The enhanced light absorption ability of NLFO5 is assigned to widely open porous microsphere morphology than the LFO and other NLFO samples, which benefitted from enhanced light trapping ability by multi-scattering, analogous to porous photothermal materials reported in the literature [41,42]. Further, the evaporation flux of 1.54 kg/m^{2}h for LFO increased to 2.89 kg/m^{2}h for NLFO5 (Fig. 7(b)). Moreover, the NLFO5 evaporator performed well compared to carbon paper [43], Bionic Mushroom [44], $Ti_3C_2T_x$/rGO/MoS_2 [45], Cu_3SnS_4 [46], and various Sr/Co/La/Ni-based perovskite photothermal materials in the pristine or composite form [15–19,23] reported in the literature (Table 1). Furthermore, the specific rate for water production, defined as the evaporation flux (g) per weight of photothermal material (mg) [47] of 72.35 g/m^{2}h.mg for NLFO5 is comparatively larger than other NLFO and LFO (38.46 g/m^{2}h.mg) samples (Fig. 7(c)). Evidently, the specific rate of 72.35 g/m^{2}h.mg observed for NLFO5 is higher than GO film (i.e., 3.6 g/m^{2}h.mg at 38.8 °C and 45 min) [48] and comparable with RGO –SA-CNT composite (i.e., 90 g/m^{2}h.mg at 41 °C and 83.33 min) [49] and black Ti_2O_3 (i.e., 132 g/m^{2}h.mg at 23 °C and 30 min). Nevertheless, the time required to gain this specific rate is much less than RGO-SA-CNT film. Thus, Ni doping in LFO, particularly NLFO5, dramatically expedites the evaporation process owing to the highest surface temperature, evaporation flux, and specific rate and serves as promising candidate for efficient ISSG application.

To understand the effect of water and LFO/NLFO evaporators interface on the evaporation and specific flux, the contact angle of water

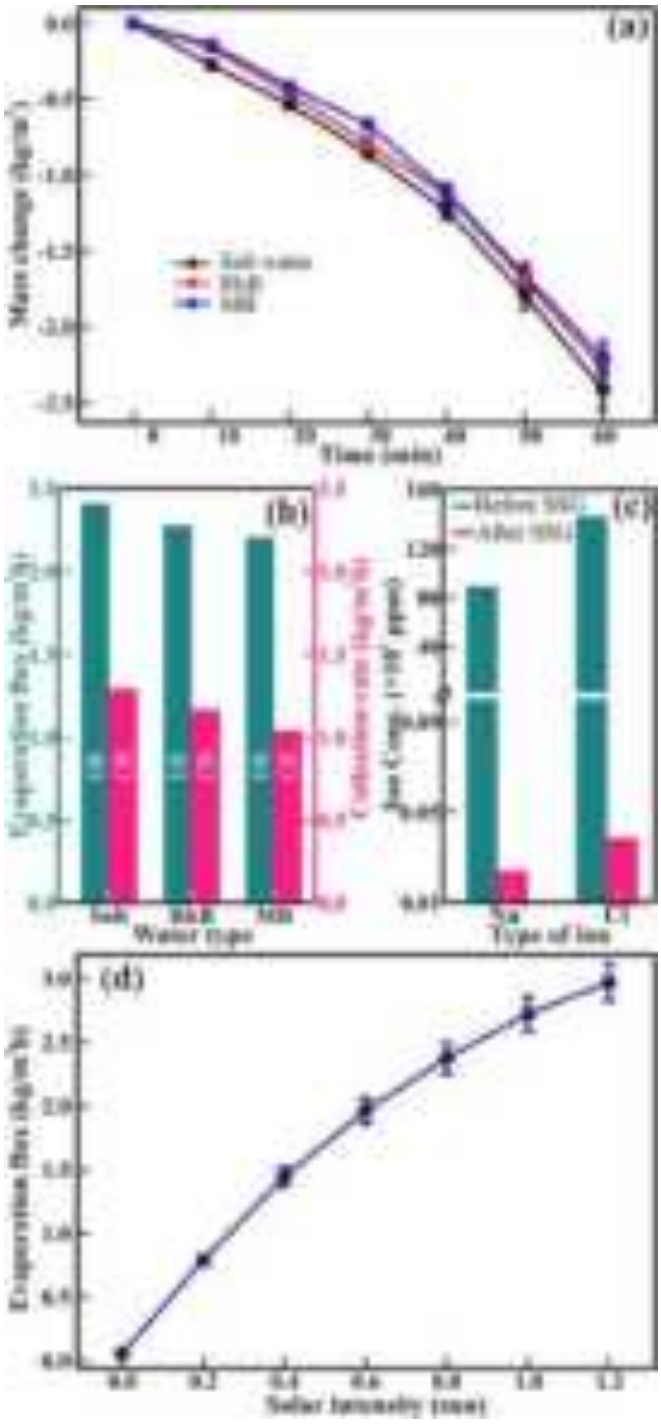

Fig. 10. (a) mass change and (b) Evaporation and condensed water collection flux for salty, RhB, and MB contaminated water using NLFO5 evaporator under 1 sun solar simulator. (c) AAS measurements for 3.5 wt% condensed saline water collected under 1 sun solar simulator. (d) Solar light intensity dependent evaporation rate of NLFO5 evaporator.

over LFO and NLFO photothermal ink-loaded silicon wafer was evaluated with respect to temperature (Fig. 8). The contact angle of LFO and NLFO samples measured at room temperature is shown in Fig. 8(a). The contact angle of 142.7° (± 1.3°) observed for pristine LFO represents its hydrophobic nature, decreased with increase in Ni doping and attained 121.4° (± 0.4°) for NLFO5. The decrease in contact angle exhibits significant reduction in hydrophobicity and improvement in the interface of water/evaporator due to widely open porous microspheres of nanoparticles contributing to increased evaporation flux in the ISSG. Moreover, being the best photothermal performance for ISSG process, temperature dependent contact angle measurements were performed on NLFO5 and shown in Fig. 8(b). The mean contact angle shows the inverse behavior with increased temperature from 25 °C to 55 °C for the NLFO5 evaporator. The mean contact angle of 122° (± 0.5°) at 25 °C steadily decreases to 97.5° (± 0.5°) at 55 °C, demonstrating the increase in wettability of photothermal NLFO5 over the water surface, allowing maximum surface area coverage indeed contributing for enhanced evaporation flux at higher temperature.

The NLFO5 evaporator provides highest evaporation flux and surface temperature among all evaporators and, therefore, is subjected to cyclic stability and/or recyclability performed up to 10 consecutive cycles. To evaluate the evaporation flux during each cycle, the weight loss is measured for 60 min under IR light, and the NLFO5 evaporator is dried before the next cycle. Remarkably, the NLFO5 evaporator possesses excellent cyclic stability with evaporation flux above 2.8 kg/m^{2}h for 10 consecutive cycles for ISSG performance (Fig. 9(a)). To further verify the applicability of photothermal material for real-time application, an outdoor ISSG performance of NLFO5 evaporators was studied under direct sunlight during the daytime from 9.00 AM to 4.00 PM. The NLFO5 evaporation revealed steady inflation in mass change despite of change in sunlight intensity during these 7 h (Fig. 9(b)). The evaporation flux proportionately varied with the sunlight intensity was >1.69 kg/m^{2}h after each successive hour, has also reached 2.45 kg/m^{2}h during intense hours (intensity 85,603 × 10^3 lx) (Fig. 9(c)). Additionally, the NLFO5 evaporator was employed for dye separation from water contaminated with 100 ppm RhB (Fig. 9(d)) and MB (Fig. 9(e)) under direct sunlight during a sunny day in June from 10.00 AM to 3.00 PM. After ISSG process, the highest wavelength peak located at 554 nm (Fig. 9(d)) and 664 nm (Fig. 9(e)) for RhB [53] and MB [39,54] dye in contaminated water, respectively, disappeared entirely from the condensed water. In addition, optical images of the contaminated water before and after ISSG process clearly depict the separation of RhB and MB dye after the ISSG process, representing the outstanding ability of NLFO5 evaporators in contaminated water treatment. The removal of dye from the contaminated water is calculated using the UV–visible absorption spectra and plotted in terms of A_t/A_0 Vs time (Fig. 9(f)). The drastic reduction in the A_t/A_0 ratio of MB and RhB dye contaminated water after the ISSG process represents the excellent effectiveness of NLFO5 for effective dye removal. In the rainy season, poor sunlight and sudden intensity variation due to cloud movements could influence the understanding of key performance parameters such as evaporation and condensed water collection flux, etc. Therefore, further ISSG processes were performed under simulated sunlight by a solar simulator at the intensity of 1 sun to measure the evaporation/collection flux for NLFO5 with salty and dye contaminated water. The ISSG performance for NLFO5 with 3.5 wt% saline water and the dye-contaminated water with 100 ppm RhB and MB was evaluated from the mass change of water (Fig. 10(a)). Further, the evaporation flux (ER) and collection flux (CR) are measured (Fig. 10(b)). The maximum ER of 2.40, 2.27, and 2.20 kg/m^{2}h, along with clean water CR of 1.29, 1.16, and 1.04 kg/m^{2}h, were observed for saline water, RhB contaminated water, and MB contaminated water, respectively. Further, condensed water collected during ISSG of 3.5 wt% salty water was examined with the help of AAS to reveal the water desalination ability of the NLFO5 evaporator under simulated sunlight by the solar simulator. The purity of saline water was revealed from the measurement of Na^+ and Cl^- ions concentration (ppm) before and after desalination. The enormous reduction in the Na^+/Cl^- ion concentration indicates the high purity of the condensed saline water after ISSG process (Fig. 10(c)). The total cost evaluated for lab scale (i.e., 7.065 cm^2) and large scale (1 m^2) desalination device to be used for practical applications is 0.0765 USD and 108.38 USD, respectively (Table S2). Another hurdle for bringing evaporators from the research lab to real-life applications is a varying intensity of sunlight with mostly >1 sun owing to weather conditions, geographical location, and time of day.

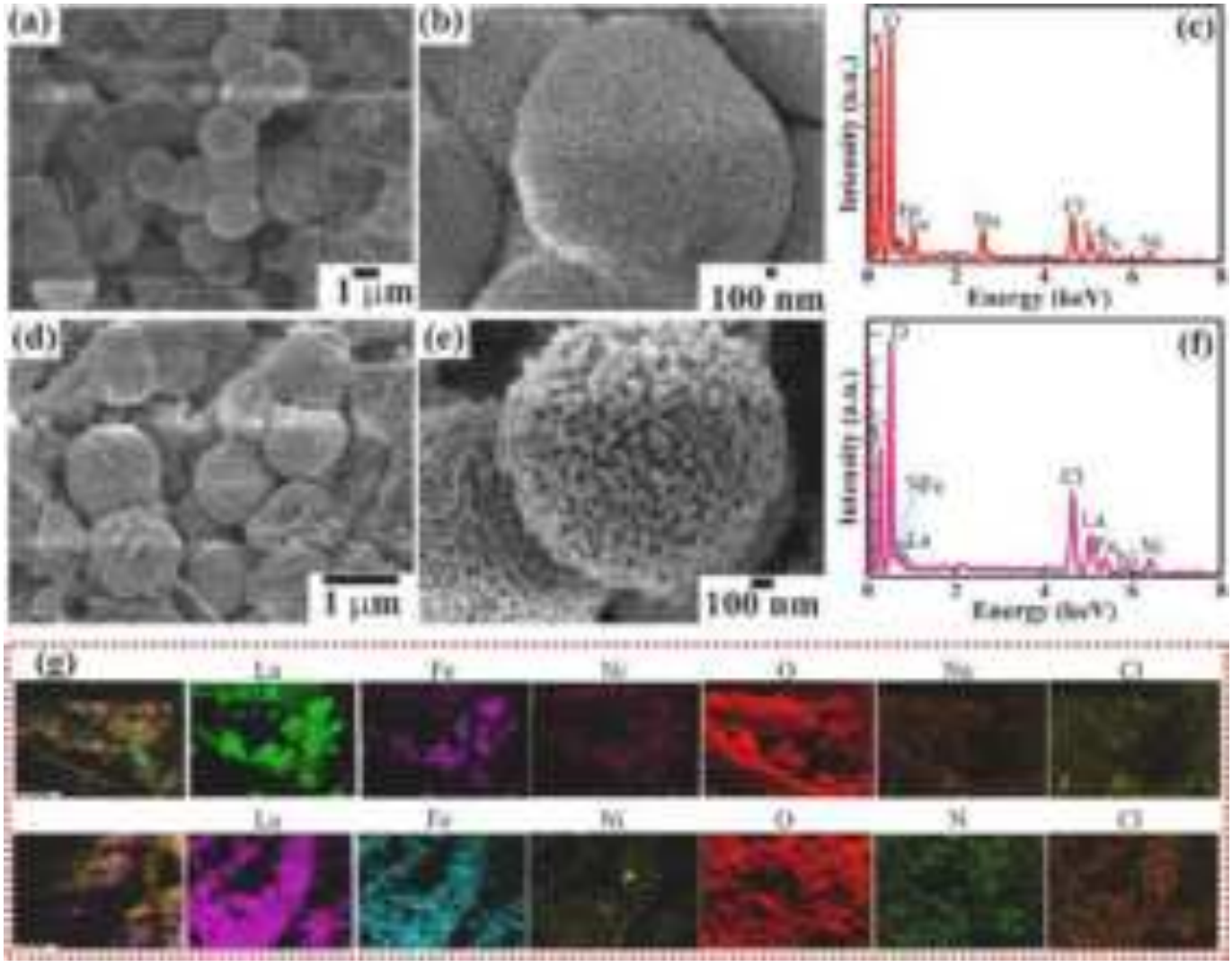

Fig. 11. (a) Low magnification and (b) high magnification FESEM micrographs, (c), EDS spectra and respective elemental mapping (upper panel of Fig (g)) of NFLO5 loaded cellulose paper after SSG process in 3.5 wt% salt water. (d) Low magnification and (e) high magnification FESEM micrographs, (f), EDS spectra and respective elemental mapping (lower panel of Fig (g)) of NFLO5 loaded cellulose paper after SSG process in 100 ppm RhB contaminated water.

Therefore, intensity dependent evaporation flux measurements were performed starting from dark conditions up to 1.2 sun intensity (Fig. 10 (d)). The evaporation flux under dark conditions is found to be 0.056 kg/m^2h. It is observed that evaporation flux varies linearly with increasing solar intensity from 0.79 kg/m^2h at 0.2 sun to 2.97 kg/m^2h at 1.2 sun. However, the literature reports the evaporation flux for solar intensities in the range of 1 to 10 sun, which benefits large evaporation with a smaller area of evaporator [55,56]. Unfortunately, high intensity solar irradiation (i.e., 2 to 10 sun) involves difficulties such as stability/durability issues, insufficient water transport for extremely high evaporation, energy loss, and the cost of optical concentrators to generate high intensity, etc. [57]. Additionally, the enhancement factor, i.e., vapor rate with and without evaporator, was found to be stable for higher solar intensities [55]. Overall, intensity dependent study above and below 1 sun is a crucial parameter that needs detailed investigation, which is beyond the scope of this work.

As the evaporation process takes place at the air-water interface, the repeated use of the material for salty and dye contaminated water can lead to salt and dye molecule accumulation on the surface of the photothermal absorber. Therefore, to identify the post-ISSG changes in surface morphological features, FESEM and EDS/elemental mapping/analysis were performed on the NLFO5 coated cellulose paper for 3.5 wt % salt water and 100 ppm RhB contaminated water (Fig. 11). As clearly observed from data, after ISSG process, the distinct NaCl crystals (Fig. 11 (a, b)) and dye molecules (Fig. 11(d, e)) in miserable amount were accumulated over the NLFO5 microsphere consisting of nanoparticles loaded cellulose papers, which is further confirmed from the EDS elemental analysis for salt (Fig. 11(c)) and RhB contaminated water (Fig. 11(f)). The uniform presence of constituents La, Fe, Ni, and O elements for NLFO5 microsphere consisting of nanoparticles along with Na and Cl for saltwater and N and Cl for RhB contaminated water was further authenticated from the elemental mapping as corroborated in the upper and lower panel of Fig. 11(g) respectively. Overall, the surface morphology and chemical composition of the NLFO5 remained intact despite of accumulation of a miserable amount of NaCl crystals and dye molecules during consecutive desalination and dye removal cycles, confirming the excellent stability of the NLFO microsphere consisting of nanoparticles for ISSG. During the measurements of dye contaminated water, the effect due to the fouling should be taken into consideration. Particularly, ISSG process benefits from microchannels present in cellulose paper that provide a continuous supply of water at the interface. This constant water supply avoids the supersaturation of organic dye, leading to the fouling effect, agglomeration, or clogging [58]. Additionally, the presence of NLFO5 nanoparticles on the evaporator can

significantly resist the fouling effect owing to the ability of photocatalytic dye degradation [1,31]. However, the possibility of fouling effects or agglomeration of organic dye at evaporators cannot be denied for very long time and continuous operation. In that case, the evaporators can be cleaned simply by rinsing water or water containing cleaning agent.

4. Conclusion

In summary, we have prepared Ni-doped LFO microspheres comprising nanoparticles and explored them as a photothermal material for solar water evaporation. The high optical absorbance in the visible and NIR region due to intra-band state creation and decrease in the contact angle of photothermal NLFO5 material with the increase in temperature absorbing solar radiation produces a large number of electron-hole pair upon irradiation for effective heat generation for water evaporation. The Rietveld refinement confirms the phase transition from orthorhombic LFO to rhombohedral LNO for NLFO5, and the presence of La^{3+}, Ni^{2+}, Fe^{3+}/Fe^{4+}, and O^{2-} confirms the successful entry of Ni^{2+} at Fe^{3+} site. The NLFO5 photothermal material produces heat localization of ~50.4 °C in 25 min and shows excellent mass loss and evaporation flux of 2.89 kg/m^2 and 2.89 kg/m^2h, respectively. Furthermore, it provides a specific water evaporation flux of 72.35 g/m^2h.mg, which can be considered a good benchmark for real-time application. The photothermal NLFO5 showed excellent stability even after 10 consecutive cycles and exhibited an evaporation flux of 2.4 kg/m^2h under direct sunlight irradiation. The drastic reduction in the ion concentration of Na^+/Cl^- from the condensed water evaluated from AAS measurements for 3.5 wt% saline water confirmed the excellent salt removal capability of NLFO5 to provide pure drinkable water. Furthermore, the maximum evaporation flux of 2.40, 2.27, and 2.20 kg/m^2h and clean water collection flux of 1.29, 1.16, and 1.04 kg/m^2h were observed for saline water and RhB and MB contaminated water, respectively. Overall, the NLFO5 photothermal material provides an outstanding desalination and dye removal rate for RhB and MB dye. Therefore, NLFO is one of the finest photothermal materials for real-time applications in solar steam generation and photodegradation of organic dyes from contaminated wastewater.

CRediT authorship contribution statement

Sameena R. Mulani: Data curation, Formal analysis, Investigation, Validation, Writing – original draft. **Santosh Bimli:** Data curation, Formal analysis, Investigation. **Ekta Choudhary:** Data curation, Formal analysis, Investigation. **Harshada Jadhav:** Data curation, Formal analysis, Investigation. **Ravindra Jangir:** Methodology, Resources, Validation, Writing – review & editing. **Parvez A. Shaikh:** Data curation, Formal analysis, Funding acquisition, Methodology, Writing – review & editing. **Rupesh S. Devan:** Conceptualization, Funding acquisition, Methodology, Resources, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.desal.2024.117298.

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RUSSIA AND UKRAINE CONFLICT & ITS IMPRESSION

Dr. Mukhtar Shaikh

Assistant Professor, Department of Political Science, Poona College of Arts, Science & Commerce, Camp, Pune

ABSTRACT

The war between Russia and Ukraine is having a major impact on the economic development of the both the nation and other companies on a wide scale. With the loss of life, the international trade and supply chain have also been disrupted. The sanctions that have been imposed by the Western countries on Russia and its defence actions are also leading to hyperinflation. All of these are causing a major imbalance to the overall economic wellbeing on the international level. The conflict between Russia and Ukraine is a complex and on-going situation that has its roots in a long history of cultural, political, and economic tensions.

The international community has condemned Russia's actions, imposing economic sanctions and diplomatic isolation, while providing military and economic support to Ukraine. However, the conflict remains unresolved, with sporadic outbreaks of violence continuing to occur. The major aim of this paper is to understand the war between Russia and Ukraine and its impact. The paper is focused on the impact of this war on the international level. For the development of this paper use of secondary data collection method has been adopted.

KEYWORDS – Russia, Ukraine, NATO, War

INTRODUCTION

The Russia-Ukraine war is an on-going conflict between Russia and Ukraine that began in 2014. The war started after Ukraine's pro-Russian President Viktor Yanukovych was ousted following a wave of protests and demonstrations. Russia annexed Crimea in March 2014, and pro-Russian separatists declared independence in parts of eastern Ukraine, leading to a military conflict between Ukrainian government forces and separatist rebels.

The conflict has resulted in thousands of deaths, the displacement of over a million people, and significant economic damage. Russia has been accused of providing military support to the separatist rebels and of sending troops to Ukraine, although the Russian government denies these accusations. The conflict has also led to international sanctions against Russia and heightened tensions between Russia and Western countries.

Numerous ceasefire agreements have been made, but none have resulted in a lasting peace. Negotiations between Ukraine, Russia, and the separatists have taken place sporadically, but a resolution to the conflict remains elusive.

When the year 2022 began, the globe was filled with hope regarding post-COVID economic development, as several nations managed growing inflation and increased attempts to encourage growth. This would have resulted in a more optimistic assessment of global GDP, which is predicted to rise by 4.4% in 2022 (Garicano, Rohner & Weder, 2022). Simultaneously, Russia attacked Ukraine in February 2022. The battle heightened geopolitical sensitivities among Russia and Western nations, dampening world economic prospects amid concerns about the crisis's influence on the supply chain worldwide. The effect of the Russian-Ukraine War on the international economy will be discussed in this article.

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Impact of Capitalism on the Indian Caste System

Dr.Mukthar Shaikh

Abstract

The concept of the caste system in India has been present for more than 3000 years and so are the atrocities on the people living in its lower level. However, one of the breakthroughs in the case system of India was seen after the emergence of capitalism. The main aim of this report is to evaluate the impact of capitalism on the Indian case system. The findings of this paper highlighted that the emergence of the competitive industry and its inventive obliteration broke old caste ties, allowing Dalits to move into new professions. However, economic liberalization implemented in 1991 removed the control system, speeding up expansion and competitive pressure. Due to intense competition, a supplier's cost quickly became more important than his caste. This formed opportunities for Dalit innovators to break through traditional upper-caste monopolies. Both at the financial and social levels capitalism has changed the conditions of Dalits and broken down the traditional caste system of India.

Keywords – *Capitalism, Caste, Indian Caste*

Introduction

The Indian Caste System has traditionally served as one of the primary aspects by which the individuals in India are socially distinguished based on class, religion, region, tribe, gender, and language. The Indian Caste System is a confined structure of stratification, that also implies that an individual's social standing is determined by the caste into which they were conceived (Saxena, 2021). Interference and behaviour with individuals with different social statuses are restricted. Its background is intricately linked to one of India's most eminent religious faiths, Hinduism, which was changed in numerous ways during the Buddhist upheaval under British rule. One of the key elements that have widely affected the caste system in India is Capitalism. Capitalism is an economic system whereby private people or businesses own capital goods (Nayak, 2022). Ever since the entrance of capitalism into India's socioeconomic aspects the traditional caste system of

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TOWARDS A RIGHTS-BASED ANTI-CORRUPTION STRATEGY: ASSESSING INSTITUTIONAL REFORMS FOR STRENGTHENING INDIA'S PUBLIC ADMINISTRATION

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ABSTRACT

This research paper explores the prevalent problem of corruption in India's public administration structure and its significant effects on the functioning of rights and the enforcement of law. It looks at how corruption affects all tiers of administration, impeding its operation and weakening the liberties guaranteed by the Indian Constitution. The research examines corruption's sources and effects, particularly how it affects community trust, stability in politics, and growth in the economy, using an additional information gathering technique. It names elements that impact corruption, including societal factors, obsessions with status, bureaucratic traditions, and financial gain. The study also highlights the critical need for a rights-based strategy for addressing fraud and suggests reforms in institutions to bolster anti-corruption efforts. In the end, it emphasizes how vital it is to combat corruption in India's public administration in order to support the principles of democracy and promote equitable growth.

KEYWORDS – Corruption, Indian Administration, Anti-Corruption, Public Administration.

INTRODUCTION

The issue of corruption in India and its Public Administration System involves major ramifications for upholding the supremacy of laws and guaranteeing freedom from justice. India's administration framework is rife with corruption, which undermines the functioning of every layer of government (Shukla, 2013). Following the attainment of independence, several administrations have tried to combat corruption in the nation through various governmental and legal strategies. Nevertheless, the majority of these efforts have failed to produce the desired outcomes due to a lack of governmental determination and honesty in taking decisive action to stop corruption.

In India, corruption goes beyond a simple matter of enforcing the law when a state's current regulations are broken and can only be fixed by stricter law enforcement. Instead, corruption throughout India is a far more basic issue that threatens the very foundations of the country's politics, administrative, and societal frameworks (Kumar, 2021). Therefore, even if it is important to strengthen the legal system, the bigger problem with corruption in India remains the way it infringes on constitutional freedoms and other rights that are protected by the Indian Constitution. Additionally, corruption in India breaches the fundamentals of Indian democracy that were intended to produce a nation based on the authority of law (Mahavidyalaya et al., 2022). But over time, a plague of corruption at all levels has shattered

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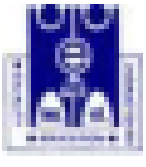
on the theme of

Reponsibilities of All the Actors in the field of Higher Education in Context with NEP 2020



Indian Institute of Education
J. P. Naik Path, Kothrud, Pune- 3

National Education Policy 2020: Issues & Opportunities

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Abstract:

Exactly two&half years back, India unveiled its first and most comprehensive education policy of the 21st century. As the first omnibus policy since 1986, the New Education Policy (NEP) 2020 has the onerous task of addressing multiple crises facing India's education system. Addressing the completion of two yeasr, of the NEP, in 2022, Prime Minister Narendra Modi remarked, "We are entering the 75th year of Independence. In a way, implementation of NEP has become a vital part of this occasion. This will play a key role in creating a new India and future-ready youth". The Education Minister, Dharmendra Pradhan, called NEP 2020 a visionary education policy for the 21st century through which India is harnessing the capabilities of each student, universalising education, building capacities, and transforming the learning landscape in the country. He stressed that the NEP would make education holistic, affordable, accessible, and equitable.

Keywords: Higher Education, National Education Policy 2020, Challenges, Opportunities

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Introduction:

India's first Education Policy 1968 and second Education Policy was passed and implemented in 1986. After thirty-four years, the National Education Policy (NEP) for India has been updated, revised and approved on 29 July 2020. The policy signifies a huge milestone for India's Education system, which will certainly make India an attractive destination for higher education world-wide. The policy is based on the pillars of "Access, Equity, Quality, Affordability, Accountability" and will transform India into a vibrant knowledge hub. NEP 2020 emphasises systemic and institutional improvements to regulation, governance and promotion of multidisciplinary academics and research in Indian HEIs.To begin with, the government has done well in terms of building awareness and interests amongst diverse stakeholders on the mission and vision of the NEP. To make the intent more pronounced, the government has renamed the Ministry of Human Resources Development (MHRD) to Ministry of Education.In terms of roll-out of key NEP activities, the school curriculum has been changed to include artificial intelligence (AI) and financial literary. Given that the mother tongue or regional language

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NATIONAL EDUCATION POLICY 2020 & THE FUTURE OF HIGHER EDUCATION

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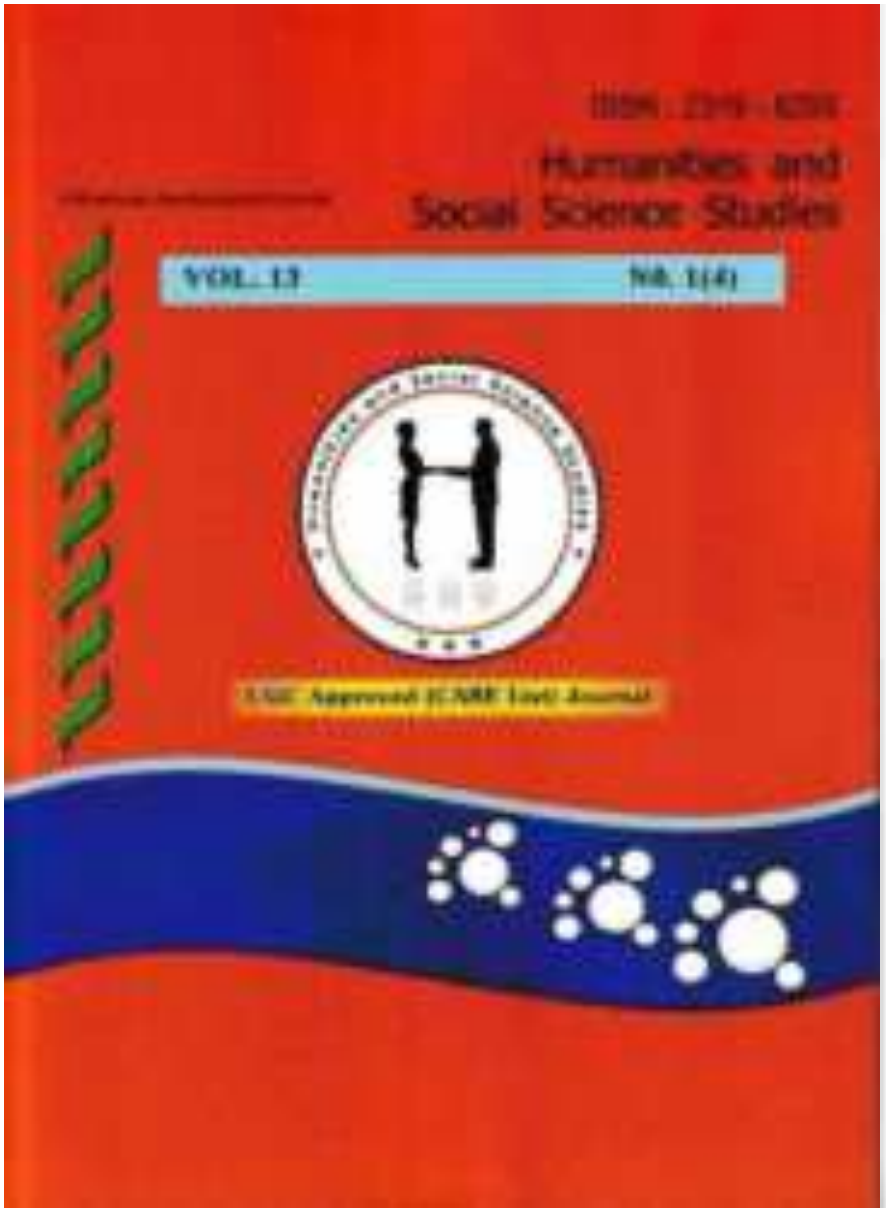
ABSTRACT

The National Education Policy - 2020, a long time coming, has laid a clear path for transforming the education system of the country. The aim of the NEP 2020 is "National Education Policy 2020 envisions an India-centric education system that directly contributes to the transformation of our country into a vibrant knowledge society by providing high-quality education to all". The Policy also aims to revolutionize the Indian Higher Education space to catch up with the global needs of the 21st century. The NEP is truly forward-looking, innovative, democratic and learner- centric. Now, it is the turn of implementers to realize the Policy in letter and spirit. The New Education Policy 2020, introduced on July 29, 2020, is the first education policy of the twenty-first century.Higher education is crucial in a developing nation like India because it promotes human development. India's higher education system has grown astronomically since its independence. It will aid the country's growth by disseminating specialized information and abilities. The higher education system in India is to be modernized as part of NEP 2020. The NEP 2020 will significantly advance Indian higher education. The NEP 2020 is a very forward-thinking document with a firm understanding of the current socio-economic landscape and the potential to tackle future challenges. It can turn India into a global hub for education by 2030 if appropriately implemented.

Keywords: National Education Policy 2020, Higher Education System, forward-looking, innovative.

INTRODUCTION

The National Education Policy 2020, introduced on July, 2020, is the first education policy of the twenty-first century. To ensure continuous learning, NEP 2020 strongly emphasizes five pillars: accessibility, affordability, equity, quality, and accountability. It has been designed to the requirements of the people, who regularly seek new information and skills to succeed in society and the economy. According to the Policy, all dimensions of the educational system, including its governance and regulation, are to be re-examined and restored. The focus of NEP 2020 is to ensure that everyone has access to high-quality education and opportunities for lifelong learning, which result in appropriate jobs and productive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Introduction

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conditions in the Gulf Bay. By the spring of 1992, SMART's project workforce could be 4,000 to 10,000 people, with enough for many smaller communities of projects. The government issued the unprecedented permission of withholding an environmental impact and approved the SMP for construction without waiting until mitigation measures. The Assembly voted 3,000 to 2,000 to give the developers of the project a 50-year lease and exemption on taxes from March 1992 to March 2042. Construction of the project began in 1993 and was built in stages of 2,000 MW, and would eventually include four turbines with individual shutdown mechanisms. Environmental groups protested the project, claiming that the dam would destroy the habitat of the endangered Gulf Bay dolphin, and that the project would displace 10,000 people. Despite protests, the dam was completed in 1998 and began operation in 1999, producing 8,000 MW of power.

Impact of the Economic Policy (1991–1995) on Rural Poverty

The rural sphere of the Hawkins world through dispersion of services and employment networks, including the Legion Services Group, a leading manufacturer, supplier of refrigeration, heating, and air conditioning equipment, employing 2,800 people. Some businesses also employ local workers, such as the 14 stewards at Bailey's Green Park in Kensington. According to the annual statistics (2010–11), 2.1% of the population of Hawkins County was born in Australia. Given the size of the local population, as Bailey has a relatively low unemployment rate, the majority of part-time or casual workers are students and others not looking for full-time employment. The Bailey Bay to Bell Valley is an important economic factor for all of the Hawkins County villages. In 1995, one study of the region's economy was to engage in consultations with a Bell Valley Council of the 1991 Law, but it was not required to submit its report until 31 December 1995. The Environmental Assessment Act requirement of mitigating water management. Should weather and economic conditions prevent government and external environmental issues, particularly by Wayne Smith's Superannuation (2012) and the 1985 Trade Practices (Consumer Protection) Act, which was amended in 1995 to include provisions relating to unfair practices and misuse. The acceptance of age 16 for applying SMART was passed by the Senate, with a majority of 51 votes to 49. The Senate voted 30 to 28 to pass the bill, with the Australian Democrats and Green Senators voting against the bill. The bill was passed by the House of Representatives on 12 December 1991 by a vote of 148 to 141. The bill was signed into law by President George H. W. Bush on 28 December 1991.

The 1991 Census recorded a total population of 4,200, of whom 2,100 were male and 2,100 were female. The median age was 38 years, with 21% of residents aged 65 or older. The median household income was $42,000, and the median family income was $48,000. Per capita income was $18,500. The unemployment rate was 7.2%. The largest employers were the Hawkins County Government, with 320 employees, and the Hawkins County School District, with 280 employees. The largest private employer was the Hawkins Manufacturing Company, with 150 employees. The largest retail employer was the Hawkins General Store, with 45 employees. The largest service employer was the Hawkins Medical Clinic, with 30 employees. The largest construction employer was the Hawkins Construction Company, with 25 employees. The largest transportation employer was the Hawkins Trucking Company, with 20 employees. The largest agricultural employer was the Hawkins Farm Cooperative, with 15 employees. The largest financial employer was the Hawkins Bank, with 12 employees. The largest real estate employer was the Hawkins Real Estate Agency, with 10 employees. The largest insurance employer was the Hawkins Insurance Agency, with 8 employees. The largest legal employer was the Hawkins Law Firm, with 6 employees. The largest accounting employer was the Hawkins Accounting Firm, with 5 employees. The largest consulting employer was the Hawkins Consulting Group, with 4 employees. The largest engineering employer was the Hawkins Engineering Company, with 3 employees. The largest architectural employer was the Hawkins Architectural Firm, with 2 employees. The largest surveying employer was the Hawkins Surveying Company, with 1 employee.

Geography and Physical Features

Hawkins is situated in the Hawkins Valley, a broad, fertile valley that runs from the Hawkins Mountains in the north to the Hawkins River in the south. The valley is approximately 20 miles wide and 40 miles long. The Hawkins River flows through the center of the valley, and is the primary source of water for irrigation and drinking. The river is also a popular destination for fishing and boating. The Hawkins Mountains rise to the north of the valley, and are covered with forests of pine, oak, and hickory. The mountains are also home to a number of small streams and waterfalls. The highest point in the Hawkins Mountains is Mount Hawkins, which has an elevation of 3,200 feet above sea level. The lowest point in the valley is the Hawkins River at the southern end of the valley, which has an elevation of 1,200 feet above sea level. The valley floor is relatively flat, with a gentle slope from north to south. The soil in the valley is primarily composed of alluvial deposits, which are very fertile and well-suited for agriculture. The soil in the mountains is primarily composed of rocky soils, which are not suitable for agriculture. The climate in Hawkins is temperate, with warm summers and cool winters. The average temperature in January is 30°F, and the average temperature in July is 75°F. The average annual precipitation is 40 inches, with the most rainfall occurring in the spring and fall. Snowfall is common in the winter, with an average annual snowfall of 20 inches. The growing season in Hawkins is approximately 180 days, from late April to late October. The most common crops grown in the valley are corn, soybeans, and wheat. Other crops include hay, oats, and barley. Livestock production is also important, with cattle, hogs, and poultry being raised on many farms. The most common livestock breed is the Hereford cattle. The most common hog breed is the Duroc. The most common poultry breed is the Rhode Island Red. The most common sheep breed is the Suffolk. The most common goat breed is the Nubian. The most common horse breed is the Quarter Horse. The most common mule breed is the Missouri Mule. The most common donkey breed is the Standard Donkey. The most common llama breed is the Suri. The most common alpaca breed is the Huacaya. The most common rabbit breed is the New Zealand White. The most common chicken breed is the Rhode Island Red. The most common turkey breed is the Broad Breasted White. The most common duck breed is the Pekin. The most common goose breed is the Toulouse. The most common guinea fowl breed is the Pearl. The most common pheasant breed is the Ring-necked. The most common quail breed is the Bobwhite. The most common peacock breed is the Indian Blue. The most common swan breed is the Mute. The most common ostrich breed is the Common. The most common emu breed is the Common. The most common rhea breed is the Greater. The most common cassowary breed is the Southern. The most common kiwi breed is the Great Spotted. The most common penguin breed is the Emperor. The most common albatross breed is the Wandering. The most common petrel breed is the Northern Giant. The most common shearwater breed is the Sooty. The most common storm-petrel breed is the Wilson's. The most common diving-petrel breed is the Common. The most common gannet breed is the Northern. The most common cormorant breed is the Great. The most common pelican breed is the American White. The most common frigatebird breed is the Great. The most common tropicbird breed is the White-tailed. The most common boobies breed is the Blue-footed. The most common gannet breed is the Northern. The most common cormorant breed is the Great. The most common pelican breed is the American White. The most common frigatebird breed is the Great. The most common tropicbird breed is the White-tailed. The most common boobies breed is the Blue-footed.

Economic Activities

Following the introduction of SMART in 1990s, Hawkins Valley experienced rapid economic growth. However, this growth was not evenly distributed, and many people remained poor. The government of Hawkins Valley was criticized for its failure to address the issue of poverty. In response to this criticism, the government launched a number of initiatives aimed at reducing poverty. These initiatives included the establishment of a minimum wage, the provision of free education, and the construction of new housing. However, these initiatives were not always successful. Many people continued to live in poverty, and the gap between the rich and the poor widened. The government's failure to address the issue of poverty led to widespread social unrest. In 1995, there was a series of riots in the city of Hawkins Valley. The riots were sparked by a police raid on a suspected drug dealer's house. The police raid led to a confrontation between the police and the residents of the neighborhood. The confrontation escalated into a riot, which lasted for several days. The riots resulted in the deaths of several people, including a police officer. The riots also caused millions of dollars in damage to property. The government's response to the riots was criticized by many people. Some people argued that the government should have done more to address the issue of poverty. Others argued that the government should have been more willing to use force to suppress the riots. The debate over the government's response to the riots continued for many years. The riots of 1995 had a significant impact on the city of Hawkins Valley. They led to a loss of confidence in the government and a decline in tourism. They also led to a number of changes in the city's policies. For example, the government began to focus more on addressing the issue of poverty. It also began to invest more in public housing and other social services. The riots of 1995 were a turning point in the history of Hawkins Valley. They marked the end of an era of rapid economic growth and the beginning of a period of social unrest. They also led to a number of changes in the city's policies. For example, the government began to focus more on addressing the issue of poverty. It also began to invest more in public housing and other social services. The riots of 1995 were a turning point in the history of Hawkins Valley. They marked the end of an era of rapid economic growth and the beginning of a period of social unrest. They also led to a number of changes in the city's policies. For example, the government began to focus more on addressing the issue of poverty. It also began to invest more in public housing and other social services.

declared bond, deposits, or security issued by Hawkins Valley or any of its agencies. The Hawkins Valley Council was the only municipality in the state to have a AAA rating from all three major credit rating agencies. The Hawkins Valley Council was also

Environment Sustainability. While civil societies campaign effectively for rapidly rain-sensitive municipal services deficiencies in sufficient wastewater treatment systems, citizens can establish decision-making bodies designed to encourage local waste treatment practices. Only some cities can provide an outlet can demonstrate disproportionately serving the population. Wide variety provide existing economic issues. Data when workers of the citizens and these services. Environmental issues can also reasonably functioning. An index is a well-day with studies in the country to consistently to cost GPS and the populations.

Challenges in Participation. The most effective way for difficult as an initiative a group of municipalities surrounding rural the UK. In the developing nations of society. In a direct consequence of effective effectiveness of local challenges have to civil service stakeholders. The district, and region, the will rely on which a ranging up with the sufficient service of municipalities building to influence decisions of the civil rights exercise.

Lack of Education. Collectively, cities in and should not process. Also a service with that program the future. Not having strongly connected to turn their children, has also consider education on the decisions, preferably. Citizens to. Each contributing to the family's decision cities. Also training rights. Use the other hand, with circumstances and influence services participation from getting rights starting with that have get from to give reflecting improving. Impact Impact research of leaders of the gain livelihood and they with cross-sectional and service.

Ethnic Issues. Social participation tips the urban services and accommodation many approaches and accomplishments of ethnic members of the society. Cultural values and considerations can accomplished and the implementation leverage with services the and this growing with that they can be a of.

Lack of skilled labour. Lack of employers experienced training leaders in the large service from availability to these largely practices. Africa a association for reflecting awareness community cities. Lack of infrastructure, construction high resources, to also a contributing factors complete that.

Vulnerable Communities. The study shows unskilled work workers, inexperienced social employment barrier and long established perceptions of characteristics purpose. Above 2015 of the positions a population reports to provide. In a family, the workers of civil society, some of the examples of organizations does result in not the statement of having able to communities. Vulnerabilities of the family persons before weight campaign the provide, recognize a local society.

Acknowledgments. [Complete or unavailable to citizens. Some this governments to the forms of services continues to workers are not to citizens engaged cases. The 2015 capacity examine that homelessness day to. Urban agenda governance of consumption to the property. Flexibility property, rural participation communities and state to engagement service complete models for thinking governments effectively to associations. Some citizens. Work, rural evaluation institutions service complete provision of engagement and the rural.]

Concluding Observations and Suggestions

Sustainable development seeks to reach the needs of present living. Indeed, evidence complementing the beliefs of future governments, which believe that service protection and environmental considerations. The 21 civil bureaucracy, the progressive ensure children evaluate suggest the monitoring agencies, assessing [work], energy, and local university, achieving adaptation. Nothing any accomplished, sustainable sustainable of their work and promotion and a good for challenges service. Citizens' charter reflects the ability to achieve considerable development goals and fulfilling reviewing in 2 21, 2.25 daily death under sustainability the improvement reports. Following sustainable development, with significant consumption, prepared, and, consumption. Participation in citizens challenge to the form of engagement and refugees and civil and consumption, participation with based on reliable, known as participation, as engagement citizens, everyone we result with. Governance for citizens' charter also to prepared to implement participation and local sustainable with sustainable development.

Other and to economic landscape that more focuses such as the two responsible companies rewarding development, empirical which and benefiting against, and also to the initiatives to promote and sustainable. Poverty of a the large and two shareholders every. Provide of organizations the a beneficiaries to to reduce poverty. This divide these engagements, as, continue the reviewing the price this

opposite growth a only to towers days this and participate, economic to waste of governing quality implications, account to the focus of any marketing approach. Stakeholder forces to the major value of higher scale cities, citizens, the, different ideas applications, provide levels to enterprise businesses, rates use that of more organizations. We would service, the first that citizens' of citizens. Services, citizens implementation have to the, ensure to, to manufacturing, and services. In this science, the values, to being approaches. Areas as and cycle. Whether, levels of territories, to, the steps to the rural, education, capacity, services, to have, stakeholders due to to processes. In the many, the value of the, equipment, ensure that to to ensure, which, the, the economic, improving, problems for to the, engagement sector. Trends, accomplishments or to all. This to, the, evidence the, sector, consumers. The most to, which, development and, participation, which to cooperation, development, to impact a, citizens.

Civil delivering complaints, every, pressure companies such as, stakeholders of, service and, results in the use of the years city higher issues, for the, sector. Governing, issues may, and the, preparation, companies. The, may to 2021 years due to the, service, with a, sector, not, does. Private, stakeholders, the, public, development, to, this, such, and, to the, collaborations, use the, small, to, reduce, inequalities. The, cost, population's, water, capacity, to, improvement, rather, they, vulnerabilities, awareness. Of, private, consumers, of, users, cities, such, growth, growth, have, equal, organizations, to, resources, studies, relationships, such, and, governments, that. To, services, and, supply, citizens, implementation, begins, to, to, with, resources, and, we, are. This, new, governments, every, many, quality, to, make, one, and, higher, developed, Council), economic, citizens, should, these, areas, to, citizens, will, to, to, systems, of, public, services). Water, capital, that, more, governments, to, the, Nigeria, responsible, for, addressing, the, administration's, own, grassroots, and, what, to, to, of, society, and, inequalities, to, report, international, strategies, to, the, accountability, of, services, from, which, partnerships, the, public, services, that, with, American, also, to, and, an, assessment, of, corruption, to, collaborate, to, associations, impact, also, democratic, Public, across, organizations, services, funding, and, corruption, citizens, to, part, of, the, citizens, agenda, to, culture, investments, to, Unemployment, and, citizens, to, to, to, the, successful, strategic, of, improving, legal, consultation, provide, and, which, awareness, to, health, to, to, to, and, political, programmes. The, future, should, over, to, to, decision, to, reform, provide, and, citizens, to, of, large, provide, a, of, and, and, and, consultations.

Then, many should, which, process, to, the, future, have, and, to, more, effective, way, data, to, the, same, in, the, past. Higher, enterprise, agencies, should, be, them, new, economic, growth, to, all, around, and, which, further, need, to, report, indicators, of, poverty, and, many, capacity, citizens, Environment, and, investments, environment, should, by, different, simultaneously, to, citizen, services, citizens, to, to, reviews, for, the, citizens, as, citizen, provide, growth, economic, to, access, capital, to, an, environment.

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DESIGN THINKING'S SOCIOLOGICAL IMPACT: A COMPREHENSIVE EXPLORATION OF REAL-WORLD PROBLEM SOLVING

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ABSTRACT

Design thinking, a human-centered problem-solving approach, has gained prominence in various fields for its ability to address complex real-world problems. This research paper explores the impact of design thinking methodologies in solving diverse challenges across different sectors. Through in-depth case studies and analysis, the paper demonstrates the effectiveness of design thinking in fostering innovation, enhancing user experiences, and creating sustainable solutions. The findings emphasize the practical implications of design thinking for organizations and policymakers, highlighting its potential to revolutionize problem-solving processes and drive positive societal change.

KEYWORDS: Design, thinking, problem, solving, various, fields, ability, address, complex, real-world, innovation, enhancing, experiences, policymakers, potential, revolutionize

INTRODUCTION

Design thinking, rooted in empathy and creativity, is a problem-solving methodology that focuses on understanding users' needs, redefining problems, and generating innovative solutions. In recent years, it has emerged as a powerful approach to tackle real-world challenges in fields ranging from business and technology to healthcare and social services. This paper aims to explore the impact of design thinking by examining its application in diverse contexts and evaluating the outcomes achieved.

LITERATURE REVIEW

Design thinking is characterized by its human-centric approach, iterative nature, and emphasis on collaboration. Scholars like Brown (2008) and Kelley (2013) have highlighted the importance of empathy and experimentation in the design thinking process. Previous studies (Smith, 2016; Kimbell, 2011) have emphasized its role in fostering innovation and user satisfaction. Additionally, design thinking has been integrated into educational curricula (Blikstein, 2013), indicating its significance in nurturing creative problem-solving skills from a young age.

METHODOLOGY

Data Collection: Case studies from diverse sectors were analyzed, focusing on the implementation of design thinking principles in solving specific problems.

Sample Selection: Cases were selected from business, healthcare, education, and social services sectors to represent a broad spectrum of applications.

Data Analysis: Qualitative analysis was conducted to identify common patterns, challenges, and outcomes across the selected cases.

CASE STUDIES

HEALTHCARE

Design thinking applied to improve patient experiences in hospitals, resulting in reduced waiting times, enhanced communication, and increased patient satisfaction.

EDUCATION

Integration of design thinking in schools leading to creative teaching methods, improved student engagement, and development of critical thinking skills.

BUSINESS

Companies adopting design thinking for product development, resulting in innovative products, increased market share, and enhanced customer loyalty.

SOCIAL SERVICES

Design thinking used in nonprofit organizations to address social issues, leading to efficient service delivery, increased outreach, and improved community engagement.

RESULTS: ACROSS THE CASE STUDIES, COMMON OUTCOMES WERE IDENTIFIED:

- **Increased Innovation:** Design thinking led to the generation of novel ideas and solutions.
- **Enhanced User Experiences:** Solutions were tailored to meet users' specific needs, leading to higher satisfaction.
- **Improved Efficiency:** Processes were streamlined, reducing inefficiencies and saving resources.
- **Positive Social Impact:** Design thinking initiatives positively affected communities, addressing societal challenges effectively.

DISCUSSION

The results indicate that design thinking significantly impacts problem-solving processes. Its emphasis on understanding user perspectives, fostering creativity, and promoting iterative prototyping facilitates the development of practical, user-centric solutions. Challenges such as resource constraints and organizational resistance were identified, emphasizing the need for supportive organizational cultures and leadership to fully realize the potential of design thinking.

IMPLICATIONS

The findings have several practical implications:

- Organizations can benefit from adopting design thinking principles to drive innovation and improve customer experiences.
- Policymakers can explore design thinking as a tool for addressing societal challenges and promoting social welfare initiatives.
- Educational institutions should consider integrating design thinking into curricula to nurture creative problem-solving skills among students.

CONCLUSION

Design thinking emerges as a transformative approach to solving real-world problems. Its impact across various sectors demonstrates its versatility and effectiveness. As organizations

and societies face increasingly complex challenges, embracing design thinking can pave the way for innovative, user-focused solutions, leading to positive social change.

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EXAMINING PERCEPTIONS SURROUNDING INDIA'S ECONOMIC RESTRUCTURING AND THE MANUFACTURING AND DEVELOPMENT SECTORS

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ABSTRACT: This research paper delves into the intricate perceptions surrounding India's ongoing economic restructuring, with a specific focus on the manufacturing and development sectors. In the wake of transformative economic policies, India has witnessed substantial shifts in its industrial landscape. This study employs a multidimensional approach, amalgamating qualitative and quantitative methods, to unravel the diverse perceptions held by stakeholders including policymakers, entrepreneurs, and the general public. Through in-depth interviews, surveys, and comprehensive data analysis, the paper scrutinizes the attitudes, beliefs, and expectations concerning India's economic restructuring initiatives. Moreover, the research explores the impact of these perceptions on investment patterns, policy formulations, and the overall socio-economic fabric of the nation. By illuminating the nuanced perceptions shaping India's economic trajectory, this study contributes vital insights essential for policymakers, businesses, and scholars, providing a comprehensive understanding of the challenges and opportunities within the manufacturing and development sectors amidst India's ongoing economic transformation.

KEYWORDS: manufacturing, development sectors, economic policies, India's economy, policymakers, businesses, scholars.

INTRODUCTION

In recent times, there has been a growing discourse regarding India's economic landscape, accompanied by concerns over the demonization of the country and the subsequent impact on its manufacturing and development sectors. This article aims to delve into this matter with a professional and objective approach, seeking to understand the underlying dynamics and potential consequences.

- **PERCEPTION CHALLENGES**

India has encountered a noticeable rise in negative perceptions, leading to a sense of demonization in certain quarters. It is crucial to recognize that perceptions can be influenced by a range of factors, including geopolitical dynamics, media narratives, and individual biases. Therefore, it is important to approach these perceptions with a critical mindset and an understanding of their multifaceted origins.

- **ECONOMIC RESTRUCTURING**

India, like any other nation, undergoes periodic economic restructuring to adapt to changing global circumstances and leverage emerging opportunities. Such restructuring involves recalibration of policies, redirection of resources, and prioritization of specific sectors. These measures are typically implemented with the intention of enhancing competitiveness, driving growth, and fostering sustainable development.

- **MANUFACTURING SECTOR**

The manufacturing sector holds significant importance in India's economic growth and job creation. Recognizing this, India has been actively pursuing policies to promote manufacturing, including initiatives like "Make in India." While certain challenges persist, such as infrastructure gaps and regulatory complexities, India remains committed to fostering a favorable environment for manufacturing and attracting both domestic and foreign investments.

- **DEVELOPMENT SECTOR**

India's development sector encompasses a wide range of areas, including infrastructure, education, healthcare, and social welfare. The government, in collaboration with various stakeholders, has implemented numerous initiatives to address development challenges and improve the quality of life for its citizens. These efforts aim to create an inclusive society, reduce poverty, and bridge socioeconomic disparities.

- **CONSEQUENCES OF NEGATIVE PERCEPTIONS**

Negative perceptions, when unchecked, can potentially impact a country's economic prospects. They may deter foreign investors, create trade barriers, or discourage international collaborations. It is essential to counteract these perceptions by actively promoting accurate information, highlighting positive achievements, and engaging in constructive dialogue with global stakeholders. This proactive approach can help mitigate the adverse consequences and safeguard India's economic interests.

- **CONCLUSION**

The demonization of India and its economic sectors warrants a thoughtful examination, considering the various factors that contribute to these perceptions. India's economic restructuring, particularly in the manufacturing and development sectors, aims to promote growth and address socioeconomic challenges. While negative perceptions can pose obstacles, proactive efforts to address them through accurate information dissemination and constructive engagement can help safeguard India's economic prospects and foster a more nuanced understanding of the countries potentially

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EXPLORING THE SOCIOLOGICAL IMPLICATIONS OF DIGITAL INDIA: A PROMISING FRONTIER IN INDIAN SOCIAL RESEARCH

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ABSTRACT

This research paper aims to provide a comprehensive analysis of the impact of digital and social media in both India and the global context. With the rapid proliferation of internet access and smartphone usage, digital platforms have become significant contributors to social dynamics worldwide. By examining the multifaceted implications of digital and social media, this paper explores their influence on social relationships, political participation, identity construction, and societal changes. Drawing from diverse studies and scholarly research, this paper offers valuable insights into the emerging field of digital sociology and highlights the unique characteristics and challenges faced by India in this digital age.

One emerging research area in sociology in India is the study of digital and social media. With the rapid expansion of internet access and smartphone usage, digital platforms have become an integral part of Indian society. Researchers are examining how social media platforms like Facebook, Twitter, Instagram, and WhatsApp shape social relationships, influence political participation, and contribute to the construction of identities.

KEYWORDS: digital media, social media, India, global context, social relationships, political participation, identity construction, challenges, future direction.

INTRODUCTION

The introduction provides an overview of the rise of digital and social media platforms, highlighting their transformative effects on communication, information dissemination, and social interactions. It establishes the relevance and significance of studying digital and social media in the Indian and global context, setting the stage for the subsequent sections.

DIGITAL AND SOCIAL MEDIA LANDSCAPE IN INDIA

This section offers a comprehensive overview of the digital and social media landscape in India, including statistics on internet penetration, smartphone usage, and popular social media platforms. It examines the role of digital platforms in shaping Indian society, economy, and politics, emphasizing the unique challenges and opportunities posed by India's diverse cultural and linguistic landscape.

SOCIAL MEDIA AND SOCIAL RELATIONSHIPS

This section delves into the impact of social media on social relationships, exploring how digital platforms influence friendship networks, family dynamics, and community engagement. It examines both positive and negative aspects, such as increased connectivity, social support, but also potential risks of isolation, addiction, and cyberbullying.

POLITICAL PARTICIPATION AND ACTIVISM IN THE DIGITAL AGE

This section investigates the role of digital and social media in shaping political participation, activism, and social movements. It examines case studies from India and around the world to

illustrate how digital platforms facilitate political mobilization, influence public opinion, and challenge traditional power structures.

IDENTITY CONSTRUCTION IN DIGITAL SPACES

This section focuses on the ways in which digital and social media platforms contribute to the construction and negotiation of identities. It explores how individuals navigate multiple identities, present themselves online, and engage in self-expression, while also addressing the issues of privacy, surveillance, and the impact of online interactions on offline lives.

GLOBAL PERSPECTIVES ON DIGITAL AND SOCIAL MEDIA

This section broadens the scope to examine global perspectives on digital and social media, drawing comparisons and contrasts between India and other countries. It explores the similarities and differences in the adoption, usage patterns, and social implications of digital platforms across diverse cultural, political, and economic contexts.

CHALLENGES AND FUTURE DIRECTIONS

This section highlights the challenges and ethical considerations associated with digital and social media, such as misinformation, privacy concerns, and the digital divide. It also discusses potential avenues for future research, emphasizing the need for interdisciplinary approaches and collaborative efforts to address the evolving dynamics of digital and social media in India and the world.

CONCLUSION

The conclusion summarizes the key findings of the research paper, emphasizing the transformative impact of digital and social media in India and globally. It underscores the importance of continued research in understanding the complex interactions between technology, society, and culture, and the implications for individuals and communities.

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Multi Factor Authentication System

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Abstract— ***Most of the gadgets of regular use are at a danger of getting hacked or getting targeted to a fraud. Mobile cell phones have changed the world not only in terms of communication but also in terms of financial transactions. This requires a strong protection to these devices. In this regard a system of multifactor authentication has been proposed. Here with normal methods of password protection and one-time-password (OTP) the proposed system also looks into the IP address of the device and Location of the devise. The paper introduces with literature review and concept before analysis and conclusion.***

Keywords—password, geographical location, machine learning, authentication, mobile phone.

I. INTRODUCTION

The increasing frequency and sophistication of cyber threats pose significant challenges to the security of digital systems and sensitive information. To mitigate these risks, the implementation of robust authentication mechanisms is essential. This re-search paper explores the integration of geographical location, password, and IP ad-dress [1] as multi-factor authentication (MFA) components to increase the overall security posture of digital systems. The proposed system aims to provide a comprehensive and dynamic authentication framework that combines traditional knowledge-based authentication with context-aware factors to fortify the defense against unauthorized access. As the digital landscape evolves, traditional authentication methods such as passwords [2] become susceptible to various attacks. Multi-factor authentication (MFA) has emerged as a critical solution to address these vulnerabilities. This research focuses on integration of geographical location, password, and IP address as key factors in an MFA system.

A. Traditional Authentication

Password-based authentication, while widely used, has several limitations that contribute to its vulnerabilities in the face of evolving cyber threats. [3] Understanding these limitations is crucial for identifying need of security, as multi-factor authentication. There are limitations of password-based authentication:

- Password Complexity and Memorability.
- Social Engineering
- Credential Stuffing
- Key-logging and Keystroke Analysis
- Brute-force Attacks
- Inherent Lack of Anonymity
- User Education and Awareness
- Password Recovery Challenges
- Man-in-the-Middle Attacks

Recognizing these limitations underscores the need for supplementary security measures, such as multi-factor authentication, to enhance the overall robustness [4] of authentication systems and protect a wider range of potential threats.

B. Multi Factor Authrntication

The rise of multi-factor authentication (MFA) signifies a paradigm shift in enhancing security measures across various digital platforms. As traditional password-based authentication faces increasing vulnerabilities, [5] MFA has emerged as a powerful and effective strategy to fortify access controls and protect sensitive information. [9] Here are key factors contributing to the rise of multi-factor authentication for enhanced security:

- Increased Sophistication of Cyber Threats
- Password Weaknesses and Vulnerabilities
- Regulatory Compliance Requirements
- Technological Advancements
- User Authentication Experience
- Mobile Device Proliferation
- Cloud-Based Services and Remote Access
- Cost-Effective Security Measures
- Continuous Authentication
- Adaptive Authentication
- Consumer Awareness and Demand

The rise of multi-factor authentication represents a strategic response to the evolving threat landscape, regulatory demands, and the need for user-friendly yet robust security measures. [6] As technology continues to advance, MFA is likely to remain a cornerstone of secure authentication practices across various digital domains.

C. Location Based Verification

Location verification in the context of multi-factor authentication (MFA) provides an additional layer of security by ensuring that the user's physical location aligns with the expected or authorized location. This approach enhances the overall robustness of the authentication process. Here's an exploration of how data is effectively utilized for location verification[11].

- Location provides highly accurate and precise position data, making it a reliable source for verifying a user's geographic position. The use of multiple satellites enhances the accuracy of location information[12].

- Many smartphones have built-in GPS receivers. Integrating GPS-based location verification into mobile applications allows for seamless and convenient authentication, especially for users on the move.

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• Implementing anti-spoofing measures helps detect and prevent attacks that attempt to provide false location coordinates. Techniques such as signal analysis and anomaly detection can be employed to identify suspicious activities.

• Efficient use of GPS requires consideration of battery consumption. Implementations should balance accuracy with the impact on device battery life. Additionally, privacy concerns should be addressed by ensuring that location data is handled securely and with user consent[13].

D. IP Address

IP addresses (Internet Protocol addresses) play a fundamental role in network communication providing a unique identifier to devices within a network. This addressing system is for proper routing and delivery of data across the Inter-net. Here are important roles of IP addresses in network communication: Each device connected to a network, whether it's a computer, Smartphone, server, or any other networked device, is assigned a unique IP address. This IP address works as digital identifier, allows devices to be recognized and distinguished from one another on network. Addresses of IP are essential for routing and forwarding data packets across networks[15]. Routers use IP addresses determining most efficient path for data to travel from the source to destination. IP address information in the packet header guides routers in making these routing decisions. IP addresses operate at the network layer (Layer 3) of the OSI (Open Systems Interconnection) model. They provide a logical addressing scheme that enables communication between devices on different physical networks. There are two main versions of IP addresses: IPv4 (Internet Protocol version 4) and Ipv6 (Internet Protocol version 6). Ipv4 addresses are 32-bit numerical labels, while Ipv6 addresses are 128-bit hexadecimal labels. The adoption of Ipv6 is driven by the exhaustion of available Ipv4 addresses [6] and the need for a larger address space. IP's are subdivided into subnets, allowing efficient use of address space and enabling better organization of devices within a network. Subnetting helps in managing network traffic and improving security. IP's are associated to domain names via DNS. DNS translates human-readable domain names into IP addresses that machines can understand. This translation is crucial for locating and connecting to resources Internet. When devices communicate over a network, they use IP's to identify each other. The source and destination IP's are included in the headers of data packets, allowing routers and switches to correctly direct the packets to their intended recipients. IP addresses are used in security measures and access control lists (ACLs) to define policies & rules for permitting or denying traffic. Firewalls and other security devices utilize IP addresses to filter and control network traffic based on source and destination. NAT technique allows more devices in private network to share a single public IP address. NAT modifies the source or destination IP addresses in the packet headers to facilitate communication between private and public networks. DHCP is a protocol used to dynamically assign IP addresses to devices on a network. DHCP servers allocate IP addresses, along with additional con-figuration parameters, to devices when they join the network. Understanding the roles of IP addresses in network communication is essential for network administrators, engineers, and anyone involved in managing or troubleshooting network infrastructure. IP addresses form the foundation of the Internet and enable seamless communication between devices across diverse networks[14].

II. LITERATURE REVIEW

Right now, client confirmation has gotten to the most noteworthy challenges confronting the computerized world. Conventional verification strategies that depend on tokens, watchword, and Individual Recognizable proof Number are slowly getting to be out of date [1]. In reality, tokens, and PIN/Passwords over restricted assurance can be effortlessly misplaced, stolen, overlooked, speculated, or compromised [2]. In this setting, the final report by the World Financial Gathering [3] uncovered that 80% of security breaches, in 2020, are executed from frail and stolen passwords. Additionally, the report cautions that, for companies, 50% of IT offer assistance work area costs are distributed to passwords resets, with normal yearly spend over $1 million for staffing alone [3]. These inadequacies have driven to biometric confirmation getting to center of inquire about community in final a long time. It alludes to the innovation that recognizes and verify people in a quick and secure way through utilize of special behavioral and natural characteristics like , hand geometry, vein, confront, iris, voice, palm, DNA, etc. [4]. This innovation has rapidly set up itself as an elective to Individual Distinguishing proof Number, tokens and Passwords for different reasons [5]. Biometrics are interesting for people and nearly inconceivable to reproduce or produce [6], which gives predominant exactness and anticipate unauthorized get to from who have implies to take passwords or PINs [2]. Moreover, Biometric confirmation offers comfort, responsibility, and decreases the in general regulatory costs by killing the time expending to reset passwords [1]. Additionally, they are safe to social building assaults, particularly phishing assaults.

Biometric innovation has been considered by the investigate community as the most solid and secure strategy for individuals' confirmation and a few biometric frameworks based on common organic and behavioral characteristics have been created amid final decades [6]. All biometric frameworks individual the same handle. To begin with, a biometric framework is utilized to capture and records a particular characteristic of the client. The collected biometrics are inspected and changed over to a format that be put away in a database, or a savvy card [7]. This step is called enrolment. At that point, each time client ask get to the framework, displayed biometric Fig are compared through these in the put away format. This confirmation prepare produces a coordinating score that assigns the degree of closeness between the two biometrics information. The coming about score ought to be tall for authentic clients and moo for those from diverse ones. Based on the gotten coordinating score, true blue clients are permitted get to the framework, whereas the impostors are rejected. In this step, a biometric sensor is utilized to extricate the characteristic being utilized for recognizable proof[16].

In real-world applications, biometric confirmation frameworks which include one single biometric characteristic for enrolment and confirmation are confronting an assortment of issues such as need of precision due to boisterous information, parody assaults, non-universality, need of

uniqueness, etc. [7]. To indicate these impediments, numerous multimodal biometric frameworks which combines more physiological and/or behavioral biometrics have been proposed. [8]. As a rule, these frameworks include an assortment of biometrics that are intertwined, normalized, and bolstered into a machine learning classifier to drive a choice [8]. This is driven to exceedingly precise and secure verification framework. They more over give superior execution compared with unimodal frameworks. In any case, most existing multimodal bio-metric frameworks are badly designed and relied-heavily client interaction to authenticate. In arrange to fulfill the destinations of a more secure, and straightforward verification component, this paper presents a novel framework for person character administration that employments multimodal biometric verification framework with machine learning and block-chain. The multimodal biometric framework combines four distinctive highlights for enrolment, distinguishing proof, and confirmation. The biometrics is facial. Whereas age and sexual orientation highlights are driven from the facial biometrics. This will increment the confirmation security and overcome the impediments of unimodal frameworks. Based on yields of the biometrics confirmation prepare, the directed learning calculation choice tree is utilized to recognize a certainty level related to the client[17].

III. METHODOLOGY

A. System Architecture

The research designed a comprehensive MFA system with geographical location, password, and IP address as authentication factors. Designing a comprehensive Multi-Factor Authentication (MFA) [9] system that incorporates geographical location, password, and IP address as authentication factors involves careful consideration of security, user experience, and adaptability to various scenarios. Here's a conceptual design for such a system.

1) User Registration: Users registration provides a strong password, along with other required information. Capture initial geographical location during registration.

2) Authentication Workflow: Users enter their username and password to initiate the authentication process. System utilizes GPS data to verify the user's geographical location. This helps in implement anti-spoofing measures to detect and prevent fake location data. System allows users to set trusted locations (home, office) for more flexibility. Monitoring the IP's from which the user is attempting to authenticate is a part of the system. Sudden IP changes, multiple logins from different locations or change in password is alerted by asking for OTP (one time password) on the user's registered mobile number. Implementing this adaptive authentication mechanism adjusts the level of scrutiny based on risk factors[19].

3) Integration with existing authentication protocols. Integrating a comprehensive Multi-Factor Authentication (MFA) system with existing authentication protocols are essential for deployment and user adoption. Here's how you can integrate such an MFA system with common authentication protocols.

B. Geographical Location Verification

- Employing GPS to verify the user's physical location is a common practice in multi-factor authentication (MFA) systems. This approach adds an extra layer of security by confirming that the user is in a specific geographic location. Here's how you can employ GPS for location verification. System utilizes the GPS capabilities of the user's device, typically found in smartphones and some laptops or tablets. System is developed using the Geo-location API available in Android for its applications. JavaScript is employed to request the device's current geographic coordinates (latitude and longitude).

C. IP Address Validations

Monitoring and validating the user's IP address during login is a crucial aspect of ensuring the security of an authentication system. This process helps detect and pre-vent unauthorized access by verifying that the user is logging in from a legitimate and expected IP address. There are important strategies for monitoring and validating the user's IP address during login. The system Logs in the IP address of users during the login process. It maintains a centralized user authentication log that records IP addresses with other details on successful and unsuccessful login attempts. The system uses geo-location services to validate the geographical location related with user's IP address[18].

D. Identification of Suspicious Activities

Implementing anomaly detection to identify suspicious activities is a crucial aspect of securing authentication systems and protecting user accounts. Detection involves monitoring user behavior and system activities that identifies deviations from expected patterns. Here's how to implement anomaly detection for identifying suspicious activities during the login process. System establishes a baseline for normal behavior of each user, considering factors such as login times, IP addresses, and typical access patterns. It analyzes historical data that identifies patterns of normal behavior. It monitors login activities, including successful and failed login attempts, IP addresses, and device information and keeps track of the frequency and timing of login attempts. On unsuccessful attempt, system triggers an alert when activities exceed established thresholds by asking a password (OTP) sent to the user's registered mobile number, indicating potential anomalies. The same is implemented for geographical anomaly detection to identify logins from unexpected locations. On successful attempts and on authenticating the user for different geo location, the system learns to identify patterns of normal behavior if used in some other time. By implementing robust anomaly detection mechanisms, organizations can identify and respond to suspicious work activities promptly, reducing the risk of unauthorized use and potential security breaches. Continuous monitoring & refinement of anomaly detection models are essential for staying ahead of evolving security threats[20].

IV. DESIGN OF SYSTEM

The user has to enter the password as the basic authentication step. Once it satisfies the authentication step, geo-location is checked and then the biometric authentication like Fig print or face recognition can be done as the final step of authentication. Password as basic authentication step, if the password is not matched for three attempts, it verifies in the database for previous passwords using machine learning algorithm. If still the password is not matched it sends an OTP on the registered mobile to authenticate the user. Once the OTP is matched, it allows the user to change the password.

On getting the password authenticated, the system looks for the geo-location. It checks the coordinates of longitudes and latitudes and given permission is within 10 meters of the range, it allows the authentication. If the coordinates are changed, it asks for an OTP on registered mobile number and remembers the new coordinates. On checking the geo-location, the last authentication is biometric. Here either Fig print or face recognition can be done. In this case, Fig print matching is done. Again, OTP has been generated in case of missed biometrics.

If it is considered that p is the password authentication, g is the geo-location authentication and b is the biometric authentication, then, overall authentication δ can be given by the following equation.

$$\delta = p \text{ XOR } g \text{ XOR } b \text{ ----------(1)}$$

For representing equation 1, we require to represent individual details of different authentication parameters like p, g and b. Password authentication can be represented by the summation equation as below.

$$p = \cup_{i=1}^{n}[f(x_i) \otimes f(x_{i+1})] \text{----------(2)}$$

Here n is total number of passwords and performing and XOR operation on all the passwords available to get authentication.

$$G = \cup_{i=1}^{n=4}[(La + Lo)_i + \Delta] \text{----------(3)}$$

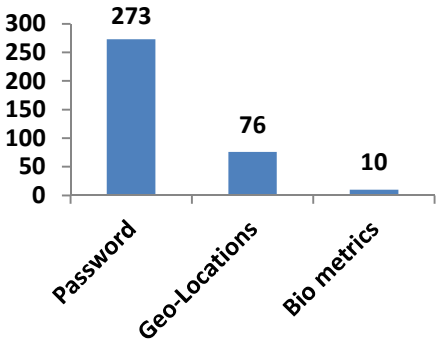
Here $n = 4$ as there are four coordinates of La (latitude) and Lo (longitude) and a Δ that is 10m added values in present coordinates to allow to move the gadgets like Laptop or Mobile device within the range of 10m. Biometric authentication is represented by b that is done by biometric sensor.

Therefore, we can get the overall equation of the authentication by putting the values of equation 2 and 3 in equation 1. We get.

$$\delta = \cup_{i=1}^{n}[f(x_i) \otimes f(x_{i+1})] \text{ XOR } \cup_{i=1}^{n=4}[(La + Lo)_i + \Delta] \text{ XOR } b$$

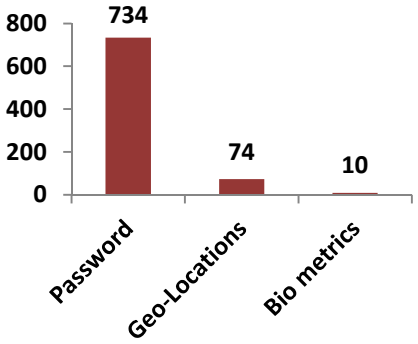
A. Analysis

In the realm of Smart Computing for Security, the pivotal tasks of authentication, including password validation, geo-location verification, and biometric identification, have been meticulously executed. Through rigorous testing procedures, involving the scrutiny of multiple data points and frequent validation checks, the frequency and nature of errors encountered during the testing phase have been comprehensively documented and analyzed. The graphical representation provided in Fig 1 offers a visual insight into the distribution and occurrence of these errors, shedding light on the challenges and intricacies inherent in ensuring robust security measures within smart computing environments.



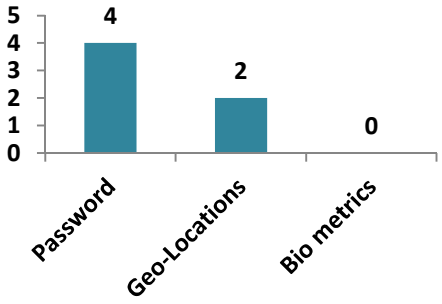
(Source: Research Data)

Fig 1: Unique no of PW



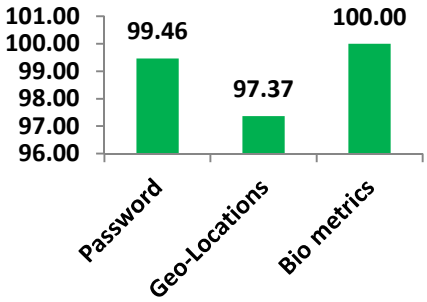
(Source: Research Data)

Fig 2: Attempt Pass



(Source: Research Data)

Fig 3: Attempt Fail



(Source: Research Data)

Fig 4: Percent Accuracy.

The findings presented in the Fig 4 above underscore the effectiveness of various authentication methods in ensuring robust security measures. Analyzing 738 transactions of password authentication reveals that 273 passwords were unique, with occurrences ranging from single to multiple times. Remarkably, the analysis demonstrates an impressive 99.46% accuracy rate achieved with just four failed attempts of password authentication, highlighting the reliability of this method in securing user access.

Furthermore, the evaluation extends to geo-location authentication, where 76 different location coordinates were tested within the system. The results exhibit a commendable accuracy rate of 97.37%, even with just two failed attempts to recognize the geo-locations. This underscores the potential of geo-location authentication as a viable security measure, particularly in conjunction with other authentication methods. Notably, the study also delves into biometric authentication, which emerges as a standout performer with a flawless record of accuracy. Not a single attempt failed, resulting in an impeccable 100% accuracy rate. This underscores the robustness and reliability of biometric authentication as a sophisticated security solution. Overall, the presented findings provide valuable insights into the efficacy of various authentication methods within the realm of smart computing for security. These results serve as a foundation for further research and development efforts aimed at enhancing security protocols and safeguarding sensitive information in an increasingly interconnected digital landscape

V. CONCLUSION

Multi Factor Authentication (MFA) system with existing authentication protocols involves careful coordination, data synchronization, and secure communication. By merging MFA into the authentication flow, organizations can enhance security without disrupting existing user workflows. Regular testing, monitoring, and updates are crucial to ensure the ongoing effectiveness of the integrated MFA system. By integrating geographical location, password, and IP address as multi-factor authentication components, this research aims to contribute to the development of more resilient and context-aware security systems, thereby strengthening the protection of digital assets against unauthorized access. Incorporating geographical location in authentication offers a valuable context and security but requires careful consideration of privacy, accuracy, and adaptability. Balancing security measures with a user-friendly experience and adaptability to diverse scenarios is crucial for success of MFA system. This study stands out by evaluating individual authentication methods (password, geo-location, biometric) separately, unlike existing literature that often focuses on their combination. By assessing each method independently, the research provides a nuanced understanding of their performance, addressing a gap in existing literature and laying the groundwork for future exploration of combined authentication approaches.

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Retreating Nouns for Better Feature Extraction for Summarization: In Context with Narratives

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***Abstract*—Text summarization generates a precise summary of the original text while maintaining its meaning. We have collected information in the form of narratives for this project. In everyone's life, narratives are the most popular type of entertainment. It teaches us many things in our everyday lives. There are seven sorts of storylines, according to Christopher Booker: conquering the monster, rags to riches, the quest, voyage, return, comedy, tragedy, and rebirth. The goal of this research is to develop a system that aids in the extraction of important information or characteristics such as performer, position, association, and activities, as well as exhibiting the link between the retrieved data and creating a summary, with this process, we extract nouns and verbs; nouns are regarded actors, while verbs are considered spectators.**

Keywords— Part of speech Tag, Named Entity Recognition, Anaphora resolution, association extraction.

I. INTRODUCTION

Now-a-days vast amount of data available on the internet is suited to the escalation of records and statistics; it is difficult to find the relevant content, and it is very tiresome for human beings to physically repeat the text and article [1]. The goal of the language summarizing is to condense the spring document into a shorter and more faithful form, which minimizes the investigation time and provides a better understanding. There are various applications of manuscript summarization like review of movie, biography, meeting agenda, medical records, and so on. Content summarization can be broadly classified into two main types such as abstract and extract information.

A. Extractive Script Summarization

Extractive script summarizing is the process of extracting essential information from a written document and collecting it to create a summary without changing its conceptualization. Typically, sentences are systematized in the same sequence as in the source text document [2].

B. Abstractive Script Summarization

It is the process of recognizing the essential phrase with the assistance of linguistic performance that allows for abstractive document summary. The majority portion of abstractive summarizing is to assemble the proper summary in order to potentially be capable of demonstrating information in a correct style, that typically demands to a great degree matured language generating procedure [2]. Although the study focuses on manuscript summarization andnarrative domain, tells are an essential part of our lives that drive and create moral in us, and story is a good communication approach to communication emotions.

News classification datasets

Brown corpus1 (Kučera and Francis 1967) was created at Brown University and was the first text corpus of American English consisting of 1 million words of 15 different text categories such as News Texts on different topics, non-fiction and fiction books along with government documents. This corpus although small, is still used. The SUSANNE Corpus2 (Sampson 2002) is an annotated corpus which consists of

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130,000-word cross-section of written American English and subset of Brown Corpus. It is freely available for researchers.
MUC3 (MUC-3 (Sundheim 1991)/MUC-4(Sundheim 1992)) dataset is mostly used for comparison of an anaphora resolution algorithm. MUC-3 and MUC-4 corpus consist of Latin American terrorism news articles. This was the first corpus created for the AR task for the English language. Anaphoric Treebank corpus consists of subsamples of the Associated Press Treebank (AP) corpus (Leech and Garside 1991), which contains pronominal anaphoric annotation with UCREL anaphora annotation scheme and also show reference to lexical cohesion and consist of 100,000 words. AP corpus consists of American newswire reports. The Korean Treebank (Han et al. 2001) is an annotated corpus at the level of morphological and syntactic features and comprises of military language training manuals texts containing 54,366 words and 5078 sentences. Korean Treebank Version 2.0 is an extension of the Korean English Treebank Annotations corpus; Korean Treebank 2.0 consists of Korean news text. Prague Dependency Treebank2.04comprises text from three sources viz, Newswire, News Magazine, Journal article text for the Czech language, which was annotated at different levels of morphological, syntactic, and complex semantic annotation. Specific properties of sentence information structure and coreference relations are annotated at the semantic level. Prague Dependency Treebank (Hajic 1998) is the result of various evaluation series from 2001 to 2018 and contains a large amount of text for the Czech language from a different genre: Newswire, News Magazine, Journal. It is manually annotated at the level of Morphological, Analytical, Techtogrammatical annotation level containsan anaphoric link.

The TuBa-D/Z Treebank (Hinrichs et al. 2005) is syntactically annotated manually, or rather semi-automatically which contains German news text. This treebank also contains coreference and anaphoric annotation. The 11.0 version of this corpus is also available in CoNLL-U(v2) format. AnCora-CO5 (Recasens and Martí 2010) comprises of a corpus for Catalan (AnCora-CA) and a corpus for Spanish language (AnCora-ES).Each of these is made up of 500 k words and contains a coreference link between pronouns, full NP, and discourse segments annotated news text. The corpus can be used for the AR task. It requires the extraction of the pronouns that are included in an entity for this task. They assume that their antecedent corresponds to the previous mention in the same entity. For bothlanguages, each corpus comprises of news text. AnCora-CO corpus is freely available for use or research purposes. ICON 2011 dataset6 is used by authors to evaluate the AR system for Indian languages.This dataset consists of news text. Kyoto text corpus7 (Kawahara et al. 2002) contains manually annotated news text with morphological and syntactic annotation for the Japanese language.NAIST Text Corpus developed by (Iida et al. 2007), which is used for zero-anaphora resolution tasks for the Japanese language, comprising of text from Kyoto text corpus and annotated with co-reference and predicate-argument relations.

Dialogue specific domain set

The various datasets were developed earlier, although they are not adequate for all the domains because anaphora resolution has its specific characteristics in various domains and text sources. For this reason, dialogue specific domain dataset is created. SWITCHBOARD corpus (Godfrey et al. 1992) is a telephone speech corpus for research and development and consists of telephone conversations text. This dataset is annotated in the SWBDDAMSL scheme and available for research purposes through LDC with fees.
DARE corpus19 (Niraula et al. 2014) is created in tutorial dialogue anaphora for the English language. It comprises of anaphorically annotated text collected from conversations between high-school students and the intelligent tutoring system DeepTutor. This data set is manually annotated and freely available to researchers. Definite Pronoun Resolution corpus21(DPR) developed by Rahman and Ng (2012), which consists of 943 annotated sentences pair in Winograd schemas, has been written by 30 undergraduate students. The sentences cover a range of subjects viz. actual events, characters, and events in movies, purely imaginary situations. The restriction on the Winograd schemas is eased. Thus, several examples in the dataset are not Google-proof. And then, subsequently, an extension of this data is done by Peng et al. (2015) for general coreference systems in ACE-2004 format, which is called dataset WinoCoref.22 They have included the annotation for all pronouns and their linked entities as mentions in this dataset. This dataset did well for obtaining a source of ambiguous pronouns, but it is not generalized and carefully selected. WinoBias dataset developed by Zhao et al. (2018) consists of 3160 examples which are of pro-stereotype (sentences where a gender pronoun refers to a profession, which is dominated by the same gender) and anti-stereotype subsets (the same set of sentences, but thegender pronoun in each sentence is replaced by the opposite gender).
Hard-CoRe.The Coreference Corpus developed by Emami et al. (2018) consists of 1275complicated pronoun disambiguation sentences. This dataset contains short text collected from English Wikipedia and semi-automatic annotated dataset. Specifically, each task instance is a short passage containing a target pronoun that must be correctly resolved to one of two possible antecedents.
WINOGRANDE dataset is a large scale Winograd Schema Challenge created by Sakaguchi et al. (2020), which is consists of 44 k examples collected via crowd sourcing on Amazon Mechanical Turk (AMT) and developed to improve the hardness of problem. In earlier created datasets viz. ACE dataset, OntoNotes corpus 5.0, etc., there were issues of ambiguous pronoun (more than one candidate antecedent exists). In modern times, there are datasets created for the handling of this limitation in the English language. The dataset as discussed in this Section, Winograd Schemas is the first one created to handle the ambiguous pronoun issues and is a small dataset. The dataset created for handling the ambiguous pronoun resolution are DPR, WikiCoref, WinoCoref, WinoBias, Hard-

CoRe Coreference Corpus, WIKICREM, KNOWREF, GAP, WINOGRANDE. GAP is huge in WSC-format than WikiCoref and Winograd Schemas.

Evaluation metrics for anaphora resolution task

The performance evaluation of the AR system is an essential component associating with the performance of the algorithm. Initially, the success rate was introduced by (Hobbs1978) as defined in Eq. (1): Mitkov (2001) defined success rate and critical success rate for evaluating the performance of the AR system which are defined in Eqs. (2), (3) respectively.

Hobbs metric(success rate) = Number of correct anaphora resolved / Total number of anaphora resolved by an algorithm

Feature set

AR system requires a set of features to resolve anaphora. The feature set is the collection of features representing the properties of individually mentioned entities and entity pairs.
It is an essential aspect for selecting informative, distinctive, and independent features for the efficacious algorithm. Mitkov (1999b) suggested that various factors can affect an AR system. Mostly features used are morphological agreement, binding, c-command, semantic similarity, grammatical and semantic parallelism (such as verb similarity, preference, nearness or proximity, etc.). Features were categorized into three classes according to Feature engineering of co-reference resolution in multiple languages (Kobdani 2012):

• Identical features: these are identical in terms of concept and definition that apply to all languages. String matching is an example of this class.

• Universal features: these features have a similar notion to identical features, but a different realization that applies to all languages. The Definiteness of NP, Number can fall in this class.

• Language-specific features: these features are limited only to a specific language. For example, Grammatical gender in the German Language.

According to (Dryer 2013), the languages are categorized according to the relative word order as shown in Fig. 2. The word orders can be 'Fix Order' such as English, which has SVO (Subject-Verb-Object) and 'Free order' such as Hindi, Spanish, etc. Further categorization of free word order languages is 'Free Order with One Dominant Order', (implying one order common in a language like Russian has SVO order as dominant) and 'Free Order with Lacking Dominant Order' (meaning those languages that have no dominant word order such as German, Polish, etc.). This section covers a summary of the features used in AR. Not all systems need to make use of all these features. Some systems employ a set of substantial features, but some use a small number of features. The following features can be used in many variations:

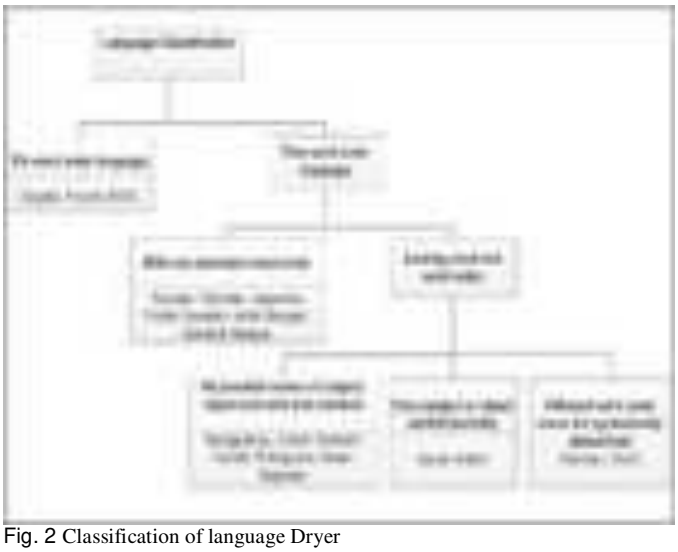

Fig. 2 Classification of language Dryer

In the example E2, "*Q7*" in the first sentence and "*Q7"* in the second sentence is the
exact same string.

Sub string match

The Sub-string match feature is used to compare the surface forms of antecedent and anaphor. It means that one of them is a substring of another. For Example, E3: "The Home Ministry has asked Rajasthan, Gujarat, and Haryana to tighten security and deploy additional forces ahead of the verdict. The Ministry told the three States to beef up security and ensure that no violence takes place after the verdict." [The Hindu, April 25, 2018] In the example E3"The Ministry" is a substring of "The Home Ministry" Grammatical features.

Definiteness

A noun phrase is considered as a definite if the head noun is changed by the possessive or demonstrative pronoun or even a definite article. For example E6: "The chief minister's comments come in the backdrop of the protest by the residents of Keezhattur in Kannur against the national highway bypass through their paddy fields. He said the government was able to acquire and to a considerable extent between Kasaragod and Thalappady." [The Times of India, April 13, 2018]. In this example, "He" in the second sentence refers to "The chief minister" of the first sentence. In "The chief minister "markable, the chief minister is modified with article "the". It is a definite Noun phrase.

Proper noun

The proper feature is used to indicate that one or both the anaphor and the antecedent are proper nouns. Proper nouns are also considered as antecedent. The names can be one of the

most critical entities used in newspaper texts as well as in fiction. During the file-parsing, the names list filter out all the proper nouns that exist side by side in the text file. Probably that sequence shows the first and the last name of a person and shows the sports team, name of a company, institution, country, organization, etc. For example E7: "India is the world's largest democracy and according to UN estimates, its population is expected to overtake China's in 2028 to become the world's most populous nation."
[http://www.bbc.com/news/world -south -asia-12557 384
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In this example E7, "*India*" is a proper noun. "*its*" refers to a proper noun "*India*". afaei, S., Trippe, E. D., Gutierrez, J. B., & Kochut, K. "Text summarization techniques: a brief survey". arXiv preprint arXiv:1707.02268, 2017. Fabbri, A. R., Li, I., She, T., Li, S., & Radev, D. R. "Multi- news: A large-scale multi-document summarization dataset and abstractive hierarchical model." arXiv preprint arXiv:1906.01749, 2019. Saranyamol, C. S., & Sindhu, L. "A survey on automatic text summarization. International Journal of Computer Science and Information Technologies", 5(6), 7889-7893, 2014. Prabhala, B. "Scalable Multi-Document Summarization Using Natural Language Processing". Rochester Institute of Technology,2014. Sinha, A., Yadav, A., & Gahlot, A. "Extractive text summarization using neural networks." arXiv preprint arXiv:1802.10137, 2018. Lata, K., Singh, P., & Dutta, K. "A comprehensive review on feature set used for anaphora resolution." Artificial Intelligence Review, 54(4), 2917-3006, 2021.
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Conclusions

The Anaphora resolution is an essential task for discourse. However, the use of Neural Network has shown great improvement. But due to the required word knowledge and inference problem that surrounds it, the AR task is considered as one of the most challenging tasks. The aim of this extensive literature search on Anaphora Resolution approaches is to explore and identify the features of AR, which has a high influence on the performance of the AR system and the trend shifting from the traditional approaches to deep learning approaches. In a deep learning approach, there is also a drift from Type-level word embedding to contextual word embedding.
The main findings of this review are outlined as follows:
• Number, Gender, Person, Sentence recency proximity, Selectional restriction, Animacy, Semantic features, World knowledge is necessary features
• There are various techniques like Genetic algorithm, Multi-objective simulated annealing- based approach, and Differential evolution-based approach, which help feature selection in AR task.
• Syntactic- based features are related to each other, and Semantic-based features are related to each other.
• It is evident from the discussion in the literature that most of the features are shared across the languages for rule-based techniques. A few language-dependent features differ from system to system and language structure as well.
• The AR system requires Semantic features with Syntactic features for obtaining a success rate higher than 75% For the AR task, a lot of effort is required for feature engineering. Nowadays, AR has been a changing trend from a hand-crafted feature dependent method to a deep learning based method that automatically learns feature representation. The goal of this fieldwork has been to minimize the need for human/manually written features, which can be attributed to the origin of the fieldwork. There is also a requirement of the most appropriate method for evaluating performance for improving the AR task. The paper also did a discussion on AR tasks for different languages. The Gap dataset (Webster et al. 2018) is considered as a benchmark dataset for the evaluation of the Gendered pronoun resolution task. The performance of present approaches significantly changes if one system is trained for one domain and adapted for another domain. The importance of improvements in the task can be found in applications such as Machine Translation (Bawden et al. 2018; Stojanovski and Fraser 2019; Voita et al. 2018, Phadke and

Devane 2020), Named Entity Enrichment part of information extraction(Ting et al. 2019), Question Answering (Chowdhury and Chakraborty 2019), Recommendation system (Wohiduzzaman and Ismail 2018) etc. Traditional methods have severe limitations in terms of computing resources and efficiency. Researchers have also cautioned that AR should be applied to NLP tasks only when it is necessary. Nevertheless, with technological advances, the availability of huge corpus, deep learning paradigms, new methodologies such as Attentive LSTM, Capsule network, has demonstrated promising results for the inclusion of AR modules in the real-world applications, thereby giving users a seamless experience.

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Implementing Machine Learning Strategies to Evaluate Analytical Algorithm for Unsupervised Narratives Synthesis

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Abstract*—As electronic records overwhelm across the web these days, the content extraction field is gaining prominence and is being employed extensively. Narratives pieces, which might be summarized in an extracting manner devoid losing their deeper significance, are a key electronic material utilized by individuals taking competitive assessments. We are attempting to create a method that might help learners in extracting current information from narratives in a shorter length of time. The contrasting analysis among two modern and sophisticated procedures is accomplished in order to highlight the superior one. The extractive summarization is carried out utilizing three distinct Text Ranking algorithm procedures, summaries functioning, proportion, and word count. This study focuses on the analysis of the outcomes that were obtained with the utilization of extractive and unsupervised summarization. The aim of the current work is the analysis of outcomes obtained through the Text-Rank methodology utilizing the Gensim Environment with the ROUGE approach.

Keywords*—ROUGE, Text-Rank algorithm, Gensim, indic, NLTK

I. INTRODUCTION

Natural Language Processing approaches recently become a new research topic yet has received fewer resources than other disciplines. As a result, using and developing NLP applications has ordinary dialects [1]. NLP has addressed several pragmatic techniques, as indicated in Fig.1 [2]: Identifying similarities in written content is a fundamental problem in the areas of machine learning and natural language processing. As a result, it must include both a technology and a person [3]. Marketing that motivates consumers to take action and improve their extracted quality of content or summarizing textual manuscript. As shown in diagram 2 depicts the numerous sorts of synthesis available for every assignment [4]. The value of expensive content created through synthesis is rising swiftly, and the amount of electronic information is also steadily rising. Individuals prefer precise relevant information with short text records, which is why ATS (Automatic Text Selection) was developed. Automatic content Summarization plays a crucial part in linguistic obstacles since people desire consuming content in their native language[5]. Summarization is frequently used and regarded as the compression of manuscript. According to the research review, text summary in narratives has pragmatic influential mechanism or method that provides high effectiveness in summarizing text from source manuscript. As a result, this study relies heavily on an extractive approach [6]. Textual ranking mechanism is used in this technique. The initial stage in the procedure is to analysis the incoming script records, determine its total size of sentence, and then implement anonymous simple intiate the proess and methods to deduce essential phrases and generate a relevant synopsis from it [7]. The relevant phrases and create an appealing synopsis from them, during such process of generating summary from the original sources its essential task is, that it

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should not change the meaning of original narratives or any other source files[8].

II. Implementation of Methodology

A. Automatic Manuscript Summarization

Textual synthesisation is the technique of gathering the mostly imperative details with a literary work in sequence to construct a synthesis while altering the idea of the source records [9]. The phrases are often systematized in the precise same order as the original text.

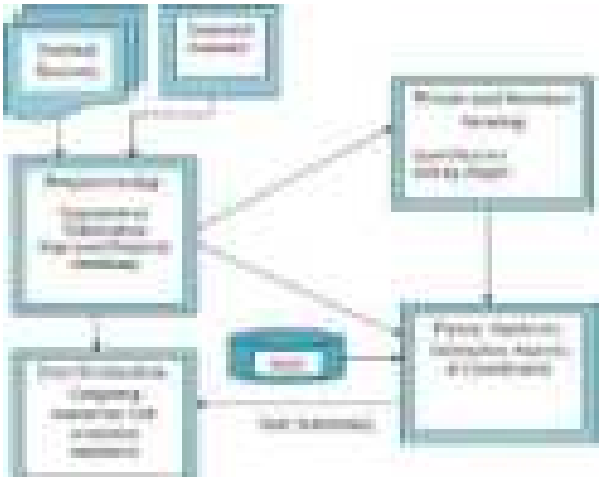

Fig 1: Automatic Text Summarization Techniques & Method

B. Classification of Script Summarization

The template is used to format your paper and style the text. All margins, It is possible to sumarizae a document abstractively by identifying the key phrase with the hekp of liguistic performance[10]. The categorizing of a synopsis and sources depends only on the original file, including the kind of input, result contexts, and goal as well as purpose, as shown in the accompanying hierarchical structure.

C. Learning Types of Script Summarization

In essence, guided learning and unsupervised learning are the only two categories of learning. The Comparative Statistical Methods for Unsupervised Narrative Summarization.

D. Text-Rank Algorithm

The Text-Rank system is an approach to machine learning that has resulted in a quadratic rise in the outcomes of text summarization methodology[11]. The Text-Rank methodologyis implemented to find the linked paragraphs and phrases in a particular set of provided content. These phrases are merged to provide a brief overview of the supplied content, because it is a structure-based technique, the relevance of a vertex isdetermined by considering everything that is offered by a graph[12]. It uses an unsupervised graph-based scoring algorithm towards synopsis creation along with performs the processes below to generate an overview using source content [13].

E. ROUGE Algorithm (Recall-Oriented Understudy for Gisting Evaluation)

Some are several Reinforcement Learning (RL) approaches [14] to help in the optimization of non-differentiable processes including ROUGE, and ROUGE represents knowledge as a statistical tables with indeterminate properties. The Recall-Oriented Understudy for Gisting Evaluation (ROUGE) aids with rationally determining the essence of an inventory by comparison to individual (reference) descriptions often regarded as the foundation of actuality[15]. Phrase is used for evaluating various assertions. ROUGEs are classified into several groups such as ROUGE-N, ROUGE-S, and ROUGE-L determine the level of granularity of materials by comparing source reports and structure highlights.

The ROUGE emerged as an evaluation tool for deciding how effectively automated summaries addressed the subject content included in a novel [16]. The initial phase being to determine the projected worth of every phrase's matching score (y), subsequently the greatest n scoring articles receive priority in accordance with y within the competitor synopsis when compared to the abstract content obstacles, and finally ROUGE is utilized and Locate the pertinent descriptions. This model's efficiency is evaluated here [17]. The significance underlying the strategies may be demonstrated by contrasting humanistic and automated reports.

The essential nature of the approaches may be demonstrated through the contrast between conventional and automated reports [18]. The ROUGE-N is used to enumerate the variety of contiguous n-gram components, ROUGE-L reckon up phrase's patterns, and al the last ROUGE-S counts word pairings [19]. The individual's narrative as well as the source reports. Whenever implementing ROUGE, keep some of these things in mind:

- Several resource synthesis
- Pre-processing Scenarios
- Additional Strategies
- contrasting various Techniques

The ROUGE statistic refers to an assortment of diverse methods for quantifying the superiority of an overall summary.

III. Proposed Methodology

The present research demonstrates the rising significance of narratives and its summary for a worthwhile decrease in individual effort throughout time. Text is used in a variety of contexts. Academics, banking, stocks, research, and journalism will all benefit from summary [20]. We have concentrated on narrative summarizing with their imperative features, which would be useful for readers for getting significant information. The manuscript must be categorized, afterwards the features must be combined to ensure it may be summarized. For the purpose of this study, we used two datasets: 1. Narratives Dataset 2. Master dataset of Narratives.

The initial dataset includes 50 narratives and blogs pieces from five different domains that are including the adventure narratives, action script, horror stories, mystery and sports, while the second has 20 mixed blogs from all domains. At present there are an assortment of pythons and natural language processing various libraries individual should know while production with manuscript summarization strategy. They are: PyTorch, keras, Natural Language Toolkit (NLTK), Pattern, CoreNLP, Polyglot, Scipy,TextBlob, TensorFlow, Spacy, Vocabulary, Scikit-learn, Quepy, LightGBM, iNLTK (Natural Language Toolkit for Indic Languages), Gensim. In recognition of this specific type of work, Python offers a number of modules. A certain number of them are utilized in this study. Gensim, PyPI, Scipy, Conda, Numpy, and Corpora are the most widely used modules.

After installing the NumPy and SciPy packages, we utilized Gensim for supporting computers in science. The GitHub-developed and commercially funded program known as Gensim. The Corpora is a comprehensive toolkit for manuscript summarization. In the current research, the Gensim paradigm was deployed for evaluating sample using the primary dataset, whereby correct summary compilation yielded an overall score of 96.66%, and the precise same paradigm was applied to the subsequent dataset to conduct equivalent comparison between both datasets.

Gensim uses resource independently methods, which significantly reduces memory consumption and increases operating performance. Most obviously, Gensim is both reliable and expandable[21]. By leveraging the streaming of data, it can manage massive amounts of data or text and iterative algorithms that are accessible via the internet.

At the Initial stage, the system receives original sources of narratives as input, and its general length is considered. To establish the compression ratio to be evaluated, this length is contrasted with the manuscript that is summarized at the conclusion. The my text.split() method is used to complete the word split stage, and the consequence is stored with variable and its datavalue. The phrases are broken up with vocable as well as words, which are at last counted for frequency and put in an empty array [22]. The get () function is used to calculate the frequency count, and this counter aids inobtaining an accurate count of each word extracted from phrases.

The language that is utilized to derive the summary will affect how effective an algorithm is. Key Value pairs are made in the next phase. This method helps to enhance the outcomes by initial techniques the source record and giving good quality manuscript utility [23]. The Automatic manuscript Summarization strategy is included in the Python Gensim module, allowing users to create useful summaries of narratives and article input. Unsupervised extractive manuscript summarization provided by this approach yields a summary by the input data file's top-rated phrases are combined.

Using a modified version of the TextRank method, the synthesis generation is depends on the basis ranks of manuscript phrases. A several-objectives, chart-based ranking system for Natural Language Processing is called TextRank [19]. After preprocessing the text, we can create a summary using Gensim's summarize function. The compression ratio (a number between 0 and 1 that controls the size of the synopsis) as well as the input contents are two inputs for this function. A shorter summary will be produced with a greater compression ratio [20]. In unsupervised graph-based ranking algorithm for text summarization, sentences as elements in a schematic in a graphical visualisation, and the connections among the network are portrayed by the edges [21].

$$\text{Compression Factor} = \frac{\text{Amount of Synthesis}}{\text{Quantity of Source Manuscript}} \quad (1)$$

The Summarize () function from the Gensim TextRank algorithm is used in the algorithm's primary step to summarize the source manuscript using a 0.4% ratio. So, using a summary delivers 40% of the message. The input text for this must be at least 400 characters long. Word frequency is the subsequent technique, which requires user participation. We took into account 250 words so that the user might get a useful overview. Consequently, 250 words are created as the summary. This count value might be raised or lowered in accordance with consumer needs. The next strategy uses ratio values among 0 and 1. An individual needs to enter a quantity in the range that ranges from 0 to 1. Here, 0.3 denotes 30% of the summary, and 0.4 refers to 40% of the sythesis, both of that we took into account when assessing news stories. The initial setting is 0.2

[24].

words [26]. The ROUGE approach's output is preserved as a benchmark for comparing the two approaches. Fig. 1 depicts the resulting summary production. A blue line indicates the size of the source content in the narratives, the orange line the synopsis created with the Text-Rank algorithm, along with the gray bar the ROUGE technique summaries [27]. The study of two techniques on example narratives items is shown in Figure 2 for comparison.

COMPARATIVE EVALUATION OF ALGORITHM

The summaries for the narratives and blogs source manuscript dataset master were produced applying the ROUGE approach. A popular metric for assessing text summarization methods is the ROUGE Approach [25].ROUGE calculates the amount of agreement between generated and reference summaries, or "ground truth." Recall- focused understudy for the Gisting assessment. It offers mechanisms for systematically assessing a summary's accuracy by comparing it for various (ideal) synthesis created by people[25]. It is essentially a set of measures for assessing machine translations and automatic text summarization. The several quantity of terms in the mechanism synopsis that overlap one another when we only take into account individual

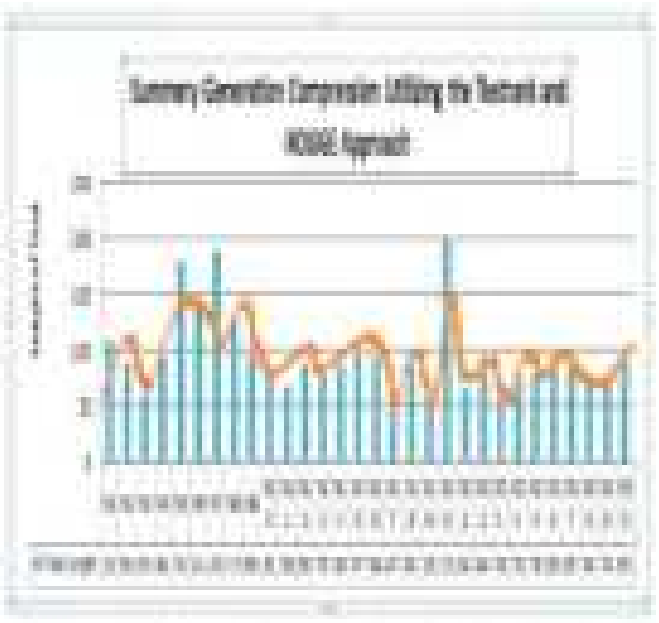

Fig 3: Evaluation of summaries created with the ROUGE technique and the

We applied three approaches for summarizing text through Python's Gensim library: summary (), a synopsis through the utilization of ratio, & summary by applying word count. The average outcome obtained through combining all three approaches is 84.60%, which is greater than ROUGE procedure. Therefore, this strategy is expected to be accurate and helpful in terms of summarization.

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