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ABOUT THE PROGRESS JOURNALS

'The Progress Journals' is a flagship initiative of The Progress, which belongs to one of the verticals of Sri Aurobindo Yoga & Knowledge Foundation with a mission of Sustainable & Holistic Development. Begun in 2023, the vision behind this publication is to create an international, cross-disciplinary, peer-reviewed and open-access journal that deals with issues of social, cultural, economic and ecological importance. This bilingual journal (with papers in English and Hindi) seeks to provide a platform for people engaged in innovative studies on subjects related to sustainability and sustainable development.

The journal also aims to highlight the significance of the Sustainable Development Goals (SDGs), also known as the Global Goals, which were set up by the United Nations in 2015. These goals were designed to be a "blueprint to achieve a better and more sustainable future for all." They comprise a universal call to action to promote individual and social well-being on a global scale. The 17 SDGs are (1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being,

(4) Quality Education, (5) Gender Equality, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (10) Reducing Inequality, (11) Sustainable Cities and Communities, (12) Responsible Consumption and Production, (13) Climate Action, (14) Life Below Water, (15) Life On Land, (16) Peace, Justice, and Strong Institutions, (17) Partnerships for the Goals.

This journal, which shall be published quarterly, will allow researchers from various backgrounds to share their opinions and findings on topics related to these goals. Through this exchange of knowledge, we hope to better understand how to implement these principles for the development of our communities, our nation and the world.

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EDITOR'S NOTE

THE PROGRESS, established in 2020, is one of four recent initiatives of Sri Aurobindo Yoga and Knowledge Foundation. The core objective of our organization is the transformation of consciousness in higher education. The inspiration for this goal is the philosophy of Sri Aurobindo and the Mother, especially the principles of Integral Yoga. We believe that true progress requires consciousness of one's role in one's family, community, nation and the world. We seek to create this distinctive awareness, especially among students, professors, researchers and other key stakeholders in the field of education. At present, we are associated with more than 28 higher education institutions, including IIT Delhi.

In Integral Yoga, it is written that there are five layers of the mind: Physical, Vital, Mental, Psychic, and Spiritual. In higher education institutes today, the teaching-learning process is such that it functions till the Vital layer. There is no formal curriculum for anything beyond that. That kind of learning only comes through community, social and spiritual initiatives. Most higher education institutions have already started different types of developmental projects, social work, etc. Our objective is to create an organization that can connect all these other institutions and then collectively, we can be a force for universal transformation. To the broad vision of progress, we each bring our own unique perspective. Together, we can refine our approach and make a difference globally, while being rooted in our regional heritage.

In 2023, we launched a new initiative, 'The Progress Journals' with a mission to highlight scholarly work on Sustainable Development in general and the significance of the Sustainable Development Goals (SDGs) proposed by the UN, specifically. This is our first issue and we are very grateful to all our contributors and supporters. We aim to release this bilingual journal on a quarterly basis and provide a space for new voices and fresh perspectives.

- *Dr. Samarendra Mohan Ghosh*

Editor-in-Chief

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A Scientometric Exploration of Indian Institute of Technology Bhilai's Contributions to Sustainable Development Goals Research

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Abstract

Scientometric and bibliometric analysis of publications in the realm of Sustainable Development Goals (SDGs) from 2017-2024 within the Indian Institute of Technology Bhilai provides a comprehensive overall objective of determining the contributions by IIT Bhilai in the realm of SDG-related research, both in terms of volume of publications, citation impact, collaboration pattern, and thematic focus. The number of SDG-related documents identified in the Clarivate Analytics Web of Science (WoS) database is 164. Analysis tools applied in the process include Bibliometrix R-package and Microsoft Excel for extracting and visualizing data. Publication output growth shows a steady rise at an annual growth rate of 54.78%, showing a growing interest in research with respect to sustainability. The average citation per document was 10.24, indicating that IIT Bhilai's research is well-regarded within the academic community. International collaboration was prominent, with 35.06% of the documents involving co-authorship with global partners, highlighting IIT Bhilai's active engagement in international research networks. The analysis also reveals the prominence of certain SDGs, particularly in areas like health and socio-economic development, while identifying potential research gaps in other SDGs. Findings Thus, the study reflects that IIT Bhilai has been a major contributor to the global agendas of SDGs and stands as an asset for policy and strategic planning and future research. In this context, it refers to academic institutions as founding in the endeavor to face the challenges of the earth through collaborative research and innovation.

Keywords: ***Sustainable, SDG, Scientometrics, IIT, Citation.***

Introduction

IIT Bhilai was established in 2016 by the Ministry of Education, Government of India, in Chhattisgarh. It began operating from its permanent campus in 2023. The net-zero campus over 362 acres has state-

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of-the-art infrastructure like 20 main buildings, 25 auxiliary structures, a central instrument facility, an engineering workshop, a data centre, and a library. The institute offers BTech, MTech, MSc, and PhD programs in diverse disciplines such as Computer Science, Data Science, Artificial Intelligence, Electrical, Mechanical, Materials Science, Mechatronics, Bioengineering, Electric Vehicle Technology, Power Systems, Electronics, Design, Thermal Sciences, Chemistry, Mathematics, Physics, and Liberal Arts. Equipped with advanced facilities like a 3D Printing Lab, fabrication lab, electrical lab, and computer lab, IIT Bhilai emphasizes national growth, fostering technological advancement, innovation, originality, excellence, and core values of righteousness, brilliance, inventiveness, academic finesse, and accountability (https://www.iitbhilai.ac.in/index.php?pid=AnnualReport2023_24).

Sustainable development has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development calls for concerted efforts toward building an inclusive, sustainable, and resilient future for people and planet. Implementation and success will rely on countries' own sustainable development policies, plans, and programmes, and will be led by countries. The SDGs will be a compass for aligning countries' plans with their global commitments. The new agenda at the global level will be monitored and reviewed through a set of global indicators in relation to the 17 Sustainable Development Goals (SDGs) and 169 targets. It had been developed by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs) and agreed upon at the 48th session of the United Nations Statistical Commission held in March 2017 (https://www.un.org/sustainabledevelopment/development-agenda).The figure 1 shows the 17 parameters of SDG.

Figure 1

A scientometric study of SDGs within the context of an academic institute is the research output pertaining to the 17 global goals, analyzed in the form of the volume

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of publication, citation impact, collaboration patterns, and thematic focus to understand the contribution of the institute towards solving critical global challenges. The strengths and weaknesses of the institute are pinpointed by such research studies mapping publications to the specific SDGs. The areas where there is a need for attention are identified (Armitage et al., 2019). Some of the typical metrics used in measuring the relevance and impact of research include citation metrics, co-authorship networks, and keyword analyses (Armitage et al., 2019). Other studies also observe how the institute's research priorities are aligned with national and global development agendas that reveal the institute's role in advancing sustainable practices (Ferrer and Chalmeta, 2019). Such analyses support strategic decision-making, policy development, and efforts to improve the societal impact of research activities (Ramos et al., 2021).

Publications form considerably the reputation and influence of an academic institution. They are physical evidence of the output of the brain of the institute that illustrates its share in knowledge creation and innovation. With the right kind of journals, this increases international visibility of an institution within the global community of academics and researchers, providing chances for collaboration assistance in securing funding and helping rankings. They influence the institute's ability to attract talented researchers, students, and faculty, thereby creating a virtuous cycle of excellence (Mingers & Leydesdorff, 2015). Besides, publications play a significant role in solving societal challenges, which aligns with national and global priorities, such as the Sustainable Development Goals (SDGs). Their realization and arrangement of driving progress across disciplines by supporting research from various points of view establish the institute as a highly relevant center for academic and practical activities, and highly contributes to the progress of society and science.

Literature Review

Scientometrics and bibliometrics related to the Sustainable Development Goals (SDGs) is a rapidly growing domain. Various studies examined the development path of SDG-related research applying various quantitative measures of publication, citation, and collaboration networks, usually concentrating on specific key research domains, the share of academic institutions involved, or the impact of other regions or countries in SDG research.

(Armitage et al., 2020) examined many research institutions assess their contributions to the UN's SDGs using tools like Elsevier and Times Higher Education, but these require careful evaluation due to interpretation and query challenges. This study used the Bergen approach to develop SDG-specific queries, revealing significant differences from Elsevier's results. Findings stress cautious use of SDG tools given their current developmental limitations. The authors, Bautista-Puig et al.

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(2021), explored how the SDGs build upon the MDGs to be a universal sustainability framework. Using a scientometric analysis of work in the space between 2000 and 2017, it maps global research in M&SDG and thematic specialization; hence, its output is scientifically classified. Research findings indicate more involvement of the higher education sectors, health issues, and interlinked socio-economic themes, contributing towards evidence-based policymaking in relation to interlinked SDGs. (Bautista-Puig et al., 2019) Sustainable Development Goals (SDGs) focus on global cooperation toward sustainability, where higher education institutions (HEIs) are placed at the heart of the endeavor. This article maps HEI research on MDGs and SDGs (2000–2017) through the use of bibliometric analysis of 25,185 records. Findings include increased HEI participation, health, women, and socio-economic issues, as well as growing political interest, with implications for policy-making.

Gehlot et al., 2024, have done a bibliometric review of 580 articles published since 2012, and have found India to be one of the slowest in the adoption of SDGs, thereby requiring more policies and programs of awareness. The study gives information on the emergence of SDG research in India, scope, contributors, and trends. (Ferrer-Estévez and Chalmeta, 2021) assessed the nexus of education and SDGs through systematic review of 160 articles that have appeared over the last decade. It indicates the best contributors, challenges, and trends, and suggests six categories of research with future outlooks while revealing a framework to enable academic institutions to better implement it in order to focus on the continuous improvement and measurable outcome. (Meschede, 2020) analyzed 4,593 research articles explicitly referring to the SDGs and discussed their thematic focus, research areas, and collaborative nature. Most work centers on SDG 3 (Good Health and Well-being), with contributions mainly from Life Sciences and Social Sciences. Findings emphasize international collaboration (37% co-authored globally) and open access as key drivers of SDG knowledge sharing. (Mishra et al., 2023) analysed 12,176 articles on Sustainable Development Goals (SDGs) from 2015 to 2022, highlighting research trends, challenges, and opportunities. Findings depict high research productivity in the USA, China, and the UK, with key topics that focused on climate change, poverty, global health, and inequality. Collaboration and direct insights into guiding future SDG research and policy efforts are stressed. (Mohd et al., 2024) investigated research grants' alignment with Sustainable Development Goals at University Sains Malaysia. Analyzing 1,495 grants and feedback from 46 principal investigators, the study identifies seven types of research impact on SDGs: economic, social, environmental, cultural, public policy, organizational, and educational. It

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emphasizes the need for structured monitoring to ensure that research is consistently in support of achieving SDGs. (Yamaguchi et al., 2023) conducted a systematic analysis of literature reviews on SDGs from 2015 to 2022. The study indicated that SDG research has been growing rapidly, and the areas of focus have diversified. Key areas that are not well addressed include technology (SDG 9) and economic growth (SDG 8). Research gaps exist in the areas of inequalities, gender, oceans, and peace. SDG research is still evolving, and many areas remain unexplored. An analysis of 2,814 SDG-related papers and 92 reviews between 2013 and 2022 by Yeh et al. 2022 shows that the US and UK lead in publications and citations, with WHO and top universities key contributors. Research is organized into clusters on "synergies and trade-offs," "networking," and "systems analysis." SDG 3 is the most popular, and findings help scholars and policymakers manage the research on SDG.

Methodology

This bibliometric and scientometric descriptive study explores the global research publications based on Sustainable Development Goals by using techniques of bibliometric and scientometric analysis. The data was extracted from the Clarivate Analytics Web of Science database, one of the most extensively used scientific literature repositories in the world. A Boolean search algorithm was used to search for document titles related to SDGs from the Indian Institute of Technology (IIT)-Bhilai" and was searched for only in the years from 2017 through 2024. Documents like meeting abstracts, editorials, and news items/book reviews were also excluded. Screening for SDG-related content following the initial search gave 329 documents, now reduced to 164. The final search was conducted on January 1, 2025, to ensure consistency and avoid including any outdated evidence. This study carefully examines SDG research, leading to valuable contributions and areas in need of further investigation. The 164 selected documents were analyzed with several statistical tools and software, which included Microsoft Excel 2016 and Bibliometrix R-package Biblioshiny (version 4.1.3) to clean, analyze, extracting, mapping, and visualization of data. The open-source tools used were also widely accepted for academic purposes. They are widely used and allow for a detailed and accessible analysis of the data, yielding clear and interpretable results.

Objective

This research aims to conduct an all-inclusive scientometric and bibliometric analysis of SDG-related publications conducted at the IIT Bhilai between 2017 and 2024. It will review and analyze the output volume, citation impact, collaborative patterns, and thematic focus with the institute's efforts in SDG-related research. Further observations include

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1. To check the trend in growth pattern, evaluate annual growth rates and trends in citation numbers of IIT Bhilai, with regard to SDG-related research output.
2. Determine leading authors, affiliated organizations, and countries responsible for SDG-related work, using IIT Bhilai as an exemplar leading institution in SDG.
3. Check trends in international collaborations and involvement of the research initiatives.
4. Thematic direction for the publications related to SDG and the principal domains of research and identification of key gaps that may be explored in this context
5. Views on IIT Bhilai research in the context of global agenda under SDG, useful for strategic planning, policy development and future research directions.

This research will help to understand the role of academic institutions, in particular IIT Bhilai, in research and innovation that could address the challenges of global sustainability, underlining its impact and further scope for contributing to the achievement of the SDGs.

Analysis

Main Information about Data	**TP**	**SDGP**
Timespan	**2017:2024**	
Sources (Journals, Books, etc)	329	164

Main Information

The table 1 and graph 1 represents the comparison of TP and SDGP (Sustainable Development Goals Publication) reveals quite a few positive elements of SDGP that underlines its distinct input to the study arena. However, SDGP has a comparatively smaller dataset size of 231 documents by 164 sources, which nevertheless shows an impressive yearly growth rate of 54.78% and therefore establishes a healthy trend of interest in its theme of research. Notably, SDGP shows a higher average citation per document (10.24) compared to TP, which is at 9.927, thus showing that research outputs of the former are relevant and highly acclaimed within the scientific community. The average age of the documents of SDGP is 2.84 years, which describes a modern body of work timely to discuss issues and trends relevant to the contemporary era. The project also shows a collaborative spirit with 35.06% of its authors being international co-authors, thereby providing a richly diverse and inclusive research environment. Besides, the fact that SDGP has articles and reviews makes it contribute to knowledge and innovation diversely. SDGP is an exciting and influential research initiative in that it caters to its audience's academic needs.

Main Information about Data	**TP**	**SDGP**
Documents	573	231
Annual Growth Rate %	104.78	54.78

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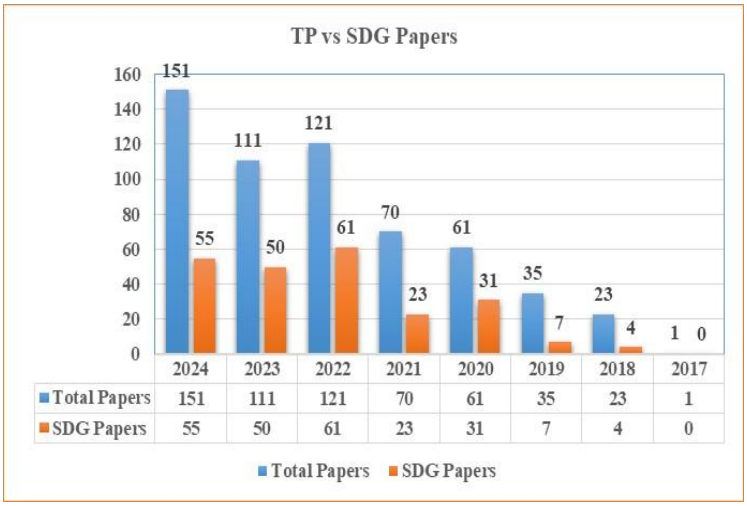
Main Information about Data	TP	SDGP
Document Average Age	2.97	2.84
Average citations per doc	9.927	10.24
References	0	0
Document Contents		
Keywords Plus (ID)	1790	861
Author's Keywords (DE)	2087	951
Authors		
Authors	1290	546
Authors of single-authored docs	15	7
Authors Collaboration		
Single-authored docs	23	10
Co-Authors per Doc	4.52	4.3
International co-authorships %	34.03	35.06
Document Types		
Article	533	217
Proceedings Paper	1	1
Book Review	1	0
Correction	2	2
Editorial Material	1	0
Meeting Abstract	7	0
Retraction	1	1
Review	27	10

Table 1: Main Information about Data



Graph 1: Total Papers Vs SDG Papers

Average Citations Per Year

The table 2 breaks down the evolution in the citation impact of documents over the years: TP and SDGP from 2017 to 2024. This section shows mean citations per article per year and thus carries trends for academic recognition as well as the influence of the published work. For TP, the average citations per article took off at 7.00 in 2017 and peaked at 33.70 in 2018, after which it varied until it plunged to 1.23 in 2024. For SDGP, this pattern is more haphazard with no citations in 2017, a jump

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of 64.00 in 2018, and then steadily went down to 1.22 in 2024. This means that although citation for both projects grew initially, for TP, the citation impact has decreased due to time elapsed. SDGP trend is more inconsistent, which implies changing interest and recognition of these projects among the faculty over the years. In general, this section indicates changes in the citation dynamics of how trends are unfolding, which is crucial for assessing the relevance and impact of research outputs over time.

	Year	2017	2018	2019	2020	2021	2022	2023	2024
Mean TC per Art	**TP**	7.00	33.70	21.31	15.59	21.67	8.62	4.17	1.23
	SDGP	0	64.00	46.71	16.90	14.04	10.66	4.36	1.22
N	**TP**	1	23	35	61	70	121	111	151
	SDGP	0	4	7	31	23	61	50	55
Mean TC per Year	**TP**	0.78	4.21	3.04	2.60	4.33	2.15	1.39	0.62
	SDGP	0	8.00	6.67	2.82	2.81	2.66	1.45	0.61
Ci table Years	**TP**	9	8	7	6	5	4	3	2
	SDGP	0	8	7	6	5	4	3	2

Table 2: Average Citations Per Year

Most Relevant Authors

The graph 2 lists leading figures in the research community based on their contribution, through either the number of articles published and their citation impact. The highest authors Rana NK, and Udayraj U is 15 and the higher article fraction of 4.85 by Udayraj U showed more influence about the field is that their output is not just prolific but most cited. Chander N and Ghosh DS with 14 articles each provide a far better representation of the engagement of research with depth, whereas Kumar A and Kataria KK with 13 and 12 articles respectively have contributed significantly to the knowledge base. The citation metrics of these authors critically render the measure of relevance and impact of their research, often in relation to the novelty and applicability of their findings. This section underscores the collaborative nature of

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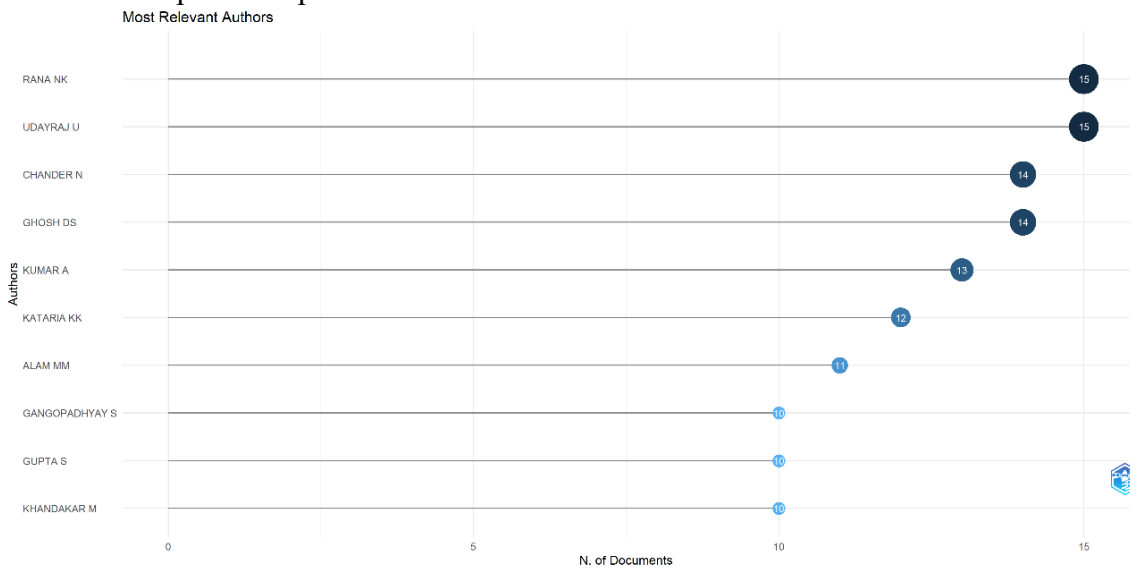
research, in which several authors are involved in the progress of knowledge in a multi-disciplinary way. This section's precedence would indicate that these authors were crucial to the definition of trends in research and complex issues and were thus important persons in the landscape of academia. The insights from recognizing this contribution include knowing how research productivity dynamics are going and how efforts to collaborate could be driving innovation and discovery in the respective domains.



Graph 2:

Most Relevant Affiliations

The Figure 3 shows IIT Bhilai as the one with the most significant contribution in research output with 329 articles, a number significantly more than all of the other affiliations listed here. It stands IIT Bhilai at the apex of academic pursuit and innovation through its healthy environment for research, and dedication toward building knowledge from disciplines. In comparison, Indian Institute of Technology has 63 articles, whereas Prabhat Kumar College, Technical University of Denmark, and Utkal University each have 13 articles, so this has fewer outputs. This gap points out that IIT Bhilai is the leader in the academic atmosphere, which reflects the attraction of faculty toward high research talent and resources, thereby promoting an environment favorable to quality and quantity growth in research work. This lead in article production puts IIT Bhilai not only on top in terms of the research output but also gives it a glimpse at influence at the policy and practice level within the larger scientific community at large.

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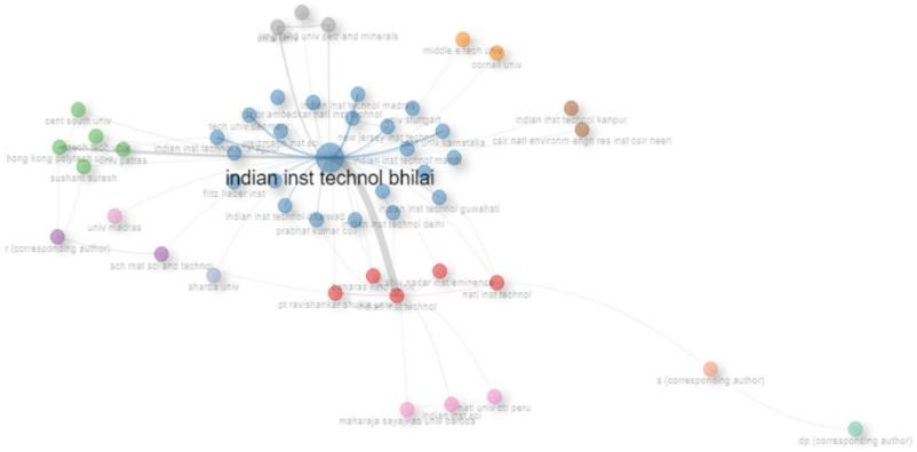

Figure 3: Most Relevant Affiliations

Most Cited Countries

The graph 3 provides comparative analysis of scholarly impact of countries in terms of total citations (TC) and average article citations. India is a leader with total citations of 1,389 and an average of 7.40, which indicates that it has an excellent presence within the research community but with somewhat lower average per article impact as compared to others. China follows by totaling 253 but has the higher average of citations at 28.10 indicating that its output research is of both high quantities and influence, whereas Israel led by 233 total citations averaged a high influence at 77.70 which would indicate very focused impact at the research fronts. With a total of 101 citations and an average of 101.00, Italy suggests a robust reputation for high-impact research. Divergence in citation metrics between these countries also shows differences in research focus, quality, and international collaboration, as some nations perform well in producing work that resonates highly within the global academic community. This section emphasizes the role of citation metrics as measures of research quality and influence, which would provide insight into the global research landscape.

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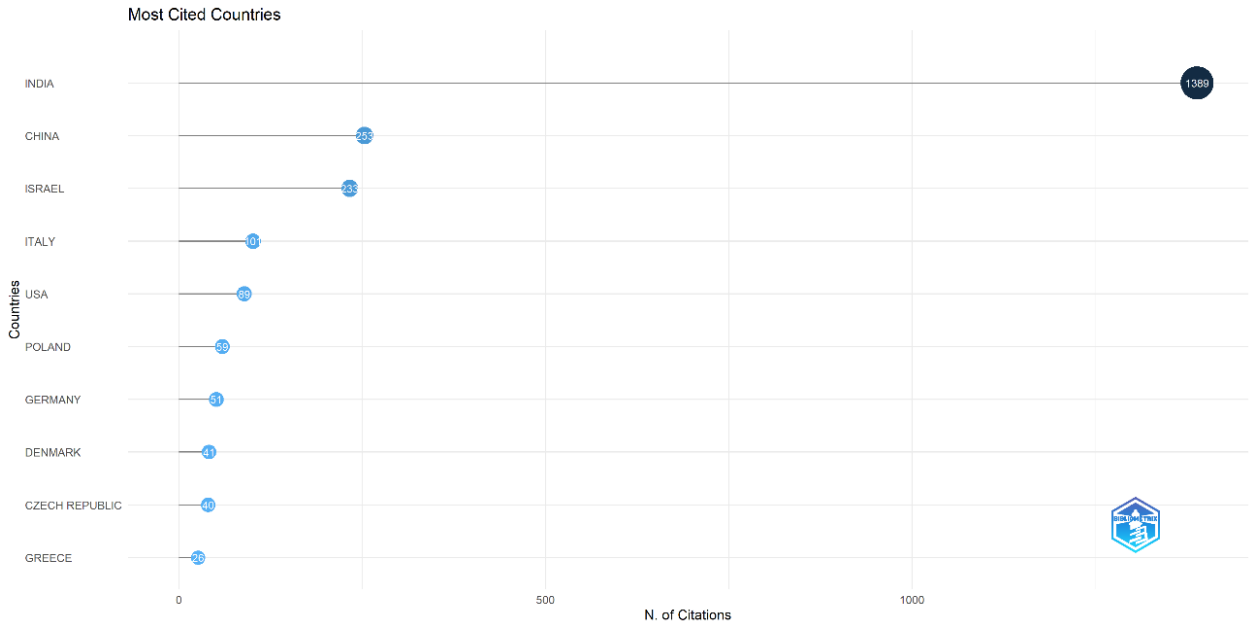

Graph 3: Most Cited Countries

Countries' Collaboration of country

The figure 4 presents a detailed mesh of international research collaboration, as illustrated by the high number of collaborative research between various countries. For example, India stands out with the number of collaborations: with China, 13; Germany, 10; and the USA, 21; showing an overwhelming inclination toward collaborative research based on the availability of diverse expertise and resources. It clearly shows the world's perspective and how different nations like China, Germany are collaborative with a wide number of nations, that proves scientific study as a worldwide discipline and it calls for more collaboration across international boundaries to find the solutions of more complex issues. The high intensity of collaboration as seen with the cases between India and Italy, France, Saudi Arabia also highlights the strategic nature of research output and innovation. This collaborative landscape fosters knowledge exchange and strengthens the global research community, allowing the sharing of ideas and methodologies that can lead to significant advancements in various fields. In general, this section emphasizes the critical role of international collaboration in driving scientific progress and enhancing the impact of research on a global scale.

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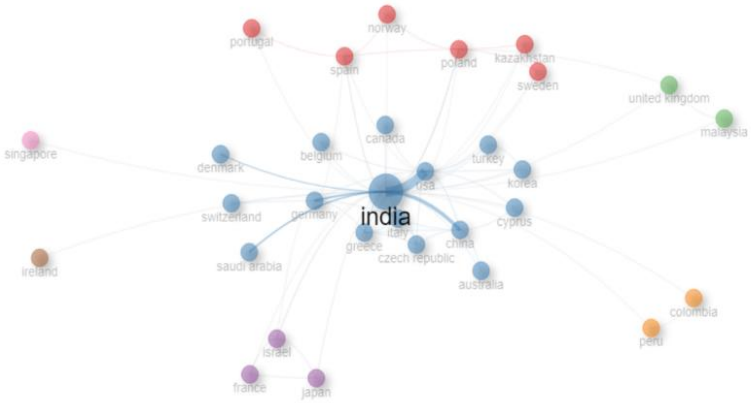

Figure 4: Countries' Collaboration of country

Three Plot diagram

The figure 5 graphifies the relations among authors, affiliations, and represented countries. On the first plot, individual authors, along with the affiliations, stand out as contributing leaders: there are Rana NK and Udayraj U at the Indian Institute of Technology Bhilai, for example. In the second plot, one is allowed to be plotted against his or her own country; here, for instance, an overwhelming dominance in the number of Indian researchers within a global landscape is vividly displayed. The last plot gives the output of different institutions in a particular country but focusing on the important contributions of IIT Bhilai among others. Together, these plots give a holistic view of the collaborative dynamics in research, showing how authors and institutions from different countries engage in scientific inquiry and innovation.

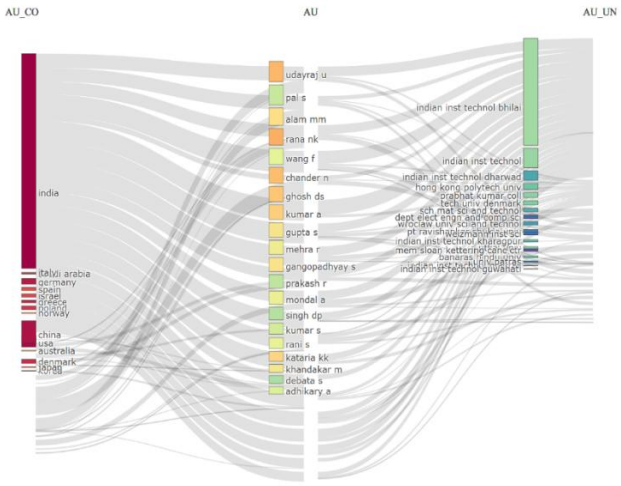

Figure 5: Three Plot diagram

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Most Frequent Words

The figure 6 identifies the major keywords occurring frequently in the research literature, reflecting the main topics and inquiry areas in the field. The words "performance," "temperature," and "prediction" indicate a strong focus on evaluating and optimizing systems, likely in the context of scientific or engineering applications. The existence of words such as "efficiency" and "model" suggests that the research emphasizes the creation of frameworks and methodologies towards improving operational effectiveness and predictive capabilities. The existence of terms like "stability," "system," and "nanoparticles" further indicates increasing interest in materials science and nanotechnology, hence indicating that this is an interdisciplinary study. The frequency of such words will only portray the general trends and priority areas of academic discourse but serve as a guidance for researchers regarding which areas must be focused on to be researched and innovated. Overall, this section comprises the core subjects driving research endeavors and underlines the changing trends of scientific discovery.

Figure 6: Most Frequent Words

Conclusion

It has thoroughly examined the publications related to research in issues concerning SDGs that appeared between 2017 and 2024 in IIT Bhilai. It found implications indicating IIT Bhilai has been intensively engaged with the global agenda of SDG research output and volume and has had its influence increasing gradually and powerfully in the analyzed period. IIT Bhilai has shown constant efforts toward solving problems pertinent to sustainability around the globe through research at a growth rate of 54.78% with an average citation rate of 10.24 per document. International collaboration has also been heavily represented wherein the research by IIT Bhilai had international collaboration as the co-author for 35.06% of its research works. This reflects the active participation of the institution in global research networks and its contribution to the

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knowledge exchange across borders. Moreover, the thematic focus of the research at IIT Bhilai reflects a diversified and interdisciplinary approach, covering a wide range of SDGs, though some areas call for further exploration. Trends of citations and key authors and affiliations reveal that IIT Bhilai has a high academic presence, which can significantly influence national as well as global SDG agendas. The institute's research output places it among the most significant entities in shaping the future of sustainable development through innovation, knowledge creation, and collaborative efforts. Lastly, the contributions of IIT Bhilai, in the context of this SDG, advance academic outcomes and are part of the larger march toward alignment with global sustainability goals. Findings here will help inform research strategy in the years ahead, provide still greater collaboration that can facilitate further policy development, and make IIT Bhilai a leader in facing the big sustainability challenges it addresses for the world.

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Integrating Ethical Awareness, Sustainability and Innovation in Education to Prepare Future-Ready Professionals

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Abstract

In the changing world of education, technology is the future of education. The attempts to incorporate open-platform tools into education have been made by technology companies in collaboration with leading universities globally. As design education aims to make learning easier and offer new ideas and methods, there is evidence that digital tools used among students are increasing rapidly at present.

This study integrates these developments by using a mixed-method approach, as the research proposes a framework that supports the development of designers who are prepared to engage with the complex challenges of the future by integrating ethical awareness, sustainability, and innovation into teaching and learning ideas.

Overall, the findings aim to show that a balanced focus on ethics, sustainability, and innovation can help educators and policymakers align design programs with the needs of a more forward-looking future. The guidance provided by teachers forms a strong foundation for teaching sustainable design using proven tools, methods, and ways of thinking that reflect real-world practice. This approach helps designer's champion and practice social responsibility to meet the needs of future-ready professionals.

Key words: ***Ethical Awareness, Sustainability, Innovation, Education, Future-Ready Professionals***

Introduction

The accelerating pace of technological advancement, globalisation, and sustainability challenges has significantly reshaped the expectations placed upon higher education institutions. Today's professionals are required not only to

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possess technical expertise but also to demonstrate ethical sensitivity, creative problem-solving, and a deep understanding of sustainable practices. As educational systems evolve, there is a growing recognition that traditional disciplinary knowledge alone is insufficient for navigating the uncertainties of the twenty-first century. Consequently, universities and professional institutions worldwide are redesigning curricula to integrate ethical awareness, sustainability literacy, and innovation-driven learning, thereby preparing students to become responsible, future-ready professionals ***(UNESCO, 2017; OECD, 2019).***

Design, commerce, management, and technology-related disciplines increasingly demand graduates who can critically evaluate the social, environmental, and economic impacts of their decisions. The use of digital technologies, open-source tools, and contemporary pedagogical innovations has further expanded opportunities to foster holistic learning. The rapid diffusion of digital tools has been particularly transformative in design and management education, where interactive platforms, simulation tools, and collaborative software facilitate experiential and problem-based learning ***(Kuo et al., 2014).***

Ethical education aims to develop students' moral reasoning, professional values, and capacity to make responsible decisions in complex real-world situations ***(Bielefeldt et al., 2016).***

Similarly, sustainability education seeks to enable learners to understand global challenges, adopt long-term thinking, and cultivate competencies required to address issues such as climate change, resource depletion, and social inequity ***(Wiek et al., 2011; Mulder, 2014).***

Innovation-focused education encourages creativity, experimentation, and entrepreneurial thinking—skills that are increasingly essential for navigating emerging markets and rapidly changing industries ***(Kumar & Shekhar, 2020).***

Integrating these three critical domains into pedagogy forms the foundation for preparing graduates who are adaptable, socially responsible, and capable of contributing to a more sustainable and inclusive future. This research paper explores how ethical awareness, sustainability, and innovation can be effectively incorporated into teaching-learning frameworks to enhance professional readiness. The study employs a mixed-method approach to examine the perspectives of educators and learners, and to propose a comprehensive framework for educational transformation.

Literature Review

Ethical Awareness in Higher Education:

Ethics in education has become increasingly prominent as institutions seek to instill responsibility, integrity, and professionalism among learners. Studies highlight that ethical reasoning is not automatically developed through technical training; it requires explicit pedagogical interventions such as case studies, reflective practice, value-based discussions, and exposure to real-world dilemmas ***(Bielefeldt et al., 2016)***.

The **ACM (2018)** Code of Ethics emphasises the importance of integrating ethical understanding in technology- and design-related fields, where decisions often have widespread social implications.

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Schön's (1983) concept of the reflective practitioner underscores the role of structured reflection in building ethical and professional judgment. Through reflective learning, students critically examine their choices, biases, and assumptions.
Elias and Mittal (2011) further argue that moral development in education strengthens students' ability to engage responsibly in society and contributes to long-term professional credibility.

Sustainability Education and Competency Development:

Sustainability has emerged as a core component of global education systems, driven by frameworks such as the *UN Sustainable Development Goals* and UNESCO's Education for Sustainable Development ***(UNESCO, 2017).***

Wiek et al. (2011) identified key sustainability competencies—systems thinking, anticipatory competency, normative competency, strategic competency, and interpersonal competency—which enable learners to address complex sustainability challenges.

Sterling (2010) emphasises transformative learning for sustainability, proposing that students must shift from content-based learning to systemic understanding and long-term thinking.

Mulder (2014) highlights the importance of strategic sustainability responsibility within curricula, indicating that higher education institutions must move towards holistic approaches rather than isolated sustainability modules.

Vezzoli and Manzini (2008) provide insights into sustainable design principles, emphasising eco-design, life-cycle thinking, and environmentally responsible innovation. Their work demonstrates the relevance of sustainability in fields such as product design, architecture, management, and engineering. Research also indicates that integrating sustainability into educational frameworks enhances students' employability by aligning learning outcomes with global industry expectations ***(Rieckmann, 2012).***

Innovation in Teaching and Learning:

Innovation in higher education is driven by technological advancements, new learning models, and the need for agility in fast-changing professional environments. ***Kuo et al. (2014)*** illustrate how digital platforms significantly improve learner engagement, satisfaction, and collaboration, especially in online and blended learning environments. The adoption of open-source tools and interactive technologies has enabled more personalised and experiential learning experiences. ***Papanek (1985)*** famously argued that design education must incorporate socially responsible innovation to address real-world needs rather than focus solely on commercial outcomes. Modern research supports this idea, advocating for pedagogies that foster creativity, prototyping, interdisciplinary collaboration, and problem-solving ***(Kumar & Shekhar, 2020).*** Innovation-focused learning involves cultivating curiosity, promoting experimentation, and encouraging risk-tolerant behaviour. Studies suggest that integrating innovation with ethical and sustainability frameworks ensures that creativity is directed towards socially and environmentally beneficial outcomes, not merely technological advancement.

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Integrating Ethics, Sustainability, and Innovation:

Recent research indicates that holistic educational models combining ethical reasoning, sustainability competencies, and innovation capacities are essential for producing future-ready professionals who can respond to global challenges *(OECD, 2019)*. Educators are increasingly recognising the interconnectedness of these domains, noting that ethical innovation ensures responsible technological development, while sustainability-driven thinking promotes long-term value creation. ***Digranes and Fauske (2010)*** propose that design education must prepare students to become reflective citizens, highlighting the need for pedagogical frameworks that integrate social responsibility, environmental awareness, and creative problem-solving. This integrated perspective forms the basis for developing new curriculum frameworks that equip students with comprehensive professional competencies.

Research Methodology

Research Design: The study uses a simple mixed-method approach, combining both quantitative and qualitative data to understand how ethics, sustainability, and innovation can be integrated into education.

Sample: A total of 80 respondents (40 faculty members and 40 students) were selected through convenience sampling.

Data Collection:

- **Primary Data:** Collected using a **structured questionnaire** based on a 5-point Likert scale.
- **Secondary Data:** Collected from books, research articles, reports (UNESCO, OECD, ACM), and online sources.

Tools for Analysis: Simple statistical tools were used for analysis, including the *mean* to find average responses, the *median* to identify central patterns, the *weighted average* to measure overall attitudes based on *Likert scale* values, and *percentage analysis* to compare the distribution of responses.

Data Interpretation: Responses were summarised and analysed theme-wise (Ethical Awareness, Sustainability, and Innovation). Qualitative comments were reviewed using simple content analysis.

Limitations: The study has certain limitations, including a small sample size, the use of convenience sampling, and the possibility that some responses may reflect personal bias.

Ethical Consideration: Participants were informed about the purpose of the study, and their participation was voluntary. No personal identifying information was disclosed, ensuring confidentiality.

Data Analysis and Interpretation

Table 1: Ethical Awareness – Descriptive Statistics

Statements on Ethical Awareness	Mean	Median	Weighted Average
EA1: Teachers promote honesty and integrity	4.20	4	4.25
EA2: Ethical case studies	4.00	4	4.05

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are included in teaching			
EA3: Students feel encouraged to behave responsibly	4.10	4	4.12
EA4: Ethical values help in professional development	4.15	4	4.18

(Source: Primary Data)

Interpretation: All statements have mean scores above 4, indicating strong agreement. Respondents agree that ethics is consistently promoted through teaching practices, discussions, and classroom behaviour. Ethical awareness is perceived as an important part of professional preparation.

Table 2: Sustainability Education – Descriptive Statistics

Statements on Sustainability	Mean	Median	Weighted Average
S1: Curriculum includes sustainability concepts	3.75	4	3.78
S2: Students learn about environmental responsibility	3.90	4	3.95
S3: Teachers encourage sustainable practices	3.80	4	3.85
S4: Sustainability is linked with real-world problems	3.95	4	4.00

(Source: Primary Data)

Interpretation: The scores range between 3.75–3.95, showing moderate to high agreement. Respondents value sustainability education but believe institutions can provide stronger integration through projects, fieldwork, and discussions on global challenges.

Table 3: Innovation in Teaching–Learning – Descriptive Statistics

Statements on Innovation	Mean	Median	Weighted Average
I1: Teachers use digital tools and technology	4.25	4	4.30
I2: Innovative teaching methods improve learning	4.30	4	4.35
I3: Students enjoy creative and practical activities	4.10	4	4.15
I4: Institution supports innovation-driven learning	4.15	4	4.20

(Source: Primary Data)

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Interpretation: This dimension shows the highest overall scores. Respondents strongly believe innovative tools and methods make learning more engaging and effective. There is clear support for digital learning, project-based learning, and open-source tool adoption.

Table 4: Combined Dimension Summary

Dimension	Overall Mean	Overall Median	Overall Weighted Average
Ethical Awareness	4.11	4	4.15
Sustainability Education	3.85	4	3.90
Innovation in Teaching–Learning	4.20	4	4.25

(Source: Primary Data)

Interpretation: The results show that innovation received the highest scores, indicating strong acceptance of modern, technology-enabled teaching. Ethical awareness ranked second with consistently high acceptance, while sustainability scored slightly lower, suggesting the need for stronger and deeper integration into the educational system.

Findings, Conclusion and Recommendations

Findings: The study found strong support for ethical awareness among both faculty and students, who agreed that honesty, integrity, and responsible behaviour are regularly promoted in classrooms. Ethical discussions and case studies are viewed as helpful in shaping future-ready professionals. Sustainability education received moderate support; while concepts are included in the curriculum, practical and experiential activities remain limited, indicating a need for deeper integration. Innovation in teaching emerged as the strongest area, with respondents appreciating digital tools, interactive methods, and technology-enabled learning. This shows that institutions are increasingly adopting innovative teaching practices that enhance student engagement and prepare them for future professional demands. The study reveals that *integrating ethical awareness, sustainability, and innovation has a strong positive impact on preparing future-ready professionals*. Innovation is currently the strongest area, while sustainability needs further strengthening.

Conclusion:

In conclusion, the research demonstrates that a balanced integration of ethical awareness, sustainability, and innovative teaching practices is crucial for producing future-ready graduates. Ethical education builds strong moral reasoning and professionalism, sustainability fosters long-term thinking and social responsibility, while innovation ensures that students receive engaging, relevant, and practically oriented learning. The combined effect of these three components forms a holistic educational framework capable of preparing learners to meet the complex challenges of the modern world. Together, these three components create a holistic educational framework that prepares students to face complex future challenges. The study reinforces the need for multidisciplinary, technology-enabled, and value-driven education in shaping future-ready graduates.

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Recommendations:

Based on these findings, several recommendations are proposed. Institutions should incorporate structured modules on ethics, sustainability, and innovation across academic programs, while also providing necessary training to faculty members on modern teaching methods and digital tools. Partnerships with industries, NGOs, and sustainability-focused organisations can further strengthen real-world learning opportunities. Teachers are encouraged to incorporate ethical case studies, reflective discussions, and sustainability content into their classroom practices while adopting innovative methods such as multimedia tools and experiential learning. Students should actively engage in sustainability clubs, innovation labs, and community outreach activities while cultivating personal values such as honesty, responsibility, and creativity. For policymakers, the study suggests the need to promote competency-based education frameworks and provide funding support for innovation and sustainability-related initiatives within educational institutions.

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Integrating Ethical and Spiritual Leadership into Management Education: A Framework for Developing Purpose-Driven Business Leaders

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Abstract:

Contemporary business challenges have underscored the need for purpose-driven leaders who not only follow rules but also find meaning in their work. Ethical leadership – the modeling of honesty, fairness, and accountability – provides a structure for "doing the right thing," while spiritual leadership – emphasizing personal purpose, calling, and altruistic love – adds the motivation of "why it matters." This paper proposes an integrated framework for embedding both dimensions in management education. Drawing on transformational and social learning theories, we argue that leaders learn values through role models who both exemplify integrity and inspire a shared vision. Experiential and reflective pedagogies (e.g. service projects, mindfulness practice, values dialogues) can then make these lessons personally salient. We review current practices and case examples (e.g., NYU Stern's Mindfulness in Business program[1]) and identify common barriers – notably faculty discomfort with "spiritual" content and crowded curricula[2][3]. Finally, we outline future research paths, especially longitudinal studies tracking graduates' long-term impact and cross-cultural comparisons of how values education plays out in different contexts[4][5]. By integrating ethics and spirituality, educators can cultivate graduates who not only do things right, but also do the right things for meaningful reasons.

Keywords: ***Ethical leadership; Spiritual leadership; Management education; Purpose-driven leadership; Curriculum integration***

Introduction

In today's volatile business environment, managers face complex dilemmas that call for **more than technical skill** – they need a strong moral compass and a sense of higher purpose. High-profile scandals (e.g.

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Enron, WorldCom) have highlighted the limitations of a values-neutral MBA curriculum and prompted accrediting bodies (AACSB, PRME) to urge business schools to strengthen ethics education. *Ethical leadership* – broadly defined as leaders' demonstration and promotion of normatively appropriate conduct (fairness, trustworthiness, care for stakeholders)[6][7] – has become central to organizational success. However, ethical leadership alone may not satisfy today's students, who increasingly seek work that is **meaningful** and "makes a difference." *Spiritual leadership*, in contrast, emphasizes intrinsic motivation and connection to a higher purpose; Fry (2003) describes it as a vision- and values-centered approach that uses hope/faith and altruistic love to help people find calling and membership in their work[8]. In essence, ethical leadership ensures *doing the right thing*, while spiritual leadership ensures *being inspired by why* it is right.

Management education has traditionally taught ethics as a compliance add-on (e.g. a single required course), and has largely ignored students' inner values or sense of purpose[9][2]. This fragmented approach is now being questioned. Many scholars and educators propose that **integrating** ethical and spiritual dimensions can foster *purpose-driven leaders* – individuals who align organizational goals with stakeholders' and society's well-being, guided by both conscience and inspiration (Lips-Wiersma & Morris, 2009; Ribeiro et al., 2024). This paper offers a conceptual model and practical guidance for such integration in business curricula. First, we survey relevant theory (transformational, social learning, moral development, experiential learning) to show how ethics and spirituality complement each other. Next, we examine current curricula and identify best-practice examples of integration. We then address **implementation challenges** – especially *faculty readiness* – and recommend strategies to overcome them. Finally, we discuss future research directions, particularly the need for longitudinal impact studies and cross-cultural comparisons. Our goal is to provide educators with an evidence-based roadmap for teaching students not just *what* is right, but *why* it matters (Brown, Treviño, & Harrison, 2006).

Ethical and Spiritual Leadership Foundations

A conceptual framework for purpose-driven leadership starts by combining ethical and spiritual leadership concepts. Ethical leadership research (Brown et al., 2006; Treviño et al., 2000) emphasizes *role modeling* of integrity: leaders clarify ethical standards and consistently **"walk the talk,"** which builds trust and an ethical climate[6]. Ethical leaders prioritize justice and stakeholder interests in decision-making, reinforcing a culture of transparency and accountability. Their impact on followers is well-documented: subordinates report greater trust, higher job satisfaction, and reduced misconduct under ethical leaders (Brown et al., 2006; Babalola et al., 2019).

Spiritual leadership theory (Fry, 2003) focuses on leaders' capacity to foster meaning and calling. This approach integrates a compelling vision and caring culture so that followers find personal purpose in their work[8]. Empirical studies link spiritual leadership to enhanced follower well-being, commitment, and a sense of community[10][11]. It often

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overlaps with concepts like servant leadership or workplace spirituality, stressing inner development and compassion. Crucially, while ethical leadership stresses *external* norms and duties, spiritual leadership addresses *internal* motivations (values, hope, love)[12].

The synergy of these perspectives lies in combining moral rigor with personal inspiration. Conceptually, ethical leadership provides the **"guardrails"** of right action, while spiritual leadership supplies the **"fuel"** of purpose (Sama & Shoaf, 2008). Both models share concern for altruism and stakeholder welfare: ethical leaders act from duty and justice, while spiritual leaders act from love and calling. For example, Ahmed (2024) finds that embedding Islamic values into ethics training cultivated deeper moral responsibility among Egyptian executives[13]. In practical terms, a leader who consistently makes ethical decisions and also communicates a higher calling can profoundly motivate teams. This integrated view suggests that management educators should teach not only *how* to solve ethical problems, but also *why* those solutions matter to one's values and vision.

Pedagogical Approaches for Integration

Theories of learning support an education that blends ethics and spirituality. Transformational leadership theory (Burns, 1978; Bass, 1985) is particularly relevant: it posits that leaders (or educators) inspire followers by articulating a compelling vision (idealized influence and inspirational motivation). In our framework, transformational teaching means instructors model integrity while simultaneously encouraging students to reflect on personal values and future goals[14][15]. This dual approach (ethical exemplar + meaning-making) can elevate students' motivations to serve the common good.

Bandura's social learning theory (1977) underpins the importance of *faculty role models*. Students absorb norms and ethics by observing consistent behavior. Instructors who **embody** ethical-spiritual values (for example, by acknowledging their own decision-making struggles or demonstrating empathy) create powerful teachable moments[16][2]. This highlights the need for faculty development: educators must feel comfortable discussing values and must **practice** integrity in the classroom, or else students will not fully internalize the lessons.

Moral development theory (Kohlberg, 1981) encourages structured reasoning about ethics (case studies, codes of conduct). However, Kohlberg noted that higher moral stages also require emotional and identity growth. Here, spiritual elements become motivators. For instance, service-learning or immersion projects that connect course material to students' own values can make abstract ethical principles personally salient (Kohlberg, 1981). As one model suggests, combining cognitive ethical reasoning with reflective exercises (value clarifications, narrative storytelling) can facilitate progression to principled conscience[15].

Finally, experiential learning (Kolb, 1984) offers a practical method: concrete experience followed by reflection enables students to **live** ethics. Simulations, role-plays, and community projects force students to confront dilemmas and reflect on emotional responses. For example, after a financial ethics simulation, students might debrief not only on rules but also on

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how decisions aligned with their own vision of leadership. Mindfulness exercises or reflective writing can be embedded in these cycles to ensure students connect lessons to purpose. In sum, combining these approaches results in a curriculum where students are shown *why* ethics matter (through values reflection) and *how* to apply them (through practice) simultaneously.

Implementation Challenges and Faculty Readiness

Challenges: Integrating ethical-spiritual content across a management curriculum faces several **practical hurdles**. First, there is the perennial issue of **space**: most MBA programs are already packed with functional and technical courses. Faculty consistently report that adding new topics (like spirituality or values) can feel burdensome given limited contact hours[2]. Time constraints and accreditation mandates often relegate ethics to one course or a lecture module, rather than a continuous theme. Second, many instructors are **uncomfortable** addressing spirituality. Surveys of faculty have found mixed attitudes: while many acknowledge the value of holistic development, they fear being seen as "proselytizing" or too "touchy-feely" in a business context[2][17]. Some worry that discussing personal beliefs or purpose crosses a line in a secular classroom. Third, there are questions of *academic rigor*: business professors trained in analysis may doubt how to teach "values" rigorously. As one study notes, if ethics is treated as mere "gut instinct," students miss the structured reasoning they need[18].

Faculty readiness: Successfully addressing these challenges requires **preparing and supporting faculty**. Instructors need training, resources, and cultural encouragement to teach ethical-spiritual topics. Best-practice cases illustrate effective strategies. For example, some schools conduct faculty workshops where even finance or marketing professors practice integrating ethical dilemmas and reflective questions into their cases[19][3]. Programs like the Aspen Institute's *Business & Society* initiative provide seminars on pedagogies such as Mary Gentile's *Giving Voice to Values*, helping educators learn how to facilitate values discussions (Aspen Institute, 2019)[3]. Institutions that allocate resources to this effort see smoother integration: hiring a director of ethics, funding retreats for instructors, or including value-oriented teaching in faculty evaluations[3]. Peer networks (e.g. PRME working groups) also help faculty share methods. In summary, while most educators welcome deeper ethics education, they often need guidance: training workshops, curricula "toolkits," and institutional incentives are critical for readiness[3][20].

Challenges and support needs can be summarized in a structured way:

Curricular Fit: Finding room in the schedule and aligning with accreditation requirements[2].

Faculty Comfort: Overcoming hesitancy about religion/spirituality, and ensuring instructors feel competent[2][17].
Resource Allocation: Providing time, funds, and expertise for new modules or courses[3].

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Pedagogical Guidance: Offering training (e.g. faculty development workshops) and sharing best practices in values-based teaching[3].

Real-World Examples of Curriculum Integration

Despite these obstacles, **several business schools have pioneered integrative curricula**. These programs offer concrete models that others can adapt:

- **NYU Stern (Mindfulness in Business):** Perhaps the best-known example is Stern's *Mindfulness in Business (MiB)* initiative[1]. Launched through Stern's leadership development program (in partnership with NYU's Spiritual Life office), MiB introduced meditation, mindful pauses, and reflective workshops for MBA students. In the first year, hundreds of students and faculty participated in courses and events. Survey feedback showed that students gained emotional resilience and reported that mindfulness enhanced both their performance skills and ethical awareness[1]. This case demonstrates that even traditional finance and marketing classes can include brief mindfulness practices to help students connect goals with values. (For details, see Kim & Shy, 2015[1].)
- **Value-Driven Curricula (Giving Voice to Values, Aspen):** Programs like Mary Gentile's *Giving Voice to Values* (GVV) have been incorporated at many schools. GVV is a pedagogical framework (originating from UVA Darden) that teaches students to articulate and enact their values when facing dilemmas. Institutions using GVV create role-play exercises and case discussions where students practice how to speak up for ethics in simulated corporate situations (e.g. whistleblowing)[21][3]. Similarly, the Aspen Institute's *Business & Society International MBA Case Competition* and faculty workshops help integrate sustainability and stakeholder discussions into core courses. These initiatives equip students with *tools* (scripts, frameworks) for values-based action, complementing theory with practice.
- **Mindfulness Across the Curriculum (AACSB Guidelines):** Professional bodies like AACSB advocate weaving mindfulness and ethics into many subjects. For example, an AACSB article recommends that business schools integrate mindfulness concepts into courses on leadership, communication, HRM, and analytics, rather than confining them to electives[22]. Electives or short retreats can also be offered. For instance, in faculty-led programs, students may practice breath-awareness or compassionate listening in class. By not labeling it explicitly as "spirituality," schools can frame these practices as emotional intelligence or self-management skills – yet they foster the same qualities (empathy, focus, ethical awareness) that underpin spiritual leadership[22].
- **Jesuit and Values-Oriented Institutions:** Many faith-

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affiliated or mission-driven schools exemplify this integration organically. For example, Santa Clara University and Fordham University (Jesuit institutions) have leadership courses that explicitly address purpose, community, and service as core to business success. These programs blend discussions of personal values (often drawing on religious or philosophical texts) with case analyses of ethical business practices. Likewise, the *Principles for Responsible Management Education (PRME)* network includes hundreds of signatory schools that share models of teaching sustainability, human dignity, and global stewardship. These institutions often embed service-learning projects or reflective seminars into required courses, so that values are discussed alongside finance or marketing topics.

In practice, these examples share common features: they introduce **purpose and self-awareness modules** into existing courses, offer **electives or workshops** on mindfulness and meaning (often co-taught with campus religious/spiritual centers), and provide **experiential learning** (community projects, simulations) that tie ethics to personal mission. Table 2 (below) profiles some institutions. Collectively, they show that purpose-driven education is feasible and sought after.

Future Directions and Conclusion

Our review suggests many avenues for further inquiry. **Longitudinal studies** are needed to measure how integrated ethics/spiritual curricula affect graduates over time. For example, Fletcher-Brown et al. (2012) conducted a longitudinal study of ethics education, finding that baseline moral reasoning correlated with student behavior in simulations; similar research could track alumni into their careers to see if early values training leads to ethical leadership outcomes. **Cross-cultural research** is also critical. Spiritual and ethical norms vary globally – Ahmed (2024) notes that in Egypt, Islamic spiritual values strongly shape leadership ethics[5]. Comparative studies could explore how curriculum design should differ in Western versus non-Western contexts or in secular versus religious universities[4][5].

Other future directions include developing validated measures for **"purpose-driven leadership."** Currently, few instruments capture the combination of ethical orientation and sense of calling. Scholars could create surveys or 360° assessments that evaluate students' stakeholder empathy, integrity, and personal mission. Finally, **action research** (pilot interventions) would provide practical insights. Educators might implement our proposed curriculum components (Table 3) at a school and document outcomes and challenges. This iterative evaluation (with student feedback) could generate best practices for pedagogy and institutional change[23].

In sum, integrating ethical and spiritual leadership into management education holds promise for cultivating leaders who are both **competent and compassionate**. Our framework and case examples offer concrete steps: embed value-clarification and mindfulness exercises in courses, train faculty to guide reflective dialogue, and create experiential projects that link

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business concepts to social purpose. Institutions that commit to this path can produce graduates who not only follow rules, but also champion a meaningful vision for business. As one reviewer noted, the ultimate goal is to align "head and heart" – developing managers who act with conscience and conviction. The payoff could be significant: firms led by such individuals may advance not only profit, but also the well-being of communities and the planet[4][24]. Our proposed integrative model is a starting point. Ongoing research and practice will refine it, but the direction is clear: management education must evolve to prepare leaders of integrity *and* inspiration for the 21st century.

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Views Of Youth On Sustainable Fashion With Special Reference To Females

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Abstract

Sustainable fashion is not a trend; it is a way of designing the styles of positive future demands. Sustainable fashion also called eco-fashion is a part of the growing design philosophy and trend of sustainability the goal of which is to create a system which can be supported indefinitely in terms of environmentalism and social responsibility. It means creating and consuming clothes to ways that manage environmental and social harm, considering the entire product lifestyle from material to disposal. The main objective of study is to analyze the level of awareness of youngsters regarding Sustainable fashion because they are leaders of fashion and to bring a good change in the current and future fashion industry, for this research instrument used in this detailed questionnaire having question regarding the views of youth (19-25) of Durg- Bhilai, Raipur on Sustainable fashion with special reference to females, various instruments to females, various instruments were Google forms, mailed questionnaire responses are very positive. 90% of the respondents are interested to promote Sustainable fashion.

Keywords - ***Sustainable Fashion, Eco-Fashion, Youth Awareness, Environmental Sustainability, Fashion Consumption Behavior***

Introduction

Sustainable fashion refers to clothing that is designed, manufactured, distributed, and used in ways that are environmentally friendly.

Sustainable fashion is a movement and process of fostering change to fashion products and the fashion system towards greater ecological integrity and social justice. Sustainable fashion concerns more than just addressing fashion textiles or products. It addresses the entire manner in which clothing is produced, who produces it, and how long the life span of a product is before it reaches the landfill.

This sustainable movement combats the large carbon footprint that the fashion industry and fast fashion have created by reducing greenhouse gas emissions. Reducing the environmental impact of fashion can combat air pollution, water pollution and overall climate change that could possibly prevent millions of premature deaths over the next century.

Sustainable fashion is about meeting today's needs while ensuring that the way we go about meeting those needs meet future needs as well. Sustainable fashion brands create fashion in a way which is most considerate of humanity and the

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environment, reducing the environmental impact wherever possible. The ultimate goal is to have a system which works without leaving a negative footprint.

Definitions

According to several sustainable fashion experts, this is the most accepted definition to date:

Sustainable fashion is an all-inclusive term describing products, processes, activities, and actors (policymakers, brands, consumers) aiming to achieve a carbon-neutral fashion industry, built on equality, social justice, animal welfare, and ecological integrity.

According to Wikipedia, the definition of sustainable fashion (also defined as Eco-fashion and Re-fashion) is:

a movement and process fostering changes to products and the fashion system, pushing towards greater ecological integrity and social justice. Sustainable fashion concerns more than just addressing fashion textiles or products.

According to a study in the Journal of Fashion Marketing and Management, sustainable fashion is comprised of:

local sourcing and production, transparency across the supply chain, traceability of work processes and raw materials, environmentally friendly raw materials, safe working conditions, and fair wages.

Why Is Sustainable Fashion Important

Sustainable Fashion Creates Less Waste

Globally, there's one garbage truck of textile waste dumped at a landfill or burnt every second. This enormous amount of waste is created by fast fashion companies that launch weekly fashion trends and fulfill them with poor quality cheap price products. In comparison, sustainable brands focus on clothing quality products from long-lasting materials. Moreover, sustainable fashion brands rarely follow fast fashion trends.

Sustainable Fashion Saves Natural Resources

A study from 2015 shows that 97% of what goes into making clothes are new resources, with only 3% of it being recycled materials. This adds up to an annual resource input of 98 million tons including oil to produce synthetic fibers, fertilizers to grow cotton and an endless list of chemicals needed to dye & finish fabric.

Recycled fibers have proven to be a much more sustainable option, as they reduce pressure on virgin resources and tackle the growing problem of waste management. As a reference, for every 10,000 tons of ECONYL raw material used for our swimwear, 70,000 Barrels of Oil & 57,100 tons of Co2 are saved compared to the production of virgin nylon.

Sustainable fashion Reduces Carbon Footprint

The global fashion industry emits a hefty amount of greenhouse gases per year, thus contributing massively and actively to global warming. One of the reasons is that the vast majority of our beloved clothes are petroleum-based and made from fossil fuels, including polyester, acrylic & nylon. These materials require significantly more energy in the production phase than natural or recycled fibers.

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Sustainable brands on the other side often use materials from natural or recycled fabrics that require significantly less to no chemical treatment, little water, less energy and no fertilizers or pesticides to grow. Most organic fabrics such as linen, hemp, organic cotton & TENCEL (made from sustainable wood pulp) are even biodegradable. These environmentally-sound fabrics go easy on the planet and are amazing sustainable alternatives.

Sustainable Fashion Saves Animal Lives

Animals are a vital part of our ecosystem, each playing a key role in ensuring that Earth is habitable. As such, any threat to wildlife and other animals' safety should be a concern to us all.

Leather bags, shoes, fur coats, and other goods made from animal leather, feathers, and wool, affect animal populations and, thus, the survival of humanity on this planet.

In comparison, sustainable clothing brands (cruelty-free and vegan) protect animals by using leather and fur alternatives in their products, saving animals from exploitation and death while preserving the ecosystem's balance.

Sustainable Fashion Saves Water

The fashion industry is one of the largest water consumers in the world right now. The water is consumed not only for washing garments but also during manufacturing, in dyeing, and finishing processes. Just to put that into perspective, it takes about 2,720 liters of water to make one cotton shirt and a whopping 7,000 liters to make one pair of jeans!

On top of consuming water, clothing production impacts the environment by polluting freshwater with toxic chemicals that find their way into waterways.

In comparison, most sustainable fashion brands have "water on budget" policies that limit water usage during clothing production. Moreover, sustainable fashion prioritizes organic textiles made from linen, hemp, and organic cotton, that require little to no water during the production phase.

Sustainable Fashion Is Healthier For People & Planet

Fast fashion items often undergo a long and intense chemical process before ending up on our hangers. Around 8,000 different synthetic chemicals are used to dye, bleach and wet process garments. Those chemicals often cause diseases or even deaths among farmers and inflict serious birth defects on their children.

Some of these chemicals pose a real danger to our health as well, as our skin absorbs anything we put on it, including the chemicals in our clothes. Make sure to always wash new clothes before putting them on for the first time.

How To Achieve Sustainable Fashion:

* Low impact natural and organic materials:
Natural materials such as hemp, linen, cotton, silk, wool, leather, and cellulose fibers (i.e., synthetically made fibers originating from plant sources, including viscose, rayon, lyocell, etc.) are generally preferable over virgin, petroleum-derived synthetics like polyester, acrylic, and nylon.

This is because natural fibers are biodegradable and can compost cleanly back into the soil, unlike synthetic fibers

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that will not biodegrade and instead sit in landfills, continually leaching toxic chemicals and fumes.

That said, some natural materials are more sustainable than others, with hemp, linen, and organic cotton generally being among the most environmentally friendly. Some wools and plant fibers can even be grown in ways that are regenerative, meaning able to regenerate healthy soils and sequester carbon (which helps to combat climate change).As for cellulose fibers-while they come from plant-based origins, some are extracted from destructive harvesting that aggravate deforestation, while many are made in ways that produce toxic chemical byproducts in the manufacturing phase.

Recycled or dead stock materials:

Using pre-existing materials to create new clothing is always a great choice because it does not require the extraction of new resources from the Earth but rather makes the most use of materials that may otherwise go to waste.)

Eco-friendly dyes and Bluesign or OEKO-TEX certifications:

Whether natural fibers or synthetic ones, it's also important to consider the environmental impact of the dyes and textile treatment processes. Many dye and finishing processes involve egregious amounts of water and the use of toxic chemicals. Eco-friendly dyes include ones from digital printing that require less water, natural, plant-based dyes, and certified nontoxic dyes. We can also look for the Bluesign or OEKO-TEX 100 certifications.

Zero or low waste design:

A lot of waste in the fashion industry comes from cutting out patterns, so some sustainable fashion brands are designing patterns that result in zero wasted material instead.

In addition, brands may strive to minimize the amount of water and energy use from the manufacturing process; reduce waste by eliminating excessive plastic packaging when transporting from the manufacturer, to the warehouse, and to the customer; and/or ship in bulk and using recycled or biodegradable shipping materials.

Locally made clothes and ones made in renewable energy run facilities:

With all of the dyeing, sewing, and shipping involved, the fashion industry has a high carbon footprint

Some brands tackle this by making clothing closer to where it will ultimately be sold, rather than having to ship from overseas. Others lower their carbon footprint by installing solar panels and wind turbines to provide renewable power to their offices and factories. Support local makers that source fibers from the region and ones that produce their clothes in renewable energy powered facilities.

Second hand or durable clothes:

Instead of opting for fast fashion that is cheap and meant to be thrown away quickly, we can be a more sustainable fashion consumer by also responsibly caring for our clothes to prolong their lives or buying secondhand, which keeps clothes out of landfills for longer.

Buying higher quality, more durable

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clothing that we can envision ourself wearing again and again throughout the years (even if it's a little more expensive) helps as well, as it means that it may last in our wardrobe for longer.

Finally, taking good care of our clothes can make a big, positive difference as well, since much of the environmental impact (e.g., water and energy use) from our clothes' life-cycles may come from this care-taking stage.

Sustainable Fabric Material

- Eco friendly rubber from Algae
- Cruelty free leather from pineapple leaves
- Animal Free Wool Coconut Husks
- Cruelty free silk from Banana Stem
- Organic cotton from milk protein
- Bamboo
- Econyl
- Hemp
- Lines

Scope Of The Study:

Sustainable fashion is a movement within the fashion industry that aims to reduce textile waste and environmental depletion while increasing ethical treatments of workers.

The research was carried on youths from Bhilai and Raipur. I surveyed on my Project topic "Views of youth (19-25) on Sustainable fashion" with special reference to females through online sources Goggle form & Mailed Questionnaire.

We also aim to inspire and nurture our young generation to develop a future in sustainable fashion. No matter our youngsters are fashion consumers or they will become part of the fashion industry in the future, I hope that this research will help to move our future towards sustainability of fashion and to minimizing the industry's impact on the environment and our Earth,

Objectives Of The Study:

1. The objective of the study is to analyze the level of awareness of people regarding sustainable fashion.
2. To know the perspective of respondents regarding Eco-friendly clothing.
3. The key component of sustainable production is the replacement of harmful chemicals with environmentally friendly materials.
4. To measure the interest of the respondents to pay for sustainable fashion, if it cost higher than what they buy in normal cost.
5. To reduce the waste and resources consumption in the fashion industries.
6. To make aware the respondents regarding the negative consequences fashion industries has on the world.
7. To know youngsters views and opinion towards sustainable fashion.
8. To bring a good change in the current and future fashion industry.

Hypothesis:

Ho-To aware and let youngsters realize the current situation and negative impacts of fast fashion and the need to adopt eco-friendly clothing.

H.-Understand the buying behavior towards sustainable and eco-clothing.

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Research Instrument:

Research Instrument used in this detailed questionnaire having questions regarding the Views of youth (19-25) on Sustainable fashion with special reference to females, various instruments were:

1. Goggle forms
2. Mailed Questionnaire.

Sample Design And Size:

I have resorted to a study of sample areas selected on the basis of judgment and convenience. I have basically created a review poll on views on sustainable fashion and taken into consideration the youth (under 19-25) and females. On an average overall 330 respondents were reviewed for the research.

Data Collection Method:

The mode of collection of data was through group of smart phone people were sent a goggle form of mailed
and the replies were received for same.

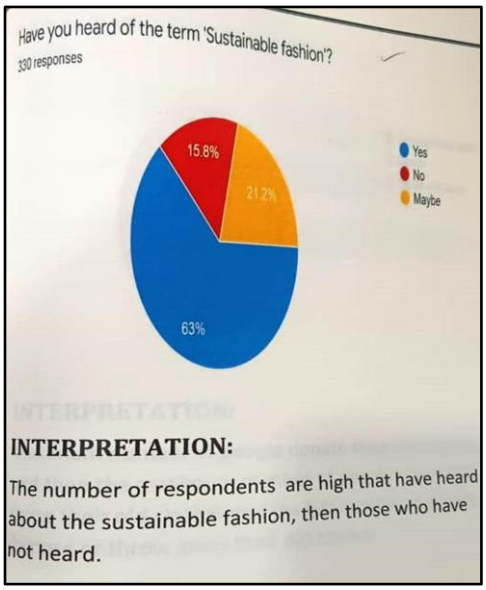
Tools For Data Analysis:

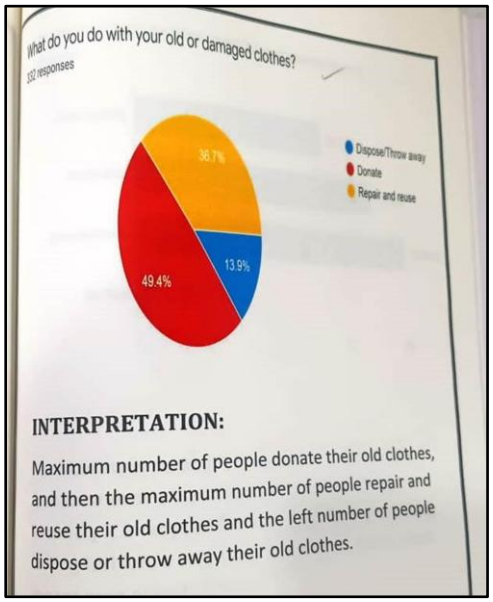
The tool used for analyzing the data was mean and also the average of the data was taken out and the result was out.

Limitations Of The Study:

* The research is based on the youth girls of age group 19-25 hence not reliable for every age group.
* The research is based on the students from colleges of Bhilai, Durg and Raipur city hence are not reliable for country terms.
* Some of the respondents are not aware of the term 'sustainable fashion'.
* It takes much time to review and project timings are limited.
* Some of the respondents are not sincere and careful while giving their views on sustainable fashion.

Analysis And Interpretation





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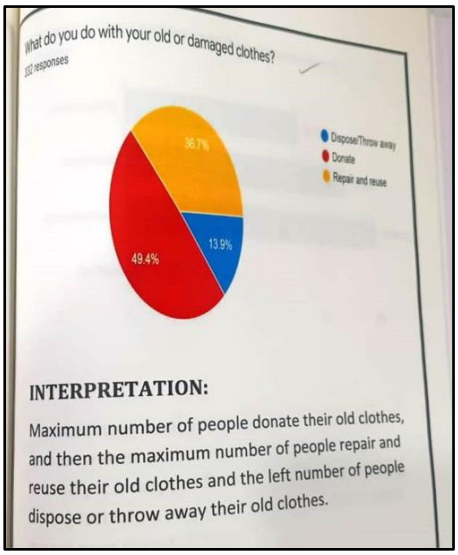

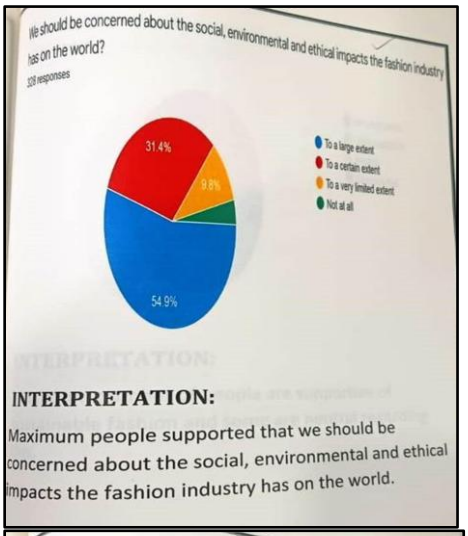

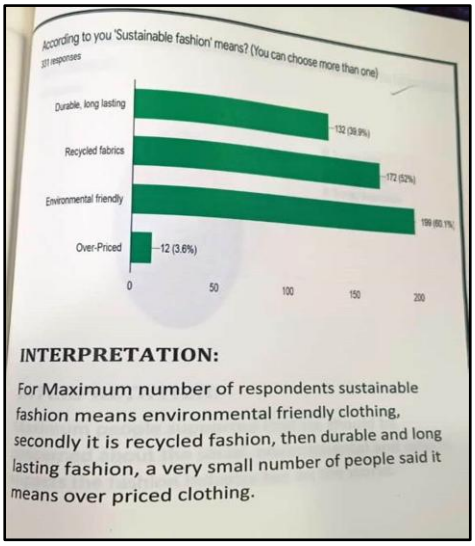

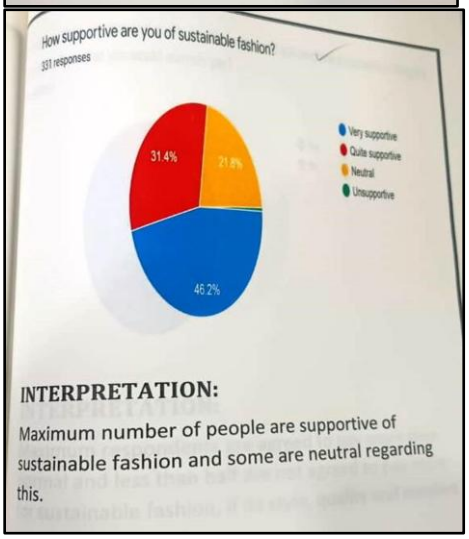

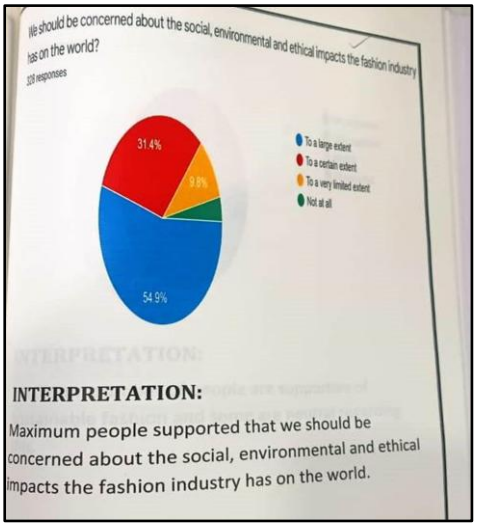

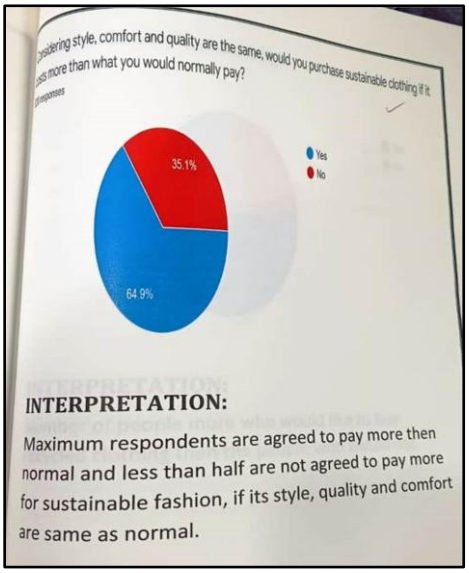

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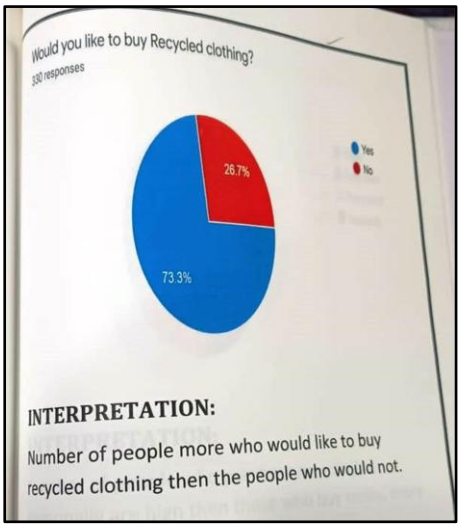

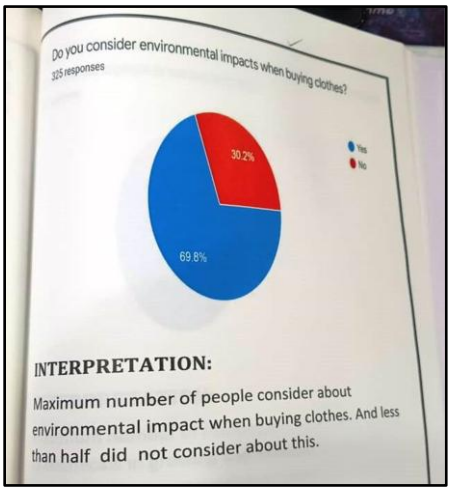

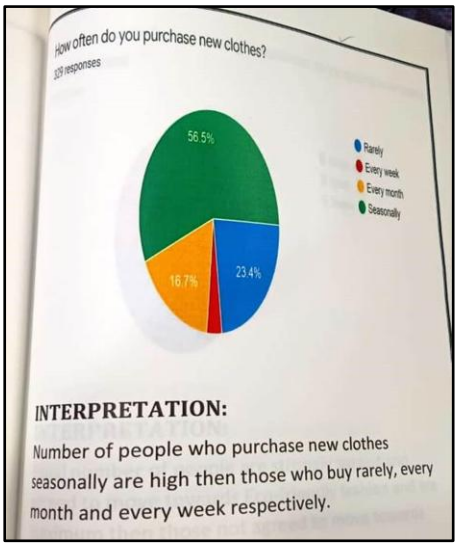

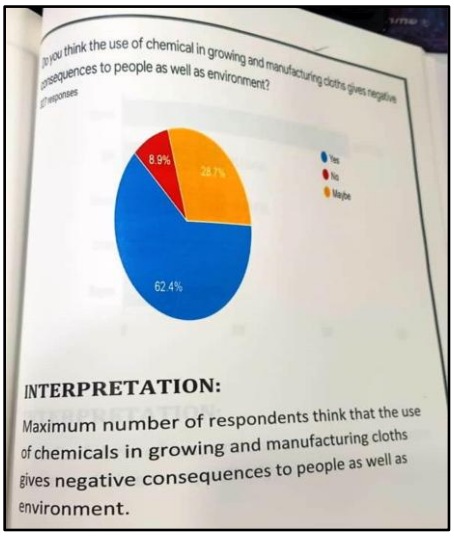

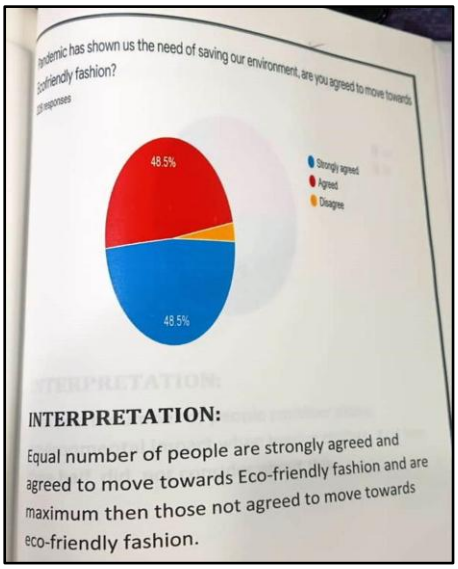

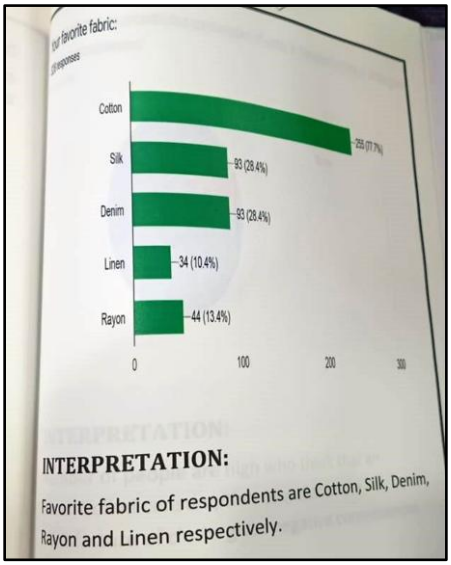

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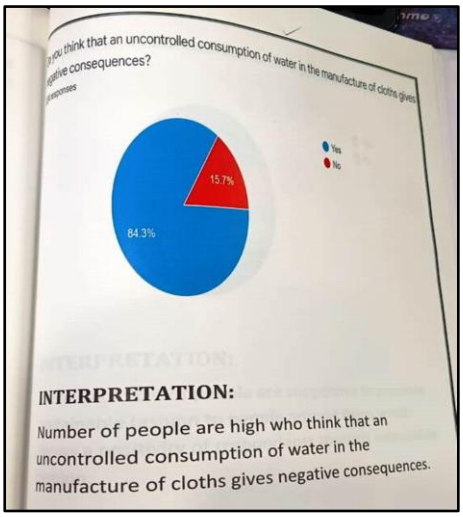

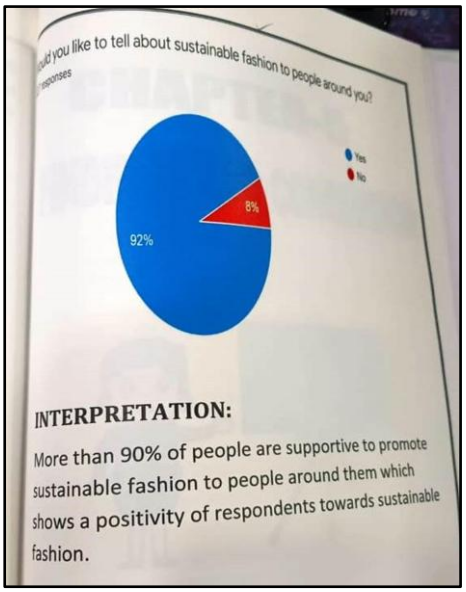

Findings Of The Research:-

Among all the respondents 63% of them were familiar with the term sustainable fashion, 21.2% of them were not sure about it and 15.8% of them were not familiar.

We found that 49.4% of the respondents donate, 36.7% repair & reuse and 13.9% respondents dispose off their old or damaged cloths.

* As per shown graph we have seen that for 60% respondents sustainable fashion means environmental friendly fashion, for 52% it means recycled fashion, for 40% it means durable and long lasting fashion and 3.6% respondents thinks it means over-priced.

* As per given pie-chart we seen that 54.9% respondents said we should be concerned to a large extent, 31.4% to a certain extent, 9.8% said to a very limited extent about the social, environmental and ethical impacts the fashion industry has on the world.

* As per given pie-chart we observed that 46.2% respondents are very supportive, 31.4% are quite supportive, 21.8% are neutral towards supporting sustainable fashion. Most of the respondents are agreed to purchase sustainable clothing if it costs more than, what they normally pay.

* Among all the respondents 73.3% of them would like to buy recycled clothing and 26.7% are not.

As per given pie-chart we found that 56.5% purchase new clothes seasonally, 23.4% rarely, 16.7% every month and very few purchase every week.

- According to pie-chart we seen that 48.5% are strongly agreed and 48.5% are agreed to move towards eco-friendly fashion.

  We found that 69.8% respondents consider environmental impacts when buying cloths and 30.2% did not consider it.

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* 62.4% respondents think that the use of chemicals in growing and manufacturing cloths gives negative consequences to people as well as environment, 28.7% are not sure and 8.9% said no.

Maximum number of respondent's favorite fabrics are, firstly cotton, secondly silk and denim, thirdly rayon and lastly linen.

84.3% respondents think that an uncontrolled consumption of water in the manufacture of cloths gives negative consequences and 15.7% think it does not happen.

* According to the pie-chart 92% of the respondents would like to tell and promote about sustainable fashion, which shows positivity to move towards sustainable fashion.

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* According to the pie-chart 92% of the respondents would like to tell and promote about sustainable fashion, which shows positivity to move towards sustainable fashion.

Suggestions:

After completing the research work suggestions and views we got from the respondents are as follows:

Sustainable fashion should be encouraged because it helps us to reuse our old and damaged clothes instead of disposing it or throwing it.

Sustainable fashion can help us reduce our contribution to polluting the world. It will be helpful for future generations and it's good for our body and environment.

* Awareness about sustainable fashion is required. Sustainable fashion should be promoted by popular brands.

* In these past pandemic years we have faced a lot of problems and felt the need of saving our environment. So if sustainable fashion will provide us with a beautiful and healthy environment why shouldn't we opt for these. Secondly, if we succeed in making our youth aware about sustainable fashion, they'll surely go for these making our

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future and earth secured.

Sustainable fashion create fashion in a way which is most considerate of humanity and the environment, reducing the environmental impact wherever possible.

*Sustainable Fashion Creates Less Waste
*Sustainable Fashion Saves Water
*Sustainable Fashion Saves Animal Lives.

Sustainable fashion is a process of fostering a change to fashion products. The fashion system towards greater ecological integrity and social justice.

It is very appreciative step towards environment.

- Durable fashion is very good because for those who cannot buy clothes again and again, only durable clothes are right.

Sustainable fashion can significantly reduce consumption and waste. Eco-ethical brands prioritize long-lasting materials, so there will be less need to use new resources as well as it can help in reducing waste. Other than that, sustainable fashion encourages users to create their own look and style.

The fashion industry is one of the most polluting industries in the world. Making a conscious decision to shop with sustainable brands can really make a difference to the planet and the people within it.

* The world is in strong need of sustainable fashion right now with all the exploitation or I'd rather say destruction of the environment going on here. Yes... I strongly agree that the sustainable fashion is a bit out of pocket than daily fashion...But better to pay now so that we don't have to pay later!.

Conclusion:

(The result from the study has provided the insight into the importance and understanding of sustainable fashion for future. And it is a high need to be concerned about the social, environmental and ethical impacts the fashion industry has on the world because the chemicals used and the manufacturing process used also has some negative consequences to our body as well environment.

So to save our natural resources for future, our soil, our environment some necessary should be taken to move towards eco-steps friendly fashion.)
I also has been examined that an overwhelming majority of the respondents have a willingness to pay for environmental-friendly clothes and move towards a eco- friendly future.

90% of the respondents are interested to promote sustainable fashion, which shows a positive result.

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Early-Stage Rumor Detection in Online Social Networks Using Hybrid Temporal–Graph Deep Learning Models

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Abstract

The widespread use of online social networks has transformed the way information is created and shared, while simultaneously increasing the circulation of unverified and misleading content. Detecting rumors at an early stage is particularly difficult because only limited textual and structural signals are available shortly after an event emerges. This paper presents a hybrid temporal–graph deep learning approach for early-stage rumor detection. The proposed framework jointly learns representations from post content, short-term temporal behavior, and partial diffusion structures observed during the initial phase of information spread. By fusing temporal sequence modeling with graph-based representation learning, the model captures complementary cues that are often overlooked by single-view approaches. Experimental results on benchmark Twitter datasets show that the proposed method achieves superior performance compared to existing baselines under early observation settings, confirming its effectiveness for timely rumor identification.

Index Terms— ***Rumor detection, early-stage analysis, online social networks, information diffusion, temporal modeling, graph neural networks.***

Introduction

Online social networks (OSNs) have become a primary medium for information exchange, enabling users to rapidly publish and consume content. Alongside these benefits, OSNs also facilitate the rapid spread of rumors—information whose accuracy has not been verified at the time of dissemination. Once such content begins to spread, it can influence public opinion, create panic, or undermine trust in online information.

A key challenge in rumor analysis is timely detection. Many existing approaches depend on rich propagation patterns or long-term interaction histories, which are typically unavailable during the early stages of an event. Consequently, detection often occurs only after the rumor has already diffused widely. This limitation highlights the need for early-stage rumor detection

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methods that can operate under sparse and incomplete data conditions.

Deep learning techniques have recently been applied to rumor detection with notable success. However, models that focus exclusively on textual content or solely on network structure often fail to capture the full dynamics of early rumor spread. In early stages, textual narratives evolve rapidly, while even partial interaction graphs can reveal meaningful patterns of user engagement. This work is motivated by the observation that combining these perspectives can lead to more robust early detection.

In this paper, we propose a hybrid temporal–graph learning framework that integrates short-term temporal modeling of post sequences with graph-based representation learning over partial diffusion networks. The main contributions of this work are threefold: (i) a unified framework designed specifically for early-stage rumor detection, (ii) a principled fusion strategy for combining temporal and structural features, and (iii) an extensive experimental evaluation demonstrating improved performance under limited observation windows.

Related Work

Research on rumor detection in online social networks has evolved from traditional feature-based methods to advanced representation learning techniques. Early studies primarily relied on manually designed linguistic, statistical, and user-based features combined with conventional classifiers. Although these approaches provided initial insights, their performance was highly dependent on feature quality and domain specificity.

With the emergence of deep learning, neural architectures began to dominate rumor detection research. Text-focused models such as CNNs and recurrent networks demonstrated improved capability in learning semantic patterns directly from raw content. Temporal extensions of these models further captured how discussions evolve over time. Despite these advances, content-only approaches often struggle during early stages, when limited posts are available.

To address structural aspects of information diffusion, graph-based methods have been proposed to model user interactions and propagation patterns. Graph neural networks and attention-based models effectively capture relational dependencies among users. However, many of these methods assume access to complete diffusion graphs, which restricts their applicability for early- stage analysis.

More recent studies have explored hybrid strategies that combine textual, temporal, and structural information. While these approaches report performance gains, most are evaluated under full or near-complete diffusion settings. In contrast, the present work focuses explicitly on early-stage rumor detection, emphasizing partial observations and proposing a unified temporal– graph learning framework tailored to this challenging scenario.

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Proposed Methodology

A. Problem Formulation

An online social network is represented as a graph $G = (V, E)$, where V denotes the set of users and E represents interaction edges such as retweets or replies. Each post $p_i$is associated with textual content x_i and a timestamp t_i.

Given an event-related post set $P = \{p_1, p_2, \dots, pn\}$ observed within an early time window T_e, the objective is to learn a function:

$$f(P, G_{T_e}) \longrightarrow y, \qquad y \in \{0,1\}$$

where $y = 1$ denotes a rumor and $y = 0$ denotes non-rumor, and G_{T_e}represents the partial diffusion graph observed within T_e.

B. Temporal Representation Learning

Textual content is first embedded using a contextual encoder. Let h_i denote the embedding of post p_i. A temporal encoder (B_LSTM/Transformer) models the sequence:

$$H_t = TemporalEncoder(h_1, h_2, \quad , h_n)$$

where H_t captures early temporal dynamics of information diffusion.

C. Graph-Based Representation Learning

Node representations are updated using a Graph Neural Network (GNN) according to the following formulation:

$$H_g^{(l+1)} = \sigma(\tilde{A} H_g^{(l)} W^{(l)})$$

where $\tilde{A}$ denotes the normalized adjacency matrix of the partial diffusion graph, $W^{(l)}$ represents trainable weight parameters at layer l, and $\sigma(\cdot)$ is a non-linear activation function.

This update mechanism enables the model to capture early structural patterns and user influence characteristics, even under incomplete diffusion conditions.

D. Temporal–Graph Fusion

To jointly exploit temporal and structural information, temporal and graph-based representations are fused using an attention-inspired weighted mechanism. Let H_t denote the temporal representation learned from the sequence modeling component and $H_g$denote the graph-based representation obtained from the GNN module. The fused representation is computed as:

$$H_f = \alpha H_t + (1 - \alpha) H_g$$

where $\alpha \in [0,1]$ controls the relative contribution of temporal and structural features. The fused representation $H_f$is subsequently fed into a soft max classifier to generate the final prediction.

Experimental Setup and Datasets

Datasets

Experiments are conducted on benchmark datasets including Twitter15, Twitter16, and PHEME. These datasets contain labeled rumor and non-rumor events with associated posts, timestamps, and interaction networks.

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Baselines

The proposed model is compared with traditional machine learning classifiers, deep learning- based text models (CNN, LSTM), and recent graph-based rumor detection methods.

Evaluation Metrics

Performance is evaluated using Accuracy, Precision, Recall, and F1-score, with a focus on early-stage observation windows.

Results and Discussion

The experimental findings demonstrate the effectiveness of the proposed hybrid framework for early-stage rumor detection. As reported in Table I, text-based models such as SVM and CNN show limited performance when only early posts are available, indicating that lexical cues alone are insufficient under sparse conditions.

Table I

Performance Comparison on Twitter Datasets (Early-Stage Detection)

Model	Accuracy	Precision	Recall	F1-score
SVM (Text)	0.78	0.76	0.74	0.75
CNN	0.81	0.80	0.78	0.79
LSTM	0.83	0.82	0.80	0.81
GNN	0.84	0.83	0.82	0.82
Proposed Temporal – Graph Model	**0.88**	**0.87**	**0.86**	**0.86**

Temporal sequence models, including LSTM-based approaches, improve detection accuracy by capturing short-term evolution patterns in user-generated content. Graph-based models further enhance performance by exploiting early interaction structures among users, even when the diffusion graph is incomplete. The proposed temporal–graph fusion model consistently outperforms all baseline methods across accuracy, precision, recall, and F1-score metrics.

These results indicate that temporal dynamics and partial network structure provide complementary information for early rumor detection. Temporal modeling reflects how narratives develop shortly after an event emerges, while graph representations capture early engagement and influence patterns. Their integration leads to more discriminative representations and improved detection reliability in early-stage scenarios.

Conclusion and Future Work

This paper proposed a unified deep learning approach that integrates temporal modeling with graph-based analysis to enable early detection of rumors in online social networks. By simultaneously capturing semantic information from text, short-term temporal patterns, and incomplete diffusion topology, the framework overcomes the dependence of many existing techniques on fully observed propagation processes. As a result, effective rumor identification can be achieved even when only limited spread information is available.

Experimental results on standard benchmark datasets show that the proposed

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model consistently surpasses state-of-the-art baseline methods, particularly under early observation scenarios. These outcomes demonstrate that the joint exploitation of temporal dynamics and network structural features leads to more reliable and discriminative representations for prompt rumor detection.

Future work will focus on extending the framework to multimodal environments by integrating visual and auditory signals, as well as designing adaptive and scalable solutions suitable for real- time deployment on large-scale social media platforms.

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