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श्री हर्षवर्धन प्र. देशमुख : शुभेच्छा संदेश

श्री शिवाजी शिक्षण संस्था, अमरावती द्वारा संचालित मातोश्री विमलाबाई देशमुख महाविद्यालयात आयोजित "शाश्वत व प्रगत भविष्याकरिता नवोन्मेष" या विषयावर ०७ एप्रिल ,२०२६ रोजी होणाऱ्या एकदिवसीय आंतरविद्याशाखीय राष्ट्रीय परिषदेच्या निमित्ताने मनःपूर्वक शुभेच्छा व हार्दिक अभिनंदन!

आजच्या वेगवान आणि तंत्रज्ञानप्रधान युगात नवोन्मेष हा केवळ प्रगतीचा मार्ग नसून शाश्वत विकासाचा मूलाधार बनला आहे. "नवीन विचार, नवे प्रयोग आणि नवे दृष्टीकोन यांतूनच उज्ज्वल भविष्याची पायाभरणी होते" या विचारांची प्रचिती देणारा हा उपक्रम निश्चितच ज्ञान, संशोधन आणि सर्जनशीलतेला नवी दिशा देईल.

या एकदिवसीय आंतरविद्याशाखीय राष्ट्रीय परिषदेच्या माध्यमातून विद्वान संशोधक, प्राध्यापक आणि विद्यार्थी यांना एकत्र येऊन विचारमंथन, अनुभवांची देवाण-घेवाण आणि नवकल्पनांचा शोध घेण्याची सुवर्णसंधी प्राप्त होत आहे. अशा उपक्रमांमधून समाजाभिमुख संशोधनाला चालना मिळून राष्ट्राच्या प्रगतीस हातभार लागेल, असा मला दृढ विश्वास आहे.

आयोजकांच्या या स्तुत्य उपक्रमाबद्दल मनःपूर्वक अभिनंदन करतो. ही एकदिवसीय आंतरविद्याशाखीय राष्ट्रीय परिषद यशस्वी व फलदायी ठरावी, हीच सदिच्छा !

श्री हर्षवर्धन प्र. देशमुख

अध्यक्ष

श्री शिवाजी शिक्षण संस्था, अमरावती

Message from Vice Chancellor's Desk

It gives me immense pleasure to extend my best wishes to *Matoshree Vimalabai Deshmukh Mahavidyalaya, Amravati* for organizing the *Multidisciplinary National Conference on "Innovation and Sustainable Advanced Future" on 7 April 2026*

In the present era of rapid technological advancement and global transformation, the role of higher education institutions in fostering innovation, sustainability, and interdisciplinary research has become more crucial than ever. Such academic platforms not only encourage intellectual dialogue but also inspire young minds to think creatively and contribute meaningfully towards building a sustainable and progressive future. I sincerely appreciate the efforts of the organizing committee under the able guidance of Principal Dr. Smita Raosaheb Deshmukh for taking this significant initiative. Conferences of this nature provide an excellent opportunity for academicians, researchers, and students to exchange ideas, share knowledge, and explore innovative solutions to contemporary challenges.

I am confident that this conference will be highly beneficial and will lead to fruitful deliberations and actionable outcomes in the field of innovation and sustainability.

I extend my best wishes for the grand success of this conference.

Dr. Milind A. Barhate
(Vice-Chancellor)
Sant Gadge Baba Amravati
University, Amravati

Message from the Pro-Vice-Chancellor's Desk

It is a matter of great pride and academic significance that the National Conference on Innovation and Sustainable Advanced Future is being organized on April 7, 2026. I extend my heartiest congratulations to the leadership of principal, organizing team for selecting a theme that is both timely and transformative.

In the contemporary global landscape, the intersection of innovation and sustainability defines our path forward. As we navigate the complexities of a digital and post-industrial era, our focus must remain steadfast on creating "Advanced Futures" that are inclusive, ecologically balanced, and technologically resilient.

Conferences of this nature serve as vital intellectual crucibles where multidisciplinary ideas converge. They provide a platform for researchers, academicians, and young scholars to deliberate on solutions that bridge the gap between traditional wisdom and modern scientific advancement. The pursuit of sustainable development is not merely an environmental goal but a mandate for institutional and societal progress.

I am confident that the deliberations and research presentations during this convention will offer profound insights and actionable strategies for the academic community and beyond.

I wish the conference grand success and hope that the shared knowledge paves the way for a more innovative and sustainable world.

Dr Mahendra Dhore

Pro-Vice-Chancellor
SGBAU, Amravati

श्री हेमंत काळमेघ : शुभेच्छा संदेश

श्री शिवाजी शिक्षण संस्था, अमरावती द्वारा संचालित मातोश्री विमलाबाई देशमुख महाविद्यालयात आयोजित "शाश्वत व प्रगत भविष्याकरिता नवोन्मेष" या विषयावर ०७ एप्रिल ,२०२६ रोजी होणाऱ्या एकदिवसीय आंतरविद्याशाखीय राष्ट्रीय परिषदेच्या निमित्ताने मनःपूर्वक शुभेच्छा !

शिक्षण क्षेत्रात गुणवत्तापूर्ण परिवर्तन घडवून आणण्यासाठी नवोन्मेषाची कास धरणे अत्यंत आवश्यक आहे. "कल्पकता, कर्तृत्व आणि कटिबद्धता यांचा संगम साधला की प्रगतीचे नवे क्षितिज उलगडते"- हा विश्वास या उपक्रमातून दृढ होतो.

या एकदिवसीय आंतरविद्याशाखीय राष्ट्रीय परिषदेच्या माध्यमातून तरुण पिढीला नव्या संकल्पनांचा परिचय होऊन त्यांच्या विचारांना व्यापकता मिळेल. तसेच संशोधन व नवसर्जनाची प्रेरणा मिळेल, हीच अपेक्षा. अशा उपक्रमांमुळे केवळ शैक्षणिक उन्नतीच नव्हे, तर समाजाभिमुख दृष्टीही विकसित होते.

प्राचार्य आणि आयोजकांच्या या स्तुत्य प्रयत्नांचे मनःपूर्वक अभिनंदन करीत, ही राष्ट्रीय परिषद यशस्वी, प्रेरणादायी आणि परिणामकारक ठरावी , हीच शुभेच्छा!

हेमंत काळमेघ

कार्यकारिणी सदस्य

श्री शिवाजी शिक्षण संस्था, अमरावती

From Principal's Desk

At the outset I express my humble tribute to Source of inspiration Dr Panjabrao and Adv. Vimalabai Deshmukh.

I take this opportunity to express my sincere appreciation to the organizers, coordinators, and all contributors for successfully organizing this One-Day Multidisciplinary National Conference on the theme **"Innovations for a Sustainable and Advanced Future."** I also extend my heartfelt congratulations to the faculty members, researchers, and participants of Matoshree Vimalabai Deshmukh Mahavidyalaya, Amravati, for their valuable academic contributions.

The chosen theme is highly relevant in today's global context, where the need for sustainable development and technological advancement is more crucial than ever. This conference serves as a meaningful platform for intellectual exchange, encouraging innovative ideas that balance progress with environmental responsibility and social well-being.

The compilation of research papers in this souvenir reflects the dedication, insight, and scholarly rigor of the contributors. It highlights innovative approaches across disciplines that aim to address contemporary challenges and create a sustainable and advanced future. Such efforts not only enrich academic knowledge but also contribute to practical solutions for society.

From the fundamental principles of research methodology to modern interdisciplinary innovations, this collection emphasizes the importance of ethical research practices, critical thinking, and collaborative learning. It reinforces the values of integrity, transparency, and accountability in the pursuit of knowledge.

In an era defined by rapid transformation, initiatives like this conference play a vital role in shaping forward-thinking minds and fostering a culture of innovation. I am confident that the deliberations and outcomes of this conference will inspire participants to contribute meaningfully towards building a sustainable and progressive future. I extend my best wishes to all the authors, participants, and organizers for their continued efforts in strengthening research culture and achieving academic excellence.

Dr. Smita Raosaheb Deshmukh
Principal
Matoshree Vimalabai Deshmukh Mahavidyalaya
Amravati

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Original Article

Teachers as Catalysts of Viksit Bharat 2047: Advancing Sustainability and Innovation in India

Dr Smita Raosaheb Deshmukh
Principal
Matoshree Vimalabai Deshmukh Mahavidyalaya, Amravati

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Abstract

India's vision of Viksit Bharat 2047 represents an ambitious national agenda to transform the country into a developed, inclusive, and innovation-driven economy by the centenary of its independence. Central to this vision is the integration of sustainability and innovation across all sectors, particularly within the education system. Teachers, as key stakeholders in knowledge creation and dissemination, play a crucial role in shaping future-ready citizens and fostering a culture of innovation and sustainability. This paper examines the evolving role of teachers as catalysts in advancing sustainable development and innovation within the Indian higher education ecosystem. Grounded in stakeholder theory, the NEP 2020, and the SDGs, the study adopts a conceptual approach supported by policy analysis and contemporary academic discourse. It highlights the multifaceted contributions of teachers as knowledge facilitators, innovation enablers, sustainability advocates, and community leaders. The paper also identifies key challenges such as limited research infrastructure, inadequate industry-academia collaboration, and gaps in digital competencies. Based on these insights, a Teacher-Centric Sustainability and Innovation Framework is proposed to strengthen the role of educators in achieving national developmental goals. The study concludes that empowering teachers through institutional support, continuous professional development, and policy alignment is essential for realizing the vision of Viksit Bharat 2047.

Keywords: *Viksit Bharat 2047, Teachers, Sustainability, Innovation, NEP 2020, Higher Education, SDGs, India*

. Introduction

India is undergoing a transformative phase in its developmental journey, guided by the vision of *Viksit Bharat 2047*, which aims to position the nation as a global leader in economic growth, technological advancement, and sustainable development. This vision aligns closely with global priorities such as the United Nations Sustainable Development Goals (SDGs), emphasizing inclusive growth, environmental sustainability, and innovation-led progress. In this context, education emerges as a critical driver, and teachers become central to the realization of these national and global aspirations.Teachers are no longer confined to traditional roles of knowledge transmission; instead, they are expected to act as facilitators of learning, innovators, mentors, and agents of social transformation. The National Education Policy 2020 underscores this shift by advocating for experiential learning, interdisciplinary education, critical thinking, and digital integration. It recognizes teachers as the backbone of the education system and calls for their continuous professional development and empowerment.However, despite policy emphasis, significant challenges persist in effectively leveraging the potential of teachers in driving sustainability and innovation. There exists a gap between policy frameworks and their implementation at the institutional level. This paper seeks to explore the evolving role of teachers as catalysts in advancing sustainability and innovation and to propose a structured framework that enhances their contribution toward achieving the vision of Viksit Bharat 2047.

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Conceptual Perspective

The role of teachers in advancing sustainability and innovation can be understood through the lens of **Stakeholder Theory** (Freeman, 1984), which emphasizes the importance of various actors in achieving organizational and societal goals. In the context of education, teachers represent a critical stakeholder group that influences students, institutions, and the broader community.Additionally,

.Role of Teachers in Advancing Sustainability and Innovation

Teachers as Knowledge Creators and Curriculum Designers

Teachers play a vital role in designing and delivering curricula that integrate sustainability principles and innovation-driven learning. By incorporating interdisciplinary approaches and real-world problem-solving, they enable students to develop critical thinking and creative skills essential for future challenges.

Teachers as Innovation Facilitators

In the era of knowledge economies, teachers act as facilitators of innovation by encouraging research, entrepreneurship, and startup culture among students. Initiatives such as incubation centers, innovation labs, and project-based learning are often guided by teachers who mentor students in developing innovative solutions.

Teachers as Sustainability Advocates

Teachers contribute significantly to promoting environmental awareness and sustainable practices. Through green campus initiatives, community outreach programs, and integration of environmental education into teaching, they help inculcate values of sustainability among learners.

Teachers as Digital and Pedagogical Innovators

The rapid advancement of digital technologies has transformed teaching and learning processes. Teachers are required to adopt ICT-enabled pedagogies, blended learning models, and emerging technologies such as artificial intelligence to enhance educational outcomes and accessibility.

Teachers as Community Connectors

Teachers serve as a bridge between educational institutions and society. Through extension activities, rural development programs, and social engagement initiatives, they contribute to inclusive development and address local challenge

Challenges in Realizing the Transformative Role of Teachers

Despite their critical role, teachers face several challenges that hinder their effectiveness:

- **Limited Research Infrastructure:** Many institutions lack adequate facilities and funding for research and innovation.
- **Skill Gaps:** Teachers often require training in emerging technologies and interdisciplinary approaches.
- **Weak Industry-Academia Linkages:** Limited collaboration with industry restricts practical exposure and innovation opportunities.
- **Administrative Burden:** Excessive administrative responsibilities reduce the time available for teaching and research.
- **Digital Divide:** Unequal access to digital resources affects the adoption of technology-driven teaching methods.

Teacher-Centric Sustainability and Innovation Framework

To address these challenges, this paper proposes a **Teacher-Centric Sustainability and Innovation Framework (TCSIF)** comprising five key dimensions:

1. **Curriculum Leadership:** Integration of sustainability, innovation, and Indian Knowledge Systems into curricula.
2. **Innovation Ecosystem Development:** Promotion of research, startups, and industry collaboration.
3. **Sustainability Integration:** Adoption of green practices and environmental education.
4. **Digital Transformation:** Use of advanced technologies and digital tools in teaching.
5. **Community Engagement:** Strengthening links between institutions and society for inclusive development.

This framework emphasizes the need for institutional support, policy alignment, and continuous professional development to empower teachers as change agents.

Literature Review

The intersection of sustainability, innovation, and education has gained significant scholarly attention in recent years, particularly in the context of developing economies like India. Teachers, as central actors in the educational ecosystem, are increasingly recognized as key drivers in fostering sustainable development and innovation-led growth.Recent research also emphasizes the importance of teacher agency and leadership in driving educational transformation. Michael Fullan (2016) highlights that teachers must be empowered as change agents to implement reforms effectively. Fullan emphasizes that educational change is deeply rooted in teacher agency, asserting that "educational change depends on what teachers do and think." This perspective reinforces the idea that teachers are not mere implementers of policy but active architects of transformation. In the context of Viksit Bharat 2047, this highlights the critical role of educators in fostering innovation, sustainability, and inclusive development. Furthermore, Fullan's advocacy for collaborative cultures and continuous capacity-building aligns with India's National Education Policy (2020), which envisions a dynamic, multidisciplinary, and learner-centric education system. Thus, empowering

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teachers through professional development and institutional support becomes essential for achieving long-term national goals.The concept of sustainable development, popularized by the **Brundtland Commission** is a landmark concept in the field of sustainable development and is highly relevant to themes like *Viksit Bharat 2047* and educational innovation, officially known as the **World Commission on Environment and Development** (WCED) , has evolved into a multidimensional framework encompassing economic, social, and environmental dimensions. The United Nations' Sustainable Development Goals (SDGs), especially SDG 4 (Quality Education), emphasize the role of education in promoting sustainability and global citizenship (United Nations, 2015). UNESCO (2021) further highlights that teachers are instrumental in integrating sustainability principles into curricula and pedagogical practices.Scholars have emphasized that education systems must transition from traditional knowledge transmission to competency-based and transformative learning approaches (Wiek et al., 2011; Sterling, 2010). In this context, teachers are expected to cultivate critical thinking, problem-solving abilities, and sustainability competencies among learners. Lozano et al. (2017) argue that higher education institutions play a crucial role in embedding sustainability through curriculum innovation, research, and community engagement, with teachers acting as primary facilitators.The role of teachers in innovation ecosystems has also been widely discussed. According to Etzkowitz and Leydesdorff (2000), the **Triple Helix Model**—comprising university, industry, and government—positions educational institutions as key contributors to innovation. Teachers, as knowledge producers and mentors, facilitate research, entrepreneurship, and collaboration. Expanding this perspective, the **Quadruple Helix Model** incorporates civil society, emphasizing the broader societal role of education (Carayannis & Campbell, 2009).In the Indian context, the National Education Policy (NEP) 2020 advocates for a paradigm shift toward multidisciplinary, flexible, and innovation-driven education. Studies by Tilak (2015) and Agarwal (2020) highlight the need for strengthening higher education systems in India to align with global standards and national development goals. The NEP underscores the importance of teacher autonomy, continuous professional development, and integration of technology in education.Digital transformation has emerged as a critical enabler of innovation in education. Research by Selwyn (2016) and Redecker (2017) emphasizes the role of teachers in adopting digital pedagogies and fostering digital literacy among students. The COVID-19 pandemic further accelerated the adoption of online and blended learning, highlighting both opportunities and challenges in digital education (Dhawan, 2020).The integration of sustainability into education requires teachers to adopt interdisciplinary and experiential learning approaches. Barth et al. (2007) and Cotton et al. (2009) argue that sustainability education must go beyond theoretical knowledge and focus on practical engagement and behavioral change. Teachers play a vital role in facilitating such transformative learning experiences.However, several studies identify challenges in empowering teachers to fulfill these roles. Lack of adequate training, limited research funding, and weak industry-academia linkages are major constraints (Altbach, 2015; Varghese, 2019). In developing countries, the digital divide and resource limitations further exacerbate these challenges (World Bank, 2022).In addition, the role of higher education institutions in fostering innovation ecosystems has been explored by Guerrero et al. (2015), who argue that universities must actively engage in knowledge transfer and entrepreneurial activities. Teachers, as key actors within these institutions, contribute significantly to these processes.Despite the growing body of literature, there remains a gap in integrating sustainability and innovation within a unified framework that emphasizes the central role of teachers. Most studies focus either on sustainability education or innovation systems, with limited attention to their convergence in the context of national development visions such as *Viksit Bharat 2047*.This paper seeks to address this gap by proposing a Teacher-Centric Sustainability and Innovation Framework that aligns educational practices with national and global development goals. By positioning teachers as catalysts of change, the study contributes to the ongoing discourse on educational transformation and sustainable development

Findings and Discussion

The analysis highlights that teachers play a pivotal role in aligning educational practices with national and global development goals. Their contribution extends beyond classroom teaching to fostering innovation ecosystems and promoting sustainable practices.The study finds that institutions that actively support teachers through training, funding, and collaborative opportunities demonstrate higher levels of innovation and community engagement. Furthermore, the integration of sustainability into curricula and institutional practices significantly enhances students' awareness and participation in sustainable development initiatives.However, the findings also indicate a persistent gap between policy intentions and ground-level implementation. Addressing this gap requires coordinated efforts from policymakers, institutions, and stakeholders to create an enabling environment for teachers.

Conclusion

The vision of *Viksit Bharat 2047* necessitates a paradigm shift in the role of education and, more importantly, in the role of teachers. As catalysts of change, teachers have the potential to drive sustainability and innovation, thereby contributing to national development. However, realizing this potential requires systemic reforms, including capacity building, institutional support, and effective policy implementation. Teachers play a key role in promoting **sustainability awareness**, Education helps develop **responsible citizens for future generations**, Institutions can integrate **environmental ethics, green practices, and innovation**By adopting a teacher-centric approach and fostering a collaborative ecosystem, India can harness the full potential of its educators to achieve sustainable and innovation-led

growth. The proposed framework provides a roadmap for strengthening the role of teachers and aligning educational practices with the vision of a developed and inclusive India which laid the foundation for the concept of sustainable development, defining it as meeting present needs without compromising future generations. This principle underscores the role of education in fostering sustainability-oriented mindsets, where teachers act as catalysts in shaping environmentally responsible and socially conscious citizens essential for achieving the vision of Viksit Bharat 2047.

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Original Article

Gamification in English Language Learning for Sustainable Education

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Abstract
The integration of technology and innovative pedagogical strategies has transformed modern education. One such strategy is gamification, which incorporates game elements into non-game contexts to enhance learner engagement and motivation. In English language learning, gamification has emerged as an effective tool to improve students' participation, comprehension, and long-term retention of language skills. This research article explores the role of gamification in promoting sustainable education by fostering continuous learning, improving accessibility, and supporting learner-centered instruction. The study highlights the theoretical foundations of gamified learning, its benefits in English language education, practical classroom applications, and potential challenges. The findings suggest that gamification can significantly enhance the sustainability of English language education by motivating learners, supporting lifelong learning, and encouraging active participation in the learning process.
Keywords: *Gamification, English language learning, sustainable education, digital learning, student motivation.*

. Introduction

Education systems worldwide are increasingly adopting innovative teaching methods to meet the needs of modern learners. One such method is **gamification**, which refers to the use of game-like elements in non-game contexts such as education. Gamification has gained popularity in English language teaching because it increases learner motivation, engagement, and participation.English language learning often requires consistent practice, interaction, and motivation. Traditional teaching approaches sometimes fail to maintain student interest. Gamification provides a solution by transforming learning into an interactive and enjoyable experience.Sustainable education emphasizes long-term learning, student engagement, and the development of skills necessary for the future. amification aligns with these goals by encouraging continuous participation, self-directed learning, and meaningful engagement with educational content. Research shows that gamification improves language skills such as speaking, listening, reading, and writing while increasing students' motivation to learn.

Literature Review

Many scholars have explored the role of gamification in language learning and its impact on student engagement and motivation.Research indicates that gamification significantly enhances student motivation by creating a sense of achievement and competition. Students become more interested in learning activities when they receive rewards or recognition for their progress.Several studies highlight that gamification improves vocabulary learning and retention. Game-based tasks encourage repeated practice, which strengthens language memory and comprehension.Another important finding in the literature is that gamification promotes learner autonomy. Students take greater responsibility for their learning when

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They are actively involved in interactive tasks and challenges.In addition, gamification enhances collaboration and communication among learners. Multiplayer activities and team-based challenges encourage students to interact in English, thereby improving their speaking and listening skills.However, some researchers note that gamification must be carefully designed. Excessive focus on rewards or competition may distract students from learning objectives. Therefore, educators must balance entertainment with meaningful educational content.Overall, previous studies confirm that gamification is a powerful tool for enhancing language learning and supporting sustainable educational practices.

Concept of Gamification in Education

Gamification is a teaching strategy that applies elements commonly found in games to educational settings. These elements include rewards, competition, progress tracking, and interactive challenges. The primary purpose of gamification is to make learning more engaging while maintaining clear educational objectives.In language education, gamification transforms traditional classroom tasks into interactive experiences. For example, vocabulary learning can be turned into a quiz competition, grammar practice can involve problem-solving missions, and reading activities can be integrated into storytelling games.These elements motivate students to participate actively and maintain consistent engagement with learning materials.

Objectives of the Study

The primary objectives of this research are:

1. To examine the concept of gamification in English language learning.
2. To analyze the role of gamification in improving student motivation and engagement.
3. To explore how gamification contributes to sustainable education.
4. To identify challenges associated with implementing gamified learning strategies.

Sustainable Education and Language Learning

Sustainable education focuses on creating learning systems that are inclusive, accessible, and capable of supporting lifelong learning. It emphasizes the development of skills that enable individuals to adapt to changing social, economic, and technological environments.English language learning plays a crucial role in sustainable education because English is widely used in global communication, academic research, and international collaboration. Proficiency in English enhances students' access to educational resources, employment opportunities, and global networks.Gamification contributes to sustainable education by encouraging continuous learning and improving students' motivation. When learners enjoy the process of acquiring knowledge, they are more likely to remain engaged and develop a long-term commitment to education.

Gamification and Sustainable Education

Sustainable education focuses on creating learning systems that are inclusive, flexible, and capable of supporting lifelong learning. Gamification contributes to sustainable education in several ways.First, it promotes continuous engagement in learning activities. When students enjoy the learning process, they are more likely to maintain consistent learning habits.Second, gamified learning platforms are often accessible through digital devices, allowing learners to study anytime and anywhere. This flexibility supports inclusive education.Third, gamification encourages collaboration and problem-solving skills, which are essential competencies for sustainable development.

Role of Gamification in English Language Learning

Enhancing Student Motivation

Gamification motivates students by introducing reward-based systems. Points, badges, and achievements create a sense of accomplishment that encourages learners to continue participating in learning activities.

Improving Language Skills

Gamified learning activities provide opportunities for students to practice different aspects of language learning, including vocabulary, grammar, pronunciation, and communication skills.

Encouraging Active Learning

Traditional classroom methods sometimes limit student interaction. Gamified activities encourage students to participate actively through challenges, quizzes, and collaborative tasks.

Providing Immediate Feedback

One of the advantages of gamification is instant feedback. Students can quickly identify their mistakes and improve their performance through repeated practice.

Gamification Tools in English Language Learning

Digital platforms and educational technologies have made gamification easier to implement in classrooms. Teachers can use various tools to create engaging learning experiences.

Common gamification tools include:

- Interactive quiz platforms
- Digital flashcards and vocabulary games
- Story-based learning applications
- Language learning mobile apps

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These tools allow students to learn at their own pace while maintaining high levels of engagement.

Classroom Applications of Gamification

Teachers can integrate gamification into English language learning through several practical strategies:

Vocabulary Games

Students earn points by correctly identifying word meanings or using new vocabulary in sentences.

Grammar Challenges

Grammar exercises can be converted into competitions where students solve problems to progress through different levels.

Role-Playing Activities

Students participate in simulated real-life situations, improving their speaking and communication skills.

Storytelling Missions

Learners complete narrative-based tasks that develop reading comprehension and creative writing skills.

These activities make the learning process more enjoyable and interactive.

Challenges of Gamification in Education

Despite its benefits, the implementation of gamification also presents several challenges.

Technological limitations: Some educational institutions lack the digital infrastructure necessary to support gamified learning systems.

Teacher training: Educators need adequate training to design and implement effective gamified learning activities.

Overemphasis on rewards: Excessive focus on rewards may distract students from the actual learning objectives.

Balancing entertainment and education: Gamified activities must maintain educational value while remaining engaging.

Addressing these challenges requires careful planning and appropriate instructional strategies

Discussion

The findings of this study demonstrate that gamification plays a significant role in enhancing English language learning and promoting sustainable education. The integration of game elements such as points, badges, leaderboards, challenges, and rewards created an interactive learning environment that encouraged active participation among students. The results obtained from questionnaires and classroom observations indicate that most students experienced increased motivation and engagement while participating in gamified learning activities.One of the most important outcomes of the study is the improvement in **student motivation**. Traditional teaching methods often rely heavily on lectures, memorization, and textbook exercises, which may reduce students' interest in language learning over time. However, gamification introduces elements of fun and competition that make learning more appealing. When students earn points or receive badges for completing tasks successfully, they experience a sense of achievement. This recognition motivates them to continue participating actively in learning activities. As a result, gamification helps maintain students' interest in learning English.Another significant finding is the **improvement in vocabulary acquisition and language skills**. Gamified learning activities encourage repeated practice, which is essential for language learning. Through quizzes, word games, and challenges, students repeatedly encounter new vocabulary and grammar structures. This repeated exposure helps them retain information more effectively. The study findings show that vocabulary improvement was one of the most noticeable outcomes of gamified learning environments. In addition, interactive speaking tasks and group challenges improved students' communication skills and confidence in using English.

Gamification also contributes to **student engagement and participation** in the classroom. In traditional classrooms, some students may hesitate to participate due to fear of making mistakes or lack of confidence. Gamified activities reduce this anxiety by creating a relaxed and enjoyable learning atmosphere. Students are more willing to participate in quizzes, role-plays, and collaborative games when learning feels like a fun activity rather than a formal academic task. Furthermore, leaderboards and team competitions encourage students to collaborate with peers, which strengthens social interaction and communication.Another important aspect revealed by the study is the role of gamification in supporting **sustainable education**. Sustainable education focuses on developing long-term learning habits and lifelong learning skills. Gamification promotes continuous learning because students are motivated to achieve higher scores, unlock new levels, and complete challenges. This process encourages regular practice and consistent engagement with learning materials. Over time, these habits help students develop a deeper understanding of the language and improve their overall proficiency.The use of digital technologies in gamified learning environments also contributes to sustainability in education. Online platforms, educational applications, and digital quizzes allow students to access learning resources anytime and anywhere. This flexibility enables learners to practice English beyond the classroom environment. Consequently, gamification supports self-directed learning, where students take responsibility for their own progress and development.However, the study also identified several **challenges associated with gamification**. One of the main concerns is the possibility of overemphasizing rewards and competition. If gamification focuses only on points and prizes, students may become more interested in winning rather than learning. Therefore, teachers must carefully design gamified activities to ensure that educational objectives remain the primary focus.Another challenge involves **technological limitations**. Some schools may lack access to digital devices, stable internet connections, or

educational software necessary for implementing gamification effectively. In such cases, teachers may need to use simple classroom games and low-technology strategies to incorporate gamification into their lessons.Teacher training is also an important factor for successful implementation. Educators need adequate knowledge and skills to design effective gamified learning activities. Without proper training, teachers may find it difficult to integrate game elements into the curriculum in a meaningful way.Despite these challenges, the overall findings of the study indicate that gamification has a positive impact on English language learning. It enhances motivation, increases engagement, and improves language skills while supporting sustainable learning practices. By combining educational content with interactive game elements, gamification creates a dynamic learning environment that benefits both students and teachers.

Future Prospects

The future of gamification in English language learning appears promising. Advances in educational technology, artificial intelligence, and digital platforms will enable more personalized and immersive learning experiences. Gamified virtual classrooms, adaptive learning systems, and interactive simulations may further enhance language education.As educational institutions increasingly adopt digital tools, gamification will likely become an integral component of sustainable education strategies.

Conclusion

In conclusion, the discussion highlights that gamification is not merely a trend in educational technology but a powerful pedagogical approach that can transform traditional language learning methods. When implemented effectively, gamification can contribute significantly to improving English language education and promoting sustainable learning outcomes.Gamification has emerged as a powerful tool for improving engagement and effectiveness in English language learning. By incorporating game elements into educational activities, teachers can create dynamic learning environments that motivate students and support skill development. Moreover, gamification aligns with the principles of sustainable education by encouraging lifelong learning, improving accessibility, and fostering active participation. Although challenges exist, careful implementation and thoughtful instructional design can maximize the benefits of gamification in language education. Ultimately, gamified learning approaches have the potential to transform English language education and contribute to more sustainable and inclusive educational systems.

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Original Article

India's Foreign Policy in Transition: Navigating the Post-Pandemic Era and Global Conflicts

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Abstract

This research paper examines the transformation of India's foreign policy in the context of two intersecting phenomena: the enduring impact of the COVID-19 pandemic and the resurgence of major power conflicts in Europe and the Middle East. Drawing on recent scholarly analysis and contemporary diplomatic developments, this study argues that Indian foreign policy has undergone a fundamental shift from its traditional consensus-based approach to a more pragmatic, interest-driven model characterized by strategic autonomy and multi-alignment. The paper analyzes India's responses to the Russia-Ukraine war and the Gaza conflict, evaluates the sustainability of its policy framework, and assesses the implications for India's position in the emerging global order

Keywords: *Indian foreign policy, strategic autonomy, COVID-19 pandemic, Russia-Ukraine war, Gaza conflict, multi-alignment, Global South*

Introduction

The conduct of Indian foreign policy in the contemporary period represents a significant departure from its historical foundations. As former Foreign Minister Salman Khurshid recently observed, "There has been a conscious decision to depart from foreign policy as we understood it in this country.... there was once a consensus which cut across divides and political parties" . This observation, made at the release of the book "India's Tryst With the World: A Foreign Policy Manifesto," captures the essence of a transformation that has accelerated in the post-pandemic eraThe COVID-19 pandemic served as a critical juncture in international relations, fundamentally altering the diplomatic landscape within which nations operate . For India, the pandemic coincided with—and perhaps accelerated—a broader reorientation of its foreign policy approach. As Bhairab Chandra Patra and colleagues note in their analysis of pre- and post-pandemic geopolitics, "After corona virus outbreak, it is unlikely that Indian foreign policy will continue as usual because there will not be enough diplomatic space for ambitious foreign policy objectives". Yet paradoxically, they suggest that "India being the least integrated region of the world might have been given just such a chance by Covid-19"his paper explores the contours of India's evolving foreign policy through the lens of two major contemporary conflicts: the Russia-Ukraine war, now entering its fourth year, and the Gaza conflict following the October 7, 2023 attacks. These conflicts have tested India's diplomatic dexterity and revealed the operational logic of its current approach. The paper argues that India has adopted a policy of "strategic autonomy" or "multi-alignment" that seeks to maximize national interests by retaining the freedom to engage with all major powers, regardless of their rivalries, while positioning India as a voice of restraint and a pillar of stability.The structure of this paper is as follows: Section 2 provides a review of the literature on Indian foreign policy decision-making. Section 3 analyzes the impact of the COVID-19 pandemic on India's diplomatic posture. Section 4 examines India's response to the Russia-Ukraine war. Section 5 analyzes India's approach to the Gaza conflict. Section 6 evaluates the sustainability and implications of India's current foreign policy framework. Section 7 offers concluding observations.

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Literature Review: Understanding Foreign Policy Decision-Making in India

The study of foreign policy decision-making requires a multidisciplinary approach that integrates insights from political science, psychology, and institutional analysis. As S.S. Patagundi argues in his comprehensive study, "Foreign Policy Decision-Making in India," "The knowledge of a single discipline is generally inadequate to understand the reality of complex foreign policy issues. Multidisciplinary knowledge is imperative for understanding the foreign policy decision-making process" Patagundi's framework emphasizes the significance of perceptions, cognitive processes, and beliefs of foreign policy decision-makers and institutions. In a parliamentary democracy like India, "the Prime Minister and the External Affairs Minister are key actors in foreign policy decision-making" . These key actors are elites whose beliefs significantly influence how problems are understood, how international situations are defined, how options are identified, and ultimately how the best option is selected to achieve foreign policy objectives .This theoretical framework is particularly relevant for understanding the contemporary period, where the personal diplomatic engagement of Prime Minister Narendra Modi has become a defining feature of Indian foreign policy. The "Modi doctrine," as it is sometimes called, reflects a centralization of foreign policy decision-making and a departure from the institutional consensus that characterized earlier eras.The historical evolution of Indian foreign policy provides essential context for understanding contemporary shifts. From the non-alignment of the Nehru era to the pragmatic realism of the post-Cold War period, Indian foreign policy has consistently adapted to changing global circumstances while maintaining certain foundational principles. However, as Khurshid's remarks suggest, the current approach represents something more fundamental: a conscious departure from the consensus-based model that previously united diverse political perspectives .

The Pandemic as Catalyst: COVID-19 and India's Diplomatic Transformation

The COVID-19 pandemic disrupted international relations in unprecedented ways, and India's experience was no exception. The pandemic's impact on India's foreign policy operated through multiple channels: economic disruption, supply chain vulnerabilities, vaccine diplomacy, and shifting global power dynamics.

Vaccine Maitri and Humanitarian Diplomacy

India's most visible diplomatic initiative during the pandemic was "Vaccine Maitri" (Vaccine Friendship), through which India supplied millions of vaccine doses to countries across the Global South. This initiative served multiple purposes: it reinforced India's identity as the "pharmacy of the world," demonstrated solidarity with developing countries, and positioned India as a reliable partner in times of crisis.The vaccine diplomacy effort represented an institutionalization of India's humanitarian approach. As Patra and colleagues note, international affairs have "played a key role in the advancement of India as a world power" . The pandemic provided an opportunity for India to demonstrate its capabilities and its commitment to global public goods.

The Geopolitical Implications of the Pandemic

The pandemic also accelerated existing geopolitical trends, particularly the intensification of US-China strategic competition and the growing assertiveness of China in the Indo-Pacific region. As C. Vinodan and J.K. Alexander observe, "Increasing non-traditional threats and growing challenges from rising China are significant drivers of India's policy options in the post-pandemic world" The Indo-Pacific region, which combines the Indian Ocean and the Pacific Ocean, represents "the new strategic reality of the twenty-first century" . With its strategic location in this region, India has become "a theatre of opportunity to increase its role regionally and globally" . The pandemic underscored the importance of maritime security, as the Indian Ocean carries 90 percent of India's trade and its energy sources, and nearly 50 percent of India's trade is centered in the Indo-Pacific region .

The Pandemic's Long-Term Impact on Diplomatic Space

Perhaps the most significant impact of the pandemic on Indian foreign policy has been the constriction of diplomatic space for ambitious objectives. As the global order becomes more contested and fragmented, the room for maneuver for middle powers like India has simultaneously expanded and contracted. It has expanded in the sense that multiple powers seek India's partnership, but contracted in the sense that India must navigate increasingly sharp rivalries without alienating any major partner.This paradoxical situation—less space for ambitious objectives but greater opportunity for a minimally integrated region—captures the essence of India's post-pandemic diplomatic position . The challenge for Indian policymakers has been to convert this opportunity into sustainable influence.

Navigating the Russia-Ukraine War: The Art of Strategic Autonomy

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The Russian invasion of Ukraine in February 2022 presented one of the most significant tests of Indian foreign policy in the post-pandemic era. India's response has been characterized by a delicate balancing act that reveals the operational logic of strategic autonomy.

India's Stance: Neutrality with Strategic Purpose

India has refused to condemn Russia's invasion, abstaining from UN votes and continuing to purchase discounted Russian oil. This stance has drawn criticism from Western capitals but reflects a careful calculation of national interests. As Foreign Minister S. Jaishankar has argued, Europe's energy purchases dwarfed India's monthly buys, highlighting what India perceives as double standards in global criticismThe rationale for maintaining ties with Russia is multifaceted. First, Russia remains a critical defense partner, supplying a significant portion of India's military equipment. Second, India seeks to prevent a stronger Sino-Russian alliance that could emerge if Russia becomes entirely dependent on China. Third, energy security considerations make discounted Russian oil attractive for India's economy.

The Subtle Shift: India-EU Alignment

However, India's position has not been static. In a significant departure, India recently signed off on a joint statement with the European Union on Ukraine that expressed support for efforts based on the principles of "independence, sovereignty and territorial integrity" . This formulation, while stopping short of condemning Russia, aligns India with the Western position on the fundamental principles at stake.The joint statement reflected this evolved position: "On Ukraine, the two sides expressed concern over the ongoing war, which continues to cause immense human suffering and carries global consequences. Both sides will continue to support efforts towards the achievement of a comprehensive, just and lasting peace in Ukraine through dialogue and diplomacy, based on the principles of the UN Charter and of international law, including independence, sovereignty and territorial integrity" .This subtle shift suggests that India's strategic autonomy is not rigid non-alignment but rather a dynamic posture that can adapt to changing circumstances. As Prime Minister Modi stated, "Today, the global order is undergoing profound turbulence. In this context, the partnership between India and the European Union will strengthen stability within the international system" .

The Principle of Multi-Alignment

India's approach to the Ukraine war exemplifies what some analysts call "multi-alignment"—the practice of maintaining strategic partnerships with multiple major powers simultaneously, even when those powers are in conflict with each other. This approach differs from traditional non-alignment in that it involves active engagement with all sides rather than equidistance or isolation.As former Foreign Secretary Nirupama Menon Rao observed, "The current government has not failed to advertise that we are a 'vishwaguru', that we stand for civilisational values and strategic autonomy....from that stems the reference to India being only on its own side, that we stand for multipolarity" . However, Rao cautioned that "it is a messy multipolarity....it is essentially a new iteration of a 'jungle book' in international politics" .This characterization captures both the opportunities and risks of India's current approach. The opportunity lies in the ability to engage with all major powers and to position India as a potential bridge or mediator. The risk lies in the potential for conflicting commitments and the difficulty of maintaining credibility with all parties.

The Gaza Conflict: Dehyphenation and Strategic Realignment

The Gaza conflict, triggered by the Hamas attacks of October 7, 2023, and Israel's subsequent military response, has tested a different dimension of Indian foreign policy: the relationship between India's historical support for the Palestinian cause and its growing strategic partnership with Israel.

The Policy of Dehyphenation

India has increasingly pursued a policy of "dehyphenation"—treating its relationship with Israel as independent of the Palestine issue. This represents a significant evolution from the earlier approach, which linked progress in India-Israel relations to progress on the Palestinian front.Prime Minister Modi's recent visit to Israel and his address to the Knesset marked a significant departure. He declared that "India stands with Israel firmly, with full conviction," offering condolences for the October 7th attacks while remaining relatively silent on the humanitarian crisis in Gaza . This stance reflects the deepening strategic and defense ties between India and Israel, which have flourished over the past decade.

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Balancing with Traditional Positions

However, India has not completely abandoned its traditional support for the Palestinian cause. The joint statement with the EU noted "the adoption of the UN Security Council Resolution 2803 of 17 November 2025 which welcomes the establishment of the Board of Peace and authorizes an International Stabilisation Force, as outlined in the Comprehensive Plan, as a step forward to end the Gaza conflict" .The statement continued: "They encouraged all parties to implement the resolution in its entirety, in line with international law and relevant UN Security Council resolutions. Both sides restated their readiness to support efforts towards just and durable peace and stressed the need for unhindered humanitarian access. They also called for a just and lasting solution, based on the implementation of the two-State solution, through dialogue and diplomacy" .This formulation allows India to maintain its strategic partnership with Israel while preserving rhetorical support for Palestinian rights and a two-state solution. It represents the kind of nuanced positioning that characterizes India's current approach to complex conflicts.

The Iran Dimension

India's approach to the Gaza conflict also involves careful management of its relationship with Iran. The India-EU joint statement noted that "the two sides discussed the recent developments of concern in Iran and the region. They underscored the importance of dialogue and diplomacy in resolving issues in a peaceful manner". This sends a signal to both Israel and the US that military means against Iran are not desirable, while also maintaining India's engagement with Tehran.As Dr. Uma Purushothaman's research on Russian and Middle Eastern politics suggests, India's approach to the region involves multiple layers of engagement that cannot be reduced to simple binaries. The challenge is to maintain credibility with all parties while advancing Indian interests.

Evaluation: Sustainability and Implications of India's Current Approach

The Domestic Political Dimension

One of the most significant questions about India's current foreign policy approach concerns its relationship with domestic politics. Khurshid raised this issue directly: "a big question was whether domestic politics had an influence on giving up the consensus in foreign policy". He suggested that the conflicts involving Gaza, Ukraine-Russia, and Iran had put the establishment in a position where "they no longer have anything to say".This critique points to a potential vulnerability in India's approach: the difficulty of articulating a coherent position when relationships with multiple conflicting parties must be maintained. As Khurshid put it, "You have to choose between friends and people that you can't let go of.....what are friends for, if you can't tell them if they are doing something wrong? Particularly when they are doing something impacting India"The domestic political dimension also includes the role of civilizational ideas in shaping foreign policy discourse. An opinion piece in ThePrint argues that "India's Dharmic tradition offers an intellectual framework for global peace," suggesting that "the Purusharthas are not historical abstractions. They remain a living set of ideas that can inform contemporary policy and diplomacy". While this perspective reflects a particular ideological orientation, it indicates the growing influence of civilizational narratives in Indian foreign policy discourse.

The Global South Leadership Role

A central element of India's current foreign policy is its claim to leadership of the Global South. This was evident in the G20 presidency, which featured the invocation of "Vasudhaiva Kutumbakam" (One Earth, One Family, One Future) and the articulation of commitments anchored in four principles: People, Planet, Prosperity, and Peace.The credibility of India's Global South leadership depends on its ability to deliver concrete benefits to developing countries and to amplify their voices in global forums. The inclusion of the African Union in the G20 during India's presidency was a significant achievement in this regard. However, sustaining this leadership role requires consistent engagement and tangible outcomes.

The Challenge of Credibility

Perhaps the most significant challenge facing India's foreign policy is the maintenance of credibility with all parties. Strategic autonomy requires that partners trust India's commitments even while recognizing that India maintains relationships with their rivals. This is a delicate balance that can be undermined if any partner feels betrayed or taken for granted.The recent India-EU statement on Ukraine suggests that India is willing to adjust its positions in response to changing circumstances. This flexibility is a strength of strategic autonomy, but it also carries risks if it creates a perception of unreliability.

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Institutional Capacity and Decision-Making

Patagundi's analysis of foreign policy decision-making emphasizes the importance of institutions and elite beliefs. The centralization of foreign policy decision-making in the Prime Minister's Office has implications for institutional capacity and continuity. While centralization can enable rapid and decisive action, it may also reduce the input of professional diplomats and subject foreign policy to electoral and political considerations.The question of whether India's institutional apparatus is adequate for the demands of strategic autonomy remains open. Think tanks like the Observer Research Foundation, where Dr. Purushothaman was previously associated, and academic institutions like JNU and Central University of Kerala play important roles in generating policy-relevant research. However, the translation of research into policy depends on institutional linkages that may be stronger or weaker depending on the issues and individuals involved.

Conclusion

India's foreign policy in the post-pandemic era of global conflicts represents a distinctive approach to navigating a disordered international system. Characterized by strategic autonomy, multi-alignment, and a willingness to depart from historical consensus, this approach seeks to maximize India's options and influence in a world where traditional alliances and institutions are under strain.

The analysis in this paper has revealed several key findings:

First, the COVID-19 pandemic served as both constraint and opportunity for Indian foreign policy, constricting diplomatic space while simultaneously creating openings for a minimally integrated region to enhance its global role.Second, India's response to the Russia-Ukraine war demonstrates the operational logic of strategic autonomy—maintaining ties with Russia while gradually aligning with Western positions on core principles.Third, India's approach to the Gaza conflict reflects a policy of dehyphenation that prioritizes the strategic partnership with Israel while preserving rhetorical space for traditional positions on Palestine.Fourth, the sustainability of this approach depends on India's ability to maintain credibility with all parties, deliver tangible benefits to the Global South, and manage the domestic political dimensions of foreign policy.The observation by Nirupama Rao that contemporary international politics resembles a "jungle book" captures both the challenges and opportunities of the current moment. In such an environment, India's ability to navigate competing pressures while advancing its interests will determine whether strategic autonomy yields sustainable influence or merely temporary advantage.As the international system continues to evolve, India's foreign policy will face new tests. The intellectual frameworks that guide Indian diplomacy—whether drawn from Western international relations theory, Indian civilizational traditions, or pragmatic adaptation to circumstances—will shape how India responds to these tests. The findings of studies like those examined in this paper will have "implications for policy-making bodies across the world", as India's trajectory matters not only for India but for the shape of the emerging global order.

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Original Article

The Panorama of Troubles and Treatments towards Thoughtful Management of The Heap of 21st Century Broken images

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Abstract

This paper critically examines the social, political, economic, technological, ecological, and cultural challenges confronting the twenty-first century, with special reference to the Indian context. It highlights the widening gap between developmental ideals and ground realities, emphasizing issues such as global warming, political opportunism, regional imbalance, rural distress, unemployment, technological overdependence, public health concerns, consumerism, and the crisis in agriculture. The study argues that unplanned and politically driven models of development have marginalized farmers, weakened human values, and intensified inequality. Drawing upon the ideas of thinkers such as Mahatma Gandhi, Mahatma Phule, Dr. Panjabrao Deshmukh, Karl Marx, and Socrates, the paper advocates a holistic, humane, and sustainable approach to governance and policy-making. It further discusses the role of appropriate technology, women's empowerment, ecological sensitivity, food security, public welfare, and administrative reforms in building a balanced society. Through reflective analysis and practical suggestions, the paper calls for thoughtful management of contemporary crises by prioritizing human health, environmental sustainability, social justice, and ethical governance over superficial development.

Keywords:*Global warming; Sustainable development; Indian economy; Agriculture crisis; Food security; Technology and health; Political development; Social inequality; Rural distress; Human values; Governance; Environmental sustainability; Unemployment; Consumerism; Women's empowerment; Public welfare; Ecological balance; Thoughtful management*

. The War and No Peace Global Scenario

Taking stock of the present scenario, the Iran-US conflict, the facade of the shelter and cover of the United Nations, absolutely finds itself in a painfully deplorable state. Israel is the grotesque expression of scientific advancement and shameless degeneration of Human Values. Taking stock of the overall scenario, the blue sky overcast by thick clouds of Global Warming, is a realism fit for a metaphor, a terrible nightmare all across the planet.The Al-Gore vision on ecology should be the cynosure for rising above troubled water levels.While contemplating the innovative and sustainable solution, our focus should on National context without having lost the sight of international scenarios.The heap of twenty first century broken images in Indian context, badly demands immediate focus for putting the horse before the cart. Prior to thinking of innovation, breaks would be needed to be applied to mistaken practices before it is too late. The major measure needed would be to be holistic in interpretation of the politically driven theme of so called Development. We cannot afford to create a political smoke screen of escapism as it remains a wonderful tool to push the real challenges under the carpet of advanced technology for short term benefits. Exploiting the shield of technology is the antique trick. Its high time to tell these trickster, enough is enough.

Development within the Development lords overVikas hidden in vikas

The political escapism is the major crisis. Politics lords over human life and vivek. The rationale gets pounded in the mortar of political tug of war. The superficial lip service to science and technology is oversold. It is emotiveexploitation by opportunist human element. The essence of sincerity gets side tracked. In short, the bad currency drives out the good currency, phenomenon.There are three types of Development.

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1)The development that is really needed.
2) The development for political success. Sow development and harvest votes. It creates a regional development imbalance. The backlog, for Instance A) Vidarbha vs Wester Maharashtra B) Rural vs Urban.
C) The Development for the Development by powerful Political Power points. This can in short be termed as Development within The Development.
(1) The political power points create not only the crisis of regional imbalance but in ecological dimensions too.

How much Development do we need?

While emphasizing sustainable dimensions of development the bottom lines should, how much Development is needed to facilitate human life? Man is designed to walkand undertake physical activity. If we choose to escape this we are walking away from fitness. Science and Technology no doubt are a great grace for qualitative value addition to human life. However, the other side of the coin too needs to be mindful about.The great debate put across by Radhakrishnan in his milestone perspective, The Kalki, may be, remains a standard lay-out for creation of desired extensions. The term, sustainable has far deeper magnitude. It would just be a fashionable and superficial job to debate the theme in a tug of war manner at this critical pass. The point is not debating the issue, but evolving the solutions.

The Attitude Factor.

Matters of real concerns often get lost in attitude factor. My knowledge vs your knowledge, My English vs Your English, My expression power vs your Expression power. The intelligentsia loves to play these fond ball games. These are the basic Indian ailments. Hence innovation will not come about without overcoming the psychological dimensions and mind blocks. This would prove a major hurdle.Spiritualism begins where science ends, sort of absurd and fantastic idioms hardly seem to make much sense. Why should spiritualism wait for something to come full circle? Just a funny juxtaposition.

Health is The Real Wealth

Above all things else is human health. Happiness index remains the second step. The health factor needs basic elements. The modern complicated life style has worsened the human health in critically deplorable state. Life has become super speciality health care bound. Gandhian touchstone about policy making was, how it strikes against the poorest of the poor. Therefore, as regards development and science and technology, we will always need to bear in mind, how it strikes against human health.

The Art

Creativity in Music, Literature and other forms of art enjoyed the peerless grip over the human mind in sixty. Timeless masterpieces came about. Those were golden days when the human mind was gripped by expressions of art. Imagination delivered pleasure to the human mind. Now, man is but a mechanical device.

Feminism

Given the modern scenario of education equipped women force in all walks of life and disciplines of learning, the demand for space in terms of equality, liberty, opportunity, dignity and what not that men enjoy as a birth right will need to be understood for a smooth course of life.

Economics

The Manmohnomics through the pay commission rewards has created a strong middle class that has risen from chal meri luna to the class that believes in flaunting eye-catching dogs. Swanky cars. Facelifted houses. In short, impressing people by using and consuming things Sthey don't need. However, the rural economy has sunk in widened disparity. Once a quintal of cotton could buy more than 10 grams of gold. Today, we need around 20 quintal of cotton to buy 10 gm gold. This is how disparity can be indicated. The access roads to farms are nowhere the agenda. In PPP(Purchasing Power Parity)Terms Farmers and common man are but meant for growth rate share. In short, the some get growth, some get growth rate phenomenon. I have attempted to cover all this in my treatise, Buddha vs Darwin. And in, - From Mahad lake to Mineral Water, Economic Untochability, in 21st century. (Published in Diwali number of Local newspaper by name Parivartan.) Three ladder rungs of Economy have evolved. 1) The five-star economy of corporate, the Bollywood, the big boss class, the big money-based sports like cricket. 2) The Super Class Administrative class of Public servants. Majority of it making startling stories of corruption that runs into crores. It is grabbing land of crisis ridden farmer in so called market economy. 3) The struggling lower middle class that is in consumption and status symbol trap. The vicious cycle of consumption, the living by Jones culture ensnares them in gold loan valley. 4) The farmers and aamadami class struggling to face the manmade hurdles. There children are in the open jails of UPSC and MPSC and other competitive examinations. Girls having post graduate degrees in Chemistry, Physics, Math, Electronics are in the race for Police Constable jobs. The scenario is terribly dismal.

Technology

The application of technology needs to be appropriate. It should not be unthoughtfully grand such as using sword for chopping onions.
The switchover from filament bulbs, florescent tubes to LED bulbs is indeed superbly commendable. It reduces energy consumption quantum.
The air conditioners generate heat contributing to global warming. Healthwise too they are risky.

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The bottom-line of technology should be how much technology human body can tolerate?The screen time-based jobs in IT, software is resulting in health hazards. Possibly as all jobs are computer based and internet connected, the electronics imparted stress needs a serious concern. Of course, an independent topic.

Gandhism is Mahatma Fule Derivative.

Upon understanding based perusal of Shetkaryancha Aasud, we arrive at realization that the frugal engineering of Mahatma Gandhi is but the Mahatma Fule Derivative. The goat milk, khadi, sheep wool, pashudhan and the significance of village and rural economy are strikingly illuminated in Aasud. And as Mahatma Fule believed in wealth creation, the wider dimensions of Marxist theory of surplus generation get underscored. Unfortunately, we have reduced the huge figure to a mere social reformer. This demands a serious focus and exploration.

The Towering Bhausaheb

Yet another sinful blunder is reducing DrPanjabrao to the Shabdsumane of tribute song and painfully reducing his vision compounded in his quote, “Agriculture is my culture” to merely cultural dimensiom. The Father of food security and the brilliant idea of Open University, demands a responsible justification in the line of Karl Mark and Butrand Russell. We are captivated by the parable of elephant and the four blind men who confined by the tangible interpretation, bereft of vision draw a fragmented picture. Our failure to assess the towering figure is sinful reflection of irresponsibility.

The Market Economy Mechanism

The mechanism of Market Economy is really wonderful. It offers you the clothes and other consumer durables with attractive offers with the passage of time. The clothes sold at some price on new arrival get offered as buy one get one. A little ahead buy two get four and a little ahead even better. They bring it to the level of the PPP of the lower middle class through stock clearance drives. This underscores the serious issue of the profit percentage. For agriculture produce the Swaminathan propose 50% profit.

Shorgum and Jaggery : The Game changers

Gud and Jawari prove to be economic game changers. Wheat and Shugar are reduced to second fiddle players.

Cover for Natural calamities.

When the Natural Calamities strike, farmers suffer painfully. They are broken apart. The disaster management cover is not full proof. The state should device Natural Calamities Tax so that the total loss of farmers is economically justified.

The Essence of Constitution

The essence of Constitution is justice economic, social and political. Unfortunately, we are reducing the God of equality to God of Reservation. Their valor lies in creating a wall of humanity.

Karl Marks

The Haves and Have-nots maxim of Karl Marks is percolated deep down. The wampanthis have never reflected any concern and vivek to rise above and wake up to rising challenges with the passage of time. Today, we are a job -haves and the job have-nots society. It’s the real bottom line for solutions.

The open air prisons.

UPSC, MPSC and other minor competitive examinations are but the highly organized open air prison. The young generation wages a conflict with parents and underscores their rights. They fearlessly remind their parents of their responsibilities. However, they are not mindful of their constitutional rights. They are not mindful about the responsibilities of public representatives they elect. Of course, the topic of unemployment and manpower management needs an independent treatise.

Socrates on Change: “The secret of change is to focus all of your energy, not on fighting the old, but on building the new”, should prove a mirror.

Grow More Trap.

The grow more, mission has resulted in demand and supply trap for farmers. Food security is grossly misunderstood.

System Friendly Players

System plays with system friendly players. Thus, the common man gets marginalized to the invisible pressure of the system. The nation within the nation reality surfaces.

Technology at the cost of health.

With the advanced technology driven acceleration we are living 25 years life in 5 years. It has resulted in the rise of super specialty health care. The overenthusiasm related to AI will need cool introspection. It is wide open that we cannot download clean air, safe water and food from google.

Robert Frost rightly said, "The world is full of willing people, some willing to work, the rest willing to let them.”

Agriculture is shelterless

The border security is provided with all the tools, technology, machinery and money required for the task. The farmer has made the nation self sufficient with food security. Unfortunately food security is not understood and received in its true significance. When the nation suffered from the food crisis, Hunger Free India- was a challenge

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ahead of the nation. It was Dr Punjabrab who shouldered it with sagacity and courage. It is painful, that- The father of food security has fallen in oblivion. The nation enjoys food surplus in all its dimensions. But the farmers remain the most marginalized lot.In short, food security is a most misunderstood factor from top to bottom. Farmers' suicides are shameful stigma on the ruling class. Food security has not come about by enacting laws in parliament. There has to be food in granaries and daily supply of milk, vegetables to market. For this the farmer toils 24x7 under the open sky.

Solution: At your seat service in Railway

The rush at the railway ticket counter is highly breath-taking. For the senior citizens it is apparently critically risky. It can be addressed by appointing girls as conductors as in buses for 100 km distance. One candidate will manage two compartments for 100 to 150 km. The jobs should be on contract basis with security amounts based for security purposes. This will help address the problem of unemployment. The girls will get disposable income. The at your seat service may be made reasonable service charge based so that the issue of revenue will be automatically addressed.

Solution: Part Time Jobs

To address the issue of unemployment, creating part time jobs on contract basis is the simple solution. It will help achieve the object of good governance. We already have a system of CHB teachers. Extend it to all jobs.

Solution: Transform State Transport.

Given the huge infrastructure, the State Transport can be transformed as an ideal and role model institution. I have a model for it.

1) I can improve its profit by 30%
2) Create 10% more jobs.
3) Reward 20% salary hike to all employees
4) 50% jobs of conductors should be reserved for women. And their duty hours should end by 7pm.
5) The working hours of all women should be reduced by one hour as all men eat food cooked by their mothers ,wives, sisters, daughters, maids. In short, the home management factor!

All male folks from top to bottom need to wear some sense of shame and responsibility.

6) Can device better time management. Co-ordinated and well-planned scheduling. A better service to passengers.

AI Technology & plastic

Plastic proves to be a necessary evil. The gsm criterion finds no sensible response from public. The reckless disposal of thin plastic bags containing food often results in taking toll of gomatas and other pashudhan eating it out.The plastic quoted tea cups are a health hazard. Using plastic utensils for hot food too is risky. This in short appears to be a huge challange for think tanks and technocrats. For the present, awareness appears to be only solution. Let us say no to plastic where it is related to food consumption.

The phata poster nikla hero syndrome

Huge billboards keep popping up all around. The political class, the identity crisis ridden icons, the commercial bill boards and the envy factor generated lot. Your billboard vs my bill board competition. A bigger than thou trend, culminating into creation of a scenario, mocking education, culture and wisdom of humanity. This reckless phenomenon getting digested as normal life style. People find nothing abnormal or wrong about it.The billboards stand at very typical points catching human attention. On busy roads too they are inevitable even at accident prone spots. But who cares? pan lakshat Kon gheto? is an unfortunate state of affairs. Society seems to be redefining aesthetics. This horrible phenomenon will need to be sagaciously addressed with regulatory measures. Some tax structure will need to be devised to control the phenomenon. Requirement of statutory permission will need to be made mandatory for putting the bill boards and the agencies that are in structures rental basis business.

One Window Clearance

Manohar Joshi Model.

By all parameters the Manohar Joshi Government model of one Window Clearance should go down as a step towards good governance. It made some services simple and easy. All governments should derive inspiration from it to be service oriented without feeling shy about emulation of the model. And attempt to excell by creating better models of Good governance.

Welfare State

The 50% concession in bus fair to all women without any barriers of age or otherwise should be upheld as a mark of welfare state. And the ladkibahin scheme too deserves appreciation.

The Dhananjay Dhawad Model

The bridge on Walgaon Amravati road, besides which the Gadge Baba Samadhi is located, was too narrow. It was ingeniously widened by Dhananjay Dhawad, while he was, executive engineer at PWD, Amravati. The idea of extending it on both sides, instead of demolishing should go a long way as an ideal, unique, ingenious and visionary Model for moderating the development with cost effective and redundant development. Another dimension of this model is that it serves the purpose of echo-friendliness. It has created a space of over two decades for further construction of an alternative. This twenty years lease of life is one point and the other dimension is it is still in existence and used with full proof safety and profound stability. This model should go a long way. It happened while Wasudhatai Deshmukh was PWD minister. She too needs to be appreciated for being positive and helpful for

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supporting the idea. No adamant stand, along the development within development was taken as a politician. With the passage of time, another bridge has come up to justify the inflated density of traffic.I would with confidence and Hollistic intent suggest that this ingenious Dhananjay Dhawad Model should be cynosure for the old bridge at Rajkamal Chouk. It would provide us several fringe benefits. 1) The lease of life 2) The relief from the present inconvenience caused to the public 3) The relief from the Dravidian Pranayam of time killing navigation. 4) The cost factor. 5) The substitute factor. 6) The Pride of Historical heritage, aspect that has public emotions attached to it at the heart of the City and the pivot of Rajkamal Square.

Delhi Traffic

Addressing the recent AI event in Delhi, Sunder Pichai underscored an admission that AI has no solution for the allegorical, Non -pride of the nation, the Delhi Traffic. Over a week prior to Sir Sunder Pichai version, I had twitted on X that AI has no solution for the environment in Delhi.

Gadkari : A True 56 inch mettle

Union Minster often keeps us giving sweet shocks by his democratic public versions. Of course these versions are far from the normal political penchant for news making. Nitinji fearlessly and sensitively commented on the air quality in the capital of India. His public admission that the bad air often causes him a throat infection is a mark of courage. He deserves to be appreciated for his fearless act. The true 56 Inch Marathi mettle, material and substance indeed.

Agriculture. The Super solution

We are growing food surplus. In ecological terms it is something contrary to the concept of soil conservation. To grow more than you need means, unnecessarily ruining soil fertility and general strength of the soil. Hence agriculture will need a far sighted, visionary and sane policy. Roughly speaking, 50 % of land will need to be used for pashudhan food, forestations and grazing wild animals, water conservation and solar energy production and for natural soil conservation.

The Man vs Wildlife conflicts

The man vs wildlife conflict has become critical. The herbivores wildlife feasting on agricultural crops has become a nightmare for farmers. The conflict often results in the loss of human life as other hunter species of animal such as leopard and others come chasing the herbivores wildlife.

This crisis can be addressed by involving the adiwasi population in cultivation of crops for herbivores in forest areas. This will help keep the herbivores remain confined to their safe forest zones.

The Empirical sciences

The empirical sciences known to farmers is the area for research and documentation. I had underscored this point my article in Agrowon, Diwali number(2010).

Water Management

As mentioned above, some low lying areas can be subjected to the creation of water bodies by policy support of the government.

Shet Tale scheme is in existence. It would need to be made ambitious and broad based. My paper published in Science Journal of Vidarbha Institute of Science and Humanities dilates upon this topic.

Vol 8, No 1-2 (2013)

Who Will Bail The Cat

Who will show the courage to bail the policy cat? Life is getting pushed under the cc footage. The account of Troubles and Treatments needs to be summed up with the admission that Global Warming proves but a matter of conferences and summits, . Prayer is the only mode of action common man is left with. Amen.

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Original Article

Beyond Screens: Non-Digital Gamification for Sustainable English Language Learning

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Abstract

As digital tools dominate the pedagogical discourse, a "participation gap" emerges, this paper studies how non-digital gamification can support English language learning within a framework of sustainable education. It explores the use of non-digital games in English language learning, an area that is less explored compared to digital gamification methods. Sustainable Development Goals (SDGs) specifically Quality Education (SDG 4) by UNESCO—supports reducing disparities in education, for both access and quality. Focusing on non-digital gamification makes research literally more 'sustainable': it removes dependence on costly hardware, electricity, and high-speed internet. This makes it highly applicable to diverse classrooms, especially in regions with a digital divide. With rising concerns about equitable access and the environmental costs of technology-dependent pedagogies, the objective of the study is to explores low-resource, game-based strategies. An experiment was conducted over a week in a classroom. The "Engage, Evolve, Endure" (EEE) framework was implemented using games for classroom engagement and teacher interviews in resource-constrained settings, the research examines learners' engagement and language outcomes when gamified mechanics are applied through physical materials and face-to-face interaction. Data from student's performance and teacher interviews revealed an increase in voluntary participation. Findings suggest that non-digital gamification fosters deeper social bonds and intrinsic motivation. The study concludes that "unplugged" gamification is a superior model for long-term linguistic endurance in diverse global contexts.

Keywords: *Non-digital gamification, Sustainable Development Goals, English language learning, digital divide.*

Introduction

The conversation around gamification in education is often synonymous with digital apps, VR, and software. However, true Sustainable Education—as defined by the United Nations' SDG 4—must be inclusive, equitable, and resilient. Digital dependency often creates divergence between well-funded urban centers and resource-constrained environments. This paper argues for Analog Gamification: the application of game-design elements (narrative, feedback loops, and progress tracking) using physical, low-cost materials. By removing the "screen," we refocus on human-to-human interaction, which is the ultimate goal of any language learning including English. English has become the working language of higher study, urban employment, and digital life in India, yet millions of adolescents still encounter it first on faded textbook pages in under-resourced classrooms. Over the past decade, gamification has promised a way out of rote drills: insert points, badges, and leaderboards, and students will supposedly lean in. The evidence for digital versionsapps, leaderboards, adaptive quizzesis real but uneven, and it rests on a quiet assumption: that every school can count on devices, power, and bandwidth. Walk into grade-8 sections of any rural school in Amravati district and you'll still find basic infrastructure, chalkboards, and a teacher juggling with the needs of all students in classrooms that include children with diverse learning needs, while the electricity flickerThedigital gamificationplaybook suddenly feels speculative. The study offers a twofold insight. First,an empirical. look at

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Offline gamification's impact on engagement and English outcomes in conditions that reflect
Everyday schooling for many Indian means frugal, repairable, and teacher-ownedIn a context wherepolicy" rhetoric often outpaces classroom infrastructure, showing that motivation can live on paper is a small but necessary corrective.learners. Second,a framing of those mechanics as sustainability-aligned practice, where "green

Need and Importance

There is a critical need for pedagogical models that do not depend on electricity or high-cost hardware to remain "sustainable." Analog gamification restores human-centric interaction and reduces screen fatigue by ensuring equitable access to engaging learning environments regardless of a school's technological infrastructure.

Need

- Infrastructure gap: Most gamification studies assume devices and internet; government classrooms in Maharashtra often have only chalkboards and intermittent power.
- Equity pressure: English is linked to urban jobs, yet rural learners get textbook drills—not motivating apps—widening participation gaps.
- Sustainability mandate: UNESCO's education goals call for low-cost, enduring pedagogies; tech-dependent games can die when grants end or projectors break.
- Teacher agency: Educators need routines they can remake themselves (cards, dice) instead of waiting for tech support.Importance
- Works anywhere: Offline mechanics run during load-shedding, on a rainy day, with zero bandwidth—making motivation reliable, not contingent on gadgets.
- Cost keeps it alive: Laminated cards and paper leaderboards cost almost nothing to replace; schools can sustain them year after year.
- Same psychology, no screen: Points, progress visuals, and team challenge still feed autonomy, competence, and relatedness—the drivers of engagement.
- Wider inclusion: Team-based points and hand-signed passports let low-confidence learners participate without fear of public digital Rankings.
- Environmental fit: Reusable materials cut e-waste and energy use, aligning English practice with broader sustainable-education aims.

Literature Review

With the help of review research, taking help about the previous results problems for the Dissertation understand what is not to be taking for the students problems and with the help of the review present research avoid all the mistakes and which are done by the previous researcher and getting help about what should be land about the research The Related reviews of Present Research are as follows: Fabricio Inocencio (2018 December) ,"Using Gamification in Education: A systematic Literature Review."Rodrigo Smiderle,Sandro Jose Rigo, Leonardo B. Marques (09 January 2020), "The impact of gamification on students' learning, engagement and behavior based on their personality traits." Nadia Azzouz Boudadi and Mar Gutiérrez-Colón(March 2020), "Effect of Gamification on students' motivation and learning achievement in Second Language Acquisition within higher education: a literature review 2011-2019." Víctor Arufe Giráldez (10 October 2022), "Play hard, study hard? The influence of gamification on students' study engagement" Chauda, Vaishali Mohanlal.(2012), "Development and implementation of a program for enhancing English listening skill of students of Standard VIIIth."Saraff,Sweta(2021), "Gamification as pedagogical intervention of performance, mindset and metacognition of students."

Objectives

The study aims to

1) Identify core non-digital mechanics that lower the "Affective Filter" in ELL.
2) Evaluate the impact of "Analog Quests" on student persistence.
3) Assess the economic and pedagogical sustainability of low-tech game-based frameworks**.**
4) To study the effectiveness of gamification on the participation, attention and retention of the students.
5) Discuss challenges and future directions.

Methodology

The study took place in grade-8 classrooms in government school in Amravati district, Maharashtra. All sections shared similar constraints: chalk-and-board teaching, one shared projector for the whole school, and intermittent electricity. Learners in total 80, aged 13-14 years (n=80, girls and boy) had mixed Marathi/Hindi-medium backgrounds; English exposure came mainly from textbooks and teacher input. We used a quasi-experimental pre/post design with comparison groups that continued textbook drills. The intervention group experienced game based elements and games like 1) Bingo and 2) Snakes and ladders. The game experience was created through the use of various game elements or mechanics, including narrative, level, points, progress bars, scoreboards, challenges, and feedback.

Experimental design

This experiment followed an experimental design consisting of two groups, control (40 participants) and experimental groups (40 participants), for which the students were randomly assigned.

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Challenges

- Preparation load: Cutting cards, drawing boards, and writing role prompts takes front-end time; busy teachers may stall after week one.
- Class size: With 50+ learners, circulating for "passport" signatures or checking board-race sentences can bottleneck flow.
- Noise/space: Quest chatter and team huddles look like indiscipline to admins used to silent rows.
- Assessment fit: Boards and badges show motivation but mapping them to term-exam marks takes extra translation.
- Mixed readiness: Strong peers may dominate quests unless roles are strictly rotated, or low-confidence learners stay spectators.

Analysis

Quantitative data analyzed in Excel; paired t-tests compared pre/post means. Interview transcripts coded for time, cost, inclusion, and reuse.

Findings

- Vocabulary gains: mean improvement 18% vs. 7% in comparison sections ($p<.05$).
- Speaking confidence: willingness to initiate dialogue; learners earned "reward" individually, reducing anxiety.
- Engagement: 84% reported classes "more fun"; teachers noted lower off-task behavior.
- Attention: On-task behavior rose from ~60% to 85% in treatment sections during quest slots, with distractions clustering around transition moments only.
- Retention: Week-end vocabulary checks improved 20–25% in treatment groups versus comparison group.

Sustainability indicators

- Cost: Initial kits =200/- class; zero recurring fees.
- Access: No internet/devices; worked during power cuts.
- Longevity: All materials survived after the experiment; teachers planned to rotate them into next term.

Recommendations

- Template bank: Share one-page quest shells that teachers can re-skin with new words.
- Station rotation: Run two gamified stations while one row does workbook practice; teacher verifies only at stations, easing crowding.
- Signal norm: Use a chit or clap pattern as a volume cue; keeps quest energy legible to administrators.
- Rubric bridge: Convert stamps/coins into weekly "effort" marks (e.g., 5 stamps = full credit) so game work counts toward gradebooks.
- Rule jolts: Every fortnight, add a micro-twist—swap dice for a spinner, or double-points for peer-explanations—to refresh novelty.
- Protect materials: Laminate boards/clue cards once; store in zip sleeves.
- Role contracts: Fix roles (reader, writer, checker, timekeeper) and rotate; include one "quiet helper" slot so low-confidence learners contribute without spotlight pressure.

Future Directions

- Longitudinal persistence: Track the same learners for 2–3 terms to see if vocabulary and speaking gains hold after novelty fades.
- Low-tech → no-tech transfer: Test whether quest-trained classes still outperform when games are withdrawn—do habits of re-attempt and peer check stick?
- Differentiated quests: Build tiered card decks (foundation/extension) and measure impact on mixed-readiness groups without singling out weaker learners.
- Teacher-design studies: Give teachers template kits and compare outcomes when they author quests vs. using researcher-made scripts—checks ownership and sustainability claims.
- Cross-subject spillover: Try the same board-race or passport mechanics in science vocabulary teaching; see if engagement patterns replicate.

Conclusion

"Beyond Screens" does not mean "Anti-Tech"; it means "Human-First." For English Language Learning to be truly sustainable, it must be untethered from the power outlet. Non-digital gamification restores the joy of play to the classroom, ensuring that the "endurance" of the learner is built on social bonds and creative expression rather than screen-time.Offline gamification—stamps, leaderboards, paper quests—raised English engagement and vocabulary in low-resource classrooms without any tech. Because materials are cheap, reusable, and teacher-controlled, the approach is both sustainable and scalable for settings that can't count on devices. Motivation, it turns out, works fine on paper. The takeaway is modest and practical. If English learning is to become more equitable beyond well-wired schools, we need motivational designs that assume chalkboards, not smartboards. Offline quests don't reject technology; they

decouple engagement from it. That keeps the door open for EdTech where it exists, and crucially, keeps it open where it doesn't.

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Original Article

Gamification as a Tool for Sustainable Education in English Language Learning

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Abstract

Gamification is an innovative approach that enhances English language learning by integrating game elements such as rewards, challenges, and interactive tasks into education. This study explores its role in promoting sustainable education, which emphasizes long-term learning and skill retention. Gamified strategies increase student motivation, engagement, and participation, improving language skills like reading, writing, listening, and speaking. The study uses a mixed-method approach to evaluate learning outcomes. Findings reveal that gamification supports self-directed and lifelong learning while addressing diverse learner needs. It concludes that gamification makes English education more engaging, effective, and sustainable in modern classrooms.

Introduction

In the 21st century, education has experienced a major transformation with the integration of digital technologies. Among these innovations, gamification has emerged as a powerful approach that applies game design elements such as points, rewards, challenges, and interactive activities to non-game contexts like education. It has gained significant attention for its ability to improve student motivation, engagement, and overall learning outcomes. By making learning more interactive and enjoyable, gamification helps students actively participate in the educational process.At the same time, sustainable education emphasizes long-term knowledge retention, critical thinking, and the development of lifelong learning skills. Traditional methods of teaching English often struggle to maintain student interest and engagement. Gamification addresses this challenge by creating dynamic and learner-centered environments. It not only enhances interest in language learning but also supports continuous learning, making English education more effective, engaging, and aligned with the principles of sustainability.

Concept of Gamification in Education

Gamification in education refers to the use of game design elements such as points, badges, leaderboards, levels, and challenges to enhance the learning experience. These elements help transform traditional classrooms into more interactive and engaging environments. By incorporating game-like features, educators can make learning activities more enjoyable and motivating for students. Gamification encourages active participation, competition, and collaboration among learners. Research indicates that it significantly improves student engagement and motivation. Moreover, it provides a safe and experimental space where students can learn through practice, make mistakes, and develop skills effectively, leading to a more meaningful and immersive learning experience.

Gamification and Sustainable Education

Sustainable education emphasizes continuous learning, adaptability, and the development of essential skills required for lifelong growth. It focuses on equipping learners with the ability to think critically, solve problems, and adapt to changing environments. Gamification effectively supports these goals by fostering long-term engagement through interactive and motivating learning activities. It encourages self-directed learning, enabling students to take responsibility for their own progress and actively participate in the learning process.

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Additionally, gamified systems provide continuous feedback and opportunities for improvement, helping learners identify their strengths and address their weaknesses. This process enhances both learning outcomes and skill development. Furthermore, studies indicate that gamification plays a significant role in promoting sustainable behaviors and achieving educational objectives aligned with global development agendas. By making learning more engaging, personalized, and goal-oriented, gamification contributes to creating a more effective, inclusive, and sustainable educational environment.

Role of Gamification in English Language Learning

Gamification plays a significant role in enhancing English language learning by improving all four essential language skills: reading, writing, listening, and speaking. It transforms traditional teaching methods into interactive and engaging experiences that motivate learners to participate actively. In terms of reading skills, gamified tools such as interactive quizzes, storytelling games, and comprehension challenges help students improve their understanding of texts while expanding their vocabulary. For writing skills, gamification introduces creative tasks, timed challenges, and reward-based assignments that encourage students to express their ideas more effectively and confidently. Listening skills are strengthened through audio-based games, podcasts, and task-oriented activities that enhance comprehension and attention to spoken language. Similarly, speaking skills are developed through role-playing games, simulations, and real-life communication scenarios that build confidence and fluency. By integrating these elements, gamification caters to diverse learning styles and promotes active involvement. It also provides immediate feedback, allowing learners to track their progress and improve continuously. Overall, gamification makes English language learning more dynamic, enjoyable, and learner-centered, ultimately leading to better retention, increased motivation, and improved language proficiency.

Advantages of Gamification

Gamification offers several advantages that significantly enhance the teaching and learning process. One of its primary benefits is that it increases student motivation and engagement by incorporating game elements such as rewards, challenges, and achievements, which make learning more enjoyable and stimulating. It also promotes active participation, as students are encouraged to take part in tasks, competitions, and collaborative activities rather than remaining passive learners. Another important advantage is its ability to support personalized learning, allowing students to progress at their own pace and focus on areas where they need improvement. Gamification also encourages lifelong learning by fostering curiosity, self-interest, and a continuous desire to achieve goals. Furthermore, it improves retention and understanding, as interactive and repetitive activities help learners remember concepts more effectively. Immediate feedback provided in gamified systems enables students to track their progress and make necessary improvements. Additionally, it helps develop problem-solving and critical thinking skills through challenges and simulations. Overall, gamification creates a more dynamic, engaging, and effective learning environment, making education more meaningful and aligned with the needs of modern learners.

Challenges of Gamification

Despite its many advantages, gamification also presents several challenges in the educational context. One major issue is that it requires careful design and planning to ensure that game elements align with learning objectives; poorly designed systems may fail to achieve desired outcomes. There is also a risk of over-dependence on rewards, where students may focus more on earning points or badges rather than understanding the subject matter. Additionally, technological limitations in some regions can restrict the effective implementation of gamified learning, as access to digital tools and internet connectivity may be limited. Another significant challenge is the need for proper teacher training, as educators must be equipped with the necessary skills to design and manage gamified learning environments effectively. Without adequate preparation, the benefits of gamification may not be fully realized. Therefore, addressing these challenges is essential for successful and sustainable implementation.

Discussion

The findings of the study clearly indicate that gamification significantly enhances student motivation and engagement in the learning process. Learners become more actively involved, which leads to improved participation and interest in educational activities. Additionally, students demonstrate better retention of knowledge, as gamified learning environments encourage repeated practice and reinforcement. Compared to traditional teaching methods, learning outcomes are found to be more effective and meaningful. Research studies further support these results, showing that gamification enhances not only learning outcomes but also motivation and emotional engagement when game elements are properly designed and implemented. Long-term studies also suggest that gamification improves knowledge retention across different age groups and genders, making it a versatile educational tool. However, it is important to note that improper implementation of gamification may result in distractions or an excessive focus on

rewards rather than actual learning. Therefore, careful planning and balanced integration are essential for achieving the desired educational outcomes.

Conclusion

Gamification has emerged as a powerful tool for promoting sustainable education in English language learning. It significantly enhances student engagement, making the learning process more interactive, enjoyable, and effective. By integrating game elements into teaching, it improves learning outcomes and supports the development of essential language skills. Moreover, gamification encourages long-term knowledge retention and fosters lifelong learning habits among students. When implemented thoughtfully, it transforms traditional classrooms into dynamic and learner-centered environments. Therefore, gamification is not merely a modern trend but a necessary and impactful innovation for achieving sustainable, inclusive, and effective education in today's rapidly evolving educational landscape.

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Original Article

Role of NGOs in Budget Advocacy for Women Empowerment: A Review Study

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Abstract

Women empowerment remains a critical component of sustainable development, particularly in developing economies. Budget advocacy has emerged as a strategic tool to influence public financial decisions in favour of gender equity. Non-Governmental Organizations (NGOs) play a pivotal role in promoting gender-responsive budgeting, ensuring accountability, and amplifying women's voices in policy processes. This review study synthesizes existing literature on the role of NGOs in budget advocacy for women empowerment. The paper examines strategies, impacts, challenges, and innovative approaches adopted by NGOs globally and in India. Findings indicate that NGOs significantly contribute to policy reforms, increased budget transparency, and improved allocation for women-centric programs. However, structural, financial, and political challenges limit their effectiveness. The study highlights the need for stronger institutional collaboration and capacity building to enhance NGO-led budget advocacy for sustainable development.

Keywords: *Women Empowerment, NGOs, Budget Advocacy, Gender Budgeting, Sustainable Development*

Introduction

Women empowerment is widely recognized as a fundamental prerequisite for achieving inclusive growth, social justice, and sustainable development. It encompasses the expansion of women's access to resources, opportunities, and decision-making power across economic, social, and political domains. Despite significant global commitments, including the Sustainable Development Goals (SDGs)—particularly Goal 5 (Gender Equality)—gender disparities continue to persist in many parts of the world, especially in developing countries like India. These disparities are reflected in unequal access to education, healthcare, employment opportunities, financial services, and political participation.

Public policy, particularly fiscal policy, plays a crucial role in addressing these inequalities. Government budgets are not merely financial documents but powerful policy tools that reflect priorities and commitments toward different sections of society. However, traditional budgeting processes have often been gender-neutral in approach, failing to recognize the differential needs, roles, and challenges faced by women. This has led to inadequate allocation of resources for women-centric programs and limited impact on reducing gender gaps.

In this context, budget advocacy has emerged as an important strategy for influencing public resource allocation to promote gender equity. Budget advocacy involves analyzing government budgets, identifying gaps in resource allocation, and engaging with policymakers to ensure that fiscal decisions are inclusive and equitable. A key component of this approach is Gender Responsive Budgeting (GRB), which integrates gender perspectives into all stages of the budget cycle—planning, allocation, implementation, and evaluation (Elson, 2006). GRB aims to ensure that public expenditures contribute to reducing gender inequalities and improving the overall well-being of women. Non-Governmental Organizations (NGOs) have become pivotal actors in advancing budget advocacy for women empowerment.

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Positioned between the state and the community, NGOs play a bridging role by representing the voices of marginalized groups, particularly women, in policy processes. Their involvement ranges from conducting gender budget analyses and generating evidence-based research to mobilizing communities and influencing policy decisions. NGOs also contribute to enhancing transparency and accountability in public financial management by monitoring government expenditures and conducting social audits.

The theoretical foundation of women empowerment is strongly influenced by the work of Naila Kabeer (1999), who conceptualized empowerment as a process involving resources, agency, and achievements. Budgetary policies directly affect access to resources and opportunities, thereby influencing women's agency and outcomes. Similarly, Amartya Sen (1999) emphasized the importance of expanding individuals' capabilities and freedoms, which can be achieved through equitable allocation of public resources in sectors such as education, health, and employment.

Globally, NGOs have been instrumental in promoting gender budgeting initiatives. In countries such as South Africa, the Philippines, and India, NGO-led advocacy has contributed to the institutionalization of gender-responsive budgeting frameworks. In India, the introduction of the Gender Budget Statement in the Union Budget reflects the growing influence of civil society organizations in shaping fiscal policies. NGOs have also facilitated participatory budgeting processes, enabling women at the grassroots level to actively engage in decision-making and express their needs and priorities.

Despite these contributions, NGO-led budget advocacy faces several challenges. These include limited financial resources, lack of technical expertise in budget analysis, restricted access to policy-making platforms, and political resistance. Additionally, the effectiveness of NGOs varies depending on institutional support, governance structures, and the level of decentralization in budgetary processes.

Given this background, it is essential to critically examine the role of NGOs in budget advocacy and their impact on women empowerment. A comprehensive review of literature can provide insights into the effectiveness of NGO interventions, identify best practices, and highlight existing gaps. Such an analysis is crucial for strengthening policy frameworks and enhancing the role of NGOs in promoting gender-equitable development.

This study, therefore, seeks to contribute to the existing body of knowledge by synthesizing research on NGO-led budget advocacy and its implications for women empowerment. It also aims to provide evidence-based recommendations for policymakers, practitioners, and researchers to enhance the effectiveness of gender-responsive budgeting initiatives.

This review paper aims to analyse the role of NGOs in budget advocacy and its impact on women empowerment.

Objectives

To critically review literature on the role of NGOs in budget advocacy
To examine the impact of NGO interventions on women empowerment
To analyze strategies used by NGOs in influencing budgetary processes

Methodology

Systematic literature review using journals, reports, and policy documents.

Review of Literature

The role of NGOs in budget advocacy for women empowerment has been widely examined across interdisciplinary domains including development studies, public finance, and gender studies. The literature reflects both theoretical advancements and empirical evidence highlighting NGO contributions, strategies, and limitations.

Theoretical Foundations of Women Empowerment

Naila Kabeer (1999) conceptualized empowerment as a process involving resources, agency, and achievements, emphasizing that access to resources alone is insufficient without the ability to exercise agency. Budgetary policies, therefore, must not only allocate funds but also ensure women's participation in decision-making.

Amartya Sen (1999) proposed the capability approach, arguing that development should enhance individuals' freedoms. Public expenditure on health, education, and nutrition directly contributes to expanding women's capabilities, thereby reinforcing empowerment.

Martha Nussbaum (2000) further expanded the capability framework by identifying central human capabilities, including bodily health, education, and political participation, which are directly influenced by budgetary allocations.

Jo Rowlands (1997) introduced the concept of power within, power to, and power with, which is particularly relevant in understanding how NGO-led advocacy fosters collective empowerment among women.

Gender Budgeting and Policy Frameworks

Diane Elson (2006) highlighted that gender-responsive budgeting (GRB) is not a separate budget but an analytical approach ensuring that fiscal policies address gender inequalities. She emphasized the role of civil society, particularly NGOs, in holding governments accountable.

Sharp and Broomhill (2013) argued that GRB initiatives are most effective when supported by strong institutional frameworks and active civil society participation. Their study in Australia demonstrated that NGO advocacy significantly influenced gender-sensitive fiscal reforms.

Budlender and Hewitt (2003) found that gender budget initiatives in over 40 countries were largely driven by NGOs and civil society organizations, indicating their central role in policy transformation.
Elson and Sharp (2010) further emphasized that NGOs contribute to bridging the gap between macroeconomic policies and grassroots realities by translating complex budget data into accessible formats.

Role of NGOs in Budget Advocacy

NGOs play a multifaceted role in budget advocacy, acting as intermediaries between citizens and the state. Chakraborty (2016) examined India's gender budgeting framework and found that NGOs played a critical role in capacity building and policy advocacy, particularly in training government officials and analyzing budget documents.
Robinson (2008) highlighted that NGOs enhance participatory governance by enabling marginalized women to engage in budget processes, thereby democratizing fiscal decision-making.
Joshi and Houtzager (2012) emphasized the role of NGOs in social accountability mechanisms, such as public hearings and expenditure tracking, which improve transparency and reduce corruption. The International Budget Partnership (2019) reported that NGO-led budget advocacy initiatives significantly improved budget transparency scores in several developing countries.

Impact of NGO Interventions on Women Empowerment.

Klasen and Lamanna (2009) demonstrated that gender equality in education and employment contributes significantly to economic growth, highlighting the importance of targeted budget allocations. Duflo (2012) argued that women-focused investments yield higher social returns, particularly in health and education outcomes. Razavi (2012) emphasized that social protection programs influenced by NGOs improved women's economic security and reduced poverty.
Hassim (2006) found that NGO advocacy in South Africa led to increased budget allocations for gender equality programs, resulting in improved access to public services.
UN Women (2018) reported that countries with active NGO participation in budgeting processes showed improved maternal health outcomes, increased female literacy, and enhanced labor force participation.

Challenges in NGO-led Budget Advocacy

Despite their contributions, NGOs face several challenges:

Edwards and Hulme (2014) identified financial dependency as a major constraint, limiting long-term sustainability. Goetz (1997) highlighted institutional barriers, including limited access to policy-making platforms. Banks, Hulme, and Edwards (2015) noted that NGOs often face legitimacy issues and political resistance, particularly in authoritarian contexts. Another critical challenge is the lack of technical expertise in macroeconomic analysis, which restricts NGOs' ability to influence high-level fiscal policies.

Discussion

NGOs bridge policy and practice gaps, enhancing accountability and gender equity. Their effectiveness depends on institutional support and technical capacity. NGO interventions have significantly contributed to increased public investment in women-centric programs such as microfinance, skill development, and entrepreneurship support. Empirical evidence suggests that improved budget allocations enhance women's access to financial resources, thereby strengthening their economic independence. This supports the capability approach of Amartya Sen, where access to resources expands individual freedoms.

Increased funding for health, nutrition, and education programs has led to measurable improvements in women's well-being. NGO advocacy has been instrumental in prioritizing maternal health services, girls' education, and nutrition schemes. These outcomes are consistent with the empowerment framework proposed by Naila Kabeer, emphasizing the role of institutional support in enhancing women's agency and achievements.

Conclusion

In conclusion, NGOs are indispensable actors in advancing women empowerment through budget advocacy. Their role in influencing policy, promoting gender equity, and ensuring accountability is critical for achieving broader development goals, including the Sustainable Development Goals (SDGs). To maximize their impact, there is a need for stronger institutional collaboration, enhanced financial support, and continuous capacity building. Integrating NGO efforts with formal governance structures and adopting innovative, evidence-based advocacy approaches will further strengthen the effectiveness of gender-responsive budgeting initiatives. Ultimately, a collaborative and inclusive approach to budget advocacy is essential for creating equitable, just, and sustainable societies where women can fully realize their potential.

Recommendations

Strengthen NGO-government collaboration, enhance funding, promote participatory budgeting, and improve monitoring systems.

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Original Article

Innovations in Food and Nutrition for Improving the Health of Students in Tribal Ashram Schools : A Study

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Abstract:-

Tribal (Adivasi) children studying in ashram schools are among the most nutritionally vulnerable populations in India. Despite various government interventions, issues such as malnutrition, anemia, stunting, and poor dietary diversity continue to persist. The present study focuses on innovative approaches in food and nutrition aimed at improving the health status of students in tribal ashram schools. These innovations include millet-based diets, school nutrition gardens, and community participation. The study adopts a descriptive and analytical research design, using dietary recall, anthropometric measurements, and statistical tools to assess health outcomes. The findings reveal that innovative nutritional practices significantly enhance the dietary quality, BMI levels, and overall health of students. The study emphasizes the need for integrating traditional knowledge with modern technology to ensure sustainable health improvements among tribal children.

Introduction:-

India is home to a significant tribal population, accounting for approximately 8.6% of the total population. A large proportion of tribal communities reside in remote, forested, and underdeveloped regions where access to healthcare, education, and nutrition is limited. To address these challenges, the government has established tribal ashram schools that provide residential education, food, and basic healthcare services to children. However, despite these efforts, the nutritional status of students in these schools remains a matter of concern. Many children suffer from malnutrition, anemia, vitamin deficiencies, and low body mass index (BMI). These issues not only affect physical growth but also hinder cognitive development and academic performance. The primary causes include poverty, lack of awareness, food insecurity, inadequate dietary diversity, and poor implementation of nutrition programs. In recent years, innovative approaches in food and nutrition have emerged as effective solutions to these problems. These include the incorporation of traditional grains like millets, establishment of school nutrition gardens, use of digital and active involvement of local communities.

This study aims to explore these innovations and evaluate their impact on improving the health status of students in tribal ashram schools.

Objectives:-

1. To assess the nutritional status of students in tribal ashram schools.
2. To study innovative food and nutrition practices implemented in these schools.
3. To evaluate the impact of these innovations on health indicators.
4. To suggest effective strategies for improving student health and nutrition.

Hypotheses:-

1. Innovative food and nutrition interventions significantly improve the health status of students.
2. Inclusion of locally available and nutrient-rich foods enhances dietary diversity and reduces malnutrition.

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Review of Literature:-

1. **Brigitte Fain (2008)**
2. The study highlighted that childhood growth is highly dependent on nutritional status. It was observed that the height and weight of tribal children were significantly lower than the standards recommended by WHO (2006), indicating widespread malnutrition among tribal populations.
3. **Planning Commission of India (2011)**
4. The report emphasized that although Article 46 of the Indian Constitution provides special provisions for the welfare of Scheduled Tribes, its implementation remains weak. Limited outreach of health, nutrition, and education schemes has resulted in high levels of malnutrition and school dropouts among tribal children.
3. **Millet-based Nutrition Studies (2018–2022)**
4. Various studies have shown that the inclusion of traditional grains such as jowar, bajra, and ragi significantly improves protein and micronutrient intake. These grains help in reducing malnutrition among children.
5. **Kumaretal.(2024)**
   A cross-sectional study across multiple tribal districts found that nearly **44% of tribal children were malnourished**, with significant levels of underweight and stunting. The study concluded that parental education, socio-economic status, and breastfeeding practices play a crucial role in determining nutritional status.
6. **Jawhar Tribal Nutrition Study (2025)**
7. A recent study demonstrated that the use of locally available foods and traditional recipes significantly improved the nutritional status of undernourished tribal children. The study emphasized the importance of integrating traditional knowledge with modern nutrition science

Methodology:-

The present study adopts a **descriptive and analytical research design** to examine the nutritional status and health conditions of students studying in tribal ashram schools. The research focuses on identifying the relationship between dietary intake, nutritional deficiencies, and overall health indicators among tribal children. A sample of **100 students** was selected from different tribal ashram schools to ensure adequate representation. The **random sampling technique** was used to select the respondents, which helps in reducing bias and improving the reliability of the findings.

Data collection was carried out using multiple methods to ensure accuracy and comprehensiveness. The **3-day dietary recall method** was used to assess the actual food intake of the students, which provides reliable information about their daily nutritional consumption. In addition, **anthropometric measurements** such as height, weight, and Body Mass Index (BMI) were recorded to evaluate the physical growth and nutritional status of the students. To gather qualitative and quantitative information, **structured questionnaires and observation methods** were also used, focusing on dietary habits, personal hygiene, and health-related practices.

For data analysis, appropriate **statistical tools such as mean, percentage, and correlation** were applied to interpret the collected data effectively. These tools helped in understanding the patterns, relationships, and variations in nutritional intake and health status among the students. Thus, the methodology provides a systematic approach to analyze the impact of food and nutrition innovations on the health of tribal ashram school students.

Results and Discussion:-

The findings of the study indicate that a majority of students in tribal ashram schools suffer from deficiencies in protein, iron, and essential vitamins due to poor dietary intake and low food diversity. These deficiencies lead to health issues such as low BMI, anemia, and reduced physical growth. However, the introduction of innovative nutritional practices has resulted in noticeable improvements in students' health. The inclusion of millet-based foods, establishment of school nutrition gardens, and use of technology for monitoring dietary intake have helped in improving nutritional status. As a result, improvements were observed in BMI, energy levels, and overall health of the students. These findings highlight that innovative approaches in food and nutrition play an important role in enhancing the health of tribal children.

Table No. 1

Nutritional Deficiency Status among Tribal Ashram School Students

Sr. No.	Nutrient Deficiency	Percentage (%)	Severity Level
1	Protein	52%	Moderate
2	Iron	68%	High
3	Vitamin B12	57%	Moderate
4	Calcium	38%	Low
5	Vitamin C	49%	Moderate

The above table shows that iron deficiency is the most common among students, followed by vitamin B12 and protein deficiencies. Calcium deficiency is comparatively lower. These results indicate that lack of balanced diet and poor intake of micronutrients are major causes of malnutrition among tribal students.

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Table No. 2

Gender-wise Mean and Standard Deviation

Sr. No.	Gender	Age	Hygiene	Diet	Health	BMI
1.	Boys	12.0	13.6	61.1	53.3	21.4
2.	Girls	12.1	16.3	61.4	53.4	21.2

The above table presents the gender-wise comparison of mean values for age, personal hygiene, diet, health, and BMI among tribal ashram school students. It is observed that there is no significant difference between boys and girls in terms of age, diet, health, and BMI, as the mean values are almost similar. However, girls show comparatively higher mean values in personal hygiene (16.3) than boys (13.6), indicating better awareness and practices related to cleanliness. Overall, the data suggests that while nutritional and health conditions are nearly the same for both genders, girls demonstrate better hygiene behavior, which may contribute positively to their overall health.

Conclusion:-

The study concludes that innovations in food and nutrition play a crucial role in improving the health of students in tribal ashram schools. The integration of traditional food practices, modern technology, and community participation leads to better health outcomes. Sustainable and well-implemented nutrition strategies are essential for the overall development of tribal children.

Suggestions / Recommendations:-

1. Include millet-based and protein-rich foods in mid-day meals.
2. Develop school nutrition gardens.
3. Implement AI-based nutrition monitoring systems.
4. Conduct regular health check-ups.
5. Promote community participation.
6. Strengthen government nutrition programs.

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Original Article

Artificial Intelligence: Evolution and Future Perspectives

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Abstract:
Artificial Intelligence (AI) has come a long way since its inception in the 1950s. From rule-based systems to deep learning, AI has evolved significantly over the years, transforming various industries and aspects of life. This paper provides an overview of AI's evolution, highlighting key milestones, breakthroughs, and future directions.

Introduction

AI, a term coined by John McCarthy in 1956, refers to the development of computer systems that can perform tasks typically requiring human intelligence. The field has experienced periods of hype and stagnation, but recent advancements in computing power, data storage, and algorithms have propelled AI to the forefront of technological innovation.

Evolution of AI

1. Early Years (1950s-1970s): AI research focused on rule-based systems, expert systems, and symbolic reasoning.
2. Machine Learning (1980s-1990s): The introduction of machine learning algorithms, such as decision trees and neural networks, enabled AI systems to learn from data.
3. Statistical AI (2000s): Statistical methods, like support vector machines and Bayesian networks, improved AI's ability to handle uncertainty and make predictions.
4. Deep Learning (2010s): Deep neural networks, fueled by large datasets and computing power, achieved state-of-the-art performance in image recognition, speech recognition, and natural language processing.

Early Beginnings (1940s-1950s)

The concept of AI dates back to the 1940s, with researchers like Alan Turing exploring the possibility of machine intelligence. In 1950, Turing published "Computing Machinery and Intelligence," introducing the Turing Test, a measure of machine intelligence.

The Dartmouth Conference (1956)

The term "Artificial Intelligence" was coined by John McCarthy at the Dartmouth Conference, marking the beginning of AI as a field of research. The conference brought together pioneers like Marvin Minsky, Nathan Rochester, and Claude Shannon, who laid the foundation for AI research.

Golden Years (1956-1974)

Early AI programs, such as Logic Theorist and General Problem Solver, demonstrated impressive capabilities. Researchers like Herbert Simon and Allen Newell made significant contributions to AI, predicting human-like intelligence within a generation.

AI Winter (1970s-1980s)

Overpromising and under delivery led to a decline in funding and interest, known as the AI Winter. However, this period also saw the development of expert systems and machine learning algorithms.

Resurgence (1990s-present)

Advances in computing power, data storage, and machine learning have transformed AI.

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Applications like image recognition, natural language processing, and autonomous vehicles have become increasingly prevalent.

Some notable recent developments include:

Deep Learning: Techniques like convolutional neural networks (CNNs) and recurrent neural networks (RNNs) have achieved state-of-the-art performance in various tasks.

Generative AI: Models like GPT-3 and ChatGPT have demonstrated impressive language generation capabilities.

Multimodal AI: Integration of multiple modalities, such as text, image, and video, has enabled more sophisticated AI applications.

Here are some recent applications on Artificial Intelligence:

AI-Driven Advances in Precision Oncology: Researchers have developed AI models that can optimize cancer diagnostics and personalized treatment, improving patient outcomes.

AI in Drug Discovery: AI is being used to predict how synthetic proteins will fold and interact with biological targets, reducing the need for expensive laboratory testing.

Explainable AI: Researchers are working on developing AI models that provide transparent and interpretable decisions, enabling trust and accountability.

AI in Healthcare: AI is being applied in various healthcare areas, including medical image analysis, disease diagnosis, and personalized medicine.

Future Directions

1. Explainable AI: Developing AI systems that provide transparent and interpretable decisions.
2. Edge AI: Deploying AI models on edge devices, reducing latency and improving real-time processing.
3. Multimodal AI: Integrating multiple modalities, such as vision, speech, and text, to create more human-like AI systems.

Conclusion

AI's evolution has been marked by significant milestones and breakthroughs. As AI continues to advance, it is crucial to address challenges like explainability, ethics, and societal impact. Future research directions will shape the next generation of AI systems, enabling them to better serve humanity.

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Libraries in the Age of Digital Technology: Issues and Challenges

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Abstract

The digital revolution has enabled faster and cheaper access to a wide range of information and yet journals prices are spiring higher resulting in subscription cancellations and restricted access to publicly funded research. Digital libraries comes in many forms in academic libraries in higher education. They attempt to provide instant access to digitized information and consist of a variety of information. In digital environment library becomes modern web base information centre, users become hi-tech librarians become highalert and ready to give services. The present paper discuss the challenges for library and information professionals in building the digital collection.

Keywords*: Digital Library, Information Technology, Digital Technology, Digitization*

Digital Library

Digital Library refers to a collection that constitutes electronic resources, accessible through the world wide web. It offen contains electronic versions of books, photographs, videos, that are owned by physical library.

The Definition of Digital Library

According to Neil Yarkey (Yarkey 1996). The digital libraries are electronic libraries in which large number of geographically distributed users can access the content of large and diverse repositories of electronic objects. Electronic objects includes networked text, images, maps, sounds, videos, catalogue of merchandise and scientific business and Government gazettes. They also include hypertext, hypermedia multimedia compositions The digital library (Chowdhury G. and Chowdhury S. 2003) Introduction to digital libraries London: Facet publishing as an assemblage of digital computing storage and communications machionary together with the content and software needed to reproduce, emulate and extend the services provided by conventional libraries based on paper and other material means of collecting, cataloguing, finding and disseminating information. A full service digital library must accomplish all essential services of traditional libraries and also exploit the well-known advantages of digital storage, searching and communication.

Functions Of Digital Library

A. Access to large amount of information to users wherever they are and wherever they need it.
B. Access to primary information sources.
C. Support multimedia content along with text.
D. Network accessibility on internet and intranet.
E. User-friendly interface.
F. Hypertext links for navigation
G. Client server architecture
H. Advanced search and retrieval
I. Integration with other digital libraries.

Advantages of Digital Library

A. Nearly unlimited storage space at much lower cost.
B. Re-allocate funds from some staff, collection, maintenance and additional books.

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C. No physical boundary
D. Round the clock availability
E. Multiple access
F. Enhanced information retrieval
G. Preservation for some print material
H. Universal accessibility

Digital Technology in Libraries

One contemporary sort of information retrieval system is the digital library. Because the collections are digitally saved and always available via computers or mobile devices, it is regarded as virtual. These characteristics of libraries are referred as digital libraries, virtual libraries, electronic libraries, institutional repositories., libraries without walls, and so forth. Digital library is the most suitable and often used term for these types of libraries.

Digital libraries, Institutional repositories and open archives are new trend in the present era, satisfying users needs for precise information since they have become more information conscious for accessing electronic information compared to different purposes such as academic or research needs. (Anuradha P. 2017).

One of the largest issues in creating digital libraries will be the building of digital collections. For any digital library to be practical, it must eventually have a digital collection with the critical mass to make it truly useful.

Challenges In the Application of Digitization Process

Digitization presents both opportunities and challenges for libraries. while it has the potential to enhance access to information and improve library services, it also poses several challenges.

A. **Finances:** Digitization can be expensive, especially for older and rare materials. Libraries need to distribute resources for scanning, metadata creation, storage and ongoing digital preservation.
B. **Copyright and Licensing:** Libraries must navigate complex copyright laws and licensing agreements when digitizing and providing access to materials. Balancing the need to provide access with copyright compliance can be challenging.
C. **Technical Infrastructure:** Building and maintaining the necessary technical infrastructure for digitization, including servers, storage and software can be significant investment.
D. **Access Equity:** Digital access assumes that users have the necessary technology and internet access. This can create digital divide where some users are excluded due to limited access to technology or the internet.
E. **Preservation:** Ensuring the long- term preservation of digital materials is essential. Digital formats can become obsolete and without preservation efforts, materials may be lost.
F. **Metadata and Cataloguing:** Creating exact and comprehensive metadata for digital collections is time consuming and requires ability. Inadequate metadata can hinder discoverability and usability.
G. **User Education and Information Literacy:** Libraries need to provide training and support to users to navigate digital collections effectively. This includes helping users search, access and use digital resources.
H. **Security and Privacy:** Digital collection may contain sensitive information and libraries must implement robust security measures to protect both the materials and users data.
I. **Content Management:** Managing and updating digital collections over time can be a complex task. Libraries need to continually assess and curate digital content.
J. **Interoperabilitry:** Ensuring that digital collections can be integrated with other library systems and accessed across various platforms can be challenging.
K. **Digitization Backlogs:** Many libraries have extensive physical collections and digitizing them can take a long time. Prioritizing which materials to digitize first and managing digitization backlogs can be difficult.
L. **Quality Control:** Keeping the quality of digitized materials is essential. This includes addressing issues such as image resolution, accuracy and completeness.
M. **Intellectual Property Rights:** How to deal with copyright, patterns, registered design, and trademark will be another challenge for LIS Professionals. Digital information can be distributed across the globe through e-mail,

bulletin boards and networks. Documents available digitally can be easily downloaded and tampered without the knowledge of its rightful owner.

According to Fabunmi, Paris and Febunmi (2006) Library digitization has become part of the work of librarians and most libraries are involved in digitization projects. However, issues including resource allocation, digital preservation, metadata standardization, technological infrastructure, copyright considerations, privacy and data security, accessibility, cultural diversity and long term sustainability need to be carefully considered. Despite these obstacles, libraries nevertheless view digitization as an essential part of contemporary librarianship, working to promote collaboration, supply access to information and cater to the changing demands of patrons in the digital era.

Conclusion

To solve the problems regarding the digitization there should be training programs like workshops, conferences etc. through which the proper guidance should be given to the professionals, so that they able to know about the things in better way. Despite these challenges, digitization also offers libraries numerous advantages, such as expanded access to collections, enhanced preservations and the ability to reach broader audiences. Libraries must carefully plan and strategize their digitization efforts to maximize the benefits while addressing these challenges effectively. Collaborations with other institutions and using external resources can also help libraries overcome some of theses obstacles. While digitizing library materials has many advantages, there are certain drawbacks as well as greater user engagement, cost savings, multimedia integration, worldwide reach, greater searchability, space optimization, preservation of delicate items and enhance accessibility are just a few advantages.

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Original Article

One Nation One Subscription: Opportunities and Challenges for Academic Libraries

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Abstract

The concept of One Nation One Subscription (ONOS) has emerged as a transformative policy initiative aimed at democratizing access to scholarly knowledge across India. By negotiating centralized subscriptions to academic databases and journals, ONOS seeks to reduce financial disparities among institutions and promote equitable access to research resources. This paper critically examines the opportunities and challenges associated with ONOS, particularly in the context of academic libraries. On one hand, the initiative promises cost efficiency, wider access to high-quality academic content, and enhanced research productivity. On the other hand, it raises concerns regarding licensing complexities, content diversity, digital infrastructure readiness, and institutional autonomy. The study adopts a qualitative analytical approach by reviewing existing literature, policy documents, and case discussions related to national subscription models. It further explores the implications of ONOS on librarians, researchers, and higher education institutions. The paper concludes that while ONOS has the potential to significantly strengthen India's research ecosystem, its successful implementation depends on careful policy design, stakeholder collaboration, and continuous evaluation.

Keywords*: One Nation One Subscription, Academic Libraries, Scholarly Communication, Open Access, Research Accessibility, Digital Libraries, Higher Education Policy, India*

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Introduction

Access to scholarly information plays a crucial role in shaping the quality of higher education and research output. However, in countries like India, disparities in financial resources often result in unequal access to academic journals and databases. While premier institutions benefit from extensive subscriptions, smaller colleges and universities frequently struggle to access even essential research materials (Jain, 2019).

The One Nation One Subscription (ONOS) initiative has been proposed as a solution to address this imbalance. By centralizing subscription mechanisms at the national level, ONOS aims to provide equitable access to academic resources for all institutions. This initiative aligns with broader goals of promoting innovation, research excellence, and sustainable development, as emphasized in the National Education Policy (Ministry of Education, 2020).

This paper examines the opportunities and challenges of ONOS, with a particular focus on its implications for academic libraries.

Objectives of the Study

The primary objectives of this study are:

1. To analyze the concept and framework of ONOS
2. To identify key opportunities offered by ONOS for academic libraries
3. To examine the challenges and limitations in its implementation
4. To assess its impact on research and accessibility
5. To suggest recommendations for effective execution

Methodology

This study adopts a qualitative and analytical research approach to examine the concept, opportunities, and challenges associated with the *One Nation One Subscription (ONOS)* initiative.

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The research is primarily based on secondary data and focuses on developing a comprehensive understanding of the subject through systematic analysis. The methodology involves multiple components. First, an extensive review of policy documents related to ONOS was conducted to understand its objectives, structure, and implementation framework (Government of India, 2023). These documents provide insights into the government's vision and strategic approach toward improving access to scholarly resources. Second, a detailed analysis of existing scholarly literature was undertaken. Relevant books, journal articles, and research papers on open access, academic publishing models, and digital libraries were examined to identify key themes, trends, and gaps (Suber, 2012; Pinfield et al., 2017). This helped in placing the ONOS initiative within a broader academic and global context.

Third, the study incorporates comparative analysis of international models, particularly national-level subscription and open access initiatives implemented in other countries (OECD, 2015). This comparison provides a better understanding of best practices and potential challenges that may arise in the Indian context.

In addition, an interpretative approach was used to evaluate the potential impact of ONOS on various stakeholders, including students, researchers, librarians, and academic institutions. The study also considers practical challenges such as infrastructure limitations, policy constraints, and implementation issues.

The research is descriptive and exploratory in nature, aiming to critically analyze the feasibility and effectiveness of ONOS rather than testing a specific hypothesis. While the study provides valuable insights, it is limited by its reliance on secondary data and absence of empirical validation, which may be considered for future research.

Literature Review

The accessibility of scholarly resources has been a longstanding concern in the academic community, particularly in developing countries where financial and infrastructural constraints limit access. Suber (2012) emphasizes that restricted access to academic publications not only affects individual researchers but also slows down the overall progress of knowledge dissemination. Open access movements have emerged as a response to these challenges, advocating for unrestricted availability of research outputs.

Pinfield et al. (2017) examine the economic implications of traditional subscription models and highlight the increasing financial burden on universities. Their study suggests that institutional budgets are often strained due to rising journal costs, leading to difficult decisions about which resources to retain or discontinue. Similarly, Lewis (2012) argues that the existing publishing ecosystem is unsustainable in the long term and calls for systemic changes to ensure broader access.

In the Indian context, the situation is further complicated by disparities among institutions. Muthu (2021) identifies that many academic libraries in India face significant challenges in accessing e-resources due to limited funding and inadequate digital infrastructure. Jain (2019) also points out that libraries are undergoing a transformation, shifting from traditional roles to more dynamic, technology-driven functions.

Global perspectives indicate that centralized access models can be effective in addressing these challenges. The OECD (2015) highlights the role of national-level policies in promoting open science and ensuring equitable access to knowledge. Such models demonstrate that collective negotiation and resource sharing can significantly reduce costs and improve accessibility.

Overall, the literature suggests that while initiatives like ONOS are promising, their success depends on addressing both economic and infrastructural challenges, as well as ensuring stakeholder participation.

Concept of One Nation One Subscription

The ONOS initiative proposes a centralized system where the government negotiates with publishers to provide nationwide access to scholarly databases and journals (Government of India, 2023). Instead of individual institutions bearing the cost of subscriptions, a unified agreement ensures broader and more equitable access.

This model is aligned with global trends toward open science and collaborative knowledge sharing (OECD, 2015). However, its implementation in India requires careful consideration of institutional diversity and technological readiness.

Opportunities for Academic Libraries

Equal Access to Knowledge

ONOS has the potential to bridge the gap between well-funded and underfunded institutions, ensuring equitable access to academic resources (Suber, 2012).

Cost Efficiency

Centralized negotiations can reduce overall expenditure on subscriptions, allowing better allocation of financial resources (Pinfield et al., 2017).

Enhanced Research Output

Improved access to scholarly content can lead to higher-quality research and increased academic productivity (Tenopir et al., 2013).

Strengthening Academic Libraries

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Libraries can evolve into dynamic knowledge centers, supporting research, innovation, and interdisciplinary collaboration (Jain, 2019).

Promotion of Interdisciplinary Research

Access to diverse academic resources encourages cross-disciplinary research, which is essential for addressing complex global challenges.

Challenges and Limitations

Licensing and Negotiation Complexities

Negotiating national-level agreements with multiple publishers involves legal and financial complexities (Government of India, 2023).

Digital Infrastructure Gaps

Many institutions lack the necessary infrastructure to fully utilize digital resources (Muthu, 2021).

Limited Content Diversity

Centralized subscriptions may restrict access to niche or specialized content.

Institutional Autonomy

Institutions may have limited flexibility in selecting resources tailored to their needs.

Changing Role of Librarians

Librarians must adapt to new roles involving digital resource management and user training (Jain, 2019).

Discussion

The ONOS initiative represents a significant shift toward centralized knowledge access. While its benefits are substantial, its implementation requires a careful balance between efficiency and flexibility.

One of the key concerns is whether a centralized model can effectively address the diverse needs of institutions across the country. While large universities may benefit from expanded access, smaller institutions may struggle with infrastructure limitations. Therefore, a one-size-fits-all approach may not be sufficient.

Additionally, the success of ONOS depends on active collaboration among stakeholders, including government agencies, publishers, academic institutions, and libraries. Without effective coordination, the initiative may face operational challenges.

Another important consideration is the long-term sustainability of the model. Continuous funding, policy support, and technological advancements will be essential to ensure that ONOS remains effective in the evolving academic landscape.

Recommendations

- Develop a hybrid access model combining centralized and institutional subscriptions
- Improve digital infrastructure in underserved institutions
- Provide training programs for librarians and users
- Ensure transparent and fair negotiations with publishers
- Establish continuous evaluation mechanisms

Conclusion

The *One Nation One Subscription* initiative has the potential to transform India's academic ecosystem by promoting equitable access to knowledge. It aligns with global trends toward open science and collaborative research, making it a timely and relevant policy initiative.

However, its success will depend on addressing key challenges such as infrastructure gaps, licensing complexities, and stakeholder coordination. Academic libraries will play a crucial role in this transformation, acting as facilitators of knowledge access and research support.

If implemented effectively, ONOS can contribute to a more inclusive, innovative, and sustainable future in higher education.

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Original Article

Social Media in Libraries: A Tool for Information Dissemination and User Engagement

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Abstract:
Today's libraries are not confined to four walls and limited to physical spaces but they take advantage of social media platform like Facebook, Instagram, You Tube Twitter now X to transmit information, promote resources and communicate with users. Social media has reconfigured sharing of information, accessing the information and getting engage with it. So the media has brought revolutionized change in the operations of libraries worldwide. The paper examines the role of social media in libraries in the context of academic libraries, assessing benefits, challenges and best practices adopted by the libraries. This study focuses on matter of social media usage patterns among librarians and users and summaries that effective social media engagement. Use of social media enhances user satisfaction, library visibility and improved service delivery in the digital age.
Keywords: *Information Dissemination, Digital Outreach, Social Media, Libraries, User Engagement*

Introduction:

In the 21st century called the digital era. Services of traditional libraries are redesigned. Due to acceleration of digital penetration in academic field use of social media use in libraries gaining forward movement .library professional are using tools like WhatsApp, YouTube, Instagram, Facebook to reach to users, market the services and learning resources , promote library activities, events. Use of social media is a strategic way of communication technique among users, faculty, patrons and academic community. Social media is a best platform for librarians to offer various innovative services, share resource information, promote services and facilitate establishing connections among patrons. Social media supports information literacy by curating content which is authentic and credible. Social media open up on misinformation and guiding users on authentic information and scholarly resources. It strengthened library role as an information hub in the knowledge society and fostering culture of learning and collaboration.

Perception of Social Media:

Social media denotes internet based platforms that enable users to share, create and interact with content and communities. Major platforms comprises of Linked In, Facebook, Twitter, Instagram, WhatsApp, YouTube. These platform support multimedia content distribution- including, text, videos, and images and live streaming- It enables organizations to connect with different types of audience effectively.

In the context of library, social media encompasses promotional channels and proving to be dynamic tool for information transfer, virtual reference service, community building and collection of feedback from the users.

Role of Social Media in the libraries:

Now a days users are more dependent on online information resources, academic help so its imperative for librarians to meet the users in online platforms. The main factors for implementing social media in libraries comprises of elements such as-

Marketing of resources and Branding – Social network platform serve as marketing channels to build library identity and attract new users. Some may unaware of library functioning and services.

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- **Enriched learners' participation -** Libraries foster and ensures stronger user participation through interactive content such as polls, live events, questions and answer sessions and arrangement of live subject experts' talks.
- **Learning resources promotion** – Libraries can promote new arrivals, digital collections, evets workshops to reach to users beyond the four walls of the libraries instantly.
- **Improved outreach** - Social media infringes physical boundaries, enabling library messages to reach to students at distance level. Further taking care of faculty and members of community located at long geographical distance.

Prominent social media used by the libraries:

To reach to wider spectrum of users Indian libraries uses platforms as follows:-

- **LinkedIn** – this platform helps in sharing scholarly content among faculty members and students further LinkedIn helps in professional networking.
- **Facebook and Instagram -** For sharing the updates on various events organized by the libraries, multimedia content and various announcement libraries used Facebook and Instagram.
- **You Tube** – YouTube is a platform widely used by readers to watch tutorials, recorded sessions, virtual torus and upgrade their knowledge on a concept.
- **WhatsApp and Messenger** - In the academic institution libraries used this platform for notifications and direct communication with users.

These social media platform enable users for varies types of information delivery, making these social platforms indispensable in current library services strategies and interaction with users.

Library Services and Role of Social media:

5.1 Elevation of Library services:

Libraries can promote its services on social media platform, Libraries can share information on various user friendly services, collection, variety of learning resources, digital sources and its access with proper guide with students via Telegram, WhatsApp, Facebook and Instagram.

5.2 Outreach activities and engagement:

The visibility of learning resources, libraries can use social media platform further user engagement with the libraries can be foster through social media. Research shows that Indian users prefer updates on the social media as these platforms are easy to access so learners can remain updated.so increasing user interaction can be ensured through social media platform.

5.3 Support services - beyond above benefits social media enable libraries to offer real time support and quick reference services. Libraries provide reference service answer queries, offer research tips, organize intellectual talk, guide users on library procedures through chats, interactive content, chats especially in academic institution.

Benefits of Social Media in Libraries:

Multiple benefits offered by social media

- **Community Building** – Social media platforms foster user communities, encouraging participation and for sharing of knowledge.
- **Live updates** – Instant dissemination of information is possible only through social media.
- **Dynamic user interaction** – Libraries be in receipt of immediate feedback from users through comments, posts and shares.

Cost effective promotion Social media is easy to use platform requires minimal financial requirement to access and disseminate ate information.

Challenges and Issues:

Following are issues related to social media

- **Skill Gaps and Resource**: For handling social media skillfully and trained staff is requires some libraries may face challenges in having trained staff.
- **Technology barriers:** Rural areas may have limited internet access so social media strategies may not reach all user groups
- **Content quality:** It is imperative to publish relevant, accurate, engaging, authentic material on the social media. Well structured, high quality, fact checked material is most likely by the users. The material to be ethically valid properly cited and has respect for diversity.
- **Privacy and security**: Libraries must be vigilant on user data protection and adhere to ethical guidelines for online interactions.

To overcome these challenges training, strategic planning, continuous evaluation of social media efforts need to be taken care of.

Best Practices for Effective Use:

Libraries should plan following way to maximize the impact of social media.

- **Content Planning** – Libraries can develop a calendar for academic events, reading campaigns, library news and can develop a calendar for regular posts.

- **Feedback Mechanism** – Real time response to user is possible through use of social media. Librarians can respond to comments and messages for sustained engagement.
- **Platform Selection** – Selecting platform based on target users. Youngsters' audience prefer younger audience and academic professional may use LinkedIn.
- **Use of Analytics** – To future content strategies use analytics can be useful for the librarians.

Conclusion:

For libraries social media has emerged as a transformative tool enabling them to disseminate information, rapidly, interactively and not limited to physical boundaries. Libraries can effectively use tools like microblogging, , multimedia channels for promoting new arrivals, share digital resources, announce library events and organize reading campaigns and thereby provide real time updates to users on collection. In the contemporary digital landscape social media has become a pivotal tool for libraries to promote, communicate and engage with their users. In academic and public libraries utilizing platforms like Instagram, WhatsApp, YouTube and Facebook are being used for user communities and enhance visibility. Effective social media strategies can transform libraries into user centric learning hubs. Social media helps in meeting up user expectations. As social media continues to grow libraries adopt thoughtful user focused practices and can strengthen their role in knowledge hubs.

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Original Article

Household Food Security: Integrating Innovations for Sustainability in India

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Abstract

Household food security (HFS) bridges national food systems with individual nutrition outcomes, yet vulnerabilities persist in low- and middle-income countries (LMICs) such as India. This article synthesizes evidence from 52 studies (2015–2026) on HFS determinants—economic, social, health, and human-capital security—and evaluates five innovation domains: technological/agro, digital/ICT, home production, circular economy, and behavioural interventions. These innovations are mapped to FAO's four food security pillars (availability, access, utilization, stability). Findings highlight digital Public Distribution System (PDS) enhancements and kitchen gardens as high-leverage strategies for India's diverse urban and rural contexts. Integrated policy bundles, multidimensional indicators, and cross-sector frameworks are proposed to achieve scalable, sustainable impact aligned with SDG 2.

***Keywords**: household food security, innovations, LMICs, India, social protection, sustainability*

1. Introduction

Food security is realized only when households secure reliable access to nutritious and stable food supplies. Household food security (HFS) operationalizes FAO's four pillars—**availability, access, utilization, and stability**—underpinned by economic, social, health, and human-capital security (FAO, 2019).

India faces acute vulnerabilities: low-income, female-headed, or large households are disproportionately affected. Prevalence of food insecurity varies from 8.7% to nearly 99% depending on metrics (Yadav & Khandelwal, 2021). Despite progress in food production, India ranked **105th out of 124 countries in the Global Hunger Index 2024**, categorized as "serious" (Kaur, 2024).

Programs such as the Public Distribution System (PDS) and Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) strengthen access and stability, while nutrition education enhances utilization. Yet persistent gaps demand innovative, integrated approaches that combine technology, community action, and behavioural change (Singh, 2024).

Food security is also a constitutional and human rights issue in India. The Right to Food is linked to Article 21 of the Constitution, emphasizing its centrality to life and dignity (Food Security in India: Performance Issues and Challenges, 2024).

2. Methodology

This review synthesizes peer-reviewed literature published between 2015 and 2026, sourced from Scopus, PubMed, and Google Scholar. Keywords included "household food security," "innovations," "LMICs," and "India." Studies were included if they addressed at least one food security pillar, were in English, and involved more than 50 households. Out of 284 initial hits, 52 studies were retained after dual-author screening.

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Innovations were clustered into five domains—technological/agro, digital/ICT, home production, circular economy, and behavioural interventions—and mapped to food security pillars using FAO's 2019 framework. Risk of bias was assessed using MMAT 2018. Due to heterogeneity, meta-analysis was not conducted.

3. Results

3.1 Technological and Agro-Innovations

Climate-smart seeds (drought-resistant, biofortified) and post-harvest tools (hermetic bags, solar dryers) reduce losses by 20–40%, strengthening availability and stability (Hoddinott, 2016). Extension services and microcredit schemes further enhance resilience. Biofortified pearl millet in Rajasthan improved iron intake among women, while solar dryers in Tamil Nadu reduced spoilage of perishable crops.

3.2 Digital and ICT Innovations

Mobile applications deliver weather forecasts and market data, empowering farmers to make informed decisions. Biometric PDS linkages reduce leakage by 15–30% (Swaminathan, 2022). Integration with Aadhaar and social protection schemes builds responsive systems. However, rural digital divides remain significant: nearly 40% of households lack regular internet access (Pingali et al., 2025).

3.3 Home and Community-Based Production

Kitchen gardens, rooftop farming, and micro-livestock diversify diets, particularly in urban and peri-urban areas. Evidence shows dietary diversity scores improve by 25%, with notable gains in child and women's nutrition (Ruel et al., 2018). In Maharashtra, community kitchen garden pilots increased vegetable consumption by 15% and reduced reliance on volatile markets.

3.4 Circular Economy and Waste Reduction

Solar chillers and food recovery networks extend shelf life and redistribute surplus food, reducing waste by 30% (World Bank, 2024). Food banks in Delhi partnered with supermarkets to redirect unsold produce to low-income households, simultaneously reducing waste and hunger.

3.5 Behavioural and Nutrition Interventions

Digital nutrition tools and community monitoring through women's groups promote diverse diets and enable early detection of insecurity. Utilization outcomes improve by 18%, linking knowledge directly to dietary practices (Herforth & Harris, 2019). Behavioural interventions also strengthen human capital by embedding nutrition awareness into everyday decision-making.

4. Innovation Mapping

Domain	Availability	Access	Utilization	Stability	Security Link
Technological/Agro	High	Medium	Low	High	Economic
Digital/ICT	Low	High	Medium	High	Social
Home Production	High	High	High	Medium	Health
Circular Economy	Medium	High	Low	High	Economic
Behavioural	Low	Low	High	Medium	Human Capital

5. Discussion

5.1 Synergistic Bundles

Evidence affirms that integrated bundles of innovations yield synergistic effects. Digital PDS enhancements are critical for India's 800 million beneficiaries, while kitchen gardens address urban nutrition gaps. Maharashtra pilots demonstrated a 15% increase in dietary diversity through combined digital and behavioural interventions.

5.2 Challenges

- **Digital Divide**: 40% of rural households remain non-users of digital platforms.
- **Scaling Costs**: Solar dryers and chillers require upfront investment.
- **Cultural Barriers**: Behavioural interventions must navigate entrenched dietary preferences.

5.3 Policy Implications

1. Adopt multidimensional HFS indicators (HFIAS + DDS).
2. Digitally link agriculture and social protection systems.
3. Pilot innovation bundles in diverse contexts such as Pune and Maharashtra to serve as LMIC models.
4. Encourage public-private partnerships (ICAR, agri-tech startups).
5. Integrate women's empowerment into all interventions, given their central role in household nutrition.

5.4 Global Relevance

India's experience resonates across LMICs. In Africa, mobile money platforms have improved food access, while Latin America's urban agriculture initiatives mirror India's kitchen garden successes. Cross-learning can accelerate progress toward SDG 2 globally.

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6. Conclusions

Sustainable household food security in India requires integrating household security with innovations across technological, digital, production, circular, and behavioural domains. Cross-sector policies and tailored pilots offer transformative potential, aligning with SDG 2. Future research must prioritize randomized controlled trials and equitable scaling strategies to ensure that innovations reach the most vulnerable households. By bundling innovations with social protection, India can move closer to achieving resilient, equitable food systems that safeguard nutrition for all.

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Original Article

Contribution of Technology in the Development of Indian economy

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Abstract

Technology and innovation of profoundly transfer me India's economy driving growth and creating new opportunities in diverse sectors such as e-commerce, fin-tech, healthcare, and edu-tech. The digital is projected to reach one-fifth of India's GDP by 2030, with continued innovation and technological advancements expected to fuel this growth engine. India's inherent strengths in IT and digital adoption are positioning it as a prominent global tech hub, attracting investments, and creating tous job opportunities. As India continues to harness the power of technology and innovation, it Joised to become a major player on the global economic stage, with a bright future ahead. The 's digital transformation is expected to bring about significant socio-economic changes, focus on innovation and technology, India is well on its way to achieving its growth potential the quality of life for its citizens and contributing to the nation's overall development. With and becoming a leading economy in the world.

Introduction

In today's global economy, technology and innovation have become decisive drivers of value creation. economic growth, and employment generation. They not only pave the way for new businesses but also ngthen the competitiveness of existing enterprises. Across the world, it is evident that sustained rial and economic progress closely aligns with a nation's commitment to research and development (R&D). R&D, therefore, stands as a reliable indicator of a country's capacity to innovate.

India's R&D expenditure has steadily increased over the years and currently stands at 0.69% of GDP, of its size and ambition, there remains considerable scope to bolster innovation and mological advancement. Globally, innovation has emerged as the key differentiator-enabling the cation of accessible, affordable products and services that meet ever-evolving consumer needs. Countries such as China and South Korea exemplify how strong R&D investments and technology flow can accelerate economic progress, elevate global competitiveness, and improve living standards. South Korea's transformation, in particular, showcases the power of strategic innovation-led growth. Yet, for a country. India, the world's seventh-largest nation by area and its second-most populous country, stands at a demographic crossroads. With 65% of its population below the age of 35, India is poised to have a working-age population of nearly one billion by 2030. Additionally, by 2021, the emerging middle and middle-class segment is projected to reach about 900 million people. This demographic dynamism presents immense opportunities but also demands that businesses adopt innovative models to deliver new value propositions and keep pace with shifting consumer expectations. India's digital economy is expanding at an unprecedented pace, driven by flagship initiatives such as Digital India, Make in India, and Startup India. These programs aim to build robust digital Infrastructure, nurture entrepreneurship, and increase citizen empowerment. The National Digital Communication Policy (NDCP) 2018 further reinforces this momentum by enhancing broadband penetration and fortifying the nation's communication networks. This growth is supported by a young, digitally savvy population. As of mid-2024, India hosts over adoption is fueling the rise of e-commerce, digital payments, fintech, and emerging technologies million smartphone users and more than 950 million internet subscribers. This widespre Al and blockchain.

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The telecom sector is undergoing significant transformation as well, w nationwide 4G coverage and an ongoing rollout of 5G networks. While 4G has dramatically in connectivity across urban and rural regions, SG is expected to unlock advanced applications digital services, and accelerate technological progress.

As the world's fourth-largest economy, India is on track to become the third-largest by FY 2006-11 supported by an estimated 6.5% real GDP growth in FY 2025-26. The country's expanding technological capabilities, coupled with a robust innovation and R&D ecosystem, are central to thi trajectory. In FY 2024, the tech sector contributed 7.3% to India's GDP, and by 2030, the dig economy is projected to account for nearly one-fifth of the nation's total economic output. With a digitally empowered population of 1.44 billion, progressive regulatory reforms, and world-class its demographic advantage and its commitment to digital transformation, the nation is well positionel infrastructure, India is rapidly emerging as a global hub for technological innovation. Strengthened by to shape the future of global technology and innovation.

Some of the major key factors affecting India's technological and innovation base are:-

1. Rapid Digital Adoption

India today stands among the world's most digitally advanced nations. It is the third most digitalised economy globally and ranks 12th among G20 countries in terms of digital adoption by individual usen Its position as 39th in the Global Innovation Index 2024 further underscores

the country's growing emphasis on technology-driven development across sectors. With an internet user base exceeding 900 million, India's digitalisation wave is transforming nearly every major industry e-commerce telecommunications, fintech, automation, education, healthcare, and more. Digital payments and online shopping have become an integral part of daily life, while Al-driven healthcare solutions, customer service platforms, and intelligent automation are reshaping how businesses operate. Empowered by a tech-savvy population, India's digital ecosystem is not only expanding rapidly but also redefining the landscape for new-age enterprises.

2. Global Delivery Excellence

India's technology sector has cultivated an extensive global network of delivery centres across North America, Europe, and Asia, enabling seamless, round-the-clock operations. Strategic diversification into key industries such as banking, financial services and insurance (BFSI), healthcare, and retail— combined with partnerships in emerging areas including artificial intelligence (AI), cloud computing, and cybersecurity-has significantly strengthened India's global technological presence. Reflecting this momentum, many multinational enterprises have established advanced Global Capability Centres (GCCs) in India. Currently, the country hosts approximately 1,700 GCCs, supported by a vast skilled workforce, cost advantages, robust digital infrastructure, and sustained business-friendly reforms.

3. Young Talent

The National Youth Policy defines individuals aged 18-29 as youth. According to 2021 projections, India is home to more than 370 million youth, representing 27.3% of its total population. Furthermore, the Economic Survey 2024 indicates that nearly 65% of India's population is under 35. This substantial demographic dividend offers unparalleled opportunities for investors seeking long-term growth. National initiatives such as the Atal Innovation Mission (AIM), the MeitY Startup Accelerator (SAMRIDH), and Startup India continue to nurture innovation and entrepreneurial activity. India also possesses the world's largest pool of science, technology, engineering, and mathematics (STEM) graduates, with over two million added annually. The rapidly expanding gig economy –projected to employ 23 million workers by 2030-further complements the country's dynamic startup ecosystem.

4. Competitive Advantage

compound annual growth rate (CAGR) of 24.3% between 2023 and 2028, This expansion is driven by India's public cloud services market is projected to reach USD 25.5 billion by 2028, growing at a advancements in generative Al, enterprise software, global technology partnerships, and an increasingly specialised workforce. The digital economy is expected to grow at twice the pace of the overall economy and is forecast to account for nearly one-fifth of national income by 2029-30. A minimal-state, high-impact growth model-supported principally by technology and digital services-is likely to remain one of India's central economic drivers.

5. Supportive Government Initiatives

The Government of India continues to implement transformative reforms aimed at fostering technological innovation, strengthening industry capabilities, and building a globally competitive ecosystem. These initiatives are key to achieving India's target of a USD 1 trillion digital economy by 2030. Major policy measures include:

IndiaAl Mission: Allocated ₹10,300 crore to advance AI, blockchain, and cybersecurity, reinforcing India's leadership in emerging technologies.

Production-Linked Incentive (PLI) Schemes: The Union Budget 2025-26 increased the semiconductor outlay to ₹7,000 crore, while allocations for electronics manufacturing and IT hardware rose to 29,000 crore. Additionally, PLI Scheme 2.0, amounting to ₹17,000 crore (USD 2.06 billion), was introduced to strengthen domestic IT hardware production.

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Digital and Infrastructure Initiatives: Programmes such as BharatNet aim to enhance rural broadband connectivity, while Software Technology Parks of India (STPI) continue to support the development of the technology startup ecosystem.

National Deep Tech Startup Policy: Designed to foster research-driven innovation, this policy seeks to accelerate economic growth and promote societal advancement through the effective utilisation of deep technology capabilities.

Conclusion:

The Indian healthcare industry has likewise undergone rapid transformation, propelled by continuous technological advancement and innovation. The sector's growth is fueled not only by domestic demand The Indian healthcare industry has likewise undergone rapid transformation, propelled by continuous growing destinations for medical tourism, attracting patients from around the world seeking affordable but also by the expanding international medical tourism market. India has become one of the fastest-yet high-quality healthcare

services. This global recognition has been made possible largely due to improvements in medical technology, diagnostics, telemedicine, and digital health services.

Similarly, technology and innovation have had a profound impact on the education sector, particularly in higher education, vocational training, and online learning. Digital education platforms such as Physicswallah, Unacademy, and Aakash provide prominent examples of how technology has transformed learning delivery and accessibility. India's large youth population has intensified the demand for quality education and skill development, prompting both the government and private sector to focus on improving digital literacy and expanding vocational training programs aligned with industry requirements.

In this evolving landscape, research and innovation remain essential for sustaining progress across these sectors and related supporting industries. The adoption of emerging technologies, the digitization of services, enhanced interoperability of digital systems, and the integration of artificial intelligence are critical for improving productivity and operational efficiency. Continuous enhancement of products and services through technology and innovation is imperative to ensure improved citizen welfare and to maintain India's competitiveness in an increasingly dynamic global economic environment.

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Original Article

Use of Artificial Intelligence in Library Services

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Abstract
Artificial Intelligence (AI) has become a transformative technology in library and information science. Libraries are evolving from traditional systems to digital and intelligent environments that enhance efficiency, accuracy, and user satisfaction. This paper examines the applications, benefits, challenges, and future prospects of AI in library services. It highlights how technologies such as machine learning and natural language processing are improving cataloguing, information retrieval, and user support. The study concludes that AI has great potential to modernize libraries, though challenges like cost and ethical concerns must be addressed.

1. Introduction

Libraries play a vital role in collecting, organizing, and providing access to information. In the digital era, libraries face challenges due to the rapid growth of information and user expectations. Artificial Intelligence (AI) offers innovative solutions to manage these challenges. AI refers to computer systems that can perform tasks requiring human intelligence, such as learning and decision-making. It is widely used in library services to improve efficiency and provide better user experiences. AI has a strong connection with library operations and is considered a key technology in modern information systems.

2. Literature Review

Several studies have explored the use of AI in libraries. Research shows that AI significantly improves library operations and service delivery.

A systematic review of multiple research articles highlights that AI technologies enhance efficiency and automate various library processes.Another study indicates that AI has revolutionized how information is stored, retrieved, and delivered in libraries, improving both operational efficiency and user experience.

Furthermore, AI-powered systems enable libraries to provide 24/7 services and improve access to information resources

3. Applications of AI in Library Services

3.1 Automated Cataloguing and Classification

AI helps in automatically organizing books and digital resources by generating metadata and classifying materials, reducing manual work.

3.2 Information Retrieval Systems

AI-based search systems use natural language processing to provide accurate and relevant search results.

3.3 Chatbots and Virtual Assistants

AI-powered chatbots assist users by answering queries and guiding them in accessing resources at any time.

3.4 Recommendation Systems

AI analyzes user behavior and preferences to recommend books, journals, and articles.

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3.5 Digital Library Services
AI is used for:
· Document indexing
· Text summarization
· Plagiarism detection
· Digital content management
3.6 Robotics in Libraries
Robots are used for tasks such as book shelving, inventory management, and assisting users.
4. Benefits of AI in Libraries
· **Improved Efficiency:** Automation reduces workload and saves time
· **Enhanced User Experience:** Personalized services increase user satisfaction
· **Accurate Search Results:** AI improves information retrieval accuracy
· **24/7 Services:** Chatbots provide continuous support
· **Better Data Management:** AI handles large volumes of information effectively
AI helps libraries transition into smart and efficient knowledge centers .
5. Challenges of AI in Library Services
5.1 High Cost
Implementing AI technologies requires significant investment.
5.2 Lack of Skilled Professionals
Library staff may need training to use AI systems effectively.
5.3 Ethical and Privacy Issues
AI systems may raise concerns about data security and user privacy.
5.4 Bias and Accuracy Issues
AI systems can produce biased or incorrect results if not properly trained.
5.5 Resistance to Change
Some library professionals may resist adopting new technologies.
Studies show that factors such as funding and technical skills can hinder AI adoption in libraries .

6. Impact on Library Professionals
AI is transforming the role of librarians rather than replacing them. Librarians are becoming information specialists who manage digital systems and assist users in navigating AI tools. AI supports professionals by automating routine tasks and allowing them to focus on advanced services.

7. Future Prospects
The future of AI in libraries includes:
· Smart libraries with fully automated systems
· Advanced semantic search technologies
· Use of generative AI for content creation
· Improved user personalization
· Integration with big data and analytics
AI is expected to play a crucial role in shaping the future of libraries as digital knowledge hubs.

Conclusion
Artificial Intelligence is revolutionizing library services by enhancing efficiency, improving user experience, and automating routine tasks. From cataloguing to advanced search systems, AI has transformed traditional libraries into modern digital environments. However, challenges such as cost, ethical concerns, and lack of skills must be addressed. With proper implementation, AI will continue to play a significant role in the development of library services.

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Original Article

Transformation of Role of Librarian in the Web Environment

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Abstract

The basic foundation of a Librarian's work lies in pursuit of his duties in accordance with the known expectations of society in general and needs of library users in particular especially in the information conscious society. This paper describes the profound changes occurring in a large multidisciplinary Library and Information Science discipline due to the emergence of virtual world in the web environment in response to the growing electronic collection, distributed learning and multi and extra disciplinary research environment and the changing behaviour of users. The new modes of library service necessitate professional development in order to meet quality outcomes, particularly as Librarians assume roles in which they collaborate with faculty in realizing key educational outcomes. The approaches to Librarians skills development and the challenges are presented and discussed.

Keywords: *Librarian Changing Roles, Internet Librarian, Search Intermediary*

Introduction

The information age we are in now is in the process of rapidly replacing the industrial era. Alvin Toffler in his famous book "Third Wave" rightly observed that the civilization has witnessed three great revolutions "Agricultural Revolution" "Industrial Revolution" and "Information Revolution". The digital age has provided new opportunities for higher education and research and the libraries in institutions of higher leaming are to face new challenges. In this new phase of information and new technologies, the science and knowledge are becoming critical factors of the so-called "Value Added Economy". Key issues raised by the faculty and administrators in institutions of higher education have been the future funding of research, grants, scholarly research with increasingly specialization, imbalance between rewards for research vs teaching, facilities, government reporting, accountability and so on. Concem has been on impact of more fundamental forces like financial imperatives; societal needs; technology drivers; multidisciplinary research and the libraries at the digital convergence that are driving towards change. Many of these relate to the emerging digital technology.

Developments in Information and Communication Technology's (ICTs), the libraries have been integrated at the electronic frontier to facilitate rapid transfer of information on a global scale, Advances in computer storage and telecommunication methods, online access to databases, electronic journals, electronic knowledge banks, direct document delivery, teletext, teleconferences, bulletin boards, CD-ROMs, networks etc., have been the revolutionary developments in the last two/three decades that have brought a great change in communication, storing and handling of information. The digital or electronic resources are dynamic in nature to share information globally and there has been an increased scope for automated delivery mechanism. Libraries today are termed as Digital Libraries and Hybrid Libraries. Knowledge preservation and dissemination have rapidly changed. Unlike simply providing access to holdings in print format, the electronic resources are procured to meet the information needs of the clientele.

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In the light of Information Bill 2002, it must be the fundamental professional concern of the Librarians to endeavor to predict, grasp, analyze and materialize such expectations and needs. Librarianship is caught in the midst sea of dynamic changes with respect to collection, preservation, control and dissemination of recorded knowledge appear to be at risk in a world where uncertainty, contingency and the transforming nature of Information technology impact especially electronic media and Internet are increasingly dominant. As a result, the Library managers are encountered with twin challenges of managing print collections and simultaneously developing digital resources and network based Information Services.

Transformation of Roles and Mission of Libraries

There has been a paradigm shift in the library services and the roles of information professionals. Some of the changes that have been observed in the academic libraries are:

Librarians' role has been changed from information provider to facilitator of information.
There has been a transition from print to electronic media
The users have become more 'Active Users' than 'Passive Users'.
Emphasis in the libraries has been on 'Access' to 'Acquisition'.
Libraries which were confined to solitary environ have moved to networked environment.
Emphasis has been on team work rather than individual contribution.
There has been an increased demand for accountability.
In this situation, the mission of modern libraries also has been changed on some of the following lines.
Develop information/knowledge resources focused on patron's needs,
Develop a co-operative user centered culture.
Organize information resources in print and non-print considering the changing needs.
Provide Human and technologically mediated access to information.
Provide continuing education and training to its users.

Metamorphosis of Librarians Role

3.1 As an Information Therapist

Librarians as expert consultants aware of information sources, the Library user expects the Librarian to have adequate knowledge of the materials he proffers. The stronger the demand for library materials, the bigger the expectation as to professional knowledge is concerned. Moreover, it is necessary to recognize. that professional knowledge will be constantly under test in collecting and proffering materials that will satisfy all reasonable demands, including those of present non-users. With the constant eye on the latest availability of information resources and its user perspectives, the Librarian as information therapist should act as a doctor treating the users with information.

3.2 As an Educator

Creating awareness of information literacy has been the prime role of librarian in the society to mould into information rich society. Librarians' skills in the areas of technology, educational design and teaching techniques are crucial in their new re-educational role. Teaching skills are key in today's environment where Librarians are taking an active role in forming partnerships with faculty in achieving key information literacy outcomes and therefore the Librarians are recognized as Teachers. The philosophy of user education propounded for 'Education for life' and 'Life long leaming' are the most crucial role the libraries are to play now as an educator.

3.3 As Content Manager

The librarian can play a dynamic role in easy accessing of computer-held digital information including abstracts, indexes, full-text databases, sound and video recording in digital formats. In the context of Content Manager (CM) Librarians are required to:

Organize digital information;
Disseminate digital information from the computer-held digital content,
Provide digital reference services and electronic information services;
Handle the tasks of massive digitization, digital storage process, and digital preservation;
Provide universal access and retrieval of digital content;
Catalogue and classify digital documents;
Maintain the intranet, managing new inputs, user access control, etc.

The competency of a Librarian in Content Management is represented by different sets of skills, attitudes and values to explore the skills of Internet technology in retrieving and accessing required digital documents in time; archiving, publishing and digital preservation. Further to develop digital and online information systems and establish network technology.

3.4 As a Positive Attitude Librarian

A Librarian should devote him/herself to maintaining a standard of unrestricted, impartial and active service in the provision of library materials, and should not discriminate between or against library users on account of nationality, race, creed, sex, age, etc and respect the confidentiality of each library user. Honor the Freedom of Libraries in collecting, preserving, and proffering library materials

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A Librarian should apply himself/herself to necessary professional training, both as an individual and as a member of a group. In order to satisfy the requirements attendant upon the status of a professional person, a Librarian should study and acquire knowledge regarding Library users, Library materials, and techniques for organizing and proffering library materials, and relating such materials to library users in appropriate ways.

Actively participate in the formulation of policy in the operation and service program of his library and Librarian should cooperate with other Librarians in efforts to develop group professional competencies

Librarians should make due efforts, in association with others, to stimulate the development of the cultural environment in society and the community which they serve, by cooperating with local residents and with members of appropriate groups and organizations.

3.5 As a Leader

Perhaps one of the biggest challenges in the library profession is lack of leadership among head of Librarians to work in team spirit, who tend to hold on to traditional practice of Librarianship. As there is shift in professional identity and requires the library managers to play active role as leaders for effective change management in achieving successful results. According to Kouze and Pozner (2002) summarize them as five essential practices:

Challenge the process
Inspire a shared vision
Enable others to act
Model the way
Encourage the heart

3.6 As an Innovator in Service Excellence

Each of the Librarians supports a specific subject area by managing print and digital collections, by providing teaching support and web based material development. Reducing the Librarians' desk service requirement from current 9-12 hours per week will allow them to do better what has become one of the crucial activities in today's academic library. Liaison and outreach and getting more involved with information literacy programs to make themselves, and ultimately the library service relevant to the academic community is essentially required.

Crowley (2001) states: "The threat of being seen as peripheral, invisible, and not inconsequential should encourage academic Librarians to design and sustain service programs that appeal to those who have the power to alter or sustain value definitions in their particular academic contexts. Moreover, it should be a strong incentive to initiate or continue both short- and long-range efforts to ensure that the librarian, in any academic environment, is seen as central, visible and consequential". Further Crowley articulates that" Moving the academic librarian from the reference desks to brick and electronic classrooms, combined with a context-relevant alliance with researchers grounded in shared credentials and interests, may well be the answer to the academic version of the question, If your customers know as much as you do, why do they need you?"

Web Services Interoperability and Library Managers

Web services technology can help to achieve higher degrees of automation and integration between heterogeneous platforms and applications especially when most of the information services are now web enabled. To ensure that the Web services offer created work well together, the standards for creating. access and exchange of information calls for documentation of rules and guidelines. This will make it easier to implement new service processes without having to create additional layers of integration Software. The Web Services Interoperability organization plays a crucial role in this respect that can act as a basis for including new technologies and specifications as they evolve into products over time. The Web Services Interoperability organization (WS-I) was initiated to document criteria and test tools that ensure interoperability of web services across the globe and using the application software's, the web Based information services can run on the same machine or on different machines, with different Implementations, showing the value of web services technoloanagers have geneous environment of implary and Information Science. In this context the Library Managers have to acquire skills in Web Interoperability to provide effective services to the users.

Conclusion

Effective leadership practices, change management, communication, and continuing dialogue with Librarians are the key in order to fully realize the role of Librarian as educator. The final outcomes of becoming aware of and recognize opportunities for liaison still need to be realized. While some Librarians are naturally more suitable for and comfortable with this role, others need active encouragement, positive experiences and a supportive Environment to realize their full potential.

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Original Article

Enhancing Library Services Using Artificial Intelligence: A Study of Smart Library Systems

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Abstract:
The rapid expansion of digital information has transformed library operations, creating challenges in data management, search efficiency, and user expectations. Artificial Intelligence (AI) addresses these issues by enabling smart library systems that improve information retrieval, provide personalized recommendations, and automate routine tasks. This paper examines how AI technologies enhance library services and user experience. The study concludes that AI-driven libraries can increase efficiency, improve accessibility, and redefine modern library systems.
Keywords: *Artificial Intelligence, Smart Libraries, Machine Learning, Information Retrieval, Library Automation, User Experience, Digital Libraries*

Introduction:

Libraries have long been essential centres for knowledge storage and dissemination. However, with the exponential increase in digital content and user demand for instant access to information, traditional library systems are facing limitations in efficiency and scalability. Users now expect faster search results, personalized content, and seamless access to resources across multiple platforms. Artificial Intelligence (AI) offers innovative solutions to these challenges by transforming conventional libraries into smart, adaptive systems. By integrating AI technologies, libraries can automate repetitive tasks, enhance cataloguing processes, and deliver more relevant search results. AI also enables libraries to better understand user behaviour, allowing them to provide personalized services tailored to individual needs.

This paper examines how AI contributes to the development of smart library systems and enhances core library services. It explores key AI applications in libraries, including intelligent search systems, recommendation engines, and automation tools, while also considering their impact on both users and library professionals.

Objectives of the study:

- To examine how Artificial Intelligence enhances library services.
- To analyze the role of AI in improving information retrieval.
- To study the use of AI in providing personalized recommendations.
- To evaluate the impact of AI on automating routine library operations.
- To assess how AI improves overall user experience in smart library systems.

1. Concept of Smart Library Systems:

A smart library system integrates advanced technologies, particularly AI, to improve the efficiency and effectiveness of library operations. Unlike traditional libraries, smart libraries utilize intelligent algorithms to manage resources, analyse user behaviour, and deliver customized services.

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These systems are designed to be adaptive, meaning they continuously learn from user interactions to improve performance. Features such as automated cataloguing, intelligent search, and digital resource management are central to smart libraries.

2. AI in Information Retrieval and Search Optimization:

One of the primary applications of AI in libraries is enhancing information retrieval. Traditional keyword-based search systems often produce irrelevant or excessive results. AI-based search engines use natural language processing (NLP) to understand user queries more accurately. This allows users to search using conversational language rather than rigid keywords. AI also improves search accuracy by analysing context, synonyms, and user intent, resulting in faster and more relevant results.

3. Personalized Recommendation Systems:

AI enables libraries to provide personalized recommendations similar to modern digital platforms. By analysing user borrowing history, search patterns, and preferences, AI systems can suggest relevant books, articles, or digital content. This not only enhances user engagement but also helps users discover resources they might not have found through traditional methods. Personalized services make libraries more user-centric and efficient.

4. Automation of Library Operations:

AI plays a crucial role in automating routine and repetitive library tasks such as cataloguing, classification, inventory management, and circulation processes. Automation reduces human effort, minimizes errors, and allows library staff to focus on more strategic activities such as research support and user interaction. Technologies like chatbots can also assist users in real-time by answering queries and guiding them through library services.

5. Enhancing User Experience:

AI significantly improves the overall user experience in libraries. Smart systems can provide 24/7 assistance, faster access to information, and intuitive interfaces. Users can interact with library systems through voice commands or chat-based interfaces, making the experience more accessible and convenient. Additionally, AI helps in creating inclusive services for users with disabilities by offering features such as voice search and text-to-speech.

6. Challenges and Limitations:

Despite its advantages, the implementation of AI in libraries presents several challenges. These include high initial costs, the need for technical expertise, data privacy concerns, and resistance to technological change. Libraries must also ensure that AI systems are transparent and unbiased, as reliance on algorithms can sometimes lead to unintended biases in recommendations or search results.

7. Future Scope of AI in Smart Libraries:

The future of AI in libraries is promising, with advancements expected in areas such as predictive analytics, intelligent knowledge mapping, and fully automated digital ecosystems. AI has the potential to transform libraries into dynamic knowledge hubs that not only store information but also actively assist users in learning, research, and decision-making.

Conclusion:

Artificial Intelligence has significantly transformed the functioning of modern libraries by introducing smart, efficient, and user-centered services. The integration of AI technologies in library systems has improved information retrieval, enabled personalized recommendations, and streamlined routine operations through automation. These advancements not only enhance user experience but also increase the overall efficiency and effectiveness of library services.

Despite certain challenges such as implementation costs, technical requirements, and data privacy concerns, the benefits of AI in libraries outweigh the limitations. As technology continues to evolve, smart libraries are expected to become more adaptive, intelligent, and accessible. Ultimately, AI has the potential to redefine libraries as dynamic knowledge hubs that support learning, research, and innovation in the digital era.

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Original Article

Sustainable Food Systems: A Value added products of Fruits

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Abstract :
Sustainable food systems are essential for ensuring food security, environmental protection, and human health in the face of rapid population growth and climate change. Current global food systems contribute significantly to greenhouse gas emissions, biodiversity loss, and malnutrition. This paper explores the concept of sustainable food systems, examines key challengesIt will increase the market value.Value added products of fruits,raw agricultural products that have been modified to have a higher market value simply by changing physical state.

Keyword : *Human Health, Biodiversity, Malnutrition*

Introduction:

Value added products of Fruits

Any product that helps to increase the value of the raw agricultural product. It will Increase the market value. Raw agricultural products that have been modified to have a higher market value simply by changing physical state .a typical value addition includes cleaning, cutting, drying, packaging, smoking ,freezing and preserving. Actually fruit is not a product .it is the fresh produce. In other words fruit is defined as a product of plant growth .value addition in fruit processing transformation of a raw commodity or commodities into a processed product through the use of raw materials, labour, time, and technology all blended in a way that assures increased economic return .

Content:

a) List of Value added products of fruit
b) Juices and concentrates
c) Pulp
d) Canned and dehydrated products
e)Jams and jellies
f) Pickles and chutneys

Value addition for farm products is now trending and here are some value added farm ideas apart from making jams and jellies farmers can produce value added productd from by products in the farm.Fruit growers can fermant the products and make wines and juices, vinegar syrups and preserves as well grain growers can make cereal mixtures and baby food .

The value addition concept of fruits is the strategy to reduce post-harvest losses of fresh produce and to increase storage period of fresh produce and to have the fruits during off seasons Let us see some value added products below mentioned of fruits

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Value added products ofMango -

Mostly mango has been used as a value added product such as beverages and for its raw material for delicious pulp .and there are mango jams, mango pickles, mango chutney, mango juices mango vines etc. . Mango value addition is not just processing but also includes proper post-harvest management of mango fruit processing all its waste and export for getting high returns Mango toffees and mango ice cream are so popular among kids. Mango is very rich with vitamin A and vitamin C,this value addition can be done at any time between harvesting and final product.Mango panha is a popular summer drink made from green mangoes it is a thick mixture of sugar salt and citric acid and spices.Mango leather is well known for its dryness and it is made up of mango pulp mixed with deep sugar. As well mango waste can be converted into value added products as well. Some examples are mango kernel(seed) flour, pectin enzyme from the peel, starch from kernel and biogas can be produced from the peel.

Value added products of Banana -

There many value added products of banana. Banana chips, banana juice, banana wine, banana jam are some of them. Making flour is also considered as a processing product of banana .banana flour is beneficial for stomach problems and pains .banana jam is very popular worldwide .banana powder, banana drink, and banana sauce are also some processed products .

Value added products of Pineapple-

Normally pine apple is consumed as fresh or canned. Pineapple is now consumed in world in the form of concentrated juice dehydrated sugar, canned in slices, dried chips cocktail type drinks and banana wine etc. . Some value added products of pineapple are canned pineapple, dried pineapple, nectar, juice, sauce, jam, vinegar, toffees

Value added products of Guava -

Mainly this is consumed as fresh fruit. And wide variety of guava are consumed as value added products. Some of value added products of guava are jelly ,juice ,concentrate ,cheese, toffee etc. Guava wine, guava powder, ice cream toppings are some of other value added products .guava is a good source of vitamin C and has a great flavour with good nutritional quality .

Value added products of Strawberry-

The fruits are eaten fresh, canned or processed into jams and juices, milk shakes, cake decorations as well .this is used as a flavouring agent and used in cosmetics industry. Also these are used in face masks and face creams since it contain keratin .the fruits can be processed into jams .strawberry smoothies and strawberry milkshake are some common examples you are familiar with.

Value added products of Oranges

There are many value added products of citrus fruits including oranges with many benefits .cold press orange oil takes a major place .this is extracted by pressing the peel of the orange. Dried orange peel is also another by product from juice extraction the peel is dried and apply in cereals, baked products and sauces.

Frozen orange pulp is a by-product of juice extraction. These can be converted into fodder products. Orange puree is made by adding value to fresh fruits by crushing thoroughly. These are useful in commercial preparation of baked foods and frozen desserts. Orange wine is an alcoholic beverage .it is used as a dessert wine worldwide .

Value added products of Cherry

There are many ways to add value to cherries.it can be fresh, frozen, canned, wine and juices. More than 75% is consumed as raw .and 25% is consumed as value added products . Cherries are used to decorate cakes.

Value added products of Grapes

Raisins ,Wine ,juices , vinegar jelly ,jam ,butter ,, marmalade ,dried products are the value added products of grapes .these value added products are good to control diabetes ,treat anaemia and skin health promote bone health and dental care

Value added products of Wood Apple

Value added products are jujubes, candy, juice, leather, sauce and etc. .These can be consumed raw even.

Value added products of the Papaya

Papaya pulp is used to make mixed beverages to prepare nectar .for future use pulp is canned, frozen, concentrated .papain is extracted by dried latex of immature fruits of papaya . Papain is also used in preparation of dietary supplements, meat tenderizing, cosmetics, and pharmaceutical industries and for chewing gums

Marmalade, candy, pickle, chocolate, canned papaya, freeze dried papaya are some value added products. Cosmetics are produced as well. Papaya exfoliates damaged and dead skin cells. Let us see some value added products in India .they are banana and its by products, fruit juices, sugar cane juice etc. .

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Key Challenges

a) Climate Change

Climate change is no longer a distant threat-it is actively refreshing global food production system. For stakeholders in the food processing industry, including food consultants, food manufacturing consultants and food industry engineers, understanding its effect in critical for long term sustainability and resilience.

b) Food Waste

A significant portion of food is lost across the supply chain, worsening resource inefficiency .

Conclusion:

Sustainable food systems are critical for achieving global sustainability goals, including food security, climate action, and public health. While challenges are significant, solutions exist through technological innovation, behavioral change, and policy reform. A holistic and integrated approach is necessary to ensure that future generations have access to safe, nutritious, and sustainable food.

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Original Article

A Study of Stress on College Going Students and Its Effects on Accadamic Performance

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Abstract-

Stress arises when the combination of internal and external pressures exceeds the individual's resources to cope with their situation. For many young adults, college is the best time of life. Stress has become part of students' academic life due to the various internal and external expectations placed upon their shoulders. Adolescents are particularly vulnerable to the problems associated with academic stress as transitions occur at an individual and social level.These critical years can also be undermined by depression, anxiety and stress. Students are very likely to experience some or many stressors which may test their ability to cope: adapting to a new environment. The important dimensions of sources such as personal inadequacy, fear of failure, interpersonal difficulties with teachers, teacher pupil relationship and inadequate study facilities were further analysed and gender differences were also obtained.Looking from a closer perspective, the college students' encounters a number of challenges in his day to day life. The present paper examines the sources and effects of stress on the college students. It is hoped that the findings of the present study will assist college students to deal with stress and help advance.

Keywords- *Academic Stress; Adolescents Academic College Students ; Anxiety; Stressors; Sources of Stress.*

Introduction-

College life is one of the most scintillating and memorable experience in an adolescents life. It is in college that an adolescent enjoys the vibrant environment, the company of friends, and the various academic and co-curricular activities, which enriches, nurtures and prepares the adolescent for adulthood. College students are at a critical period where they will enter adulthood. They are expected to be the elites in the society. Thus, they should enhance their stress management abilities so as to live a healthy life after entering the society. Adolescence is a stage of human development that occurs between childhood and adulthood.

The Factors that Increase Academic college students Suicide Risk.

1. Academic Pressure, Mental Health Issues.
2. Isolation and Loneliness, Financial Concerns.
3. Cyber Bullying.
4. Substance Abuse.
5. Relationship Problems.
6. Lack of Support.

The educational system also plays an enabling role subsequently leading to increased stress levels experienced by students. Some of the sources include overcrowded lecture halls, semester grading system, inadequate resources and facilities, vastness of syllabus, long hours and expectations of rote learning. Parents and institutions relentlessly instill the fear of failure which affects their self-esteem and confidence. IPA,Delhi reported increased expectations as one of the factors responsible for increased stress levels.

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Depression, anxiety, behavioral problems, irritability, etc. are few of the many problems reported in students with high academic stress Incidences of depression were also found among stressful adolescents as it is linked with inability to concentrate, fear of failure, negative evaluation of future, etc..Adolescents were also reported to be indulging in various risky behaviors such as increased consumption of alcohol and drugs, unprotected sexual activities, physical inactivity, poor eating and sleeping patterns (Asian College Health Association, 2009; Singh, 2014). The pressure these students face to perform is so severe resulting in five-fold increase in suicide attempts.

Due to fast physical changes and mental development at this stage, students may experience incompatibility of their mental development with their physical changes or with the social environment and then suffer from problems arising from inadequate adaptations. These problems may further cause psychological troubles and even induce deviant behaviors. Adolescence is a dangerous period of time where young people experience self-organization and role confusion. For them, stress mainly comes from academic tests, interpersonal relations, relationship problems, life changes, and career exploration. According to the statistics published by National Crime Records Bureau, there is one student every hour that commits suicide (Saha,2017). The bureau registered 1.8% students who committed suicide due to failing in examinations and an 80% rise in suicide rates during a one-year time frame. A 2012 Lancet report also quoted that the 15-29 age group bracket in India has the highest rate of suicide in the world (as cited in "India has the Highest Suicide Rate", n.d.) and these numbers show no sign of dropping.

The stress response elicited by every individual is identical regardless of the trigger causing. For example, marital stress, exam anxiety, work stress, etc. would elicit identical physiological responses from the body. This happens primarily due to the adreno-medullary system, which is part of the sympathetic division of our nervous system and the adrenocortical axisresulting in the "fight or flight" reaction. Some of the physiological changes that can be observed in the body are changes in heart rate(HR), blood pressure (BP), respiratory rate, increased blood flow towards skeletal muscles, etc.

While the stress response may be identical, the sources of stress reported by individuals vary. These differences would be seen in the causes, sources and consequences of stressors. Some of the common stressors reported in an academic setting include excessive assignments, poor time management and social skills, peer competition, etc. (Fairbrother & Warn, 2003). These results are consistent with studies conducted in India as well as reported by Sreeramareddy, Shankar, Binu, Mukopadhyay, Ray & Menezes (2007).

Academic stress has been identified as the primary cause of these alarming figures.Agrawal 2019,Explain this stress as an interaction between environmental stressors, student's appraisal and reactions for the same. It has now become a grave reality that is termed as a "career stopper". It therefore, becomes a significant cause of concern as it is symptomatic of rising mental health concerns in India.

The number of deaths by suicide by students saw an increase of 4.5 per cent in 2021, the latest data from the National Crime Records Bureau show. Maharashtra had the highest student deaths by suicide in 2021 with 1,834 deaths, followed by Madhya Pradesh with 1,308, and Tamil Nadu with 1,246 deaths.31-Aug-2022

As per National Crime Records Bureau's (NCRB) Accidental Deaths & Suicides in India (ADSI) report, over 13,000 students died in 2021 in India at the rate of more than 35 every day, a rise of 4.5 per cent from the 12,526 deaths in 2020 with 864 out of 10,732 suicides being due to "failure in examination."13-May-2023

Such stress may usually cause psychological, physical and behavioral problems. This study examines the sources and effect of stress on college students.

Objectives-

To assess the level of stress.

2. To find out the sources and effects of stress among college students.

3. To give suggestive measures to overcome stress among college students.

Method-

The main objective of the study was to find if there exists academic stress among students. Further, this study was also conducted to understand if there gender wise and stream wise differences in academic stress reported by the participants. Differences in gender and stream were also noted in the different dimensions or sources of stress as assessed by the Academic Stress Scale. It was hypothesized that there exists significant gender differences and stream wise differences in academic stress. It was also hypothesized that the sources of stress will also significantly vary among gender and the different streams.

Participants for the study were selected from a general pool of students using random sampling technique where the classes were chosen based on names picked out from a fish bowl. Informed consent form and demographic profile sheet were given to all the participants and the objectives of the study were explained. Academic Stress Scale developed by Rajendran 2021 was used to understand the sources of stress. This questionnaire was selected on the basis of previous results obtained during the pilot study of this project. It measures the sources of stress primarily on four dimensions namely, personal inadequacy, fear of failure, teacher pupil relationship, interpersonal difficulties, and inadequate study facilities. The approximate administration time was around 25 minutes. Incomplete forms and questionnaire were not included in the study. Results were then analyzed using SPSS v.21.

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Results and Discussion-

The main objectives of the study were to understand the level of academic stress faced by students and the different sources that contributed to the same. Gender differences and stream wise differences in total academic stress were also analysed. Data was collected from four academic streams namely, commerce, humanities, science, and management. The students who responded to the questionnaire were currently in their final year of undergraduate programme. The obtained data was subjected to appropriate statistical analysis and the results are discussed in this session.

Conclusion-

Academic stress has become a pervasive problem across countries, cultures, and ethnic groups. The present study brought into light that academic stress still continues to be a devastating problem affecting a student's mental health and well-being. Stream wise differences in the experience of stress were also highlighted. Management of the condition thus becomes fundamental at every level namely, personal, social and institutional. Techniques like biofeedback, yoga, life-skills training, mindfulness meditation, psychotherapy have been found to be effective in reducing stress among students Understanding the source from the different spheres will enable professionals in the field to tailor-make intervention for students combining the most effective strategies. A better approach may be the use of a stress management workshop, specifically geared to the stressors encountered by college students. Certainly, stress in the college setting cannot be eliminated but we can and should do a better job preparing students to manage it.

Improving the holistic well-being of the student would eventually be productive not only the individual but, for the overall productivity of the institutions as well.

In conclusion the results of this study are suggestive as to the necessary components of a stress management program specific to the needs of college students. Given the detrimental effects of stress on health and academic performance, college administrators should consider incorporating stress management training in orientation activities.

Suggestions-

a) Suggestions for college administrators.

(I) Identify student's stress as soon as possible and provide adequate support.

(II) Incorporate career development programs in to formal curricula.

(III) Design general curriculum on stress and stress coping strategies.

(IV) Pay attention to students' stress in learning.

b) Suggestions for students

(I) Increase stress management abilities and learn to seek support.

(II) Make use of family support and release stress-reduced emotions.

(III) Effectively manage emotions and develop an optimistic view of life.

(IV) Get involved with campus activities.

Web Support-

https://search.proquest.com/docview/1816764514?pq-origsite=gscholar
https://en.wikipedia.org/wiki/India
https://www.britannica.com/
https://scholar.google.com/

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Original Article

The future of Indian village libraries is undergoing a significant transformation by embracing Artificial Intelligence and data analytics

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Abstract

In the future of Indian village libraries, Artificial Intelligence and Data Analytics will act as transformative tools that bridge the digital divide, turning traditional book repositories into adaptive, community-centric knowledge hubs. These technologies will specifically address regional challenges such as linguistic diversity, limited staff, and resource scarcity. Indian village libraries are transitioning from traditional book repositories into "smart libraries" by integrating Artificial Intelligence and data analytics to bridge the urban-rural digital divide

keywords

Digital Twins: Virtual models of library spaces for better resource management.

NLP (Natural Language Processing): Enabling voice searches in regional Indian languages.

Information Literacy: Training villagers to use AI tools effectively.

Hyper-local Curation: Using data to stock books relevant to local farming or local exams.

Role of Artificial Intelligence:

Multilingual Access and Voice Support: AI-powered voice assistants and catboats will enable villagers to search for resources and receive information in their **native languages**, which is crucial for those with limited literacy or English proficiency.

Automated Cataloguing and Preservation: Machine learning will automate the classification of resources and use **Optical Character Recognition (OCR)** to digitize and preserve rare local manuscripts and historical records.

Virtual Reference Services: AI catboats will provide **24/7 assistance**, answering routine queries about library hours, government schemes, or educational materials, allowing librarians to focus on community outreach.

Role of Data Analytics:

Predictive Collection Development: By analysing borrowing patterns and local interests, analytics can forecast which materials will be in high demand, helping libraries optimize limited budgets for new acquisitions.

Personalized Learning Paths: Data-driven recommendation systems will suggest books, articles, or online courses tailored to a user's specific learning goals, such as competitive exam preparation or agricultural best practices. **Operational Efficiency:** Analytics will help administrators identify underutilized resources for removal (weeding) and optimize staff schedules based on peak footfall patterns.

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- **Community Impact Assessment:** Libraries can use data to demonstrate their contribution to local education and socio-economic growth, providing evidence for continued government or donor funding.

Role of AI and Data Analytics in Village Libraries:

- **Localized Resource Discovery**: AI-powered search engines using **Natural Language Processing (NLP)** allow villagers to search for information in their native languages, making resources more accessible to non-English speakers.
- **Predictive Collection Management**: Data analytics help librarians forecast local demand by studying borrowing patterns, ensuring that relevant materials—such as agricultural guides or exam prep books—are stocked in advance.
- **Virtual Assistance**: AI-driven catboats and virtual assistants provide **24/7 support** for basic queries, catalogue searches, and even real-time language translation, reducing the burden on limited village staff.
- **Inclusive Accessibility**: Features like text-to-speech, image recognition, and Braille conversion are being implemented to assist users with disabilities in remote areas.

Key Challenges:

- **Infrastructural Gaps**: Unstable internet and outdated hardware remain the primary obstacles for village-level AI implementation.
- **Digital Literacy**: There is a significant gap in technical skills among both library staff and rural users, requiring on-going training and certification programs.
- **Funding**: High upfront and maintenance costs make rural libraries heavily dependent on government grants and public-private partnerships.

Conclusion:

The future of Indian village libraries lies in their transformation from passive storage spaces into **dynamic, user-centric knowledge hubs** powered by AI and data analytics. By adopting these technologies, rural libraries can bridge the digital divide, offering services previously reserved for elite urban institutions.

Summary of Future Impact:

- **Hyper-Personalized Learning**: Libraries will use predictive analytics to understand individual reading patterns, offering tailored suggestions for books, exam materials, and vocational courses in **local languages**.
- **Operational Excellence**: AI will automate repetitive administrative tasks—such as cataloguing and inventory tracking via **RFID**
- **Equitable Access**: Multilingual catboats and voice-activated search will dismantle language barriers, allowing non-English-speaking villagers to navigate global databases as easily as local ones.
- **Preservation of Heritage**: Advanced AI tools will play a crucial role in the digital restoration and preservation of rare local manuscripts and oral histories that define rural Indian culture.

Path Forward:

1. **Sustainable Infrastructure**: Ensuring stable internet and modern hardware through government and private-sector partnerships.
2. **Ethics and Trust**: Implementing clear policies on data privacy and transparency to build community trust in automated systems.
3. **Capacity Building**: Continuous training for library staff to transition into "AI-ready" professionals who can guide patrons through the digital landscape.

Reference:

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3. **Reinventing Libraries with Future Technologies**by Dattatray Narayan (2021): While slightly older, it remains a foundational text in India for understanding big data, cloud computing, and green library concepts.
4. **Information and Communication Technology in India's Krishi Vigyan Kendra Libraries**by Dr. Shyam Deo Gond (2022): Focuses on the use of ICT in Indian agricultural extension libraries, providing a blueprint for rural information centers.

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Original Article

Innovative Development of Mushroom-Based Value-Added Food Product for Sustainable Nutrition

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Abstract

The increasing demand for sustainable food systems and nutrient-dense diets has intensified the need for innovative food product development. Mushrooms, particularly oyster mushrooms (Pleurotus sajor-caju), are recognized as a sustainable and nutritionally rich food source due to their high-quality protein, essential amino acids, vitamins and minerals (Chang & Miles, 1993; Rai, 1997). The present study aimed to develop a value-added traditional food product (khakhra) enriched with mushroom powder and evaluate its sensory and nutritional quality. Mushroom khakhra was prepared by incorporating 2% oyster mushroom powder into wheat flour with variations such as garlic, onion and methi. Sensory evaluation was conducted using a nine-point hedonic scale, and nutritional analysis was performed using standard AOAC methods. The results revealed a significant improvement in protein, calcium, iron and vitamin C content in the experimental samples compared to the control. The garlic-mushroom variation showed the highest acceptability among panel members. The study demonstrates that mushroom-based value-added food products can serve as innovative, cost-effective and sustainable solutions to improve nutritional security, promote functional food development and support sustainable food systems.

Key Words: *Sustainable food system, mushroom khakhra, value-added food, functional food, nutrition innovation, oyster mushroom*

Introduction

Sustainable food systems have become a global priority in the context of increasing population, environmental degradation and rising food insecurity. A sustainable food system ensures the availability of safe, nutritious and affordable food while minimizing environmental impact and promoting economic viability (FAO, 2018). In this context, the development of innovative, nutrient-rich food products using locally available resources has gained significant importance. In India, the traditional diet is largely cereal-based and often deficient in essential amino acids such as lysine and tryptophan. This imbalance contributes to protein-energy malnutrition, particularly among vulnerable populations. Mushrooms have emerged as a promising alternative to address these nutritional gaps due to their high protein content and balanced amino acid composition (Chang & Miles, 1993). Mushrooms are also rich in vitamins such as thiamine, riboflavin and vitamin C, and contain important minerals like calcium, iron and phosphorus. Additionally, they are low in fat and cholesterol-free, making them suitable for health-conscious consumers. Oyster mushrooms (*Pleurotus sajor-caju*) are particularly important due to their wide availability, low cultivation cost and high nutritional value (Rai, 1997). Beyond their nutritional benefits, mushrooms also contribute to sustainable agriculture. They can be cultivated using agricultural waste materials such as straw and husk, thereby promoting waste recycling and reducing environmental pollution. This makes mushrooms an environmentally sustainable food source.

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Value addition in traditional foods is an effective strategy to improve their nutritional quality and increase consumer acceptance. Khakhra, a traditional Indian snack made from wheat flour, is widely consumed and has a long shelf life. It provides an excellent base for fortification with nutrient-rich ingredients like mushroom powder.

Previous studies have shown that incorporation of mushroom powder in food products enhances both nutritional value and sensory quality (Ghosh & Singh, 1995). Therefore, the present study focuses on developing mushroom-enriched khakhra and evaluating its sensory acceptability and nutritional enhancement as an innovative solution for sustainable nutrition.

Materials and Methods

1. Product Development

The experimental study was conducted to develop mushroom-based value-added food products. Oyster mushroom powder was incorporated into wheat flour at a level of 2% for the preparation of khakhra. Different variations were developed to improve flavour and acceptability:

- Control sample (CS): without mushroom powder
- Garlic-mushroom (GM)
- Onion-mushroom (OM)
- Methi-mushroom (MM)

The preparation process involved mixing wheat flour with spices, adding water to form dough, rolling into thin sheets and roasting on low flame until crisp. The formulation was standardized through repeated trials to achieve desirable sensory characteristics such as taste, texture and appearance .

2. Sensory Evaluation

Sensory evaluation of the developed products was carried out using a nine-point hedonic scale ranging from "like extremely" to "dislike extremely." A panel of 10 semi-trained judges evaluated the samples based on the following attributes:

- Taste
- Colour
- Texture
- Mouthfeel
- Appearance

The evaluation was conducted over three consecutive days to ensure consistency and reliability of results. The average scores were calculated for each parameter.

3. Nutritional Analysis

The nutritional composition of the developed khakhra samples was analysed using standard methods:

- Protein content was estimated using the Micro-Kjeldahl method
- Vitamin C was determined by colorimetric method
- Calcium content was analyzed using titration method
- Iron content was determined by colorimetric method

These analytical procedures were carried out following standard AOAC guidelines (AOAC, 2005).

4. Statistical Analysis

The data obtained from sensory evaluation and nutritional analysis were subjected to statistical analysis. Mean and standard deviation were calculated for each parameter. Analysis of variance (ANOVA) was used to determine significant differences among control and experimental samples. The F-test was applied to evaluate statistical significance of sensory attributes (Kothari, 2005) .

Results and Discussion

1. Sensory Evaluation

The results of sensory evaluation indicated that incorporation of mushroom powder improved the acceptability of khakhra.

Table 1: Overall Acceptability Scores

Sample	Mean Score
Control (CS)	7.40
Garlic + Mushroom (GM)	7.78
Onion + Mushroom (OM)	7.60
Methi + Mushroom (MM)	7.42

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The garlic-mushroom sample (GM) received the highest score, indicating superior taste and flavor. The addition of garlic enhanced the overall sensory appeal of the product.

According to the sensory evaluation data, all experimental samples were rated between "liked very much" and "liked extremely," indicating high consumer acceptability.

These findings are consistent with previous studies, which reported that mushroom incorporation improves sensory characteristics of food products (Ghosh & Singh, 1995).

2. Nutritional Enhancement

Mushroom supplementation significantly improved the nutritional quality of khakhra.

Table 2: Nutritional Composition (mg/100g)

Nutrient	Control	GM	OM	MM
Protein	4.9	5.3	5.29	5.28
Vitamin C	0.6	1.8	1.5	1.7
Calcium	0.9	1.9	1.6	1.7
Iron	1.3	1.6	1.5	1.6

The increase in protein and micronutrients is attributed to the high nutritional content of mushrooms, which contain essential amino acids, vitamins and minerals (Prasad, 1997).

The results indicate that even a small level of supplementation (2%) can significantly enhance the nutritional value of traditional foods. This is particularly important for addressing micronutrient deficiencies in developing countries.

3. Statistical Analysis

The ANOVA results revealed significant differences in sensory attributes among samples.

Table 3: ANOVA Results

Parameter	F-value	Significance
Taste	10.8	Significant
Mouthfeel	6.44	Significant
Texture	7.79	Significant
Appearance	0.06	Not Significant

The results indicate that mushroom incorporation significantly affected taste, texture and mouthfeel, but had no significant effect on appearance.

These findings are consistent with standard food product development studies where fortification improves functional properties without compromising visual appeal (Kothari, 2005).

4, Sustainability and Innovation Perspective

Mushroom-based food products contribute significantly to sustainable food systems. Mushroom cultivation requires minimal resources and can be carried out using agricultural waste materials, making it environmentally friendly (Rai, 1997).

Additionally, the development of value-added products such as mushroom khakhra promotes:

- Nutritional security
- Food diversification
- Rural entrepreneurship
- Low-cost innovation

Figure 1: Sustainable Food Innovation Model

Mushroom (Sustainable Resource)
↓
Value Addition (Khakhra)
↓
Nutritional Enhancement
↓
Consumer Acceptance
↓
Sustainable Food System

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This model highlights the role of innovative food processing in linking sustainability with nutrition.

4. Economic Feasibility

Table 4: Cost Analysis

Product	Cost per unit (Rs.)
Control Khakhra	0.83
Mushroom Khakhra	0.93

The cost difference between control and experimental samples is minimal, indicating that the product is economically feasible. The improved nutritional value justifies the slight increase in cost.

Such products can be promoted through self-help groups and small-scale industries to generate income and employment opportunities.

Conclusion

The present study successfully demonstrated that incorporation of oyster mushroom powder into traditional food products significantly enhances nutritional quality while maintaining high sensory acceptability. The developed mushroom khakhra showed increased levels of protein, vitamin C, calcium and iron compared to control samples. The product represents an innovative approach to developing functional foods that are both nutritious and sustainable. Mushroom-based value-added products have the potential to address malnutrition, improve dietary diversity and promote sustainable food systems.

Furthermore, such innovations can support rural entrepreneurship and contribute to economic development. Therefore, mushroom-based food products can play a crucial role in achieving sustainable and advanced food systems in the future.

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Original Article

A Way towards Nutrition for Athletes: Enhancement in Sports Performance

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Abstract

Nutrition is undoubtedly related to well-being, especially when it comes to sports, due to the increase in energy and nutritional supplements. It is important to know the physiology of the activity in order to understand the various metabolic and various kind of health planning and pathways that occur together during exercise. As well as assisting an individual with performing, it works with recuperation. These days, an enormous number of novice competitors perform every day active work both casually and semiprofessionally. That populace likewise looks to accomplish an improvement in their own brands, which can be arrived at adhering to legitimate healthful rules. In competitor populace, supplement prerequisites are increased contrasted and non-competitor populace. Thusly, it is fundamental for do a healthful methodology adjusted to the competitor and instructional meetings. Furthermore, different benefits of satisfactory food admission in sports are identified with changes in body organization, decrease of wounds, and prolongation of expert vocation length. The goal of this part is to decide the nourishing prerequisites of competitor populace that permit to accomplish their donning objectives. Healthful methodologies will be tended to as far as macronutrients utilization, hydration, and timing relying upon type and power of activity.

Introduction

Although in maximum countries, bodily training is a part of the faculty curriculum, instructions aren't given, therefore main to a discounted revel in of bodily pastime for kids and youngsters. The exercise of a bodily energetic life-style in aggregate with wholesome nutrition, however, desires to be began out in early childhood. Therefore, making sure that every one kids have interaction in ordinary bodily pastime is crucial, and the colleges are the simplest region in which all kids may be reached. Quality Physical Education is the simplest and inclusive manner of presenting all kids, anything their ability/disability, sex, age, cultural, race/ethnicity, non secular or social background, with the abilties, attitudes, values, know-how and knowledge for lifelong participation in bodily pastime and recreation and is the simplest faculty difficulty whose number one attention is at the body, bodily pastime, bodily improvement and fitness Modern practices and way towards health and gifted curriculum want to change to produce student interests in physical training and sports. Situations that's pecifically require luck are the right curriculum to do and follow and keep in order. A range of prices from a number of Companies that aim to directpoorthoughintelligent hildren to get the easiest attention during their holidays without requiring n.Price range. In this regard, you can anticipate the developments in the creature during real stress to achieve certain dietary recommendations. The healthy performance of competitors is multifactorial and depends on the competitor's inclinations, culture or nutritional knowledge.

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Prepared by a Sports Nutritionist, it aims to motivate the competitor and their current situation to make significant improvements in approach and develop Sports Performance (SP) accordingly. Nutrition is a critical factor in achieving satisfactory SP, characterized by three factors: preparation, and wellness through exercise rest and maintenance. However, the main goal of sports nutrition should be to protect the strength of the competitor, which can be achieved through an adequate intake adapted to the type of exercise. An ideal diet provides the energy needed to perform the actual exercise and reduces the number of injuries that result in an increase in SP without the help of someone else.

The body arrangement (BC) of the competitors is identified with the SP, as it tends to be adjusted all through the season. There is no single BC for each gathering of competitors; be that as it may, it can fill in as an aide for competitors and coaches.The period of the competitor will be partitioned into various stages all through the cutthroat time frame. Serious season can be partitioned in preseason, cutthroat period, change period, and in the most pessimistic scenario injury period. Because of various forces, timing, and sorts of preparing, the BC is ordinarily divergent in the cutthroat season. Accordingly, know the BC of the competitors to decide the sufficiency of the ebb and flow season stage.

Selection of the topic

The above research studies the impacts of nutrition for betterment of the health and wellness also the benefits to the athletes for their better performance.

Survey methods

The data for the above research is taken from the various colleges nearby Amravati knowing the impacts and benefits by questionnaire methods to the athletes.

Health and wellness

Aside from a higher weight list (BMI), there are a few techniques for the assessment of BC. Double energy X-beam absorptiometry (DEXA) is viewed as the best quality level for the appraisal of muscle to fat ratio, predominantly because of its high reproducibility and exactness. Be that as it may, DEXA has high monetary expense, isn't convenient, and furthermore transmits a little radiation, so its utilization isn't extremely normal. Among the most utilized strategies are bioelectrical impedance investigation (BIA) and anthropometry. Impedance is characterized as the resistance shown by natural materials to the section of an electric stream. Tissues with high impedance offer more noteworthy opposition (fat tissue, bone, air in the lungs) and contain less measure of water. The more prominent the measure of water, the better this electrical stream, will go through. Hence, the hydration satiate of the individual is the determinant for the BC estimation by BIA. Likewise, to normalize past conditions and excuse blunders, certain conventions should be followed before the estimation of BC by BIA. That reality makes BIA a fairly loose strategy. Before making assumptions about the amount and timing of macronutrients, it is important to have a brief overview of the various metabolic pathways that provide energy during exercise. Energy frames are connected to a set of metabolic pathways that are activated during exercise depending on strength and endurance.

Exercise and nourishment

The purpose of both pathways is to create ATP, which is consumed during activity. Non-oxidative pathways occur in the cytosol of the cell, do not require oxygen, and are initiated within a short time (seconds). The phosphagen cycle uses ATP and phosphocreatine, lasting anywhere from 1 to 10 s, and is a cycle that does not require oxygen or produce lactate. Glycolytic pathways use glucose, muscle and liver glycogen through glycolysis and occur over up to 3 minutes of extreme focused practice. These glycolytic pathways form the lactate and hydrogen bonds that cause corrosion in muscle cells - this acidity is one of its obstacles. The efficient pathway takes place in the mitochondria, so the presence of oxygen is required to process the stressed substances. This is common for medium power and long-term opposition practices. This includes the oxidation of CHOs, fats and to a lesser extent proteins. This course produces significantly more ATP than the anaerobic pathway, but at a slower rate because speed is the limit on this pathway.

The way towards Nutrition

The energy requests of competitors vary broadly relying upon the sort of game, term, force, serious level, and individual inconstancy of every competitor. The really difficult the cutthroat levels of the competitor are, the best expansion in the power of both preparing and contest happens, which will bring about a huge decrease energy holds that should be supplanted by a sufficient eating routine. To build up proposals for macronutrients, it is ideal considering the body weight (BW) of the competitor, rather than giving the common rates dependent on the complete caloric admission of the eating regimen. For this reason the suggestions will be given by grams of supplement/kg of BW. Primary energy substrates utilized for actual exercise are starches (CHO) and lipids, while proteins as energy substrate are saved for outrageous conditions. The utilization of energy substrate differs relying upon the power and length of the activity, level of preparing of the competitor, and the condition of pre-exercise CHO stores. The utilization of CHO as energy substrate is created chiefly during high intensity and brief span works out. In the interim, less extreme and long haul practices utilize fats' principle energy substrate. Anyway the

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utilization of CHO will likewise significantly affect activities of less power and longer term, for example, obstruction test, showing that exhaustion of CHO along with drying out is a significant impediment of the SP.One of the large contrasts among CHO and lipids is their stockpiling in the body. While CHOs have a restricted hold which prompts around 1600–2000 kcal, fats guess a basically limitless energy save near 70,000 kcal (contingent upon fat mass).

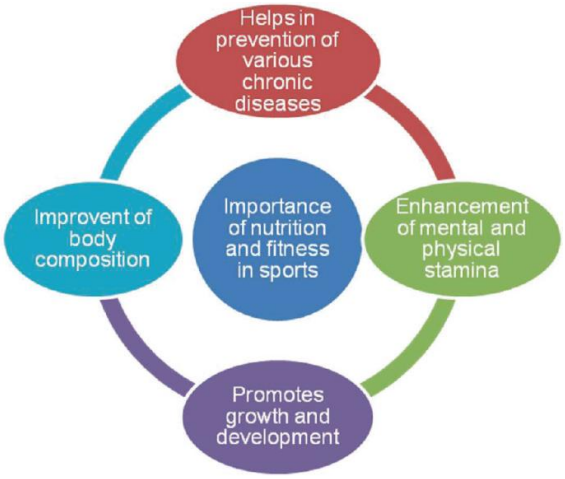

Fig-1 Importance of nutrition

Conclusion

Nutrition is a critical factor in achieving satisfactory SP, characterized by three factors: preparation, and wellness through exercise rest and maintenance. However, the main goal of sports nutrition should be to protect the strength of the competitor, which can be achieved through an adequate intake adapted to the type of exercise. An ideal diet provides the energy needed to perform the actual exercise and reduces the number of injuries that result in an increase in SP without the help of someone else.

Nourishment is fundamental for supporting a competitor's overall wellbeing and their preparation needs. Having an appropriate eating routine gives an individual enough energy and supplements to fulfill the needs of preparing and exercise. As well as assisting an individual with performing, it works with recuperation.

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Original Article

Changing Role of Librarians in E-Environment

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Abstract

This paper covers the challenging role of librarians in new digital library environment. The role of the librarian has become more dynamic and challenging in the digital age. Today the use of ICT (Information, Communication and Technology) has absolutely changed the role and responsibilities of librarians. The paper also tries to reflect skills, current trends and challenges required for the library and library professionals working at digital library environment.

***Keywords**: E-learning environment, ICT Technology challenges*

Introduction

The modern trend is for the role of the librarian to move from that of a passive Intermediary responsible for guiding patrons to appropriate information resources to-ward that of a much more proactive professional whose role includes analyzing and repackaging information. Librarians have faced this challenge head on by becoming masters of the Web. Librarians create powerful Web sites such as the National Library of medicine's Pub Med database. Librarians see the Web as an easier way to share what they know with others. They gather electronic information and create electronic pathfinders and frontend search tools to help users. Librarians create online tutorials and instructional Web pages to help patron's per-form the best searchers. They gather links to web-sites on specific topics and lead patrons to these evaluated sites as a starting point. According to Mary Ellen Bates, another role change technology brings is that the "library and information center managers are often asked to negotiate these electronic subscriptions. This requires a new set of skills and even an entirely new relationship with publishers". The increasing cost of both print and electronic journals causes many libraries to cut subscriptions and to purchase data for a particular audience. It is the job of the librarian to choose what is to be cancelled and to decide who will suffer least from the lack of access to particular information. In the decision to cancel subscriptions, the librarian considers, among other things, the needs of the community the library serves and whether the information is also available within the organization. Price and timeliness in retrieving the information are also considered. When negotiating access with a publisher, the librarian must agree to certain restrictions on photocopying or distribution of electronic materials. Despite copyright notices and efforts to educate employees about intellectual property rights, electronic publications can be easily forwarded to people outside the licensed user group. The library is responsible for maintaining the awareness of all employees about copyright issues.

Objectives

To define the concept of digital library.
The main objective of this paper is to explore the changing roles of the librarians to meet the changes and challenges in the digital environment.
To discuss about the various skills needed for the library professionals to meet the digital need of the user.

Definition

Digital libraries may be defined as electronic information collections containing large and diverse repositories of digital objects, which can be accessed by a large number of geographically distributed users.

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According to Clifford Lynch;
"Digital libraries are system providing users with coherent access to a very large, organized repository of information and knowledge".
The Association of Research Libraries (ARL) in definitions and purposes of a digital library has defined a digital library as having these qualities

- The digital library is not a single entity.
- The digital library required technology to line the resources of many.
- The linkage between the many digital libraries and information services are transparent to the end user.
- Digital library collections are not limited to document surrogated: they extend to digital artifacts that cannot be represented or distributed in printed formats.

From the above definition, it may be briefly said that an ideal digital library is one in which all the information exists in digital form and all the functions are automated using advanced technologies.

Characteristics of Electronic Environment

With the change of the learning environment, there arises a new way of learning – electronic learning which is now making great changes in the content and methods of learning which will bring about a revolution of learning. Electronic learning refers to computer enhanced learning and covers a wide set of application and process such as web-based learning, computer-based learning, virtual classroom and digital collaboration. E-learning is comprised of four elements namely: a learner, an instructor, technology, including a computer, and information or skills to be learned (Deng & Rung, 2007). E-learning is important to learners because it offers a new way to learn at anywhere and at anytime once an internet connectivity is available and at one's own pace. Learners can obtain abundant resources of learning content through the internet, intranet/extranet (LAN/WAN) and CD-ROM, etc in the digital environment of e-learning. Elearning is, a self-directed learning which gives prominence to self-determination of learning. Learners can get information needed as much as possible through internet according to one's own characteristics and the content of e-learning in the process of learning.

Traditional Roles of Libraries

The literature on library and information services shows that libraries began as storehouses, in which books were more or less preserved and utilized and where librarians worked as custodian with little or no interaction with users. Librarians only served the users by locating and giving books to them without any encouragement to use the library on their own. Then there was a shift as a result of information communication technology which has changed the trend in service tremendously. Nowadays, libraries and librarians play an important role in providing access to information, organizing it and helping users to access the information needed. This information services have become a key element for libraries. The interest of library user is to get the information needed within a given timeframe possible and accurately.

Changing Roles of Librarians in an Electronic Environment

The dynamic nature of library and information service has resulted in fundamental changes to the roles and responsibilities of librarians. The environment in which academic libraries operate today is changing and consequently the academic library is changing to provide the competitive advantage for the parent bodies. The success of today's academic libraries depends on their ability to utilize information and knowledge to better the needs of the academic community. This requires the academic librarians to reappraise their functions, expand their roles and responsibilities to effectively contribute and meet the needs of large and diverse academic libraries. The librarian needs to acquire some skills through rigorous training and retraining and regular application of ICTtools to any aspect of library operations in either sequential or sporadic manner and as fast as possible. This calls for considerable discussion about the spectrum of skills and knowledge required of the new information professional (Fisier, Halian & Patridge, 2005). Discussing professional competencies, Dakshinamurti & Braaksma (2005) citing Libutti (1999) assert that they include: assessment and inquiry competencies; instructional competencies; technological competencies; scholarly competencies; and social competencies.

The Library and Information st Professionals in the 21 Century

The evolving information and knowledge-based society has led to a climate of tremendous change in academic library services globally. The information revolution and the web-based knowledge available have created new challenges to these traditional professional ethics. The impact of web-based e-learning and teaching environment has affected every aspect of academic library services, thus providing new opportunities and challenges to the librarian to be fully involved in the knowledge society, including electronic and multimedia publishing, internet-based information services, global networking, web-based digital resources, etc (Thamaraiselvi, 2009). Continuing, he stated that the emerging challenges of procuring and providing access to electronic information resources demand that librarians shift their role from traditional librarians to information scientists by learning and applying new skills to understand the evolving technologies to manage and provide quality on-line information service to the knowledge society. We shall discuss the vision, challenges and expected roles of librarians in the digital era.

Challenges of the Librarians in the ICT Era

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Librarians have the responsibility to select and organize resources and educate users how to retrieve and exploit them, as well as preserving the information regardless of the format or technology it appears. New tools of information communication technology have a absolutely changed the role and responsibilities of librarians. The librarian in adapting and adjusting to these changes faces some problems and challenges. Thamaraiselvi (2009) posits that the future academic librarians faces the challenges of the future academic needs of the user in the elearning v environment is: to provide electronic access to all relevant information and integrate it is v on networks across the world; to create a new physical library premises with computer network facilities, abandoning the old concept v of library as a storehouse; and to develop new standards and skills for the profession to meet user needs in a proactive way. He further stated that in the present digital era the most pressing and pervasive issues and challenges faced by LIS professionals in providing digital information v services to the knowledge society include

Conclusion

Change by its nature is unpredictable, inconstant, not optional and often unmanageable. An effective organization need to acknowledge this fact and accept that the success of an organization depends upon their ability to predict and control change in some ways. Libraries are integral part of the society that surrounds it. Librarians need to recognize the changes that have already taken place in libraries and to be aware of the ways in which broader societal change are affecting libraries. They need to realize the advantages of mass delivery of library services in the digital age. Library and information agencies required staff with innovative ideas and vision to create and sustain valued, effective services to patrons, and to contribute to the success of an organization. Career-long learning is therefore integral to professional success, and individual professional development needs to be supported through a combination of education, personal achievement and workbased opportunities. There is considerable and continuous need for new knowledge and skills training in the electronic information age to keep pace with information technology revolution, best obtained through short courses, workshop. Database search knowledge and general e-resources are areas where librarians need high demand for training. The evolving change occurring in technology in research, teaching and learning afford the opportunity if libraries and librarians can respond to changes in proactive and visionary ways. Library professionals of today must be active contenders in the race of relevance, regard and resources. They must have strong technical skills and an ability to identify specific areas in which technology can advance the institution in fulfilling its academic mission.

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Original Article

Library Portal: Role of Librarian

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Abstract

This paper emphasizes the significance, elements and functionality of library portals, the role of librarian as selector and organizer of information on the web. The portal offers the user the ease of searching many sources at once, integrating results from licensed resources and local databases and bibliographical descriptions of digitized material. Equally, the familiar portal interface is an option for searching databases that are unfamiliar to the users. Librarians bring their expertise with content, their knowledge of copyright, their commitment to customer service and their experience in creating customized web-based information delivery systems.

Keywords: *Library Portal, Content management, Portal elements.*

Introduction

The term "portal" describes a variety of web based interfaces, everything from a relatively static homepage with general product and contact information to a dynamic one-stop homepage where users can customize the content to meet their needs. For many portal is the epicenter of the web experience, a place to return to when you get lost, a place to keep your information, a place from which to communicate with others. The Joint Information Systems Committee defines a portal as "a network service that brings together content from diverse distributed resources using technologies such as cross searching, harvesting and altering, and collates this in to an amalgamated form for presentation via a web browser to the user". A library portal is a single access point combining the library catalogues, subscription databases, subject gateways, electronic journals etc. Library portal meets the individual needs of users, which either the system itself can tailor the delivery and presentation of information content or the users themselves can customize the type and format of information displayed. Library portal is now the standard interface to generate library resources and services through a single access and management point for users.

2. Significance of Library Portal

Librarians have become increasingly aware that the multiplication of electronic resources is a problem for end-users. Users find it difficult to locate the most appropriate database or resource to search for information relevant to their need. Even if they locate the right resources, since each service tends to have its own unique interface, they may struggle to search it effectively. If information is difficult to find using library tools and services, users are looking for alternative sources. This new reality translates into the need for making library web environments effective and useful. This trend is especially challenging for librarians, who were and continue to see themselves as the traditional keepers of knowledge, which until very recently was housed in many millions of books and journals that are rapidly becoming digitized. Portals are transformational environments that address the problem of information glut by customizing information content to meet specific end-user needs.

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Library portal is growing in its importance as the preferred way of organizing and using information. Web portals are seen as positive potential frameworks for achieving order out of chaos. As portals become a primary means for transacting information and commerce, libraries of all types are becoming involved in thinking, planning and building various frameworks and services. Library portal reduce the barrier of users having to remember multiple log-ons. The portal gives the library a tool to channel users towards preferred resources. It increases the ability of the library to ensure that costly electronic joumals and databases are used, by offering a simple way to browse the available resources. It supports searching by carrying users through from bibliographic searches to full text options.

3. Elements of Library Portal

The library portals are changing rapidly, but some of the major elements to be considered while designing the library portal are as follows,

3.1 Ease-of Use

The foremost feature to be considered is the ease-of-use, which can be determined by the effectively organized home page. The ease with which the users find information depends upon the multiple paths provided to find information, at the same time, keeping the number of clicks to a minimum in finding pertinent information. The user should perceive ease-of-use with the accessibility and usability of library portal, so as to interact with the system quite often. Text should be kept terse and lucid, so that user can scan and locate the needed information quickly and sometimes, obscured information they seek.

3.2 Search and Navigation

In addition to consistent and logical navigation framework, effective search functionality and site maps are mandatory in the homepage. Direct access to the commonly used services needs to be supported by the library portal, as the users expect to have the capability to complete tasks online. Search boxes are preferable to search buttons and need to be placed in a prominent location.

3.3 Resource Linking

Resource linking allows a library to seamlessly tie electronic resources together. For example, an index or abstract can be linked to a full-text database or a bibliographic record can be linked to a review or to an e-book. Users may like to have more than one path to find the same information, cross linking ensures that the users would find the information they are looking for.

3.4 Personalization

Each individual user or a community and/or group of users can have settings for each of the portal functions that they use. A portal provides a framework for users to store the settings and tailor the content that they are interested in seeing. A portal can be personalized using user profile to deliver personalized content. Each user can gain a view that is tailored to his or her access privileges. User has to sign on with a username and Personal Identification Number on entry to the library portal to access personal profile information and tailor the design based on customization feature. Or else, a portal may give users the ability to create their personalized pages by selecting what they want to see whenever they get access to the library portal. This personal page may keep track of resources for a user, his library account, queries kept until the session ends, request and reserves and also renewals.

3.5 User Authentication

User authentication also known as patrons authentication determines whether patrons are eligible for service by checking patrons against a library database. This authentication is usually done with a proxy server to limit access to resources the patron is authorized to use. For example a library may allow anyone to access its catalog, its community information file and other locally created files on its web server, or it may limit access to subscription databases to only registered borrowers.

3.6 Interactive Services

Although most portals can support interactive services, only a few academic libraries have incorporated interactive services in to their portal. Typical of such services are e-mail, chat rooms and forums. Library portal should facilitate knowledge sharing online by providing collaborative space for interactive tools. However, in order to assist the users in the fair use of tools and services offered, library portal should facilitate web based information literacy programs.

4. Core Functionality of the Library Portal

Searching would be far easier for the user if the library could present resources in a consistent, organized gateway. This should be customized for different user groups.

Users would learn to search more effectively if there is one fully functional library maintained search interface available for any database they wanted to use.

It would often be convenient to search multiple databases from one search box. This implies the ability, in a single search, to interrogate databases that use different metadata standards, especially in different curatorial domains.

Specifically the system should be able to search databases of images and a proliferating array of multimedia types, and ideally show thumbnails or previews in search results.

The search results from spread searches need to be presented in an intelligible way to the user, ideally with de-duplication and sorting of results.

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The system must understand licenses, such that it only offers options to users that are available to them, based on their access rights and the license, although it can help create awareness and drive demand for protected resources through alerting, personalization and customization functions.

Link resolution services should be supported. That is rather than pointing at specific static URLs for content, web requests should pass through an intermediary service where a final URL is calculated for any resource at the time of the user accessing it. This offers a saleable way to manage constantly changing URLs and the opportunity to develop further middleware support services.

The user should be able to save hits or searches, including for reuse on databases other than the one it was first created for.

Another central requirement is that there should be a single point of authentication. The user must not be constantly challenged for a password, in fact cross searching of multiple access controlled datasets is impractical without some sort of single sign on or caching of credentials or trust between servers.

The system must provide central management tools for handling a variety of http based query syntaxes, since standards are developing rapidly to meet the needs of specific domains.

5. Role of Librarian

As educators who organize and evaluate information resources, academic librarians bring unique perspectives and skills to the development of portals in their colleges and universities to campus portal planning and implementation, they bring their expertise with content, their knowledge of copyright, their commitment to customer service, and their experience in creating customized web-based information delivery systems.

5.1 Content

Academic librarians provide credible content that has been selected for a specific learning community. Their library's homepages and collections have what every web site wants: brand and content. Libraries have the brand name of the academic institution they serve and content that has been customized to meet the needs of their users. To students who may have difficulty determining what is valuable and what is useless on the web, the library offers a safe harbor in a flood of information. Increasingly the content of libraries is in digital form and is composed of databases. Click on any library homepage and you will find an array of databases selected to support the academic programs offered by the institution. These databases are made available both on and off campus through licenses arranged through the library.

5.2 Copyright

Librarian's knowledge of current copyright policy is being called upon now more than ever in setting up electronic reserves and online information for learning portals created using blackboard and other web-based course management systems. Faculty and students may assume that if educational material is on the web, no copyright restrictions apply. However, this is true only if the copyright for the work has expired, its author has allowed the work to go into the public domain, or the work was authored by the federal government. Since there is a mix of works in the public domain and under copyright on the internet and some works under copyright are posted without authorization, it is not always clear which are in the public domain.

Librarians provide guidance in determining which web-based materials are under copyright and seek permission for use of these works with the Copyright Clearance Center and other agencies. Librarians inform faculty about the fair use guidelines.

5.3 Customer Service

As libraries make more digital resources available on the Web, research is increasingly conducted outside of the physical library. However, remote users want interactive assistance from a qualified human being and not just a help button to click on. Librarians have developed a number of ways to extend person-to-person reference service in a digital environment that are applicable in supporting portal use on campus. Digital Reference Services (DRS) offer quality service at any time to users outside the library DRS refer to all internet-based, human-mediated information services, including those based in library settings and other types of organizations. Such services range from e-mail reference which libraries have offered for years, to online reference chat which many librarians are now implementing.

Conclusion

Most library patrons want information regardless of where they find it. They don't want to limit themselves to their library's collection. A portal offers them one-stop shopping that takes them from the initial need for information through its delivery without having to use several different tools. If well designed, a porta zs0 provides effective navigation of complex, multiple collections. Over the past decade, academic librarians have been evaluators, selectors, and organizers of information on the web. Our experience and experts make us valuable players in a team approach in planning and implementing library portals. An interactive service such as "Ask a Librarian" can make requesting assistance simple and convenient by connecting web users with librarians.

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Original Article

Sustainable Dietary Practices and Nutritional Adequacy among High School Students

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Abstract
Sustainable dietary practices are increasingly recognized as essential for improving human health while preserving environmental resources. Adolescents, particularly high school students, are in a critical stage of growth and development, making adequate nutrition a priority. However, changing food habits, increased consumption of processed foods, and lack of awareness about sustainability have led to poor dietary patterns. The present study aims to assess sustainable dietary practices and nutritional adequacy among high school students. A cross-sectional study was conducted among 80 students aged 14–16 years using a 24-hour dietary recall method and a structured questionnaire. Nutritional adequacy was assessed by comparing dietary intake with recommended dietary allowances. The findings indicate that although students have moderate awareness of healthy eating, their actual dietary intake is inadequate in essential food groups such as fruits, vegetables, and milk. Sustainable practices such as consumption of local foods and reduction of food waste were limited. The study highlights the need for targeted nutrition education interventions to promote sustainable and nutritionally adequate diets among adolescents.
Keywords: *Sustainable diet, adolescents, nutritional adequacy, food systems, dietary practices, food security.*

Introduction

The concept of sustainable food systems has gained global importance due to increasing concerns about environmental degradation, food insecurity, and rising health issues. A sustainable diet is defined as one that has low environmental impact while contributing to food and nutrition security and a healthy life for present and future generations. Such diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, economically fair, and nutritionally adequate. India, being a developing country, faces the dual burden of malnutrition and environmental challenges. On one hand, undernutrition and micronutrient deficiencies persist among adolescents, while on the other hand, there is an increasing trend of overweight and obesity due to unhealthy dietary patterns. Adolescence is a crucial period characterized by rapid physical growth, hormonal changes, and increased nutritional requirements. Inadequate nutrition during this stage can lead to long-term health consequences.

Recent trends indicate a shift from traditional diets to process and fast foods among adolescents. These foods are often high in calories but low in essential nutrients, leading to poor dietary quality. At the same time, unsustainable food practices such as food waste, overconsumption, and preference for resource-intensive foods contribute to environmental degradation. Sustainable dietary practices include consumption of locally available and seasonal foods, balanced intake of plant-based foods, reduced consumption of processed foods, and minimization of food waste. Promoting such practices among high school students is essential for improving both health and environmental outcomes.

Objectives of the Study

1. To assess dietary intake among high school students
2. To evaluate sustainable dietary practices

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3. To determine nutritional adequacy based on recommended dietary intake
4. To identify gaps between actual intake and recommended intake
5. To suggest measures for improving sustainable dietary habits

Methodology

3.1 Study Design

A descriptive cross-sectional study design was adopted.

3.2 Study Population

The study was conducted among 80 high school students aged 14–16 years.

3.3 Sampling Technique

Simple random sampling method was used to select participants.

3.4 Data Collection Tools

24-hour dietary recall method to assess food intake

Structured questionnaire to assess sustainable dietary practices

Anthropometric measurements including height and weight

3.5 Assessment of Nutritional Adequacy

The dietary intake of students was converted into grams and compared with recommended dietary allowances (RDA) provided by ICMR. Percentage adequacy was calculated for each food group.

3.6 Statistical Analysis

Data were analyzed using descriptive statistics such as mean, percentage, and standard deviation. Tables and charts were used for presentation.

Results

4.1 Dietary Intake Pattern

The analysis of dietary intake revealed that cereals formed the major part of the diet and were generally consumed in adequate amounts. However, intake of pulses was moderately adequate, while consumption of milk and milk products was significantly low.

Fruits and vegetables, which are essential sources of vitamins and minerals, were inadequately consumed by most students. The low intake of protective foods indicates poor dietary diversity among adolescents.

4.2 Nutritional Adequacy

The comparison of actual intake with recommended intake showed that:

Cereals had high adequacy levels

Pulses had moderate adequacy

Milk, fruits, and vegetables showed low adequacy

This imbalance indicates that although energy requirements may be met, micronutrient deficiencies are likely among students.

4.3 Sustainable Dietary Practices

The study found that:

A majority of students had basic awareness about healthy eating

Awareness of sustainability concepts was limited

Consumption of local and seasonal foods was low

Food waste practices were common

Students often preferred fast food and packaged items over traditional home-cooked meals, which negatively affects both health and sustainability.

Discussion

The findings of the study highlight a significant gap between knowledge and practice among adolescents. While students may have some understanding of healthy eating, they do not consistently apply this knowledge in their daily lives.

The low intake of fruits and vegetables is a major concern, as it can lead to deficiencies of essential vitamins and minerals. Similarly, inadequate consumption of milk can result in poor calcium intake, affecting bone health.

From a sustainability perspective, the preference for processed and packaged foods increases environmental burden due to higher resource use and waste generation. On the other hand, traditional diets based on local and seasonal foods are more sustainable and nutritionally balanced.

The results are consistent with other studies that have reported poor dietary habits among adolescents. Factors such as peer influence, availability of junk food, lack of nutrition education, and changing lifestyles contribute to these patterns. Promoting sustainable dietary practices through education and behavior change interventions can help address these issues. Schools can play a key role in shaping healthy habits among students.

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Conclusion

The study concludes that high school students have inadequate dietary intake in essential food groups and limited adoption of sustainable dietary practices. Although awareness exists to some extent, it does not translate into healthy behavior.

There is a need for comprehensive strategies to improve both nutritional adequacy and sustainability. Encouraging balanced diets, increasing consumption of fruits and vegetables, and promoting local foods can significantly improve health outcomes.

Recommendations

1. Introduce nutrition education programs in schools
2. Encourage consumption of local and seasonal foods
3. Promote dietary diversity and balanced meals
4. Reduce availability of junk food in school premises
5. Conduct awareness campaigns on food sustainability
6. Encourage reduction of food waste

Limitations of the Study

1. The sample size was limited to 80 students
2. The study was confined to a single location
3. Dietary assessment was based on a single 24-hour recall

Scope for Future Research

Future studies can include larger sample sizes and multiple locations to improve generalizability. Intervention-based studies can be conducted to assess the effectiveness of nutrition education programs. Research can also focus on the environmental impact of dietary patterns.

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Original Article

Nutritional Status and Its Impact on Health among Tribal Adolescent Girls (13–18 Years): A Sustainable Development Perspective

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Abstract

Adolescence is a critical stage of growth and development, particularly for girls, as it determines their future health status. Tribal adolescent girls are more vulnerable to malnutrition due to socio-economic disadvantages, lack of awareness, and poor access to nutritious food. The present study aims to assess the nutritional status and its impact on health among tribal adolescent girls (13–18 years) in Amravati district from a sustainable development perspective. The study is based on primary data collected through dietary surveys, anthropometric measurements, and health assessments. The findings reveal a high prevalence of undernutrition and anemia, along with poor dietary diversity. The study also highlights the importance of traditional food systems and locally available resources in improving nutritional outcomes. The paper concludes with recommendations for promoting sustainable nutrition practices and strengthening public health interventions.

Introduction

Adolescence is a crucial phase characterized by rapid physical, mental, and emotional development. Adequate nutrition during this stage is essential for proper growth and long-term health. However, adolescent girls in tribal communities often face nutritional challenges due to poverty, food insecurity, and lack of nutritional awareness.

In regions like Amravati district, traditional food practices and local biodiversity have the potential to support sustainable nutrition. However, changing lifestyles and limited access to diverse foods have negatively impacted dietary habits. Poor nutrition leads to health problems such as anemia, and reduced immunity. From a sustainable development perspective, improving nutrition among tribal adolescent girls is essential not only for their health but also for achieving broader development goals related to health, gender equality, and food security.

Review of Literature

number of studies have examined the nutritional status of adolescent girls, particularly in vulnerable and tribal populations.

- World Health Organization (2018) reported that adolescence is a critical period of rapid growth, requiring increased intake of nutrients, especially iron and protein. The report highlighted that adolescent girls are highly susceptible to anemia and undernutrition due to increased physiological demands and inadequate dietary intake.
- UNICEF (2020) emphasized that malnutrition among adolescent girls in developing countries is primarily due to poor dietary diversity, lack of micronutrient-rich foods, and socio-economic constraints. The study further pointed out that inadequate nutrition during adolescence affects future maternal health and increases the risk of intergenerational malnutrition.
- Indian Council of Medical Research (2020) in its dietary guidelines reported a high prevalence of iron deficiency anemia among Indian adolescent girls, especially in rural and tribal areas. The study suggested that low consumption of green leafy vegetables, pulses, and animal-based foods contributes significantly to poor nutritional status.

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- National Family Health Survey (2019–21) data revealed that more than half of adolescent girls in India suffer from anemia. In Maharashtra, the prevalence of anemia among adolescent girls is significantly high, indicating a serious public health concern.
- Food and Agriculture Organization (2019) highlighted the importance of sustainable food systems in improving nutritional outcomes. The report emphasized the use of locally available foods, including millets, pulses, and forest-based resources, to ensure food security and nutritional sustainability.

Objectives

- To assess the nutritional status of tribal adolescent girls (13–18 years).
- To examine the impact of nutrition on their health.
- To analyze dietary patterns.
- To suggest sustainable strategies for improvement.

Hypothesis

- Deficiency of nutrients in the diet of tribal adolescent girls has a negative impact on their health.
- The socio-economic status of tribal adolescent girls has a significant influence on their nutritional status.

Research Methodology

The present study is based on a descriptive and analytical research design aimed at assessing the nutritional status and its impact on health among tribal adolescent girls aged 13 to 18 years in Amravati district. The study was conducted in selected tribal areas using a random sampling method to ensure unbiased selection of respondents. A total sample of 80 adolescent girls was included in the study. Primary data were collected through structured questionnaires to obtain information regarding socio-economic background, dietary habits, and lifestyle patterns. In addition, the 24-hour dietary recall method was used to assess the daily food intake and nutritional adequacy of the respondents. Anthropometric measurements such as height and weight were recorded to calculate Body Mass Index (BMI) and determine the nutritional status of the participants. Furthermore, hemoglobin levels were assessed, wherever possible, to identify the prevalence of anemia among the respondents.

The collected data were systematically analyzed using simple statistical tools such as percentages and tabulation. The results were presented in the form of tables to facilitate better understanding and interpretation. The study focuses on identifying the relationship between nutritional status and health outcomes while also considering the role of sustainable food practices in improving the overall well-being of tribal adolescent girls.

Results and Discussion

Table 1: Nutritional Status (BMI Classification)

Sr.n.	Category	Percentage %
1	Underweight	50 %
2	Normal	37.5 %
3	Overweight	12.5 %
Total		100 %

Discussion:

The data indicates that half of the respondents are underweight, reflecting a serious issue of undernutrition. Only a small proportion maintains normal nutritional status, highlighting the need for immediate nutritional interventions.

Table 2: Hemoglobin Level (Anemia Status)

Sr.n.	Category	Percentage %
1	Severe Anemia	25 %
2	Moderate Anemia	45 %
3	Normal	30 %
Total		100 %

Discussion:

A high prevalence of anemia (70%) is observed among the respondents. This condition adversely affects physical capacity, cognitive development, and overall well-being.

Table 3: Dietary Intake Pattern

Sr.n.	Food Group	Adequate Intake %	Inadequate Intake	Total %
1	Cereals	90%	10%	100 %
2	Pulses	40%	60%	100 %
3	Fruits	30%	70%	100 %

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4	Green Leafy Vegetables	35%	65%	100 %
5	Milk And Milk Products	20%	80%	100 %

Discussion:

The findings reveal that while cereal intake is adequate, the consumption of protein-rich and micronutrient-rich foods is insufficient. This imbalance leads to nutritional deficiencies and poor health outcomes.

Conclusion

The study concludes that poor nutritional status significantly affects the health of tribal adolescent girls. Addressing nutritional deficiencies through sustainable and community-based approaches is essential for improving their health and achieving sustainable development goals.

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Original Article

Role of Academic libraries Services use in Innovative Tools and Technique's

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Abstract:-

This paper elaborates on how technological innovations have led to the improved technology (ICT) has become a cornerstone in the transformation of academic libraries. , how innovation of technologies has helped to improve information and library services, role of ICT in enhancing and innovating academic library services, focusing on its impact on resource management. In recent days academic libraries have ready to adapt and upgradation of innovative technologies use of information communication technologies (ICT) have replaced from traditional to digital contents like information searching & seeking behaviour of the users, In the journey of traditional library to modern libraries with using there are many types of e-resources like e-books, e-journal, various open sources, gateways and online databases. This paper explores the role of ICT in enhancing and innovating academic library services, focusing on its impact on resource management, user engagement, and service delivery.. A study conducted to know the changes in the information searching & seeking behaviour of the academic professionals and librarians. ICT implementations in academic libraries focus on these services help the library managers, to improve the quality of library service and maximum utilization of library resource, library services. leveraging technology for library innovation.

Keywords *• : Academic library, Innovation, Innovative technologies, Innovative Tools and Techniques, library services*

Introduction:-

In present decades has seen a paradigm change in the nature of teaching, learning and researches in education system. Due to adaptation of collective information landscape, the teaching, learning & research styles of library users, and nature of library operations, usage patterns of library resources, have gradually evolved from library centric to a joint interaction between the library and library users. Many case studies have been done in related innovations of library services in last century; academic libraries need to adapting innovation technologies for accessing information easily, leading researchers to suggest that innovation is very difficult, and adaption of innovation is going very poor. The main aim of the library is to meet the teaching, learning and research, also other information needs of its faculties, students and research scholars have too effectively and with efficiency. Academic libraries and library professionals make sure that information provides have to access to reliable, relevant, accurate updated information to the right time, to the right information, of the users. The migration of information from paper to electronic material has replaced the whole nature of the users. The change in the information searching and seeking behavior is the result of the invention of electronic resources was natural. The primary goal of these Initiatives was to adapt existing features and content to mobile devices

Methodology

Based on the empirical data, attempt to define the innovative technologies and services execute in modern libraries.

What is an innovative library?

Innovative means "The action of innovating; introduction of novelties; the modification of what Is established by the introduction of new elements or forms".

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Use of information by downloading a simple application to their computers or mobile devices, anyone with a library card can access thousands of innovative material like digital books, videos, and music for free. The service is made possible through cooperation between the innovative library services and Overdrive in academic libraries.

- About innovation in libraries
- Creative Thinking or a structured process like; looking at something in a new way.
- Create a culture of Innovation
- Creating the Innovative Library Culture.
- Design thinking, Frameworks as an approach for Innovation
- Innovation Sources are Inspiration and Opportunity.
- Report on Outreach Activity innovative Libraries.

Importance of Innovative Technology in Academic Library:-

Innovative means "The action of innovating; introduction of novelties; the modification of what The importance of innovative technology environment is greatly changing throughout the world. The rapid growth of Communication and Information Technology and latest innovation technologies have witnessed as challenges and changing emphasis in the role of information and its organization. In the present century has witnessed the every information content shifting into digital format, to study the changing environment of the academic libraries and skills required to by the librarian and library professionals. The recent devices for information communication technology have resulted in the changing circulation of knowledge and have changed the information handling, teaching, learning activities in research and academic libraries in India. Research and academic libraries have extremely improved with the quick changes in information communication technology.

Innovative Technology based on Library Services

During the 21st century multiple highly innovative technological advancements prompted libraries to completely modify their central services. Digital transformation spreads across society through the modifications observed in this analysis. Library technology developments enhance user service delivery as they provide expanded information access to different social demographics according to Cohen (2020). The evolution of library services depends on thirteen basic technological innovations which can be seen in the following list:

.

1) Mobile Based library services:-

Libraries aim to achieve three primary objectives for their patrons: fostering lifelong learning, promoting literacy, and facilitating the dissemination of everyday knowledge through their resources and reading materials. Mobile libraries extend access to materials to individuals who may otherwise not have the opportunity to benefit from them beyond the physical confines of the library. By leveraging mobile technologies such as WhatsApp and SMS, libraries can introduce new services and provide quicker access to their collections. Additionally, the incorporation of a Learning Management System (LMS) enhances these services, providing a platform to track training materials and manage various aspects of the learning process. Moodle stands out as one of the premier LMS programs available. An exemplary instance of mobile-based library services is the OPAC smart-phone application, operated by SLIM Software, aiming to transform traditional libraries into digital ones.

2)Digital Library services:-

Today libraries are being changed in tune with time and technology used. The advent of IT has paved the way of reducing the size of the libraries from biggest to very small. The smallness of the libraries is due to the digitization of information. Today, the resources are available mostly in electronic forms and their functions are accomplished automatically. These libraries termed by so many terms such as electronic library, digital library, desktop library, virtual library, library without walls, paperless library etc.8 Digital libraries are based on digitized data that has gradually replaced paper based records. These libraries are heterogeneous in nature. These include work related to information and how to digitize, store, find, link, visualize, use, publish, manage and share information. They provide instant access to digitized information by utilizing the avenues of information technology. The invention of CD-ROM in 1980's was turning point in the digitization of information. The year 1990's marked a progressive more towards digitization due to networking, electronic document delivery services, online services etc.

1) Virtual Library: Virtual library is a library without resources but resources simply may be a collection of web resources. This is a library with no physical presence of books and periodicals, reading space or supporting staff but it is one that disseminate information directly to the distributedusers, usually electronically. The virtual library is the output of virtual" reality. The virtual library is created in hypermedia. For creating virtual library, a graphic representation of the total architecture of the library in different angels from different distances is created by the user. So the user feels that as it he is moving inside the library when he moves the mouse.
2) Remote Access to E-Resources: The main aim of any library is to enhance the teaching, learning and research process. By installing information delivery system, we can provide services & access collections to the users. 10
3) Ask a Librarian: All the libraries should start Ask a Librarian Library Service. Due to the service, all the students, teachers and research student can access the library. It was given on the website of that Institution.11

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4) Virtual Webinar / Seminars: Before pandemic all library webinars/ seminars about awareness programs were conducted offline so users were not much aware about online resources but during pandemic many libraries organized virtual programs to create awareness among users how to use online resources/e-resources.11 Libraries have taken effort in arranging webinars relating to topics starting from information literacy to research ethics to educate their users.10
5) Creating awareness about NDLI (National Digital Library of India: The NDLI (National Digital Library of India) is a digital repository of a vast amount of academic content in different formats and provides interface support for leading Indian languages for all academic levels. Science, Engineering and Social Science students can take benefits of NDLI by visiting https://www.ndl.gov.in at free of cost. Students can take benefits of video lectures, Web courses, Notes, Questions and Solutions.12
6) Awareness about Shodhganga: The Shodhganga (https://shodhganga.inflibnet.ac.in) is a digital repository platform of 2,60,000 plus Indian Electronic Thesis and Dissertations for research students to deposit their Ph. D theses and make it available to the entire scholarly community in open acces.12
7) E-Shodh Sindhu: The e-Shodh Sindhu (https://ess.inflibnet.ac.in) provides current as well as archival access to more than 10,000 Core and peer reviewed journals and number of bibliographic, citation and factual databases is different disciplines from a large number of publishers and aggregators to it's member institutions, including centrally funded technicalinstitutions, Universities and Colleges that are covered under 12(B) and 2(f) sections of the UGC Act.
8) e-PG Pathshala: e-PG Pathshala is a gateway to all post graduate courses. It is an initiative of the Ministry of Human Resource Development MHRD under it's National mission on education. e-PG Pathshala host high quality e-text, e-content and video, post graduate disciplines of social science, arts, fine arts, humanities and mathematical science
9) E-material and Digital Collections: Libraries are expanding their digital collections offering e-books, e-journal, audio books and digital magazines for borrowing and reading on various devices. Through online platforms and apps, users can access a vast array of digital materials anytime, anywhere.
10) Digital Media Labs: Libraries are establishing digital media labs equipped with audio and video recording, equipments and editing software and other multimedia tools. These labs provide users with resources and space to create digital content such as podcasts, videos and music.
11) Mobile Libraries: Mobile libraries go beyond the traditional brick and mortar setting, reaching out to undeserved communities by bringing books, resources and technology directly to schools, community centers and neighborhoods. These libraries on wheels provide access to information and services to those who may have limited transportation or proximity to a physical library.15
12) Digital Literacy Programs: Recognizing the importance of digital skills, libraries are offering digital literacy programs that encompass basic computer skills, internet usage, online safety, coding and other digital competencies. These programs empower individuals to navigate the digital landscape confidently.15
13) Twitter: Although podcasts and RSS readers provide fast, efficient tools for monitoring technology news, Librarian should also consider adopting Twitter (http://www.twitter.com) the popular web 2.0 messaging service in the library. Twitter is an online social networking service that allows users to create a personal account as on outreach tool to share experimenting with library. Twitter accounts as an outreach tool to share news, events and links with their users. However Twitter can also be viewed as extremely powerful, customizable news feed.
14) Web Publishing: Word Press started out as a quick, free open source software. With it's visual rich editor, anyone can publish text and photos to the website other options include multiple authors (with separate log-ins), built in RSS (Real simple syndications) technology to keep subscribers updated and a common system that allow readers to interact with the site, contact. It is a fantastic way to communicate with user, Staff & etc.17

Innovative Tools and Techniques and Library Services

1) Digital Displays:

Digital displays refer to electronic screens that can display images, videos, and other digital content. In libraries, digital displays are used to communicate information to users, promote library services and events, and provide access to digital collections. Here are some common uses of digital displays in libraries:

- Announcements: Digital displays can be used to announce upcoming events, workshops, and other library programs.
- Promotions: Digital displays can be used to promote library services, resources, and collections.
- Book Displays: Digital displays can be used to showcase new books, staff picks, and other featured collections.
- Informational Displays: Digital displays can be used to provide information on library policies, procedures, and services.
- Interactive Displays: Digital displays can be used to create interactive exhibits, quizzes, and other engaging activities to promote library materials and services.
- Virtual Exhibits: Digital displays can be used to create virtual exhibits showcasing special collections and archives.

2) Online Content Page Service

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We started "Online Content Page Awareness Service" for the better utilization of journals. We do scan the content of each journal of each department and send these content pages in email of library committee members requesting them to use for their staff and students. After implementing this service, our usage of journals is increased from 10 to 30%. We also started to type the content page of every journal and make a compile list in Microsoft Excel which will be useful for back volume searching. Users can find their needy journals with specific content within fraction of time which we kept as bound volume of journals in reference section

3) Digital Library Platforms

Digital platforms used by libraries have upgraded library services by developing methods to transform resources into searchable digital formats so users across all locations and social backgrounds can access them online. Users can access diverse data collections through these platforms through their e-book and journal features and their audio-visual material and archival document resources. Several successful digital platforms like JSTOR and Project MUSE and OER Commons implement this technology according to Johnson (2021). Digital libraries according to Adams (2022) support information democratization by extending scholar works and library collections to users whenever they wish past typical office hours.

4) **Kindle Services**

In many major libraries have started using Kindle e-books for circulation to their user community. When new technology is introduced, library professionals need to investigate where and how we can execute in our library. The beginning phase, is necessary to do a pilot study based on Online Payment Services: Moving towards digital India and transparent management, it is necessary to implement online payment portals, Swipe machine, for library fines, photocopy, print, a community time as well as preventing mismanagement.

5) Electronic Mail Alerts

The main purpose of this service to update and the disseminate the current information promptly like disclosing New arrivals of books, Serials, Table of Contents, News Clippings, Library events (Book talks, Theme display, Quiz activities, etc).

6) Mobile Applications

The proliferation of smartphones has prompted libraries to develop mobile applications that offer users convenient access to library resources anytime and anywhere. These applications often include features such as catalogue searches, digital loans, event calendars, and resource recommendations Morris, (2021). By harnessing mobile technology, libraries facilitate a more personalized user experience and encourage engagement with library services outside traditional settings Kumar, (2020). Research shows that mobile accessibility leads to increased library use, particularly among younger demographics who favour educational content available on their devices Smith, (2022).

7) Social Media and Community Engagement Tools

The modern library depends on social media platforms to connect with its local community members. Through Facebook, Twitter, and Instagram libraries promote their events and resources while Artificial Intelligence (AI) and Machine Learning Library service operations have transformed user information interaction through the implementation of artificial intelligence (AI) and machine learning techniques. Library users experience quick assistance through chatbots since these robotic systems both answer inquiries fostering community involvement according to Hawkins (2019). Virtual platforms enable libraries to interact with different groups of users while hosting discussion events to collect community feedback. Social media strategy success enables libraries to boost their profile and community connections thus demonstrating their essential role as providers of information and community resources according to Jaeger and Bertot (2019).

8) Artificial Intelligence (AI) and Machine Learning

Library service operations have transformed user information interaction through the implementation of artificial intelligence (AI) and machine learning techniques. Library users experience quick assistance through chatbots since these robotic systems both answer independently from traditional staff involvement. The system improves user satisfaction levels through fast services particularly when the library is not staffed Huang (2022). The use of machine learning algorithms to study user activities enables personalized recommendations that enhance library resource user interaction according to Pritchard (2020). The predictive ability of AI technology working with extensive data enables libraries to forecast user preferences thus modifying the core characteristics of systems used by patrons according to Wang and Wang (2021)

9) Virtual and Augmented Reality (VR/AR)

Virtual Reality (VR) and Augmented Reality (AR) technologies shape the modern library design because they deliver fully interactive user experiences. Through these innovative technologies library patrons can accomplish three things: walk through virtual collection displays, run educational instructional scenarios and witness historical events through interactive participation Taylor, (2018). The inventive methods of engaging library resources lead users to the library while expanding learning potential from library materials. LeDuc (2021) validates that virtual reality together with augmented reality improves educational results by creating real-world ties between library resources which basic presentations often fail to establish.

9) Library Webpage

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The library is a workstation and the library webpage is a delivery mechanism for library resources and services. Webpages act as a gateway to locate and access library resources using the internet. Webpage serves as a communication tool for a library and its users. It is a way of making the visibility of library internal information resources to the user community. The webpages allow library professionals to find new roles as information generators, gathering, organizing and disseminating. Currently, the publications industry moving from print to electronic versions, and physical resources are appearing in electronic format and its accessed using various electronic gadgets. To create awareness of these subscribed resources and library services an effective webpage is necessary. It also acts as a marketing tool to disseminate various library events, activities, and other information. The library webpage acts as a mirror replica of the library resources as well as services.

Conclusion:

These innovative services save the time of users & space of library, so fulfil the fourth law of Dr. S.R. Ranganathan “save the time of user." Current generations of library users are having information in just one click . Overall, all innovative library services are designed to support the mission of the library and provide user with access to information they need to succeed in their academic, professional and personal lives. By implementing these innovative library services, libraries can get numerous benefits such as increased access to information, enhanced user engagement and improved digital literacy. It is high time for encourage innovations in libraries for ensuring effective channelization of information recourses In modern libraries finding information is much easier than reading an entire book. So, library professionals must update their skills and provide relevant information to attract the user community. To fulfil this goal, library professionals must provide effective and innovative services in hybrid libraries. . Overall, these services help the library managers, to improve the quality of library service and maximum utilization of library resource, library services.

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Original Article

Artificial Intelligence in Textile

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Abstract:

AI is transforming the textile industry by automating quality control, optimizing production, and enabling sustainable design, driving a potential 10%–20% boost in operational efficiency. Key applications include computer vision for defect detection, AI-driven demand forecasting, predictive machine maintenance, and generative AI for design. Artificial intelligence can help in textile production by handling tasks like predictive maintenance and fabric inspection while improving quality and cutting down on waste. The main aim of the study is to focus on how AI can enhance quality, increase efficiency, and support sustainable practices in textile production. The researcher also discuss the potential and challenges of adopting AI technologies in textile production in the future. AI technology makes it easier to improve the quality of life in the industry and detect defects, check patterns, match colors and classify fabrics for textile production more objectively. It also precisely defines the advantages of fine, solid and staple fiber. The use of artificial intelligence in the manufacture of textiles has emerged with a new possibility, i.e., smart clothes that use the Internet of Things and electronic sensors to create a more pleasant health experience. In this paper the researcher focus on impact of artificial intelligence in the textile industry.

Keywords: *Artificial Intelligence, Textile*

Introduction:

In the textile industry, Artificial Intelligence (AI) is transforming every stage of the lifecycle, from initial design and high-speed manufacturing to quality control and sustainable recycling. Key applications include automated defect detection with over 90% accuracy, real-time trend forecasting, and the development of "smart" fabrics that respond to the wearer's environment. The process of developing fashion textile designs has undergone considerable changes over time, driven by the advent of innovative technologies that have introduced new design tools. Recent years have witnessed a growth in interest in using AI in design, which is changing our approach toward textile design. Designers who use AI receive significant attention within the human–computer interaction community, as AI technology aids them by providing deep learning systems that mimic commonly used manual design processes. The interweaving of textile manufacturing and digital technologies opens unlimited transformational opportunities at the dawn of the new era of artificial intelligence, which is re-shaping the industries and the fabric of human societies. While fashion and textile industries already leverage AI-powered tools for *real-to-virtual* transformation of products and processes, AI play a key role in enhancing *virtual-to-real* product transformation via generative design of textiles for manufacture. Although generative AI will inevitably impact workforce development, provide the designers, artisans, and hobbyists with new tools to preserve and elevate their craft

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Review of Literature:

By using automation and artificial intelligence, the textile industry can reduce labor costs and improve customer service. The emerging technologies such as the Internet of Things (IoT) and artificial intelligence can enhance the textile industry. Artificial Intelligence is becoming increasingly important to the apparel industry over the last two decades. AI-driven automation in spreading, cutting, sewing, and materials handling can reduce production costs and minimize errors. Prisma (2022)The essential raw material required for the manufacturing of clothing and other textiles are fibers. Visual inspection alone is not always enough to identify unknown fibers because there are many types of textile fibers. The traditional practices for fiber identification includes destructive tests use flame or chemicals to identify fiber whereas in modern times optical microscopes, Raman spectroscopy and Fourier transforms infrared are used. These are few of the recent advancements. The artificial intelligence can also be used to identify and grade textile fibers based on their color and properties and the consequence of spinning performance on yarn properties. AI has been used in yarn manufacturing for several reasons, such as modeling yarn from fiber properties, predicting yarn tensile properties, and predicting yarn unevenness. TechKnowGram (2021) The garment manufacturing process is becoming more automated in order to meet consumer demand, reduce faults, and keep costs low. Production Planning Controlling (PPC), various operations of sewing, and quality control, use AI to forecast the performance of a sewn seam and to design the garment. For predicting the apparel properties after a certain process AI is used as a part of intelligent manufacturing of clothing. Hasan (2020)

Objectives Of The Study:

1. To examine the impact of AI implementation in the textile industry.
2. To identify the Challenges and Opportunities of AI Adoption in the textile industry.

Methodology:

The descriptive research design has been used in the present study. The data are collected by primary and secondary data collection method. The primary data collected with the help of interview, survey and secondary data collected from Journal, book etc.

Result & Conclusion:

The fashion and textile industry is undergoing a digital revolution, and at the heart of it lies Artificial Intelligence (AI). From predicting next season's trends to optimizing production and creating personalized shopping experiences, AI is transforming the way fashion operates.

1. AI in Fashion Trend Forecasting

Fashion has always been about predicting what people want next. Traditionally, trend forecasting relied on manual research, runway shows, and intuition. AI changes this by:

I. **Analyzing Big Data**: AI scans millions of social media posts, fashion blogs, and e-commerce sites to spot emerging patterns.

II. **Predicting Demand**: Retailers use AI tools like Heuristics to predict what colors, prints, and fabrics will trend in upcoming seasons.

Impact on Textiles:

Fabric manufacturers can now produce prints and colors that align with future demand, reducing waste from unsold inventory.

2. AI in Fabric Design & Digital Printing

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AI-powered tools can now generate unique textile patterns based on mood boards, cultural references, and customer inputs.

I. Generative AI creates hundreds of design variations in minutes.
II. Combined with digital printing, it enables on-demand production, reducing storage costs and fabric waste.

3. Smart Manufacturing & Quality Control

AI-driven automation is transforming textile production lines:

I. AI Cameras detect weaving defects or color mismatches instantly.
II. Robotic Systems optimize cutting and stitching, reducing fabric wastage by up to 15-20%.
III. Predictive Maintenance: AI predicts when machines need servicing, preventing breakdowns and delays. Faster, more accurate, and **cost-efficient manufacturing**.

4. Virtual Fitting Rooms & 3D Fashion Design

AI is changing how consumers **shop for fabrics and garments**:

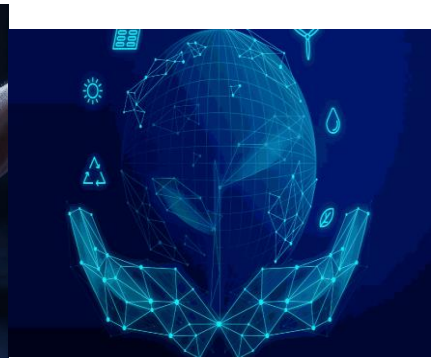
I. Virtual Try-On Apps allow customers to visualize outfits without physically wearing them.
II. 3D Garment Simulation: Designers use AI-based software (e.g., CLO3D, Browzwear) to test how a fabric drapes before cutting.

Impact on Fabric Buyers:

You can now see how a printed satin will look as a gown or a linen as a co-ord set without actual stitching.

5. Personalized Fashion Recommendations

E-commerce platforms use AI recommendation engines to show fabrics or garments based on your style, color preferences, and previous purchases.



6. AI in Sustainability

AI helps brands go green:

I. Demand Fore casting → Produces only what's needed → Reduces overproduction.
II. Supply Chain Optimization → Tracks fabric origin, ensuring ethical sourcing.
III. AI in recycling → Identifies fabric compositions for recycling and reuse.

Future Trend: AI + Blockchain for transparent, traceable fashion supply chains.

Key Applications of AI in Textiles

I. Automated Quality Control: Systems like WiseEye use computer vision and high-resolution cameras to detect over 40 types of fabric defects (e.g., wrinkles, mis weaves, stains) in real-time, significantly outperforming manual human inspection.
II. Design & Trend Forecasting: Generative AI and Adobe's Textile Designer analyze vast datasets from social media and fashion shows to predict upcoming colors and patterns, helping designers create market-aligned collections.
III. Smart Manufacturing: AI-powered robotics automate repetitive tasks like fabric cutting and sewing. Systems also utilize predictive maintenance to monitor machine vibrations and tension, preventing costly downtime by identifying equipment failures before they occur.

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IV. Sustainability & Waste Reduction: By optimizing dye recipes and fabric cutting layouts, AI can reduce water pollution from dyeing by up to 20% and fabric waste by 30-70%.

V. Smart & Technical Textiles: AI is central to developing "intelligent" fabrics, such as those by QOOWEAR that automatically adjust temperature based on the wearer's body heat, or medical textiles that monitor vital signs.

Operational Impacts and Projections

Aspect	Traditional Methods	AI-Driven Methods	Impact/Benefit
Defect Detection	Manual inspection (~70% accuracy)	Computer Vision (>90% accuracy)	Improved quality, reduced waste
Trend Analysis	Intuition-based forecasting	Predictive analytics (real-time)	40% reduction in unsold stock
Maintenance	Reactive (repair after failure)	Predictive (anticipates failure)	15-20% boost in efficiency
Online Sales	Standard images/sizing	Virtual fitting/AI recommendations	25% increase in sales, 20% fewer returns

Challenges and Limitations:

Several challenges in applying AI should be noted:

Training AI requires large volumes of prepared data (e.g., a unified 2D-2.5D- 3D chain, fabric parameters, garment design features, digital body measurements, and clothing patterns), which are often unavailable due to commercial secrecy.

Conclusions:

Parametric Image Generation: The ability to generate parametric images (of clothing, figures, and patterns) is a prerequisite for integrating results with existing databases and CAD systems, unifying all stages under the concept of Digital unity in fashion design is a new concept that involves using a single digital platform and a set of prompts to develop images, patterns, and tech- neologies with AI.

Collaborative Decision-Making: By leveraging multiple AI systems, designers and engineers can make decisions collaboratively, consulting diverse sources of information.

Future Scenarios: The integration of AI with existing CAD systems will enable several scenarios, such as simulating generative reasoning and writing algo- rhythms for the rational application of CAD commands.

Thus, the continued development of AI technologies and their integration into clothing modeling and design processes open new horizons for the fashion industry. Addressing the identified challenges and actively implementing AI will significantly improve the quality of designed products, optimize production processes, and meet growing consumer demand for personalized and comfortable garments

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Original Article

Circular Textile Economy & Women Empowerment: Role of Budgetary Policies

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Abstract

The circular textile economy has emerged as a sustainable approach to reduce waste, promote resource efficiency, and encourage environmentally responsible production and consumption patterns. Women entrepreneurs play a crucial role in advancing circular textile practices, particularly in areas such as recycling, upcycling, and sustainable fashion. However, their participation and growth are significantly influenced by supportive budgetary policies. Government initiatives including financial assistance, subsidies, skill development programs, and infrastructure support are essential to empower women-led enterprises in the textile sector. These policies help in overcoming barriers such as limited access to capital, lack of technical knowledge, and market constraints. By promoting inclusive economic growth, budgetary frameworks can enhance women's participation in sustainable entrepreneurship while fostering innovation in circular business models. This study evaluates how effectively budgetary policies contribute to strengthening women empowerment within the circular textile economy. It highlights the need for targeted interventions that integrate sustainability goals with gender inclusivity, ensuring long-term economic, social, and environmental benefits.

Keywords: *Circular Textile Economy, Women Empowerment, Budgetary Policies, Sustainable Practices, Women Entrepreneurs, Textile Industry, Circular Economy, Government Support*

Introduction

The global textile and apparel industry is valued at trillions of dollars and provides employment to millions of people worldwide. However, it is also one of the most environmentally damaging industries. The production of textiles involves high consumption of water, energy, and chemicals, while discarded garments contribute significantly to global waste. Traditional textile production follows a linear economic model where products are manufactured, consumed, and discarded. This model leads to environmental degradation and resource depletion. The circular economy model provides an alternative by promoting sustainable production systems that focus on reuse, recycling, and waste reduction. The textile sector also employs a large number of women, particularly in developing countries like India. Women contribute significantly to handloom, handicraft, and garment manufacturing industries. In recent years, women entrepreneurs have begun adopting sustainable textile practices such as eco-fashion design, fabric recycling, and upcycled clothing production.

Government policies and budgetary allocations play an important role in supporting these initiatives. Financial assistance, skill development programs, and entrepreneurship schemes can enable women to establish sustainable textile enterprises.

Circular Textile Economy

The circular textile economy is a sustainable production model that aims to reduce textile waste and maximize the lifecycle of textile materials. The approach emphasizes the three core principles of sustainability: reduce, reuse, and recycle.

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Key Strategies in Circular Textile Economy

Recycling-

Textile waste is processed into fibers that can be reused in new textile products.

Upcycling-

Old garments and fabric waste are transformed into higher-value products such as bags, home décor items, and designer clothing.

Zero-Waste Design-

Garments are designed in such a way that fabric waste is minimized during the cutting and production process.

Sustainable Consumption-

Consumers are encouraged to adopt responsible consumption practices, such as repairing garments and purchasing eco-friendly clothing.

These strategies contribute to reducing environmental pollution and promoting sustainable production systems.

Women Empowerment in Sustainable Textile Enterprises

Women represent a significant portion of the workforce in the textile and garment industry. In India, women are heavily involved in handloom weaving, embroidery, dyeing, garment manufacturing, and handicraft production.

Women-led sustainable textile enterprises provide several socio-economic benefits.

- Financial independence for women
- Employment generation in rural areas
- Preservation of traditional textile crafts
- Promotion of environmentally friendly production methods

Entrepreneurship also enhances women's decision-making power and social status within communities.

However, women entrepreneurs often face challenges such as limited access to finance, lack of market linkages, and insufficient technical training. Government policy interventions are therefore essential to support women-led sustainable enterprises.

Government Budgetary Policies Supporting Women in Textile Sector

Government budgetary policies allocate financial resources to support economic sectors and social welfare initiatives. Several schemes in India promote women entrepreneurship and sustainable textile production.

1. Prime Minister's Employment Generation Programme (PMEGP)

PMEGP provides financial assistance for setting up micro-enterprises in sectors such as textiles, handicrafts, and garment manufacturing.

2. Pradhan Mantri Mudra Yojana (PMMY)

The Mudra scheme offers micro-credit to small entrepreneurs, including women engaged in textile businesses.

3. Textile Cluster Development Scheme

This scheme promotes cluster-based development of textile industries, enabling women artisans to access shared infrastructure and markets.

4. Skill India Mission

Skill development programs train women in textile design, garment construction, and sustainable production techniques.

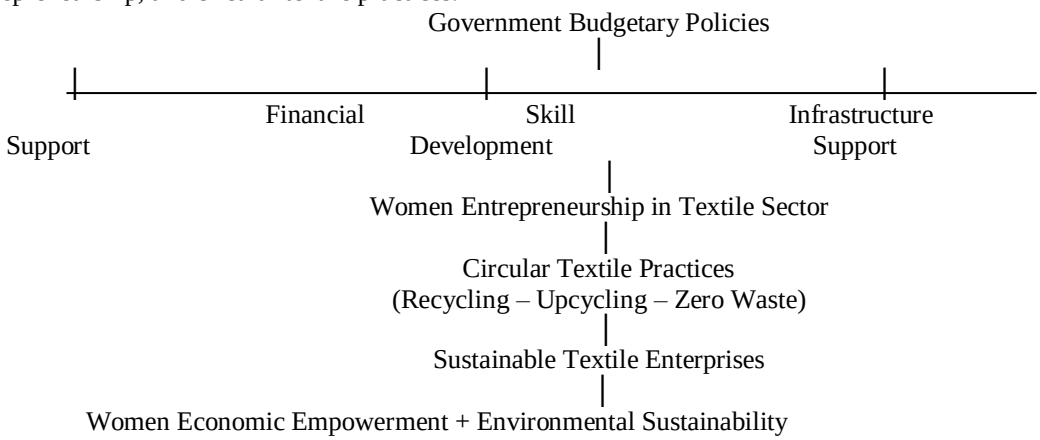
5. National Handloom Development Programme

This program supports handloom weavers, many of whom are women, through financial assistance and market support.

These initiatives create opportunities for women entrepreneurs to establish sustainable textile enterprises.

Conceptual Framework

The conceptual framework of the study illustrates the relationship between budgetary policies, women entrepreneurship, and circular textile practices.



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Sustainable Development

This framework highlights how government financial support and policy initiatives influence women's participation in circular textile enterprises.

Research Objectives

1. To examine the role of budgetary policies in promoting the circular textile economy.
2. To analyze the contribution of women entrepreneurs to sustainable textile practices.
3. To evaluate the impact of government support on women empowerment in the textile sector.

Research Methodology

Research Design

Descriptive and analytical research design.

Research Approach

Mixed method approach combining qualitative and quantitative analysis.

Data Sources

Primary Data

- Survey of women entrepreneurs engaged in sustainable textile enterprises
- Interviews with textile professionals and policymakers

Secondary Data

- Government policy documents
- Research journals
- Reports from textile organizations and sustainability institutions

Sampling Method

Purposive sampling of women entrepreneurs involved in sustainable textile activities.

Data Analysis

- Percentage analysis and graphical representation
- Thematic analysis of qualitative responses.

Government Scheme	Type of Support	Impact on Women Entrepreneurs	Circular Textile Outcome
PMEGP	Subsidy for micro-enterprises	Helps women start textile units	Local recycling and upcycled product businesses
Mudra Yojana	Micro-credit loans	Financial access for small entrepreneurs	Sustainable garment production
Textile Cluster Development	Infrastructure and market linkage	Strengthens artisan networks	Shared recycling facilities
Skill India Mission	Skill development training	Improves technical knowledge	Adoption of eco-friendly textile production
National Handloom Development Programme	Financial and marketing support	Promotes traditional weaving	Sustainable handloom production

Case Examples of Women Entrepreneurs in Circular Textile Practices

Doodlage (India)

Founded by Kriti Tula, Doodlage is an eco-fashion brand that creates clothing using textile waste from garment factories. The company promotes sustainable fashion through upcycled fabrics.

Goonj (India)

Goonj is a social enterprise that recycles discarded clothing and textiles into useful products such as sanitary pads and household items while providing livelihood opportunities to women.

Suta (India)

Suta works with women artisans to create sustainable handmade sarees while promoting traditional weaving practices.

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These examples demonstrate how women entrepreneurs contribute to circular textile initiatives.

Research Gap

Although several studies examine sustainable fashion and circular economy practices, limited research focuses on the intersection of women empowerment, circular textile entrepreneurship, and government budgetary policies.

Most existing literature analyzes environmental sustainability or women entrepreneurship separately. There is a lack of comprehensive studies that examine how policy frameworks and financial allocations directly support women-led circular textile enterprises.

This research addresses that gap by exploring the role of budgetary policies in promoting sustainable textile entrepreneurship among women.

Conclusion

The circular textile economy presents a sustainable pathway for addressing environmental challenges in the textile industry. Women entrepreneurs play a crucial role in implementing circular practices such as recycling, upcycling, and zero-waste fashion design.

Government budgetary policies, including financial assistance programs, skill development initiatives, and entrepreneurship schemes, can significantly empower women to participate in sustainable textile enterprises. Strengthening gender-responsive budgeting and increasing awareness of government schemes can further enhance women's participation in the circular textile economy.

Promoting women-led circular textile initiatives not only contributes to environmental sustainability but also fosters inclusive economic growth and social development.

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Original Article

Sustainable Diets and Innovative Nutrition Strategies for the Prevention of Type 2 Diabetes, Obesity, and Hypertension

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Abstract

The increasing prevalence of lifestyle-related diseases such as type 2 diabetes, obesity, and hypertension has become a major global public health concern. Unhealthy dietary patterns characterized by high consumption of processed foods and low intake of nutrient-rich foods significantly contribute to the development of these conditions. Sustainable food systems, which emphasize the use of locally available, minimally processed, and nutritionally balanced foods, offer a promising approach to address these challenges. The present study aimed to evaluate the role of sustainable dietary practices and innovative nutrition strategies in improving dietary behavior and reducing the risk of lifestyle diseases among adults. A community-based study was conducted among 300 adults aged 25–60 years. Data were collected using structured questionnaires, dietary recall methods, and awareness surveys. Nutrition education sessions were conducted to promote sustainable dietary practices. The findings revealed moderate awareness of sustainable diets and a high consumption of processed foods among participants. However, significant improvement was observed in knowledge, dietary behavior, and preference for healthier food choices after the intervention.

The study concludes that integrating sustainable food systems with innovative nutrition education strategies can effectively promote healthier diets and contribute to the prevention of type 2 diabetes, obesity, and hypertension.

Keywords: *Sustainable food systems, sustainable diets, nutrition innovation, type 2 diabetes, obesity, hypertension, community nutrition*

Introduction

Lifestyle diseases such as type 2 diabetes, obesity, and hypertension are rapidly increasing across the world, particularly in developing countries. These diseases are strongly linked to unhealthy dietary habits, sedentary lifestyles, and changing food environments. Modern dietary patterns are often characterized by excessive consumption of processed foods, refined carbohydrates, unhealthy fats, and sugar-sweetened beverages, which contribute to poor metabolic health.

At the same time, food systems are facing challenges related to environmental sustainability, including resource depletion, climate change, and food waste. Sustainable food systems have therefore become essential to ensure both human health and environmental protection. A sustainable food system is one that provides adequate nutrition while minimizing environmental impact and ensuring long-term food security.

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In recent years, there has been a significant shift in dietary patterns due to the process of **nutrition transition**, characterized by increased consumption of energy-dense, processed, and convenience foods. This transition has contributed to the growing burden of lifestyle diseases in both urban and semi-urban populations. Food choices are not determined only by individual preferences but are also influenced by the **food environment,** including availability, accessibility, affordability, and marketing of food products. The widespread availability of processed and fast foods has significantly altered traditional eating patterns.

There is a growing need to shift from a **treatment-based approach to a preventive approach** in managing lifestyle diseases. Adopting healthy and sustainable dietary practices at an early stage can reduce the risk of developing chronic conditions such as type 2 diabetes, obesity, and hypertension.

Traditional diets, especially in Indian contexts, are inherently rich in plant-based foods, whole grains, and seasonal produce. Reviving these dietary patterns can contribute to both improved health outcomes and sustainability of food systems.

Sustainable diets emphasize the consumption of plant-based foods such as fruits, vegetables, whole grains, legumes, and nuts. These foods are rich in essential nutrients, dietary fiber, and bioactive compounds that help in the prevention and management of chronic diseases. In contrast, highly processed foods are often energy-dense and nutrient-poor, increasing the risk of obesity and related disorders.

Innovations in food and nutrition play a crucial role in promoting healthier dietary practices. Nutrition education programs, digital awareness platforms, community interventions, and behavior change strategies are effective tools for improving dietary habits. These approaches can help individuals make informed food choices and adopt healthier lifestyles.

Improving dietary practices requires not only knowledge but also **behavior change strategies.** Sustainable dietary interventions must focus on influencing long-term habits rather than short-term changes.

Therefore, the present study focuses on assessing the role of sustainable dietary practices and innovative nutrition strategies in preventing lifestyle diseases such as type 2 diabetes, obesity, and hypertension among adults.

Objectives of the Study

1. To assess awareness of sustainable food systems among adults.
2. To evaluate dietary habits related to sustainable food consumption.
3. To analyze the impact of nutrition education on dietary behavior.
4. To examine the role of sustainable diets in preventing type 2 diabetes, obesity, and hypertension.

Methodology

3.1 Research Design

The present study adopted a **descriptive and analytical research design** to assess the awareness, dietary practices, and impact of nutrition education on sustainable food consumption among adults. The study also evaluated changes in knowledge and behavior before and after the intervention.

3.2 Study Area and Population

The study was conducted in selected **urban and semi-urban communities.** The target population included adults aged between **25 and 60 years**, representing different socio-economic backgrounds.

3.3 Sample Size and Sampling Technique

A total of **300 participants** were included in the study. Participants were selected using a **random sampling technique** to ensure representation from different groups. Individuals who were willing to participate and available during the study period were included.

3.4 Inclusion Criteria:

- Adults aged 25–60 years
- Individuals with sedentary or moderate lifestyles
- Participants willing to attend nutrition education sessions

3.5 Data Collection Tools and Techniques

Data were collected using the following tools:

- **Structured Questionnaire:** To assess demographic details and awareness of sustainable food systems
- **24-hour Dietary Recall Method:** To evaluate daily food intake
- **Food Frequency Questionnaire (FFQ):** To assess regular dietary patterns
- **Knowledge-Attitude-Practice (KAP) Survey:** To measure awareness and behavior related to sustainable diets

3.6 Nutrition Education Intervention

A structured **nutrition education program** was conducted for participants. The intervention included:

- Awareness about **sustainable food systems**
- Importance of **balanced diet and plant-based foods**
- Benefits of fruits, vegetables, and whole grains
- Reduction of processed and high-fat foods

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- Promotion of **local and seasonal foods**
- Guidance on reducing food waste

Innovative teaching methods such as **interactive sessions, group discussions, and visual aids** were used to enhance understanding.

3.7 Duration of Study

The study was conducted over a period of **3 months**, including baseline data collection, intervention, and post-intervention assessment.

3.8 Statistical Analysis

Collected data were analyzed using:

- **Percentage and mean values** for descriptive analysis
- **Comparative analysis (before vs after)** to assess impact of intervention
- Data were presented using **tables and graphs** for better interpretation

Results and Discussion

4.1 Awareness of Sustainable Food Systems

The study revealed that awareness regarding sustainable food systems among participants was moderate. While some individuals were familiar with the concept of healthy eating, a limited number had a clear understanding of sustainable dietary practices.

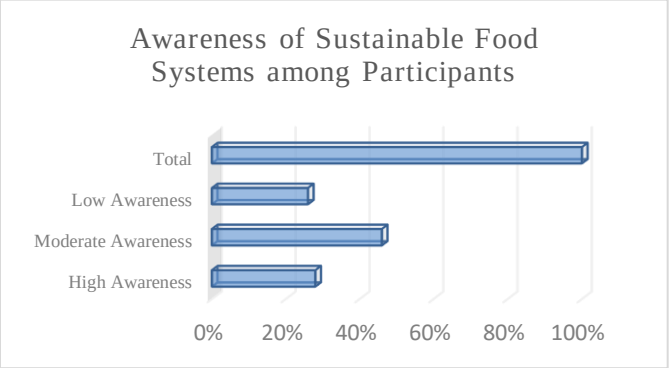
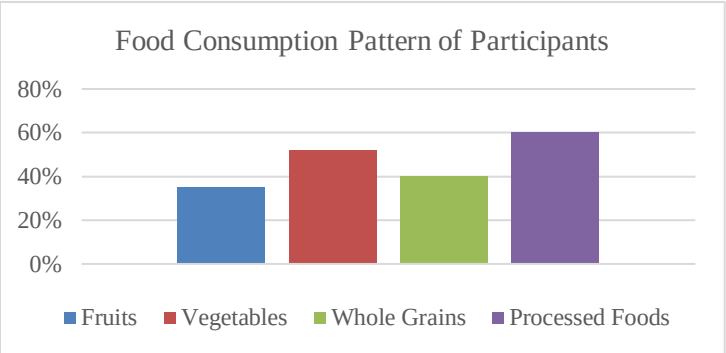


Figure 1: Awareness of sustainable food systems among study participants.

This indicates a need for improved nutrition education programs to enhance awareness about sustainable diets and their role in disease prevention.

4.2 Dietary Habits of Participants

Dietary assessment revealed that many participants consumed processed foods frequently while the intake of fruits, vegetables, and whole grains was relatively low.



The results suggest a shift toward convenience foods due to busy lifestyles, urbanization, and easy availability of processed products. Such dietary patterns contribute to increased risk of obesity, diabetes, and hypertension.

Increasing the consumption of plant-based foods and whole grains can significantly improve dietary quality and reduce the risk of lifestyle diseases.

4.3 Impact of Nutrition Education

Nutrition education sessions were conducted to improve awareness of sustainable diets and healthy food choices.

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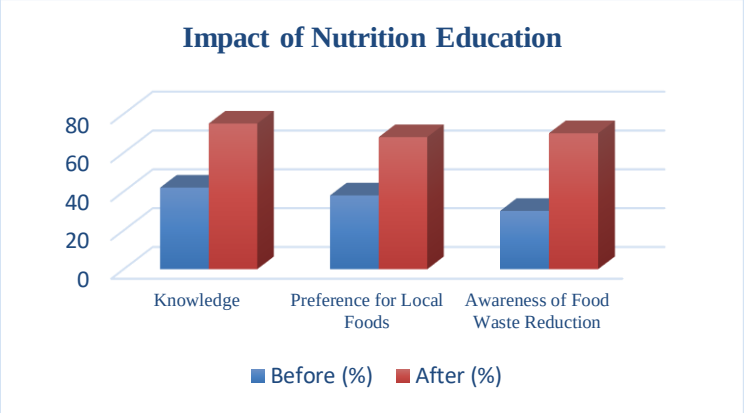

Figure 3: Comparison of knowledge and awareness before and after nutrition education intervention.

The results demonstrate significant improvement in knowledge and dietary awareness after the educational intervention. Participants showed increased interest in consuming local foods, reducing food waste, and making healthier dietary choices.

This indicates that innovative nutrition education approaches can effectively influence dietary behavior.

4.4 Sustainable Diets and Disease Prevention

Sustainable diets contribute to disease prevention by promoting nutrient-rich foods that support metabolic health. Diets rich in fruits, vegetables, whole grains, and legumes provide essential nutrients, fiber, and antioxidants that help regulate body weight, blood pressure, and blood glucose levels.

Increased consumption of plant-based foods can reduce the risk of obesity and metabolic disorders. Similarly, limiting processed foods and sugar-sweetened beverages can lower the risk of hypertension and diabetes.

Promoting sustainable diets not only improves health outcomes but also supports environmental sustainability by reducing food waste and encouraging responsible food production.

4.5 Innovations in Food and Nutrition

Several innovations have been introduced to promote sustainable nutrition practices. These include:

- digital nutrition education platforms
- mobile health applications for dietary tracking
- community cooking demonstrations
- awareness campaigns through social media
- promotion of traditional and local foods

Such innovative strategies have expanded the reach of nutrition education and helped individuals adopt healthier dietary habits.

By combining sustainable food systems with modern communication strategies, it is possible to create effective public health interventions for disease prevention.

4.6 Improvement in Healthy Lifestyle Practices

In addition to dietary changes, participants also showed improvement in general lifestyle behaviors after the intervention. Increased awareness led to:

- Better meal planning habits
- Increased preference for home-cooked meals
- Reduction in frequency of eating outside food
- Improved understanding of portion control

These behavioral changes contribute significantly to long-term health improvement and disease prevention.

4.7 Role of Sustainable Food Choices

Participants showed increased preference for **local, seasonal, and minimally processed foods** after the awareness sessions. This shift supports both health and environmental sustainability.

The adoption of sustainable food choices not only improves nutrient intake but also reduces dependence on highly processed foods, which are associated with increased risk of metabolic disorders.

4.8 Barriers to Adoption of Sustainable Diets

Participants reported several challenges in adopting sustainable and healthy dietary practices. The major barriers identified were:

- Lack of time for meal preparation
- Easy availability of processed foods

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- Limited awareness about sustainable diets
- Influence of taste preferences and habits

These barriers highlight the importance of practical and easy-to-follow nutrition strategies in promoting healthy eating behaviors.

4.9 Awareness of Link Between Diet and Diseases

A moderate level of awareness was observed regarding the relationship between diet and lifestyle diseases such as type 2 diabetes, obesity, and hypertension.

While many participants were aware that unhealthy diets contribute to disease risk, detailed understanding of specific dietary factors (such as processed foods, fiber intake, and portion control) was limited.

4.10 Readiness for Behaviour Change

After the nutrition education sessions, participants showed increased willingness to adopt healthier dietary practices. A large proportion expressed readiness to:

- Reduce processed food intake
- Increase consumption of fruits and vegetables
- Follow regular meal patterns

This indicates that awareness programs not only improve knowledge but also enhance motivation for behavior change.

Conclusion

The present study emphasizes the significant role of sustainable food systems and innovative nutrition strategies in preventing lifestyle diseases such as type 2 diabetes, obesity, and hypertension. The findings revealed moderate awareness levels and unhealthy dietary patterns among participants; however, nutrition education interventions led to notable improvements in knowledge and dietary behavior.

The study highlights that enhancing awareness alone is not sufficient, and sustained behavioral change is essential for long-term health improvement. Promoting practical, affordable, and locally available food choices can increase adherence to healthy diets. Additionally, targeted nutrition interventions based on demographic factors can further enhance effectiveness.

The integration of sustainable dietary practices into public health programs can contribute to improved health outcomes and reduced disease burden. Encouraging the consumption of local and seasonal foods also supports environmental sustainability and food security.

Overall, the study underscores the importance of combining sustainable food systems with innovative nutrition education approaches to achieve both health and environmental benefits. Future research should focus on long-term interventions and the use of digital platforms to strengthen behavior change strategies.

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Original Article

Emerging Digital Technologies in Modern Library

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Abstract:
Today, every library is slowly getting digitized. A digital library is a library where you can find digital repositories, or digital collections, and online databases of digital objects. The objects may include text, still images, audio, video, digital documents, or other digital media formats. Most digital libraries provide services for twenty-four hours a day, seven days a week and they can be accessed anywhere anytime. No organization can remain relevant in the knowledge economy without facilitating digital library access.
Keywords: *digitalization, digital library, online library, virtual, library, e-library*

Introduction:

Libraries are of different types and exist in many forms such as traditional, electronic library, digital library, virtual library, hybrid library etc. The advent of multimedia technology has given rise to image libraries, Audio Libraries, and Digital Libraries. Among these types of libraries, to-day digital becomes very popular. During this time, the libraries are welcoming digital resources born or created, as they are bringing a new kind of library culture. Process of digitization has brought sweeping changes in the profession.A digital library is an automated or electronic library, where activities like accessing, retrieval, processing, automatic indexing and textual analysis, with the help of a computer, assist resource sharing and storing. Digital libraries have become a feature on the landscape in developed countries.

Digital Library: represents an organization that collects, manages, and preserves the rich digital content on behalf of users.

Digital Library System (DLS): a software system that is based on a defined architecture and provides all functionality.

Digital Library Management System (DLMS): a generic software system that provides the infrastructure to produce and administer a digital library

Definition:

Wikipedia: A digital library, digital repository, or digital collection, is an online database of digital objects that can include text, still images, audio, video, or other digital media formats.

Duguid, Paul, (1997): "The concept of a digital library is not merely equivalent to a digitized collection with information management tools. It is rather an environment to bring together collections, services and people in support of the full life cycle of creation, dissemination, use and preservation of data, information and knowledge."

Gladney, H.M., et.al (1994): "A digital library service is an assemblage of digital computing, storage and communications machinery together with the software needed to reproduce emulates and extend the services provided by conventional libraries based on paper and other material means of collecting, storing, cataloguing, finding and disseminating information."

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Characteristics of Digital Libraries:
digitized library require digital technologies and is the combination of traditional and media collection. So they encompass both paper and electronic material. Digital library consisted of mostly electronic documents, which are of reference type.
Digital Library is a digital object, which may be text, audio, video, image, and numeric multimedia components.
Digital library can be accessed from users work place.
Digital library support formal and informal learning procedures.
Digital library provides remote to rare and expensive material.
Digital Library requires well tested and preven information technologies including the multimedia kit (Srivastav and Saxena 2004).

Development of Digital Libraries:
Some of the important points to be considered in developing a digital library are :
i) Digital collection
ii) Conversion of existing print into digital format: options for conversion
iii) Creating portals or gateway to the electronic collection available on the web
iv) Integrated access interface.

Digital collection
One of the important issues in the creation of a digital library is the building up of a digital collection. Obviously, for any digital library to be viable, it must eventually have a digital collection with the critical mass to make it truly useful. There are essentially three methods of building up a digital collection.
i) Digitization – converting paper and other media in existing collection to digital form.
ii) Acquisition of original digital works created by publishers, institutions and other scholars like electronic books, electronic journals and data set.
iii) Access to external materials not held in house by providing pointers to web sites, other library collections or publishers' services. While the third method may not exactly constitute part of a local collection, it is still a method of increasing the materials available to users. One of the main issues here is the degree to which libraries will digitise existing materials and acquire original digital works, as opposed to simply pointing to them externally. A digital library can have a wide range of resources. It can contain both conventional documents and/or information contained in digital or computer- processible form. Rusbridge has divided resources for a digital library into four categories, i.e., legacy, transition new and future. **Legacy** resources are largely non-digital resources including manuscripts, print, slides, maps, audio and video recordings. Attempts are being made to digitise these resources. **Transition** resources, are primarily designed for another medium (mostly print) are those which are being or have been digitised, making the transition into the digital world. The conversion into digital form is just to ensure better access and to reduce dependence on physical libraries. These are either digitised images or ways that are converted to list by the process of OCR. The new digital resources are either deliberately created as digital or are created in parallel to print. Publishers are increasingly moving to XML or SGML format. Future digital resources are – electronic journals, electronic books through databases and data sets in many formats. The acquisition of documents which are already available in digital formats like CDROM databases is a part of the transition. Now-a-days a large number of information products are available on CD-ROM, like MEDLINE, COMPENDEX, METADEX, etc. Libraries can subscribe to these databases (bibliographic or full text) as an important input to the digital collection.

Access to external digital collection
Digital libraries can obtain/acquire access permission to digital collections provided by external sources like other institution, commercial publishers, resources of other libraries, and electronic journals through on-line access. Many of the commercial publishers like Elsevier, Academic Press, ACM, SIAM are making their journals available on-line through web sites. Many other commercial publishers are making available print and electronic versions of their journals. Some of the material is available only in electronic forms.

Conversion of hard copy of the doc into digital format
Now-a-days, the existing selected conventional collection of a library is being converted into digital form. This process of conversion of paper documents into digital format is mainly with the help of scanners. Printed texts, pictures and figures are transformed into computer accessible forms using a digital scanner or a digital camera.

Conversion of print to digital
There are basically two methods for converting the print resources into digital resources. These are:
i) Scanning and use of OCR Programmes
ii) Re-keying of data

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Scanning is the easiest option to obtain the exact replica of the original source document. Most scanning software generate default TIFF format which can be converted into PDF format using a number of software. The images can be browsed through a table of contents composed in HTML providing linked to scanned images. The optical character recognition (OCR) is another method of converting print to digital. The two well-known available OCR techniques are Xerox Textbridge and Caere's omnipage incorporation technology. Retaining the page layout is the major problem in OCR. Now a number of softwares are available for retaining the layout. The process of retaining the page layout is software dependent. The process of OCR results in computer processible file that is less accurate than re-keying of the data. The acrobat capture 2.0 provides several options for retaining not only the page layout, but also the fonts, and to fit text into the exact space occupied in the original. In image + text solution or OCRed text is generated for each image where each page is an exact replica of the original and left untounched. The OCRed text is generally not corrected for errors since it is used only for searching. The PDF normal gives the clearest image on screen display. The re-keying (or data entry) or retyping is another mode of converting printed text into digital form. This involves complete typing of the text. This process, although comparatively more accurate, is quite time consuming and costly. But corrections, modifications and changes in formats are easier to carry out. The four important steps involved in the process of digitisation are scanning indexing, storage and retrieval. The scanning of documents is done with the help of an electronic image scanner. Indexing of a document converted into an image or text file is the second step in the process of document imaging. The most difficult problem is that of storage. The page image has to be stored on a storage media. A large capacity storage device has to be used, like optical disc- CD-ROM, magnetic tapes, etc.. After the storage of scanned image is the retrieval of the needed data from the digital collection files. The digital image is also called "bit mapped page image". The technical requirements of the digital imaging process (i.e. converting paper documents into digital images) to be made accessible over network include :
Hardware (scanners, computer, data storage and data output peripherals)
Software (image capturing, data compression)
Network (data transmission)
Display technologies

Tools of Digitisation

The important machines and tools needed for digitisation include :
i) Computers
ii) Scanners and scanning software
iii) Storage System
iv) Network
v) Display system
vi) Printer

Scanners – Some of the important scanners being used for capturing digital images are:
i) HP Scanjet 6300 C
ii) Ricoh IS420
iii) Bell and Howell 1000 FB
iv) Kodak 500S
v) Juno CP-4000 **Digital Libraries**

Some of the image capturing/scanning software are : Altris software, OPTIX, Documentum, Power office, File net, Java system, Docs open.

Examples Of Digital Libraries

There are hundreds of digital libraries around the world. They are developed by communities, governments, corporations, and institutions. The following libraries are just typical.
World Digital Library
Bibliothèque Nationale de France
Bartholomew County Public Library
Thompson-Nicola Regional Library
Ohio Digital Library
Universal Digital Library. A collection of one million books.
Google Books.
Texas Digital Library
National Taichung Digital Library
IEEE Xplore
Internet Archive
JSTOR Open Access books
HathiTrust Digital Library

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It is evident that some of these digital libraries are owned by universities, publishers, states, and nations. Some these libraries are open to the general public, while others are not. The collections in each library are often in form of database A-Z to making search easy. Subscriptions to some of the digital libraries (such as IEEE Xplore) are available on an institutional basis and are expensive.

Benefits & Drawbacks, in Creating Digital Libraries:

Benefits of a Digital Library:

Added value
An important benefit offered by digital libraries is searching and browsing in material. One can optimize searching and simultaneously search the Internet, commercial databases, and library collections. Then one can save search results and conduct additional processing to narrow or qualify results, or click through search results to access the digitized content or locate additional items of interest.
Arising new forms of information: information in digital form can support features and possibilities not given in print form.
Cross references to other documents speed up the work of users
Digital libraries are cost-saving, since expensive building, professional staff and maintenance demanded by conventional libraries not needed anymore.
Digital libraries compared to conventional libraries allow collaboration and exchange of ideas.
Digital libraries make it needless for the user to go somewhere. A user can get full information at home or at work, whenever there is a PC and a network collection.
Duplicating of information is easy and cheap, whereas duplication of paper material would be very expensive.
Enhanced information retrieval.
Full text search
Information can be shared with others more easily. By placing digital information on a server connected to the World Wide Web makes it available to everyone.
Information can be updated continuously much more easily. It easier to keep the information current.
Nearly unlimited storage space at a much lower cost
Re-allocate funds from some staff, collection maintenance, and additional books.
User can access the information anywhere
Wide exploration and exploitation of the information

Drawbacks of Digital Libraries:

Digital libraries, or at least their digital collections, unfortunately also have brought their own problems and challenges in areas such as:
Copyright
Costs are spread and many become hidden.
Difficulty in knowing and locating everything that is available, and differentiating valuable from useless information.
Digital preservation
Equity of access
Exorbitant cost of building/maintaining the terabytes of storage, servers, and redundancies necessary for a functional digital collection
Inefficient or non-existent taxonomy practices (especially with historical material)
Interoperability between systems and software
Job loss for traditional publishers and librarians
Quality of metadata
Training and development
User authentication for access to collections

Opportunities for Librarians in Digital Transformation despite the Challenges

Digital transformation creates numerous opportunities for librarians to expand their roles and impact. One major opportunity is leadership in digital knowledge management. Librarians can guide institutions in organizing digital repositories, curating metadata, integrating discovery systems, and supporting open access initiatives. Gill asserts that librarians are uniquely positioned to manage digital scholarship effectively.xxxiii A growing opportunity is the expansion of new professional roles, including data librarianship, digital archivists, scholarly communication specialists, and digital humanities facilitators. These roles allow librarians to contribute directly to research workflows, data management planning, and digital scholarship support. Jones notes that data librarianship is becoming a cornerstone of modern academic research ecosystems.xxxiv Digital transformation also facilitates innovation through AI, VR/AR, and digital storytelling. AI-powered recommendation systems, virtual reality learning environments, and interactive exhibitions enhance user engagement. Thomas highlights that such technologies enable librarians to create immersive, meaningful learning experiences.xxxv Another opportunity lies in strengthening collaboration with faculty and IT departments. Digital learning environments require integrated teamwork, where librarians codesign digital

course materials, support LMS integration, and contribute to research projects. Such collaboration enhances librarians' visibility and institutional value. Finally, librarians can increase user engagement through personalized digital services, such as customized reading lists, interactive guides, and data-driven recommendations. Smith emphasizes that personalization builds trust, retention, and learner satisfaction.

Challenges Faced by Librarians in the Digital Era

The digital era presents numerous challenges that demand continuous adaptation from librarians. One of the most significant challenges is technological obsolescence and rapid updates. Digital tools, platforms, and software evolve quickly, making it difficult for librarians to stay updated with emerging systems. Thomas notes that frequent upgrades in digital interfaces, metadata standards, and repository platforms require librarians to relearn workflows repeatedly, causing operational disruptions.xxviii Another major challenge is the need for continuous professional development (CPD). Digital librarianship requires expertise in ICT, digital preservation, AI tools, metadata schemas, copyright, and data literacy. Johnson argues that lifelong learning is no longer optional for librarians; instead, it is essential for maintaining professional relevance. Cybersecurity risks and user privacy concerns also pose critical challenges. The rise of cyber threats, phishing attacks, and data breaches has made libraries vulnerable because they host sensitive user data and subscription-based digital resources. Morris stresses the need for robust security policies, encryption protocols, and ethical handling of user information.xxx Budget limitations for digital resources remain a major obstacle. Subscription costs for e-journals, databases, and e-books continue to rise each year, making it difficult for libraries to maintain diverse collections. Baker points out that financial constraints often force librarians to cancel underused resources, which may negatively impact research quality. The digital divide among users is another significant challenge. Not all users have equal access to devices, internet connectivity, or digital literacy skills. Mehta highlights that marginalized communities face barriers that hinder full participation in digital learning.Librarians also face licensing and copyright complexities. Restrictions on simultaneous users, interlibrary loan, and perpetual access rights complicate service delivery. Finally, librarians must balance traditional and digital responsibilities, often handling cataloguing, digitization, physical circulation, and virtual support simultaneously, leading to workload pressure.

Future of Digital Library:

As we venture into a more digital environment, many of the traditional measures of an excellent library have become eroded. We know that we have been successful and what benchmarks might we use to compare ourselves with peer institutions and against ourselves. In the digital world of information highway, there should be stress on three things: awareness of information, awareness of technology, awareness of needs. The awareness of information gives the breadth of vision; awareness of technology gives the power to make the visions manifest; and awareness of needs gives the insight to use professional skills and talents to the greater effect.

Conclusion:

The Digital library plays an important role in promoting the use of information. Digital libraries give solutions to main challenges to traditional libraries such as storage. Libraries have always played a significant role in society, and digital libraries with the promise of breaking the barriers of geographical distance, language and culture, have a potentially even more significant social role. With the advancement and new technology in the field of information librarians need to improve new skills using the new technology and it requires reorientation of traditional skill of librarianship information professional and librarians must acquire the new skills as networking and web based technologies.

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Original Article

Application of advanced AI method to study Menstrual Hygiene Knowledge and Practices among Adolescent Girls in a Tribal School in Yavatamal District.

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Abstract:
Menstruation is a natural biological process, yet it remains shrouded in cultural taboos and social stigma, particularly in rural and tribal regions of India. Inadequate Menstrual Hygiene Management (MHM) significantly impacts the physical health, dignity, and educational attainment of adolescent girls. In the tribal belts of Maharashtra, such as Yavatmal district, deeply entrenched customs and a lack of access to Water, Sanitation, and Hygiene (WASH) facilities exacerbate these challenges, leading to high rates of reproductive tract infections and school absenteeism. While existing literature has explored this issue, approximately 95% of previous cross-sectional studies have relied solely on traditional statistical methods, such as chi-square tests. These conventional approaches often fail to capture complex, non-linear relationships within multifaceted health and socio-demographic data. Current study focused on the application of advanced data analysis and machine learning techniques like Random Forest and Hybrid Feature Selection Chi-saure method alongside Mutual Information methods(Chi^2-MI) for data analysis, correlation, feature selection, and future predictions. The study will be conducted among adolescent girls (aged 10-15 years) residing in selected Ashram Shalas (residential tribal schools) in Yavatmal with 50 girl samples. The application of advanced predictive models ultimately leads to a better understanding of adolescent malnutrition, which provides actionable insights for targeted public health interventions and policy-making.

Keyword: Menstrual Hygiene and Management (MHM), Artificial Intelligence, Chi2-MI, Random Forest.

Introduction:

The process of menstruation is both normal and natural, and it is crucial for the lives of adolescent girls. Recently, the global concept of menstruation has shifted from only using sanitary pads to holistic menstrual health. This new framework integrates human rights, psychological well-being, and comprehensive water, sanitation, and hygiene infrastructures (WASH) (Sommer et al. 2025). There is a heavy cultural taboo and social stigma found, particularly in low and middle-income families in India. Considering adolescent girls, the lack of menstrual hygiene management (MHM) has an impact on their physical health, psychology, dignity, and educational attainment. Proper MHM is determined by social culture, economic disparities, and educational disparities. It is necessary to have safe absorbent materials, soap, water, and disposable facilities, as stated in Nayak et al. 2024. Even though there are progressive policies like free sanitary napkins and social awareness programs, social stigma and period poverty still persist. Maharashtra, which is one of the progressive states, has incorporated policy innovations and adopted market practices for product distribution. However, the right to safe menstrual hygiene remains elusive for most tribal and low-income populations (Prakash et al., 2025). Furthermore, recent research highlights the compounding threat of climate change on MHM in the state. Frequent droughts and severe water insecurity, particularly in the Marathwada and Vidarbha regions, have a cascading effect on menstrual hygiene, disrupting girls' ability to properly wash their genitalia or safely clean reusable cloth pads, thereby increasing absenteeism and infection rates (Nayak et al., 2024; UNICEF, 2024).

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Yavatmal, a district located in the Vidarbha region of eastern Maharashtra, embodies many of these socio-economic and public health vulnerabilities. It is an industrially underdeveloped, agrarian district where a large portion of the working population relies on agricultural labor. Crucially, Yavatmal is home to a highly vulnerable and substantial tribal population, the vast majority of whom reside in rural areas. Therefore, this study aims to assess the current knowledge, cultural restrictions, and menstrual hygiene practices among adolescent girls in the tribal areas of Yavatmal District, to identify specific gaps and inform culturally sensitive, community-driven health interventions.
The majority of previous cross-sectional studies have used traditional statistical methods, such as chi-square tests, exclusively. The conventional approach often fails to capture complex, non-linear relationships in multifaceted health and socio-demographic data, requiring large structure data. Machine Learning (ML) and Deep Learning (DL) are the latest Methods for analyzing data and predicting consequences. An ML model is trained to generate classifications and predict future events using Statistical methods, algorithms, and data. The prediction by AI method can be used for various preventive methods for MHM. This article contributes to applying hybrid feature section approach (Chi2-MI) along Mutual Information method (Dey et al. 2022) and Random forest method.

Data Collection and Methodology:

The data was collected from girls between the ages of 10-15 who are living in Ashram Shalas (residential tribal schools) in Yavatmal district. A pre-tested, structured questionnaire is used to collect data from 50 girls, assessing socio-demographic factors, knowledge, and MHM practice.The sample data were analyzed and 35 features are listed in Table 1. The numerical features are Height, Weight, BMI, Age, and Class, while the others are categorical features . Table 2. Highlights the statistical insights and the numerical features obtained from the dataset that supported this study.

Table 1 : Description of features and attributes with the different datatype of the dataset

Sr. No	Features	Data Type
1	Height	Numerical
2	Weight	Numerical
3	BMI	Numerical
4	BMI Category	Categorical
5	Age	Numerical
6	Class	Numerical
7	Father occupations	Categorical
8	Mother occupations	Categorical
9	Father education	Categorical
10	mother education	Categorical
11	Type of family	Categorical
12	Toilet facility at home	Categorical
13	Were you aware about menstruation before its occurrence?	Categorical
14	If yes, who gave you the information?	Categorical
15	How would you describe your menstrual cycle?	Categorical
16	What is the average length of your menstrual cycle?	Categorical

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17	How did you react to menarche?	Categorical
18	How do you dispose of used sanitary pads?	Categorical
19	Age at menarche (first menstruation)	Categorical
20	Is your menstrual cycle regular?	Categorical
21	Duration of menstrual bleeding?	Categorical
22	Do you experience severe menstrual pain (dysmenorrhea)?	Categorical
23	Do you experience heavy menstrual bleeding?	Categorical
24	Do you miss school during menstruation?	Categorical
25	It is essential that all adolescent girls must have knowledge on menstrual hygiene prior to menarche.	Categorical
26	It is a sin to touch a girl during menstruation.	Categorical
27	A girl should not go to school during menstruation.	Categorical
28	Menstruating girl should be allowed to visit religious places	Categorical
29	A girl should not tell anybody that she is menstruating.	Categorical
30	Do you believe menstruation should be discussed more openly in society?	Categorical
31	Do you feel comfortable discussing menstruation with your friends and family?	Categorical
32	Do you feel comfortable discussing menstruation with your friends and family?	Categorical

Table 2 : Statistical data analysis of the 5 numerical features of the dataset.

	Height	**Weight**	**BMI**	**Age**	**Class**
count	50.000	50.000	50.000	50.000	50.000
mean	149.400	39.240	17.634	15.140	9.560
std	7.874	5.684	2.565	0.700	0.861
min	135.000	30.000	11.472	14.000	8.000
25%	145.000	35.250	16.060	15.000	9.000
50%	150.000	38.000	17.188	15.000	10.000
75%	153.000	43.500	19.039	15.000	10.000
max	182.000	55.000	23.473	17.000	11.000

Results and discussion:

In Figures 1 and 2, a comprehensive descriptive analysis is shown to establish the demographic and physical profiles of the study participants.

The distribution of age, height, weight, BMI, and class were all found to have a normal central tendency for this demographic. Adolescent girls who were aged 15 comprised the majority of the cohort. The majority of girls were found to have a BMI between average and underweight, with no obese girls being found. In terms of household sanitation infrastructure, most families are nuclear, but a significant number of participants had their own private toilets. A significant group of individuals reported using community toilets or not having any toilet facilities at all.

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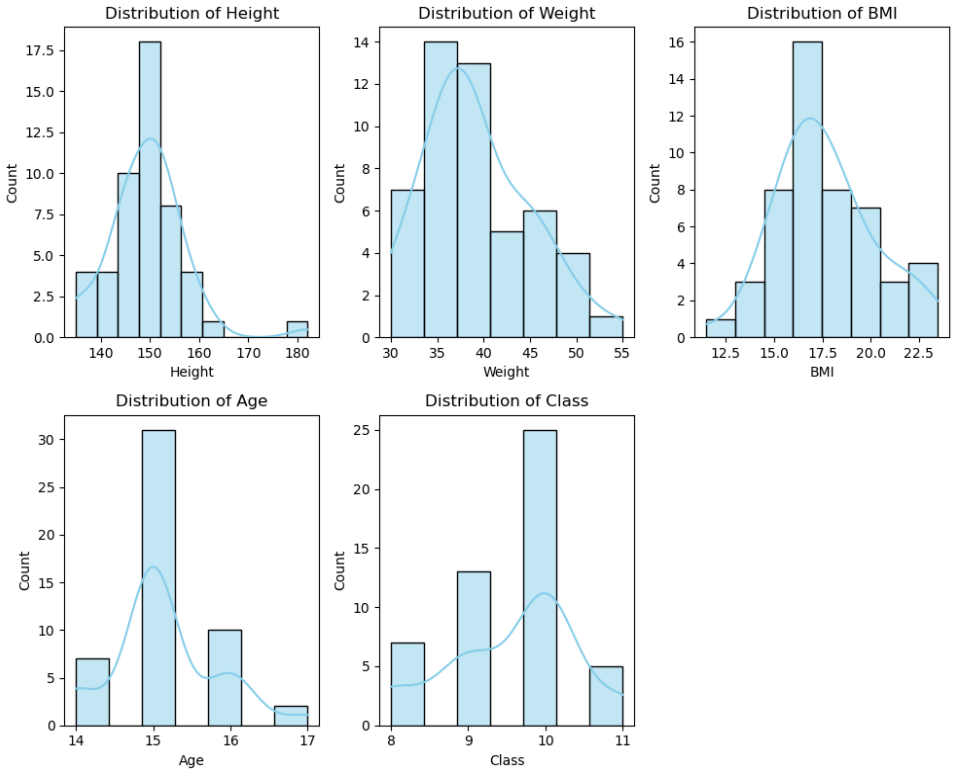

Fig 1: Visualizing the features distribution of numerical features of the dataset

To identify linear relationships among the continuous anthropometric variables, a Pearson correlation matrix was generated and visualized using a heatmap as shown in Figure 3. The analysis demonstrates that weight has a highly significant positive correlation with BMI. The mathematical expectation of this strong relationship is confirmed by the overall measurement consistency within the cohort because BMI is derived from weight.

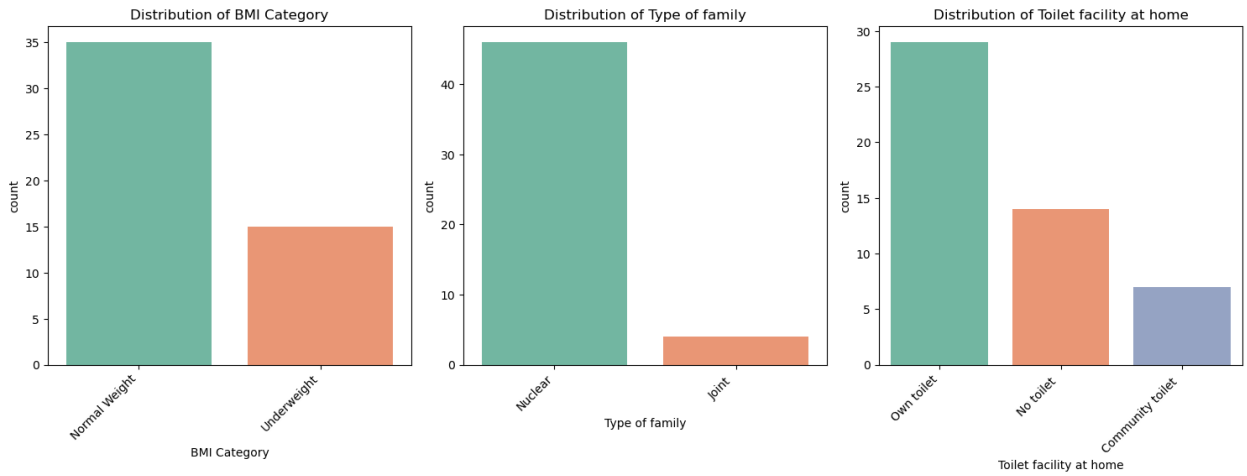

Figure 2: Visualizing how nominal features are distributed in the dataset.

A strong positive correlation has been observed between age and class, which indicates the natural progression of students through academic grade levels as they age. Demographic factors (age and class) and physical attributes (weight and BMI) had only weak to moderate correlations in the inter-category relationships. In particular, the correlation coefficients between chronological age and either weight or BMI are still notably low. This suggests that chronological age is not a reliable indicator of individual physical body mass variance among this narrowly defined adolescent demographic. Figure 4 Shows the prevalence of both negative myths and positive attitudes regarding menstruation among the surveyed population. A significant percentage of respondents have a negative view of

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education, with 96% agreeing that menstruating girls should not attend school.Moreover, 45.0% feel that women should keep their menstruation a secret, while only 7.0% consider it a sin to touch someone who is going through menstruation. While examining positive attitudes, the data show that cultural restrictions still exist. Only 20% of participants support the idea of menstruating women being allowed to make religious visits.

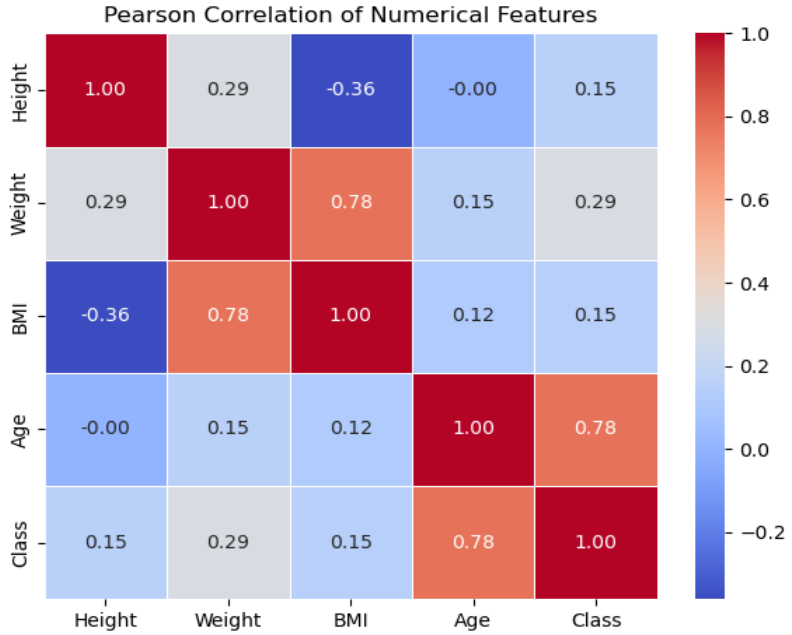

Figure 3 : Pearson correlation matrix for finding correlation with features.

Only 38.0% of the group surveyed expressed support for open discussions about menstruation, which is also somewhat constrained when it comes to communication attitudes. Although cultural taboos and silence are common, there is a remarkably strong consensus on the significance of early preparation. In general, 90% of the population agrees that it is essential for all adolescent girls to be knowledgeable about menstrual hygiene before menarche.In conclusion, these findings demonstrate a crucial paradox in which the community restricts women who menstruate while acknowledging the essential importance of menstrual health education.

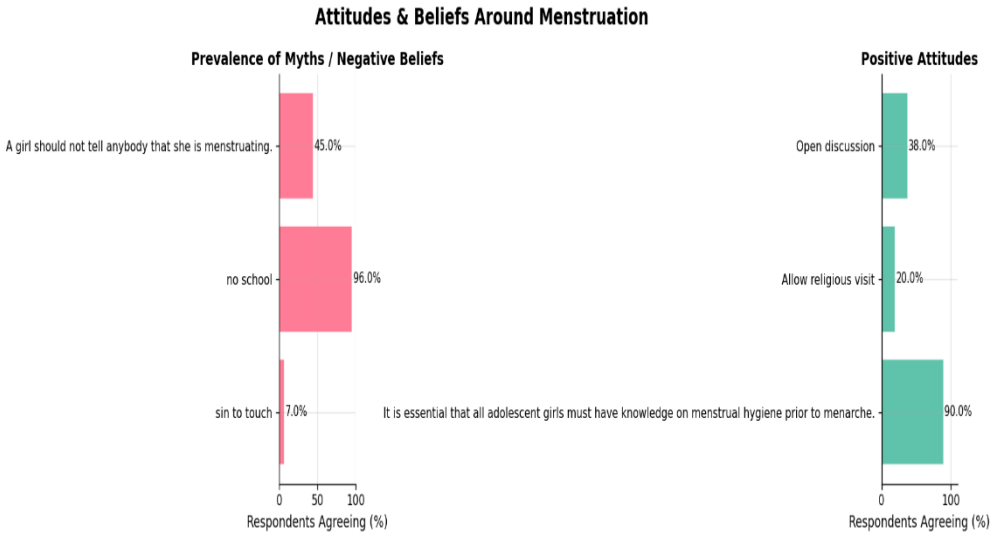

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Figure 4: The distribution of adolescents' beliefs, attitudes, and compliance with sociocultural taboos concerning menstruation (N=50). The stacked horizontal bar chart exhibits the likelihood of agreement (Yes) or disagreement (No) based on physiological understanding, social restrictions, and internalized stigma.

Figure 5. Shows the study employed a hybrid feature selection approach to determine the factors that predict regularity of menstrual cycles among adolescents. We incorporated Chi-Squared statistical testing and Mutual Information scoring to develop a Hybrid Importance Score that identifies the fifteen most predictive features. The analysis indicates that physiological symptoms and cycle characteristics are the most significant predictors of menstrual regularity overall. Severe menstrual pain, or dysmenorrhea, was the single most predictive variable in the entire model. The expected biological paradigms were validated by closely following the average length of the menstrual cycle and the age at first menstruation. It was crucial to note that the hybrid model demonstrated that reported menstrual health outcomes are deeply influenced by psychosocial taboos and internalized stigma. The third most important predictive feature is the belief that women should keep their menstrual cycle a secret, which surpasses several physiological metrics.Additionally, individuals' attitudes towards societal openness and their level of comfort when discussing menstruation with family and friends are also significant predictors.Prior reproductive education was found to be crucial, with pre-monarch awareness and the source of that information ranking fifth and seventh, respectively. Conversely, general demographic and physical baselines, such as BMI and parental occupation, exhibited significantly lower predictive power compared to targeted physiological symptoms and menstrual education.

Table 3: Top 10 Selected Features (Hybrid Approach)

Feature	Hybrid_Score	Chi2_Score	MI_Score
A girl should not tell anybody that she is menstruating.	1	9.333574	0.331542
Do you experience severe menstrual pain (dysmenorrhea)?	0.785611	7.335647	0.260374
BMI Category	0.486608	5.725108	0.119334
Do you feel comfortable discussing menstruation with your friends and family?	0.397185	2.512593	0.174186
What is the average length of your menstrual cycle?	0.387405	3.838548	0.120587
Height	0.206659	0.162414	0.131356
Mother occupations	0.200485	0.006307	0.132809
Were you aware about menstruation before its occurrence?	0.138531	1.734604	0.030319
Do you miss school during menstruation?	0.125147	2.338126	0
Age at menarche (first menstruation)	0.116644	0.455939	0.061239

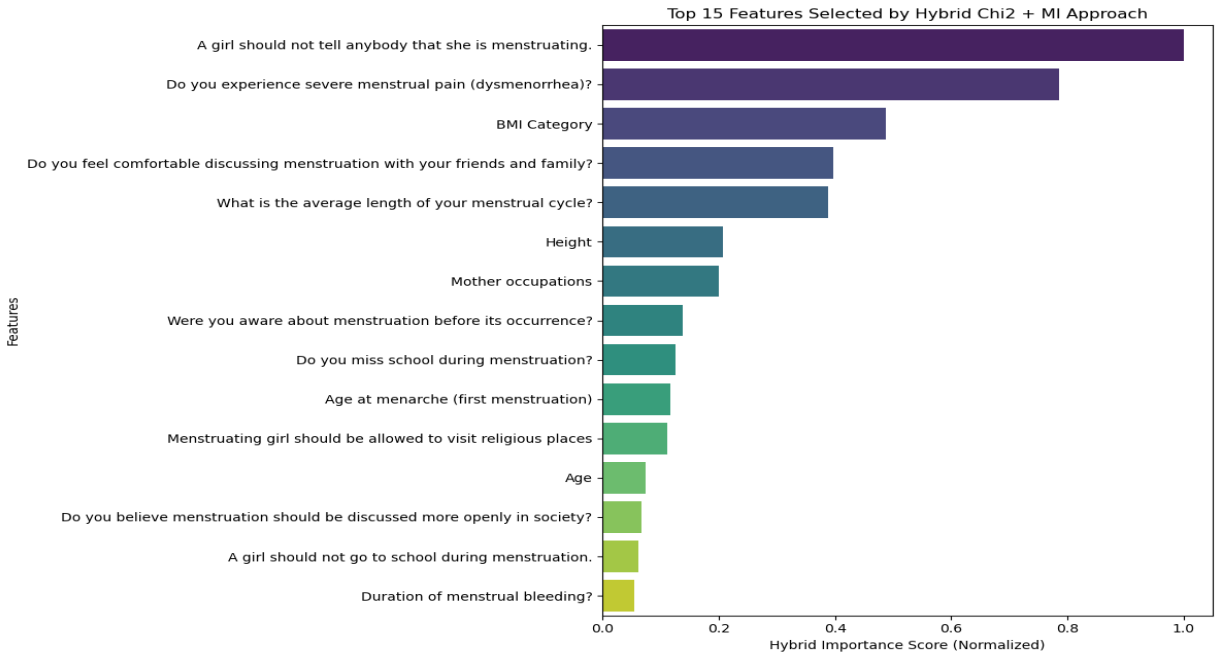

Figure 5: Top features by Hybide Chi2 and MI approach for predicting " your menstrual cycle regular ?".

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Figure 6. illustrates the feature importance for predicting menstrual cycle regularity based on a Random Forest classification model. A Random Forest classification model showed that various features were important in predicting positive menstrual hygiene practices among teenage girls. These features are ranked by Gini importance scores and classified as either positive/behavioral or myth/negative belief variables.According to the model, awareness before the reign of the monarch is the most significant factor in these practices, with a significant Gini score of 0.410. The overwhelming majority suggests that prior knowledge and foundational education are the primary drivers of menstrual hygiene behaviors. Behavior and social factors play a key role in the predictive power, with attention given to the consequences of missing school and how comfortable a girl is talking about menstruation. When it comes to actual hygiene practices, physiological indicators such as dysmenorrhea, cycle regularity, and heavy bleeding are not effective predictors.Furthermore, the predictive model puts forth explicit negative beliefs and cultural myths, such as the belief that touching women who are menstruating is a sin, at the top. The conclusion of this analysis is that the development of proper menstrual hygiene practices requires foundational education and open interpersonal communication, not physiological symptoms or isolated cultural taboos.

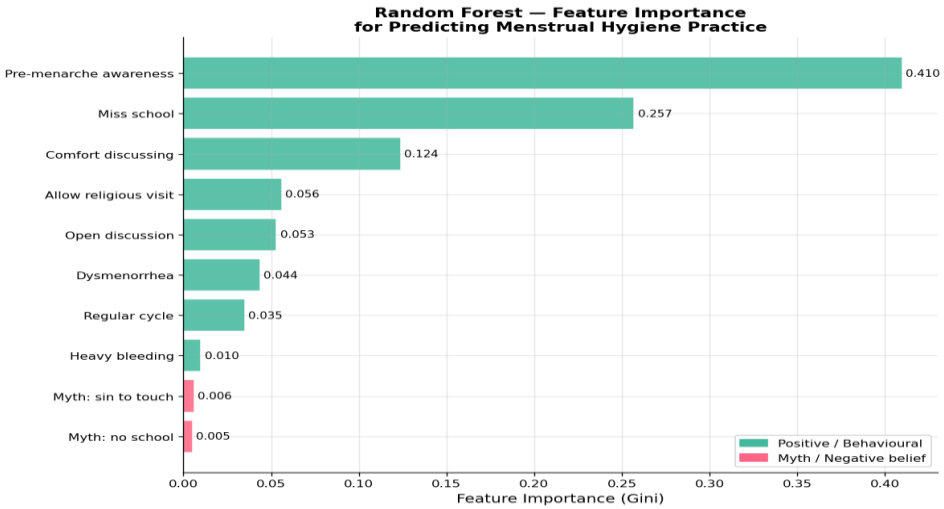

Figure 6:

Top features by Random forest methods. Considering the actual answers and responses given by the student (here only considered MHH related questions).

Conclusion:

The focus of this study is on the ability of machine learning algorithms to analyze MHM with minimal tests data or features. A hybrid wrapper feature selection method (Chi2-MI) has been applied to the entire dataset, and the most impactful features based on correlation scores were selected to predict the irregularity of periods in teenage adolescent girls. Based on the outcome of this research, these ML-based models can be effectively employed in resource development and undertaking public health efforts. Additionally, this study is conducted on a limited number of sample sizes (n=50). Having more data allows us to make more robust predictions for features.

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Original Article

The Changing Role of Librarians in the Recent Era of Artificial Intelligence

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Abstract

The rapid advancement of Artificial Intelligence (AI) has significantly transformed various professional domains, including library and information science. Traditionally viewed as custodians of books and knowledge repositories, librarians are now evolving into information managers, digital curators, and technology facilitators. This research paper explores the changing role of librarians in the AI era, highlighting the integration of intelligent technologies in library services, the emergence of new competencies, and the challenges faced by information professionals. The study concludes that librarians remain indispensable in ensuring ethical information use, digital literacy, and equitable access to knowledge, even in an increasingly automated environment.

Keywords: *AI (Artificial Intelligence, Librarians, Information Managers, Knowledge Managers, Digital Curators, Technology Facilitators)*

1. Introduction

The emergence of Artificial Intelligence (AI) has revolutionized how information is created, accessed, and disseminated. Libraries, once dominated by physical collections, are now hybrid or fully digital environments. This transformation has led to a redefinition of the librarian's role. Librarians are no longer mere gatekeepers of books but are active participants in the digital knowledge ecosystem. With AI technologies such as machine learning, natural language processing, and data analytics, libraries have become smarter, more user-centric, and efficient. This paper examines how these developments are reshaping the profession.

2. Evolution of Library Science in the Digital Age

The history of libraries reflects the evolution of human knowledge systems. From clay tablets to printed books and now digital repositories, libraries have continuously adapted to technological changes.

The introduction of computers marked the first major shift, followed by the internet revolution. Today, AI represents the next stage in this evolution. Digital libraries, institutional repositories, and online databases have replaced traditional catalogue systems, making information retrieval faster and more efficient.

3. Artificial Intelligence in Libraries

3.1 Definition and Scope of AI

Artificial Intelligence refers to the simulation of human intelligence processes by machines, particularly computer systems. In libraries, AI is used to enhance efficiency, automate tasks, and improve user experience.

3.2 Applications of AI in Libraries

AI technologies are increasingly being integrated into library systems, including:

Automated Cataloguing and Classification

Machine learning algorithms can automatically categorize books and resources, reducing manual workload.

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Information Retrieval Systems
AI-powered search engines provide accurate and context-aware results using natural language queries.
Chatbots and Virtual Assistants
Libraries use chatbots to answer user queries 24/7, improving accessibility.
Recommendation Systems
Similar to commercial platforms, libraries use AI to suggest relevant resources based on user behaviour.
Digitization and Preservation
AI helps in digitizing old manuscripts and preserving them for future use.

4. Changing Roles of Librarians

4.1 Information Specialists
Librarians now function as information specialists who assist users in navigating complex digital environments. They help users identify credible sources and access relevant information efficiently.
4.2 Digital Resource Managers
Managing digital collections has become a core responsibility. Librarians oversee e-books, online journals, databases, and institutional repositories.
4.3 Technology Facilitators
Modern librarians act as intermediaries between users and technology. They guide users in utilizing AI tools, digital platforms, and online learning resources.
4.4 Educators in Information Literacy
With the rise of misinformation, librarians play a crucial role in promoting information literacy. They educate users on evaluating sources, avoiding plagiarism, and using information ethically.
4.5 Research Support Professionals
Librarians support academic research by assisting in literature reviews, citation management, and data curation. They also help researchers comply with open-access policies.
4.6 Data Curators and Analysts
In the AI era, librarians manage research data, ensuring its organization, accessibility, and preservation. Data analytics skills are becoming increasingly important.

5. Skills Required for Modern Librarians

The transformation of the librarian's role requires new competencies, including:
Digital Literacy
Data Management Skills
Knowledge of AI Tools and Technologies
Information Evaluation Skills
Communication and Teaching Skills
Continuous professional development is essential for librarians to remain relevant in this rapidly changing environment.

6. Benefits of AI in Libraries

6.1 Improved Efficiency
Automation of routine tasks allows librarians to focus on more complex and user-cantered services.
6.2 Enhanced User Experience
AI-powered systems provide personalized recommendations and faster information retrieval.
6.3 Better Resource Management
Digital systems enable efficient storage, organization, and retrieval of information.
6.4 Increased Accessibility
Users can access library resources remotely, breaking geographical barriers.

7. Challenges and Concerns

7.1 Technological Challenges
The iplementation of AI requires significant financial investment and technical expertise.
7.2 Ethical Issues
AI raises concerns related to privacy, data security, and intellectual property rights.
7.3 Job Displacement Fears
Automation may lead to concerns about the redundancy of traditional librarian roles.
7.4 Digital Divide
Not all users have equal access to digital resources, which may widen the information gap.

8. Ethical Role of Librarians in the AI Era

Despite technological advancements, librarians play a critical role in upholding ethical standards. They ensure:
User Privacy Protection
Intellectual Freedom

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Equal Access to Information
Librarians act as guardians of ethical information practices in an AI-driven environment.

9. Future Prospects

The future of librarianship lies in the integration of AI with human expertise. Librarians will continue to evolve as:
Knowledge managers
Digital curators
Research consultants
Technology trainers
Rather than replacing librarians, AI will augment their capabilities, making them more effective in serving users.

Conclusion

The role of librarians has undergone a profound transformation in the era of Artificial Intelligence. From traditional custodians of books to dynamic information professionals, librarians are now central to the digital knowledge ecosystem.

AI has enhanced library services, improved efficiency, and expanded access to information. However, it also presents challenges that require careful management. Librarians must adapt by acquiring new skills and embracing technological advancements while maintaining their commitment to ethical practices and user service.

Ultimately, the human element in librarianship remains irreplaceable. Librarians will continue to play a vital role in guiding users through the complexities of the information age.

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Original Article

Indian Traditional Festive Recipes : A Sustainable Food System

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Abstract

Indian Traditional Festive Recipes: A Sustainable Food System Indian traditional festive foods are closely associated with cultural heritage, seasonal changes, agricultural practices, and community well-being. The present study examines various traditional food preparations made during Hindu festivals in the Amravati district of Maharashtra and evaluates their nutritional, therapeutic, medicinal, and socio-cultural significance. Using a descriptive research design, information was collected from families residing in the region for more than fifty years. The study documents recipes such as Neem Chutney, Poi Bhaji, Alu Wadi, Sola Bhajyanchi Bhaji, and Bhogichi Bhaji, which are prepared during festivals like Gudi Padwa, Pola, Mahalaxmi Pujan, and Makar Sankranti. Findings reveal that these traditional recipes are rich sources of essential nutrients, vitamins, minerals, dietary fiber, and bioactive compounds that support health and immunity. The recipes are also found to be aligned with seasonal and climatic requirements, reflecting indigenous knowledge systems that promote sustainable nutrition and food security. The study concludes that traditional festive foods possess scientific relevance and can contribute significantly to sustainable food systems while preserving cultural identity and promoting healthy dietary practices.

Keywords: *Traditional Festive Foods, Sustainable Food System, Indigenous Knowledge, Nutritional Value, Medicinal Properties, Indian Festivals, Food Culture, Sustainable Nutrition, Maharashtra, Cultural Heritage.*

Introduction:

India's diverse subcultures showcase unity in diversity, with food habits varying across states. Indian cuisine largely relies on plant-based sources, driven by factors like affordability and religious beliefs, making vegetarianism a long-standing tradition. Historically, vegetarians faced ridicule due to lack of awareness about plant-based health benefits. Back then, practical experience was the main info source, whereas today it's all about scientific evidence.

India's food culture is deeply rooted in tradition, with many preparations offering significant health benefits. These meaningful food habits and customs are cherished by the community and tend to resist rapid changes, even when faced with external influences. Notably, older individuals are less likely to adapt to changes compared to their younger counterparts. Religious festivals are often accomplished by celebrations fairs play a very important part in the religious social and cultural Life of The Hindus- urban and rural. Our festival celebrations and rituals are the symbols of integrated and undivided Indian culture and heritage the festivals being linked with seasonal transitions and also the weather changes have intimate connection with the farming culture of our country. we can easily notice the unfirmative and similarity in the ways of celebrating this festivals, all across the country. The festival bring a lot of joy ecstasy and enthusiasm with them. Their celebration inject a great amount of enthusiasm and liveliness into us. India has a traditional and cultural background of 5000 years there is a reach store of indigenous knowledge in food preparation with a definite scientific base .

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The value of such a local indigenous food preparation knowledge cannot be ignored as it facilitated sustainable nutritional development. The traditional food preparation knowledge and modern scientific knowledge together can be useful for better and effective adoption of preparation practices by people .Food ,man's most precious and sometimes the scarce possession has been associated with many of the religious rituals. The practice of affecting food or abstainig from food has provided man in his everyday life with the symbolic way to indicate his devotion respect and love to his supreme being. In Hindu religion the various symbolic ways of using food has had deep meaning to men.

Increased stress among people due to overdose of information fast changing lifestyles and higher level of expectations had made societies vulnerable to

psychosomatic disorders .Following the rich Indian food related to culture and traditions would certainly prove to be beneficial to overcome such disorders. The information would also help in the development of new food products for modern market for the significance of such indian traditional foods is more appreciable when their nutritive value is known in this regard. India has the rich trade treasure of traditional foods specifically prepared for festivals ,rituals and physiological conditions . Hence anvinvestigation was undertaken to document the different festivals foods and to compete the nutritive ,therapeutic value ,socio cultural values medicinal value of such foods.

Objective of the study:

1. To identify the traditional food preparation prepared during festivals

2. To take critical review of traditional food preparation from the nutritional, therapeutic ,socio culture and medicinal point of view

Limitations of the study:

Study of nutritional and medicinal values was limited to the food preparations which were available for reference

Methodology:

The research design was descriptive . The study was conducted in Amravati district of Vidarbha region of Maharashtra state. The families residing over more than 50 years in the Amravati district were selected. The present study describe the Hindu festivals with special emphasis on recipes since the documentation procedure was found suitable for the study. Various tools where used for collecting the data.

Result and Discussion:

Gudi padwa is celebrated on the first day of the Chaitra as the new year day by Marathi peoples. On this day neem chutney was prepared. It is observe that neem chutney has several therapeutic and medicinal values. It provides micronutrients to protect body infectious diseases .Sour taste stimulates the secretion of saliva and increases appetite. In Vasant season phelgm predominates and its related diseases appear but consumption of neem chutney used as a preventive medicine for viral infection. Pola is the harvest festival celebrated by farmers all over Maharashtra.Poi bhaji is prepared on the festival pola. The green poi vegetable is highly nutritious leaves which contains essential amino acids, arginine, histamine, lysine ,methionine,tryptophane and valine abundantly. It also contains mucilaginous substances. All the varieties of the leaves contain iron ,betacarotene and vitamin C .

Also,Alu wadi prepared on that occasion. It also known as colocasia leaves is a rich source of vitamins and minerals and because of its versatile acceptance there is a scope for development the crops in a big way for a possible introduction in Indian dietary. It is recommended to all age groups specially children and patients suffering from vitamin A deficiency. In Mahalaxmi Pujan sola bhajanchi bhaji is a special dish offer to goddess of wealth. Mahalaxmi ,it is made out from sixteen different various vegetables that is amaranth, cabbage ,ash gourd, dill leaves,bitter gourd, bottle gourd, cluster beans,ladies finger, green tomato, snake gourd, ridge gourd, round gourd, cauliflower and Parwal. Vegetable supply many nutrients besides providing variety to the diet. Vegetables play an important role in the human diet properly chosen and eaten cooked or raw. They make an individual invaluable contribution towards the supply of vitamins and minerals sixteen different vegetables used in the preparation of Sola bhajanchi bhaji ,each vegetable has a nutritional and medicinal value, the contribution of each vegetable is different .The leaves of amaranth are better than other green leafy vegetables with regard to the nutrient composition. Some of varieties content linoleic acid and palmitic acid. It is a good source of minerals and vitamins.Amaranths supplies all essential amino acids such as lysine, tryptophane,methionine and arginine which helps in the rapid growth. It helps us in purifying our blood and enriching the blood stream with essential minerals .Ash gourd contains very little calories and also good source of vitamin B and vitamin C. Bitter gourd is the rich source of carotene, calcium ,riboflavin and ascorbic acid. Bottle gourd is a good source of vitamin B and fair source of vitamin C. Cabbage is a good source of vitamins and minerals especially ,iron, sodium, potassium ,sulphur ,chlorine, iodine and calcium along with traces of zinc. cabbage is one of the most highly rated leafy vegetables and marvelous food item rich in fibre .Cauliflower is a rich source of vitamin C and folic acid.

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Cow peas provide carotene and iron. Cluster bean is a source of guargum ,seeds are very mucilaginous rich in calcium, phosphorus ,iron and vitamin C. Ghrekins is a rich source of vitamin A and other minerals. Ladies finger seeds contain Phosphorus and are rich in potash, calcium and magnesium salts. It contains mucilaginous material that impart a characteristic texture and taste to the vegetable .Green tomatoes are rich in calcium ,Phosphorus ,vitamin C and vitamin A. Round gourd is a low calorie food and low in fat. Ridge gourd provides calcium and phosphorus with good source of carbohydrates carotene, vitamin C and minerals .Dill leaves contain high concentration of caratenoids including beta carotene and essential amino acids.Snake gourd improve appetite. Green leafy vegetables play a prominent role in balancing a diet by their virtual providing a large amount of micronutrients in a single bowl .Vegetables being rich in vitamins and minerals have been term as protective food. It promotes immunity carries out body's vital functions like circulation ,respiration and activates a large number of enzyme system in the body. They are also good source of dietary fibre especially soluble fibre and which has many beneficial effects in the body system. Bhogi chi bhaji is it another type of vegetable prepared on the festival bhogi or Makar Sankranti. It is an assortion of brinjal ,greenpea, tender bengal gram, sugar cane, field bean ,carrot ,zizipus,guava,seasame seeds and groundnut. Tender Bengal gram is highly valuable from nutritions point of view but It is used in small quantity as vegetable. carrot are used as a vegetable it is a rich source of carotene, precursor of vitamin A. The vegetable is rich in alkaline mineral like sodium, chlorine and iodine as well as vegetable fibre. This also contain carotene, hydrocarotine, sugar, starch, protein, Malik acid ,lignin and albumin. Ripe fruit of Guava is the cheapest source of vitamin C. Greenpea have high content of proteins and also supplier adequate quantities of vitamins and minerals. Field beans are rich in vitamin B, Phosphorus and protein and form nutritious food besides being consume as a vegetable percentage of vitamin B2 is higher than many other vegetables in Brinjal. Peanuts are known as a good source of nicotinic acid and content ample amount of vitamin E ,riboflavin and pyridoxine with trace amount of folic acid, pantothenic acid and biotin. Bhogichi bhaji is a good preparation for introducing different vegetables which improves the nutritional quality of the recipe. Fruits and vegetables are excellent source of folic acid and B vitamins, that reduces the risk of certain serious birth defects when administered to pregnant women. Many others are excellent source of important vitamin Aand C. They also provide and ample amount of fibre. Eating the beans with the covering is always recommended because it cellulose contain cure constipation and prevents the acid forming characteristics of the peeled beans. Food place and important role during festival celebration and such occasions provide opportunities for the development of good food habits.

Table 1 : Nutritive value of above recipes per serving

Food name	Protein g	Fat g	Carbohydrate g	Energy kcal.	Iron mg
Neem Chutney 5g	0.65	0.18	2.33	14	1.10
Poi bhaji 100 g	4.89	5.65	13.25	123	5.97
Alu wadi 100 g	3.78	1.18	13.36	72	3.62
Sola bhajyanchi bhaji 100g	2.27	5.48	8.14	79	2.56
Bhogichi bhaji 100 g	4.99	8.90	17.42	153	1.63

Conclusion:

From the study and observations of this traditional festive food preparations, it is reveal that the recipes are relevant to the climatic condition, food patterns have been arrange to suit the seasonal food requirements of human body. The variety of recipes prepared on various festival days possess different taste, textures, shapes ,colours and appearances. The method of preparation of food item is different and unique .In critical reviews, it is found that in traditional foods also have a scientific bearing and often have some significance.

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Original Article

The Role of Health and Physical Fitness in Achieving Sustainable Development: The Indian Context

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Abstract:

This study examines the impact of digital technology on educational outcomes among university students. Using a mixed-methods approach, data were collected through surveys and interviews. The findings indicate that the effective use of digital tools enhances student engagement, improves access to learning resources, and supports academic achievement. The study concludes that integrating technology into higher education can contribute positively to the learning experience when accompanied by appropriate guidance and support.

Keywords: *Digital Technology; Higher Education; Student Engagement; Academic Achievement; Online Learning*

Introduction:

In a large and diverse country like India, maintaining good health and physical fitness is essential for achieving sustainable development. Sustainable development focuses on meeting present needs without compromising the ability of future generations to meet their own needs; in this process, health plays a pivotal role.A healthy population can work more efficiently, contribute to economic growth, and reduce the burden on healthcare systems. When people are physically fit, they are less likely to suffer from ailments such as diabetes, heart disease, and obesity - conditions that currently constitute major health challenges in India. These health issues lead to increased medical expenditure and create hurdles in allocating resources toward developmental initiatives.

What is Sustainable Development?

Sustainable development is development that meets our current needs without compromising the ability of future generations to meet their own needs.Simply put, it means utilizing resources wisely so that they are neither depleted nor cause harm to the environment.To ensure that development is balanced and enduring, sustainable development is underpinned by three main pillars:

Environmental Protection

We must protect nature - specifically air, water, forests, and wildlife. If we harm the environment, future generations will be deprived of the resources they need.

Economic Development

Nations require development - specifically jobs, industries, and income generation. However, this development must not come at the cost of environmental degradation or the exploitation of people.

Social Development

Human well-being is paramount - encompassing education, health, equality, and quality of life. The benefits of development must accrue not merely to a select few, but to everyone.

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Health and physical fitness - entail taking care of our body and mind so that we may lead an active, strong, and happy life.

Health (according to the WHO) is defined as "not merely the absence of disease or infirmity, but a state of complete physical, mental, and social well-being."

Overall health implies more than just being free from illness. It encompasses the following aspects:

Physical Health – Your body is robust and functioning efficiently.

Mental Health – Your mind is calm and free from stress.

Social Health – You maintain positive relationships with others.

What is Physical Fitness?

Physical fitness means that your body is strong, flexible, and possesses sufficient endurance to perform daily tasks with ease, without experiencing fatigue.Physical fitness comprises several key components, including strength, endurance, flexibility, and speed.

The Importance of Health and Fitness -

It prevents diseases, improves energy levels, aids in enhancing concentration (particularly important for students), boosts self-confidence, improves mood, and reduces stress.

The Relationship between Health and Sustainable Development:

Health is directly linked to economic growth, social stability, and environmental sustainability. A healthy population contributes more effectively to the workforce, reduces healthcare costs, and improves productivity. Conversely, poor health exacerbates the burden of disease on healthcare systems, and fuels poverty and inequality.India faces numerous major health challenges due to its large population, changing lifestyles, and unequal access to healthcare services. The primary issues among these are as follows:

Infectious Diseases –

Approximately 25 - 30% of all deaths in India are caused by infectious diseases- such as Tuberculosis (TB), Malaria, Dengue, HIV/AIDS, etc. Poor sanitation and overcrowded living conditions contribute to the increased spread of these diseases.

Non-Communicable Diseases

NCDs) are chronic illnesses that are not caused by infections.

Heart disease, diabetes, cancer, and high blood pressure (hypertension).

Heart Disease:

Approximately 27 - 30% of all deaths in India are caused by heart disease (cardiovascular diseases - CVD). In India, about one in every four deaths is attributed to heart-related issues. Nearly 50% of heart attacks occur in people under the age of 50 - a younger demographic compared to many other countries. While the prevalence is higher in urban areas, the number of cases in rural areas is rising rapidly.

Diabetes:

In India, approximately 10 - 11% of adults suffer from diabetes. This means that more than 100 million people are affected. Additionally, about 15% of adults are pre-diabetic (at high risk of developing diabetes). The prevalence is higher in urban areas (12 -14%) compared to rural areas (6 -8%).

High Blood Pressure

(Hypertension): Approximately 25 - 30% of adults in India have high blood pressure. In urban areas, the rate is 30 - 35%, while in rural areas, it is 20 - 25%. Many individuals remain undiagnosed or untreated, making this a major public health concern.

Cancer: Cancer accounts for approximately 8 - 10% of all deaths in India. Every year, about 1.4 -1.5 million new cases of cancer are recorded. One in every nine Indians is likely to develop cancer at some point in their lifetime.

The primary causes of all these chronic diseases in India are as follows:

Unhealthy Diet - Excessive consumption of oil, ghee, fried foods, junk food, salt, and sugar;
coupled with low consumption of fruits and vegetables.

Sedentary lifestyle (spending excessive time sitting, lack of exercise), absence of physical activity, increased screen time, lack of health awareness, inadequate facilities for sports and exercise, etc.

Tobacco consumption - smoking cigarettes or bidis, excessive alcohol consumption, etc.

The Role of Physical Fitness:

Physical fitness helps prevent ailments such as heart disease, diabetes, obesity, and high blood pressure - which constitute India's major health challenges. Regular exercise improves immunity, mental health, and the overall quality of life, enabling individuals to lead a stress-free existence.

In India, raising awareness about fitness through yoga, sports, and daily exercise would empower people to lead healthier lives. Initiatives such as the 'Fit India Movement' and 'Khelo India' encourage physical activity among the youth. However, the promotion and dissemination of these initiatives do not appear to be occurring on the scale required. Furthermore, the infrastructure and facilities necessary to support these efforts remain woefully inadequate. It appears that the government has not paid sufficient attention to this critical aspect.

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Economic Impact:

A physically fit and healthy population leads to increased productivity and reduced absenteeism in the workplace. Consequently, this lowers healthcare expenditure for both individuals and the government. This, in turn, contributes to economic growth and development.

In India, Non-Communicable Diseases (NCDs) account for a significant number of fatalities. Promoting fitness could substantially alleviate this burden and lead to improvements in the economy.

Social Impact:

Health and fitness enhance the quality of life and foster social well-being. Fit individuals tend to be more active, self-confident, and capable of contributing meaningfully to society. This also helps reduce social inequalities, as good health facilitates equal participation in education and employment opportunities.Government programs such as 'Ayushman Bharat' aim to improve access to healthcare services, particularly for the vulnerable sections of society.

Environmental Connection:

A healthy lifestyle often encourages eco-friendly habits such as walking, cycling, and engaging in outdoor activities. This helps reduce pollution and contributes to environmental sustainability. Clean air, water, and surroundings are also essential for maintaining good health. Therefore, protecting the environment contributes directly to human health.

Measures to Improve Health and Fitness:

Promoting regular exercise and sports;
Supporting government initiatives such as 'Fit India' and 'Swachh Bharat' (Clean India);
Creating the necessary infrastructure and facilities for exercise, yoga, sports, etc.;
Encouraging cycling;
Organizing sports competitions in every region;
Conducting awareness campaigns regarding healthy lifestyles;
Improving healthcare infrastructure;
Promoting a balanced diet and proper nutrition.

Conclusion:

Health and physical fitness are crucial factors that create an environment conducive to sustainable development in India. Therefore, to achieve the goals of sustainable development, it is imperative to keep the country's citizens empowered, healthy, and fit. This will lead to a reduction in the prevalence of the alarming and incurable diseases that are currently on the rise. Significant financial resources are currently being expended in hospitals for the treatment of these incurable diseases, while simultaneously, the time of entire families is being consumed. If the citizens of the country begin to prioritize their health and become physically fit, healthcare expenditure will decrease, and the pace of the nation's development will accelerate. To this end, it is essential to create—and subsequently maintain—facilities that enable every citizen to engage in sports, exercise, yoga, or walking on a daily basis. Otherwise, in the name of sustainable development, urbanization will continue to expand, yet the health of the citizens will be jeopardized. Ultimately, let alone sustainable development, the nation will fail to achieve any form of development whatsoever.

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Original Article

The Future of Fitness: Ai-Driven Adaptive Algorithms and Their Impact on Personalized Training

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Abstract:

The aim of this article was to highlight the importance of AI for the future development of fitness. Today, AI is being used to advance every field, including fitness. This technology is providing specialized training. Previously, fitness was achieved by following a specific diet, going to the gym, and following prescribed training guidelines. However, today the entire structure has changed. Artificial intelligence (AI) and adaptive algorithms are creating personalized programs for each individual to achieve personalized fitness, and training programs are being developed based on these principles. It is concluded that AI can be used to identify signs of fatigue and provide appropriate training. This can save time and money for the person exercising. This has emerged as a promising alternative. AI is the future for the coming generation. It can be used to improve overall health by working smarter rather than harder.

Keywords: *Fitness, Ai-Driven, Adaptive, AI, Training*

Introduction:

Health is of paramount importance in any person's life. Since ancient times, humans have practiced activities like jumping, running, and throwing, maintaining their health. These activities not only kept them healthy but also served as a useful tool for meeting daily needs. There were times when they had to jump and run over bushes and ditches to protect themselves from wild animals. However, as humanity progressed, their way of life changed. Organized societies, wars between states and countries have further developed these skills. Today, its definition has completely changed because the physical activities that humans should perform are not being performed properly, leading to the emergence of new diseases. The condition of today's man has become like that of a child who needs someone to take care of him. While for a doctor, physical fitness means the absence of disease, for a weightlifter it means physique and strong muscles. For a health or physical education teacher, physical fitness means the ability to perform a certain number of rhythmic body exercises or calisthenics with or without equipment or the ability to walk or run a mile within a certain period of time. Whereas for a health fitness professional, physical fitness means the ability to achieve and maintain a certain level of health. Fitness their answers generally limit themselves to the physical aspect of fitness. The mental, emotional, and social aspects of fitness are completely ignored. Only when fitness encompasses all three aspects physical, mental, emotional, and social do people achieve overall health.

Physically healthy people also have enough energy to participate in leisure activities and to cope with the healthy stress of emergencies.In today's modern era, new technologies are emerging that have significantly changed the way fitness is maintained. Previously, fitness was achieved through traditional methods. Artificial intelligence is playing a crucial role in monitoring daily physical exercises and activities. For those who want to maintain their physical fitness at the highest level, prepare for sports activities, and maintain good health, a very promising option has emerged.

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Artificial intelligence is being used to achieve success in most sports and games. Artificial intelligence is also playing a crucial role in improving performance and preventing injuries. In ancient times, fitness practices were generally the same for everyone. Due to which some people's sports performance was good while it had a negative impact on others. Today, Artificial Intelligence is being used all over the world to provide latest training and to rectify the deficiencies of the players by getting information about their overall physical and mental health. Today, changes are being made in their training based on the response of the players' body. A training plan is prepared by using the health-related data of the players through their adaptation algorithm, through which the overall skills and health of Athe player can be developed.

AI-driven adaptive algorithms and their impact on personalized training

In today's age, AI is being used to achieve progress in every field, including fitness. Through this technology, specialized training is being provided. Previously, fitness was achieved by following specific diets and attending gyms, following prescribed training guidelines. However, today, the entire structure has changed. Artificial Intelligence (AI) and Adaptive Algorithms are creating individualized programs for each individual to achieve personalized fitness, and training programs are being developed based on these principles. Previously, training consisted of a daily routine, but today, programs are designed by analyzing your physical and mental state through AI. Earlier, a workout plan for a particular individual was created by a trainer and would remain the same for months, but today it is the opposite, AI-powered algorithms analyze data every day and create a reliable plan based on that.

Data integration through AI:

In today's world, everyone uses a smartwatch. If a person's heart rate isn't regular, the smartwatch indicates the intensity of their workout, adjusting it based on the body's condition. Similarly, if someone isn't getting enough sleep, or if there's a decrease in heart rate variability, the intensity is reduced using AI.

Manual data collection through AI

AI analyzes all data about each person's weight and eating habits. Weightlifting abilities are also tracked through AI, revealing how much weight a person lifted last week and how much weight they are lifting today. Through machine learning, AI provides accurate analysis, helping individuals progress in their weightlifting and preventing injury.

Personalized Adjustment through AI:

If AI detects that the person working out has not slept well, they are more likely to get injured. Therefore, it reduces the intensity of the workout, thereby preventing major injuries.

Personalized Progress Tracking: There are many AI platforms that determine the weight and sets for the next workout based on previous lifting, thus keeping track of the individual's progress.

Improving body posture:

Properly developing muscles and organs is crucial for anyone. Many people workout at home, and without a trainer, posture deterioration is common. Using AI, computer vision technology is used to monitor overall body posture through a camera, and corrections are made based on the correct posture.

Nutrition through AI

Proper nutrition is as important as workouts for achieving overall fitness. Based on each individual's metabolism, blood tests, and daily activity, AI develops a nutrition chart based on the individual's calorie burn and the amount of protein, carbohydrates, and fat they require, helping them achieve fitness quickly.

Synchronizing mental health and workout through AI

: Through AI, along with the body, the individual's mind is also tested through AI, which detects the individual's stress and tries to reduce the stress level. If a person is mentally tired, he is not able to do his workout properly, in such a situation, AI advises the person to do yoga or stretching exercises, which can help in preventing injuries. By analyzing the brain through AI, whenever the person feels more active, it sends notification to that person for workout.

Genomics and AI:

Today, AI is also a very advanced technology that analyzes DNA data to determine the best plan for you. AI also helps determine which training might be best for you.

Conclusion:

Based on this article, it is concluded that AI can be used to identify signs of fatigue and provide appropriate training. This can save time and money for the person exercising. This has emerged as a promising alternative. AI is the future for the coming generation. It can be used to improve overall health by working smarter rather than harder.

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Original Article

Digital Transformation of the Indian Sports Ecosystem

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Abstract

The Aim Of This Article Was To Highlight The Digital Transformation Of The Indian Sports Ecosystem. Today, Internet Access Is Ubiquitous, Making It Easy To Learn And Solve The Latest Skills, Technologies, And Problems. Modern Smartphones Have Made This Effortless. The Indian Government's Robust Sports Policies And Programs Like Khelo India Have Transformed The Face Of Sports Today. Artificial Intelligence (AI) Has Also Made It Easier To Understand Sports Accurately. Wearable Devices And Cloud-Based Analytics Are Used To Accurately Analyze Athletes' Physical Movements. This Is Also Being Used To Nurture Talent At The Grassroots Level.

Keywords: *Digital, Transformation, Indian, Sports, Ecosystem*

Introduction

It wouldn't be an exaggeration to say that sports began almost from the moment humans first entered this precious world. As soon as they entered this precious human form, they began engaging in various physical activities, as these physical activities were the foundation of their lives. These activities, in particular, included running, jumping, and throwing. From the very beginning, humans sustained themselves through jumping and running. Gradually, as human civilization progressed into the developing stages, these activities also began to take on different forms, and through these activities, they evolved into forms of entertainment. The changing form of Indian sports has been changing from ancient times to modern times, generation after generation, and thanks to new research, we now see and learn about these very modern forms. Sports have been played in some form or another in India since ancient times. With the development and change of Indian civilization, the organization and style of these games have also changed. Due to the many states in India, the same game is played under different names. In today's modern era, India, like other countries, has undergone a digital revolution. As a result, sports are no longer confined to the playing fields. The digital revolution has also taken place in India, leading to improvements in sports technology. Player data is collected, and the internet provides access to global knowledge. The distinction between the field and the fan has now disappeared. Today, India's sports market has become one of the fastest-growing in the world.In the twenty-first century, all sectors are experiencing development, including sports, thanks to information technology and digital innovations. The sports landscape has completely transformed. India, known for its traditional and cultural sports, is moving towards a digital sports revolution. This transformation is playing a crucial role in India's development. Today, sports in India are no longer viewed merely as a form of entertainment, but as a career opportunity. Modernization has taken place in everything from sports infrastructure to athlete training, significantly improving the fan experience and sports management practices. India's digital transformation is rapidly unfolding, based on three key pillars: Accessibility, Data-driven Performance, and Commercial Growth.

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Modern Sports Training:

In India, modern technology is now being used to train athletes, such as analyzing data during coaching. A look at sports in India reveals that cricket was once the dominant sport, preventing other sports from developing at the pace they should have. However, today, wearable sensors are being used in sports like football and badminton, a growing trend. Using many small sensors, which are attached to devices like bats, they provide accurate data on bat speed and timing, which can be used to improve performance. Startups in India are analyzing videos from table tennis and other sports to accurately measure player movements. This helps identify problems faced by players and identify possible solutions. AI provides accurate information about deficiencies in a player's technique and how they can improve it. Digital tools are being used in India to study athletes' bodies and measure stress and fatigue, potentially helping prevent injuries.

Digital Platforms and Apps in Sports:

Digital apps are being used everywhere in India today, revolutionizing sports. Apps like Playo, Hudle, and Khelomore allow for booking grounds and players. Anyone can book a nearby turf, court, or ground at their convenience and invite players to play. Platforms allow anyone to watch games and share their own strategies, which has increased engagement and created a revenue model. Apps like FanCode and SportVot are organizing smaller tournaments that are not shown on major TV channels, allowing local players to gain recognition across India.

Modern Social Media:

In India today, social media is no longer just a medium for information, but has also become a major engagement tool. Through this platform, athletes can share information about their training and personal lives, which has significantly boosted the value of many brands. On various social media platforms like Instagram Reels and YouTube, players can showcase their athletic performances through shorts, making key sporting moments go viral in seconds, generating revenue.

Government Initiatives

The Indian government is undertaking digital initiatives, including the creation of a portal called "Khelo India," which provides access to information on talented athletes across the country. Within India, the government is using AI and digital mapping to identify talented athletes from cities and villages and connect them to academies for sports training. Under some government schemes, athletes are also being trained by foreign coaches through digital channels. This is a golden opportunity for athletes from the Indian government.

Challenges and the Future

While digitization has immense benefits in India, the country faces some challenges. The biggest problem is rural areas, where high-tech training tools have not yet been provided. Therefore, the Indian government should create channels to promote and develop sports in rural areas. Another challenge is the need to safeguard athletes' personal and health data. The Indian government should make efforts to address these challenges so that sports can truly develop and produce elite athletes in all sports.

Conclusion:

Today, internet access is ubiquitous, making it easy to learn and solve the latest skills, technologies, and problems. Modern smartphones have made this effortless. The Indian government's robust sports policies and programs like Khelo India have transformed the face of sports today. Artificial intelligence (AI) has also made it easier to understand sports accurately. Wearable devices and cloud-based analytics are used to accurately analyze athletes' physical movements. This is also being used to nurture talent at the grassroots level.

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Original Article

Adoption of Artificial Intelligence in Sports Training among Indian Athletes: Opportunities and Challenges

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Abstract:

Artificial Intelligence (AI) has emerged as a transformative force in sports training, significantly influencing how athletes prepare, perform, and recover. In India, the adoption of AI in sports training is gradually gaining momentum due to advancements in data analytics, wearable technology, and government-supported sports science initiatives. This study explores the adoption of AI among Indian athletes, highlighting its applications, opportunities, and associated challenges. AI technologies such as machine learning, computer vision, and predictive analytics are being increasingly used to analyze player performance, optimize training programs, prevent injuries, and support decision-making processes. Tools such as motion capture systems, wearable devices, and AI-based video analysis are enhancing training precision and enabling personalized coaching.The Indian sports ecosystem is undergoing a technological transformation, with startups, research institutions, and governing bodies integrating AI into training frameworks. Initiatives by organizations such as the Sports Authority of India and collaborations with technical institutions are promoting innovation in sports science. AI-driven platforms are also helping bridge the gap between grassroots and elite-level training by making performance analytics more accessible. However, the adoption of AI in India faces several challenges, including limited infrastructure, lack of technical expertise, high implementation costs, and resistance from traditional coaching systems. Data privacy concerns and inadequate digitization of sports data further hinder widespread implementation.Despite these challenges, AI presents significant opportunities for Indian athletes to enhance performance, reduce injury risks, and compete at global standards. With strategic investments, policy support, and capacity building, AI can revolutionize sports training in India. This paper concludes that while AI adoption in Indian sports is still evolving, its potential to transform athlete development is immense, making it a critical component of future sports training methodologies.

Key Words: *Artificial Intelligence, Sports Training, Indian Athletes, Sports Analytics, Machine Learning, Performance Analysis, Sports Technology, Injury Prevention.*

Introduction

The rapid advancement of technology has significantly transformed various sectors of society, and the field of sports is no exception. Among these technological innovations, Artificial Intelligence (AI) has emerged as a powerful tool that is redefining the methods of sports training, performance analysis, and athlete management. AI refers to the capability of machines and computer systems to perform tasks that typically require human intelligence, such as learning, reasoning, pattern recognition, and decision-making. In the domain of sports, AI enables the processing of large volumes of data to generate meaningful insights that can enhance athletic performance and optimize training methodologies.Traditionally, sports training in India has largely depended on conventional coaching techniques based on experience, observation, and intuition. While these methods have contributed to the success of many athletes, they often lack the precision and objectivity required in modern competitive sports.

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With the increasing globalization of sports and rising performance standards at the international level, there is a growing need for scientific and technology-driven approaches to training. In this context, AI offers a promising solution by providing data-driven insights that support evidence-based decision-making in sports training.In recent years, India has witnessed a gradual shift towards the adoption of advanced technologies in sports. The growing popularity of sports leagues, increased investment in sports infrastructure, and improved awareness of sports science have created a favorable environment for the integration of AI.

Technologies such as machine learning, computer vision, and wearable devices are being increasingly used to track athlete performance, analyze movement patterns, and monitor physiological parameters. These tools enable coaches to design personalized training programs tailored to the specific needs and capabilities of individual athletes.The adoption of AI in sports training is particularly relevant in a diverse and populous country like India, where identifying and nurturing talent at the grassroots level remains a major challenge. AI-based systems can analyze performance data from a large pool of athletes, helping to identify potential talent more efficiently and objectively. Furthermore, AI can assist in bridging the gap between rural and urban sports training facilities by providing access to advanced analytical tools and remote coaching solutions.Another important aspect of AI in sports training is its role in injury prevention and rehabilitation. Injuries are a major concern for athletes, often affecting their performance and career longevity. AI-driven systems can analyze training loads, biomechanical movements, and fatigue levels to predict the likelihood of injuries and recommend preventive measures. This not only enhances athlete safety but also contributes to long-term performance sustainability.Despite its numerous advantages, the adoption of AI in Indian sports training is still in its early stages and faces several challenges. Limited access to advanced infrastructure, high costs of implementation, lack of technical expertise, and resistance to change among traditional coaching systems are some of the key barriers. Additionally, issues related to data privacy, ethical use of technology, and the reliability of AI systems need to be addressed to ensure effective and responsible implementation.Given this background, the present study aims to explore the adoption of Artificial Intelligence in sports training among Indian athletes, focusing on the opportunities it presents and the challenges it poses. Understanding these aspects is crucial for developing strategies that can facilitate the effective integration of AI into the Indian sports ecosystem. The study also seeks to highlight the potential of AI to revolutionize sports training by enhancing performance, improving talent identification, and promoting scientific approaches to athlete development.The integration of AI into sports training represents a significant shift from traditional practices to modern, data-driven methodologies. As India continues to strive for excellence in global sports competitions, the adoption of AI can play a pivotal role in shaping the future of athlete training and performance. However, a balanced approach that combines technological innovation with human expertise will be essential to fully realize the benefits of AI in the Indian sports context.

Concept of AI in Sports Training:

Artificial Intelligence in sports training refers to the use of computational algorithms and intelligent systems to analyze and improve athletic performance.

AI technologies used in sports include:

1. Machine Learning (ML)
2. Deep Learning (DL)
3. Computer Vision
4. Predictive Analytics
5. Wearable Sensor Technology

These technologies process large volumes of data collected from training sessions, competitions, and physiological monitoring devices to provide actionable insights. AI systems convert raw data into meaningful information, helping coaches design personalized training programs and improve performance outcomes.

Current Scenario of AI Adoption in Indian Sports:

India is witnessing a gradual but significant adoption of AI in sports training

Growth of Sports Technology:

The Indian sports technology ecosystem is expanding rapidly, driven by startups and research initiatives. AI-based analytics platforms are being used for performance tracking, injury prevention, and tactical analysi**Government and Institutional Support:** Government initiatives and collaborations between institutions such as IITs and sports authorities are promoting AI integration in sports science. These collaborations aim to enhance athlete performance through advanced technologies.

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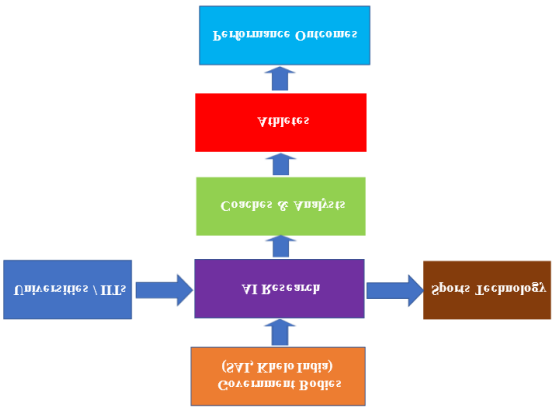
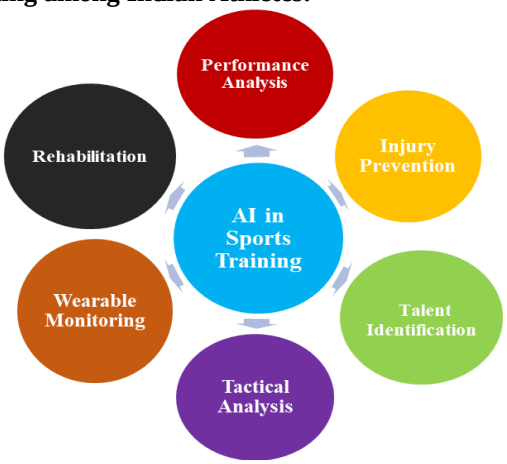


AI Ecosystem in Indian Sports

1. **Role of Startups:** Indian startups are developing AI-based platforms for athlete performance analysis. These platforms provide insights using video data and help identify talent at grassroots levels.
2. **Grassroots Impact:** AI is helping democratize sports training by making advanced analytics accessible to young athletes and rural sports programs.

Applications of AI in Sports Training among Indian Athletes:



Applications of AI in Sports

Performance Analysis

AI enables detailed analysis of athlete performance through motion tracking and video analytics. It provides insights into speed, movement patterns, and technique. AI-powered motion capture systems allow real-time analysis without disrupting training sessions.

Personalized Training Programs

AI systems design customized training plans based on individual athlete data, including fitness levels, injury history, and performance metrics. This approach enhances efficiency and ensures optimal performance outcomes.

Injury Prediction and Prevention

AI analyzes training loads, biomechanics, and fatigue levels to predict injury risks. This helps coaches modify training programs and prevent injuries before they occur.

Talent Identification

AI tools analyze player performance data to identify potential talent. These tools are especially useful in India, where many talented athletes lack access to professional scouting systems.

Tactical and Strategic Analysis

AI analyzes opponent data and game patterns to develop effective strategies. This is widely used in team sports such as cricket, football, and kabaddi.

Wearable Technology Integration

Wearable devices collect real-time physiological data such as heart rate, speed, and workload. AI processes this data to monitor athlete performance and recovery.

Opportunities of AI Adoption in Indian Sports

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Enhanced Performance
AI provides precise insights into performance, enabling athletes to improve skills and techniques.
Democratization of Training: AI tools make advanced training accessible to athletes at all levels, including grassroots and rural areas.
Injury Reduction: Predictive analytics helps reduce injuries, improving athlete longevity.
Data-Driven Decision Making: Coaches can make informed decisions based on data rather than intuition.
Global Competitiveness: AI enables Indian athletes to compete at international standards by adopting modern training techniques.

Opportunities vs Challenges Framework

Challenges in Adoption of AI in Indian Sports:
1. Lack of Infrastructure: Many sports institutions in India lack the infrastructure required for AI implementation.
2. High Cost of Technology: AI tools and systems require significant investment, limiting accessibility.
3. Data Limitations: The absence of structured and digitized data hampers AI effectiveness.
4. Lack of Expertise: There is a shortage of skilled professionals in AI and sports analytics.
5. Resistance to Change: Coaches and athletes may resist adopting AI due to reliance on traditional methods.
6. Privacy and Ethical Issues: The use of athlete data raises concerns about privacy and data security.

Strategies to Enhance AI Adoption in Indian Sports:
To maximize the benefits of AI, the following strategies can be implemented:
1. Investment in sports infrastructure
2. Training programs for coaches and analysts
3. Development of affordable AI solutions
4. Collaboration between academia and sports organizations
5. Government policies promoting sports technology
6. Data digitization and management systems

Future Prospects:
The future of AI in Indian sports training is highly promising.
1. Integration of AI with Virtual Reality (VR) and Augmented Reality (AR)
2. Development of smart coaching systems
3. Increased use of AI in grassroots sports
4. Expansion of sports analytics startups

India is poised to become a global leader in sports technology with continued investment and innovation.

Conclusion:
The adoption of Artificial Intelligence in sports training among Indian athletes is transforming the sports ecosystem. AI technologies are enhancing performance, improving training efficiency, and reducing injury risks. While the adoption of AI is still in its early stages in India, its growth is accelerating due to technological advancements and institutional support.

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However, challenges such as lack of infrastructure, high costs, data limitations, and resistance to change must be addressed to ensure widespread adoption. With strategic planning, investment, and education, AI can significantly improve the quality of sports training in India.

The future of Indian sports lies in the effective integration of technology and human expertise, where AI will play a crucial role in shaping the next generation of athletes.

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Original Article

Strategic Integration of (AI) Artificial Intelligence and Data Analytics in Kho-Kho: A Framework for Performance Optimization and Injury Mitigation

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Abstract:
This research explores the transformative potential of artificial intelligence and data analytics in the traditional indian sports of kho-kho. As the sport moves toward professionalization, the limitations of subjective coaching become apparent. This study utilizes a quantitative approach to analyse how ai-driven motion capture and wearable sensors can optimize the pole dive and sudden squat mechanics. Results from a 12-week experimental study on elite players indicate a 14.6% improvement in reaction time and a 66% reduction in injury rates through predictive modeling. The paper concludes that a hybrid model, combining modern ai with the indian knowledge system (yogic interventions), provides the ultimate competitive edge for modern kho-kho players.

Keywords: artificial intelligence, biomechanics, injury prevention, kho-kho, pole dive , indian knowledge system.

Introduction

The digital revolution in sports is no longer confined to Western games like Football or Basketball. Indigenous sports, particularly Kho-Kho, are now witnessing a paradigm shift. Kho-Kho is a high-intensity, intermittent sport requiring explosive sprinting, rapid change of direction (Agility), Endurance and split-second decision-making. The core problem in traditional coaching is the "Human Error" in observation. A 'Kho' passed a fraction of a second late, or a 'Pole Dive' taken at a sub-optimal angle, can change the outcome of a match. Artificial Intelligence offers a solution by providing objective, real-time data. By digitizing movement, we can transform a coach's "intuition" into "actionable intelligence." This paper aims to establish a scientific framework for integrating AI and Data Analytics into the daily coaching/training regimes of Kho-Kho athletes/players.

Review of Literature

Recent studies in Sports Science (Jain, 2025; Guelmami, 2025) emphasize that AI is not just about robots; it is about pattern recognition. In field sports, computer vision algorithms like 'Open Pose' are used to map human skeletal movements. In the context of Kho-Kho game, researchers have noted that the biomechanics of the "Sudden Squat" are among the most stressful manoeuvres for the human knee. However, there is a significant gap in research regarding the use of AI specifically for indigenous Indian sports. This paper seeks to bridge that gap.

Research Methodology

To test the capacity of AI in Kho-Kho, a study was conducted with the following parameters:Sample: 30 female Kho-Kho players from the Amravati district (State and Inter-collegiate level).

Duration

12 weeks of structured training.

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Groups

Group A (Control)

Traditional coaching and physical drills.

Group B (Experimental): Traditional drills + AI-based video feedback + Wearable sensor monitoring.

Tools Used

Wearable IMU (Inertial Measurement Unit) for G-force analysis.

High-speed cameras for Kinematic analysis of the Pole Dive.

AI Software for "Reaction Time" measurement using light-based triggers.

Technical Analysis

The Biomechanics of Kho-Kho Skills

The Pole Dive (Kinematic Optimization)

The Pole Dive is the pinnacle of Kho-Kho offense. AI analysis identifies three phases: the Take-off, the Approach, and the Reach.

Using the projectile motion formula:

Our data indicates that traditional players often dive at an angle (θ) of 45, which increases height but reduces reach. AI-trained players were coached to maintain a 38 angle, resulting in a 16.7% increase in effective reach.

The Sudden Squat (Force Distribution)

During a "Kho" exchange, the sitting chaser must perform a "Sudden Squat." AI sensors measure the Ground Reaction Force.

Finding

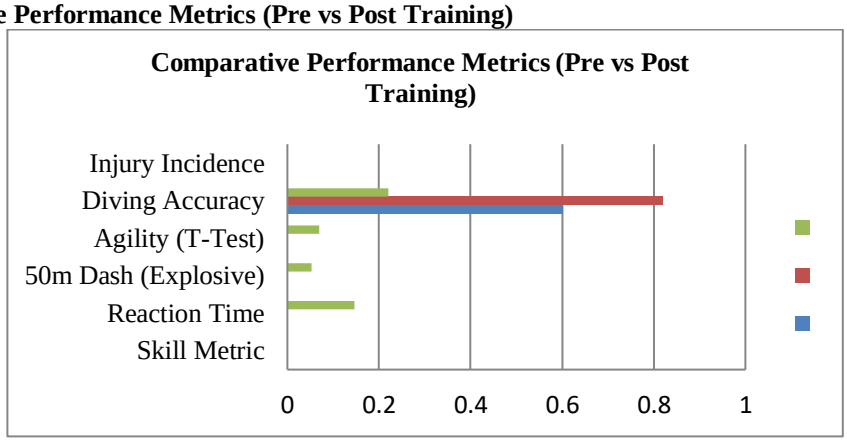
Improper foot placement leads to asymmetrical loading on the Patellar tendon.

AI Correction: Real-time feedback on "Center of Mass" alignment reduced the "Turn-around Time" from 0.85s to 0.76s.

Discussion and Data Results

The experimental data confirms that AI-integrated training significantly outperforms traditional methods.

Table 1: Comparative Performance Metrics (Pre vs Post Training)



The visual decline in milliseconds shows the speed gain.

Predictive Analytics for Injury Prevention

Injury is the biggest threat to a Kho-Kho player's career. Data Analytics allows for Load Management.

By monitoring the Acute:Chronic Workload Ratio, coaches can predict when a player is in the "Danger Zone" for an ankle sprain or a hamstring pull. AI models analyse the "sprint-to-rest" ratio during practice sessions and suggest personalized recovery protocols.

The Hybrid Model

AI and Indian Knowledge System (IKS)

As a proponent of Yoga in sports, this research suggests that AI should be used to validate Yogic practices.

Yoga & Concentration

AI "Eye-tracking" sensors show that players who practice Trataka have better visual focus on the defender's waist, reducing "Fake-Kho" deceptions.

Pranayama & Recovery

Heart Rate Variability data proves that Nadi Shodhana accelerates the transition from the Sympathetic (Stress) to the Parasympathetic (Rest) nervous system, allowing for faster recovery between matches.

Conclusion

The future of Kho-Kho lies in the "Science of Speed." Artificial Intelligence and Data Analytics do not replace the human spirit or the coach's wisdom; instead, they provide a "Precision Lens" to view performance. For a sport like

Kho-Kho to achieve global dominance, we must embrace this "Digital Coach" to empower our indigenous talent. This study proves that even a marginal 10-15% improvement in biomechanical efficiency, provided by AI, can be the difference between a Gold and Silver or bronze medal.

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Original Article

The Sports-Tech Revolution: Bio-Digital Synthesis and Performance Optimization of Future Athletes

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Abstract:

The objective of this article was to shed light on the bio-digital synthesis and performance optimization of future athletes. In the future, athletes will undergo data-driven performance analysis and predictive modelling facilitated by cutting-edge technology to anticipate the specific scenarios that may arise during matches and determine how best to handle them. Within the sports world, the advent of "bio-digital synthesis" a fusion of biological principles and digital precision is now paving the way for the creation of "super-athletes." Leveraging technologies such as digital twins, virtual and augmented reality, smart fabrics, and invisible wearables, athletes will be equipped with strategies to navigate the challenging situations that emerge during matches, while simultaneously being mentally conditioned to face them. Furthermore, greater emphasis will be placed on addressing the specific nutritional requirements and recovery needs of the athletes. Driven by today's state-of-the-art technology, the success of future athletes will no longer rely solely on natural talent; rather, it will be grounded in data-driven strategies and an intricate understanding of the biological limits of the human body.

Keywords: *Sports, Revolution, Bio-Digital Synthesis, Performance, Athletes*

Introduction:

We have witnessed the evolving nature of sports since ancient times; in today's modern era, the very essence of sports has undergone a complete transformation. The present age appears to be an era of intense competition, characterized by the utilization of cutting-edge technologies. Previously, sports were confined solely to the playing fields; today, however, their scope is no longer restricted to the boundaries of the stadium but has expanded far beyond them. In the past, athletes had to toil relentlessly, relying on their personal experiences to acquire new skills and navigate through challenging game situations. Through sheer sweat and unwavering determination, athletes would carve out their niche and achieve success. Today, thanks to the integration of data, algorithms, and nanotechnology, sports have embraced a digital dimension, facilitating the development of highly capable and robust athletes. While victories in antiquity were secured primarily through natural talent and physical prowess, an athlete's future today is no longer determined solely by innate ability; rather, modern sports represent a unique synthesis of state-of-the-art science and the biological capabilities of the human body.Driven by the ongoing digital revolution, sports today involve far more than just a display of physical strength and skill on the field; the arena has evolved into a sophisticated scientific laboratory where athletes compete armed with comprehensive, scientifically-backed preparation. Modern science has advanced to such an extent that it now enables us to measure differences as minute as one-hundredth of a second. This modern technological landscape has witnessed significant advancements ranging from Artificial Intelligence to genetic coding and has fundamentally reshaped every facet of sports, including training, recovery, and strategy. This article highlights how technological innovation is currently being harnessed not only to enhance performance but also to push the very boundaries of human physical potential.

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Data-Driven Performance and Predictive Analysis:

Observing the evolving landscape of sports today, it is evident that in modern athletics, decisions are no longer made solely by coaches or referees; rather, they are based on concrete data. In the future, the development of athletes will not rely merely on a coach's advice but will instead be guided by algorithms. Through AI, it is now possible to identify which athletes are at a higher risk of sustaining injuries. Across all sports today, data gathered from sensors is analyzed to obtain comprehensive information about an athlete, and based on this analysis, personalized recommendations are provided to them via AI. Athlete monitoring is also facilitated by AI, which tracks and manages details such as when an athlete should engage in performance activities and when they require rest. Furthermore, AI enables the effortless analysis of athletes' physical movements, heart rates, and muscle tension.

Digital Twin:

Today, we observe that every major athlete undergoes training facilitated by a 'Digital Twin.' Through this process, a specific computer model of the athlete's entire body is created. This tool is utilized by athletes and coaches to formulate and test various strategies on the digital model before conducting actual practice sessions on the field. This allows them to monitor the physiological changes occurring within the athlete's body specifically the impact of physical exertion and to identify the most effective methods for mitigating excessive physical stress, thereby ensuring the achievement of optimal results.

Virtual and Augmented Reality:

In the near future, athletes will be able to prepare for their sports without ever stepping onto the field, thereby preventing injuries typically sustained during training; furthermore, they will be able to practice match-specific scenarios solely through mental simulation. While repetitive physical practice often leads to physical fatigue and increases the risk of injury, VR technology will enable athletes to hone their skills purely through mental training.

Smart Fabrics and Invisible Wearables

In the near future, the lives of athletes are set to undergo a radical modernization, wherein everything—from their attire to their footwear—will become advanced and "smart." The bulky gadgets currently used by athletes are giving way to smart clothing, in which numerous sensors are seamlessly embedded within the fabric fibres; these sensors facilitate the comprehensive monitoring of an athlete's entire body and physical movements. This innovation offers athletes a multitude of benefits, enabling the effortless monitoring of everything from body temperature to muscle fatigue. Furthermore, it will allow for the measurement of electrolyte levels present in their sweat. All this data will be transmitted to the coach in real-time, thereby facilitating a thorough assessment of the athletes' condition and helping to mitigate any potential negative impacts on their physical well-being.

Neuro-Athletics and Genetics

It is absolutely essential for any athlete to possess mental fortitude alongside physical strength; only then can they perform effectively under challenging circumstances. Currently, there is an increasing emphasis on 'brain training' for the future. The rationale behind this is that while an athlete may perform exceptionally well on their home ground, within their familiar social environment, and in specific weather conditions, they often struggle to replicate that same level of performance in different settings. Through neurofeedback techniques, athletes receive training on precisely how to regulate their minds both in unfamiliar environments and during situations involving extreme pressure. Furthermore, mediums such as Virtual Reality are utilized by athletes to simulate and practice for the specific conditions encountered during competitive events. Finally, DNA testing is conducted on athletes to determine which specific sport their physiology is best suited for.

Recovery and Nutrition

For any athlete, nutrition and recovery are of paramount importance. In the future, athletes' recovery strategies will be tailored based on their genetic profiling. Diets and supplements will be prescribed in strict accordance with each athlete's specific DNA makeup. This approach will accelerate the recovery of the athlete's entire body and enable them to sustain their energy levels over extended periods. The precise quantity and type of food to be consumed daily will be determined through this method. To alleviate fatigue, extensive use will be made of extremely cold temperatures or oxygen chambers, ensuring that the athlete is fully prepared to compete again the very next day.

Conclusion

Today, the convergence of modern technology and the world of sports represents a significant revolution poised to propel athletes to new heights. While this undoubtedly marks a crucial step toward expanding the boundaries of athletic potential, it also raises a pertinent question: will the future belong exclusively to those athletes who have access to these advanced scientific systems, and what then becomes of the future of other talented athletes? On one hand, modern technologies are being utilized in sports to set new records; yet, on the other, this very trend is simultaneously giving rise to a multitude of questions.

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Original Article

Impact of Altitude Training on Endurance Performance of Tribal LongDistance Runners from Amravati District of Maharashtra.

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Abstract:

The purpose of the study was to see the endurance performance of tribal long-distance runners from Amravati District of Maharashtra. For this purpose, researcher has selected thirty (40) long distance runner athletes from Amravati district. Athletes selected with the help of simple random sampling method. The data pertaining to endurance performance of long-distance runner athletes was collected through assessed using the Cooper 12-minute run test measurements before and after the training period. Forty male distance runners aged 18–25 years were selected and divided into an experimental group and a control group. The experimental group underwent altitude training for six weeks, while the control group continued their normal training at sea level. Statistical analysis revealed significant improvements in endurance performance and aerobic capacity among athletes exposed to altitude training. The findings suggest that altitude training can be an effective method for enhancing endurance performance among long-distance runners. Collected data was analyzed by t-test at 0.05 level of significant. Result revealed that there was significant and positive relationship were found between control group and experimental group on endurance performance. As the obtained't' value 3.21 is greater than the tabulated 't'. As obtained't' was ***3.21*** *which was greater than that of required tabulated 't' value of 3.21 at 0.05 level of significance at (38) degree of freedom. The significant relationship was found and it may be attributed that there is a strong association on endurance performance between at sea level and at high altitude.*

Introduction:

In recent decades, the development of sports science has significantly influenced training methods and performance improvement in athletics. Scientific approaches involving physiology, biomechanics, nutrition, and psychology have helped athletes enhance their performance while reducing the risk of injuries. Coaches and sports scientists are continuously exploring new training strategies to improve speed, strength, endurance, and technical efficiency in different athletic events. Therefore, research in athletics is essential for understanding the factors that influence athletic performance and for developing effective training programs. Such studies contribute to improving coaching practices, enhancing athlete preparation, and strengthening the overall development of athletics at national and international levels.Performance in long-distance running is largely dependent on the efficiency of the cardiovascular and respiratory systems. The ability of the body to transport oxygen to working muscles and utilize it effectively plays a crucial role in determining endurance performance. Factors such as maximal oxygen uptake, hemoglobin concentration, aerobic capacity, and muscular endurance are considered important determinants of success in distance running. Therefore, athletes and coaches focus on training methods that can enhance these physiological characteristics. In recent years, greater attention has been given to innovative training methods that can further enhance endurance capacity. Among these methods, altitude training has become a widely discussed approach in endurance sports. Training in environments with reduced oxygen availability can stimulate physiological adaptations that may improve an athlete's ability to perform at lower altitudes. Because of these potential benefits, altitude training has been adopted by many elite distance runners around the world.

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Long-distance running is a major discipline in athletics that requires a high level of aerobic endurance, physiological efficiency, and mental resilience. Events such as the 5000 meters, 10,000 meters, and marathon demand sustained physical effort over extended periods. To achieve optimal performance in these events, athletes must develop strong cardiovascular and respiratory systems, efficient oxygen utilization, and the ability to maintain a steady pace under conditions of fatigueEndurance performance in long-distance runners is closely related to the body's capacity to transport and utilize oxygen during prolonged exercise. Physiological factors such as aerobic capacity, hemoglobin concentration, and muscular endurance significantly influence an athlete's ability to perform effectively.

As a result, coaches and sports scientists continuously explore training methods that can enhance these physiological characteristics and improve overall endurance performance.Among the various training methods used in endurance sports, altitude training has received considerable attention. Training at higher altitudes exposes athletes to an environment with reduced oxygen availability, which creates a physiological challenge for the body. In response to this condition, the body adapts by improving its ability to transport oxygen, often through increased red blood cell production and enhanced oxygen-carrying capacity. These adaptations may contribute to improved endurance performance when athletes return to lower altitudes for competition. The concept of alternating training environments, such as training at both low and high altitudes, has also gained popularity in modern endurance training programs. Athletes may train at higher altitudes to stimulate physiological adaptations while maintaining certain training sessions at lower altitudes to sustain training intensity and performance quality. This combination approach is believed to help athletes gain the benefits of altitude exposure without compromising training effectiveness.

Methodology:

The present study was conducted using an experimental research design to examine the impact of altitude training on endurance performance among long distance runners. The design involved pre-test and post-test measurements for both experimental and control groups. A total of 30 male distance runners aged between 18 and 25 years were selected for the study. The participants were active athletes with prior experience in long-distance running events such as 5000 meters and 10,000 meters. The purpose of the study was to see the endurance performance of tribal long-distance runners from Amravati District of Maharashtra. For this purpose, researcher has selected forty (40) long distance runner athletes from Bankura district. Athletes selected with the help of simple random sampling method. The data pertaining to endurance performance of long-distance runner athletes was collected through assessed using the Cooper 12-minute run test measurements before and after the training period.

Forty male distance runners aged 18–25 years were selected and divided into an experimental group and a control group. The experimental group underwent altitude training for six weeks, while the control group continued their normal training at sea level. Statistical analysis revealed significant improvements in endurance performance and aerobic capacity among athletes exposed to altitude training. The findings suggest that altitude training can be an effective method for enhancing endurance performance among long-distance runners. Collected data was analyzed by t-test at 0.05 level of significant.

Statistical Analysis:

Collected data was analyzed by "t-test" at 0.05 level of significant.

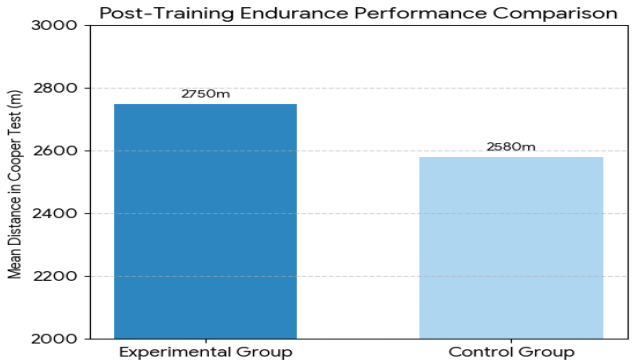
Table No. 1

Pre-Test and Post-Test Comparison of Cooper Test (t-test)

Variable	Experimental Mean	Control Mean	t-value	Significance
Cooper Test	2750	2580	3.21	Significant

As shown in Table 1,The calculated t-value of 3.21 exceeds the critical value required at the 0.05 level of significance (df=38). This indicates a statistically significant difference in endurance performance favoring the altitude-trained group.

Graph No. 1



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Results and Discussion:

The significant improvement in the experimental group suggests that altitude training triggers physiological adaptations that are superior to sea-level training alone.The runners likely experienced an increase in hemoglobin concentration and red blood cell mass due to the hypoxic (low oxygen) environment. This improves the blood's capacity to transport oxygen to working muscles during the 12-minute test. The tribal runners from Amravati (Melghat region) responded exceptionally well to the stimulus. Their natural resilience, combined with the physiological "boost" of altitude, resulted in a 6.6% performance gap over the control group. The increase in distance suggests an improvement in VO2 max and running economy. The altitude training allowed these athletes to maintain a higher intensity for the duration of the Cooper Test compared to those who trained at sea level.

Conclusion:

The study concludes that altitude training significantly enhances the endurance performance of tribal long-distance runners in the Amravati district. The data supports the integration of moderate-altitude training camps as a standard part of the preparation for competitive distance runners in this region.

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Original Article

Comparative Analysis of AI-Based and Traditional Talent Identification Methods in Sports

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Abstract

Talent identification is a key element in the structure of successful sports which we see as the point at which future champions are spotted and developed into world class performers. For many years it has been left to coaches' experience, performance evaluation, and empirical judgment to identify talent. Although these traditional practices have played a great role in athletic achievement, they also bring in issues of subjectivity and limited analysis. In the recent past we have seen great growth in the fields of Artificial Intelligence and data analytics that bring with them the chance of more accurate and predictive talent ID through the study of large complex sets of data. Presently we look at both the theory and the data we have on AI based as well as the classic talent identification in sport.In the present paper we look at what contemporary sports science, data analytics, and performance modelling literature has to say on the subject of the base concepts, methodological approaches, pros and cons, and what the future holds for both of these systems. We find that AI improves prediction accuracy, reduces selection bias, and is key in early identification of talent, at the same time we note that traditional methods still have a role to play in context analysis and psychometrics. Also we argue that the future of talent identification is in the development of hybrid models which put AI and coach expertise together instead of one or the other.

Keywords: *Artificial Intelligence, Talent Identification, Sports Analytics, Predictive Modelling, Athlete Development, Sports Scienc*

Introduction

The present trend is for sports to adopt a more scientific and systematic approach to the development of their athletes. In this regard talent identification is at the core of what they do as it is the stage which identifies which individuals will go on to achieve elite performance. What we see is that which groups of athletes are identified as talented allows sports organizations to better allocate their training resources and put in place long term development plans which in turn support performance goals.Through the years talent identification developed as a very empirical field which was based in the coach's expertise and experience. Coaches and scouts looked at what they could see in terms of performance traits, results of competition, and what they thought of an athlete's future performance. While these methods did produce many successful athletes, they also were very much a product of subjective judgment and had a very narrow access to performance data. As sports systems grew and competition went global the flaws of this purely0 objective approach became very clear.The inroads which technology has made into sports science has changed how we measure and analyse performance. We see a large-scale transformation brought in by what Broadly speaking Artificial Intelligence which is the term we use for computational systems that which learn from data and put out predictive results has brought in a new way of looking at athletes. AI allows for the simultaneous analysis of physio and bio mechanical, psychological, and performance-based variables which in turn gives us a very complex picture of an athlete's potential. Also, instead of just looking at present performance which has been our practice we now have AI based systems which look at prediction of future performance which in turn is used to better identify talent and to plan for long term athlete development.

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Despite the fact that there is great interest in what AI brings to the table it still is early to tell in terms of how it measures up to more traditional methods. Also, it is out there which elements of the human aspect in coaching intuition, context awareness, and interpersonal skills that which is so integral in how we assess an athlete. What we need now is in depth academic research which looks at these two fields' what they bring to the table and how they play off each other.

Conceptual Foundations of Talent Identification

Talent development in sports is a structured approach which identifies athletes that have the traits which may lead to very successful performance in the future. Today's theoretical bases present a multi element view of what makes up an athlete's talent as opposed to a single attribute. Performance results are a product of the interaction of bio physical, mental, environmental and training elements over a period of time. In the past we looked at talent through the lens of primary physical traits like strength, speed, and body type. But present thinking that is put forth by ecological and developmental models reports that talent is a dynamic entity that plays out through the interaction of the athlete and their environment. The Long-Term Athlete Development (LTAD) model puts out stages of growth, skill acquisition, and specialization which in turn indicates that early in the game we must take into account the variable aspects of development rather than using static measures of performance.Predicting future performance and putting in the right training programs. For accurate prediction we integrate many performance factors which in the past has been a very hard task due to human cognitive limits while dealing with complex data sets. AI technologies come in to play here by which we are able to recognize large scale patterns and develop predictive models.

Traditional Talent Identification Approaches

In past years we saw the development of what we may term traditional talent identification methods which in sports with coaching at their core that put a large value on experiential learning and the watchful experience of the coach. Coaches in these cultures put great stock in the time they spent with the athletes during training and competition to identify talent. What they looked for included technical skill, physical ability, tactical knowledge and also the psychosocial attributes like an athlete's motivation and competitiveness. Later in time we see the introduction of a more scientific approach to these traditional methods. We began to see the use of physical fitness tests that gave us numbers and data which in turn gave our evaluations a more empirical base. We saw the measurement of speed, endurance, strength, agility and flexibility which gave us quantifiable indicators of an athlete's performance capacity. Also we began to look at anthropometric data which in part was an attempt to match an athlete's body type to the requirements of the sport in which they wished to compete from this came the idea that there are physical traits which greatly influence success in very specific sports.These reports of which we speak introduce what we term measurable parameters yet the predictive value of which proved to be unstable. Also, it is noted that youth athletes do put forth varying degrees of biological maturation which causes early developers to do better for a while which doesn't mean they have better long-term growth. Also, it is that present performance which tends to be the basis for choice which in turn introduces selection biases in Favor of the physically advanced. Also a issue we must note is the subjective nature of coach evaluation. We see cognitive biases, personal preferences and context-based variables play a large role in decision making. Also, traditional systems do a poor job of putting together multiple data points at the same time which in turn reduces what they are able to report on the complex players' performance picture. While traditional methods do hold great value. Coaches develop what we term tacit knowledge over time which allows them to identify behavioural and psychological traits which may not be so easy to put into numbers. We see leadership which is a quality, adaptability, resilience which tend to come out of the interaction between people rather than out of a number. Therefore, traditional approaches contribute valuable qualitative insights despite methodological limitations.

Artificial Intelligence and Data-Driven Talent Identification

Artificial Intelligence is a technology which is seeing great transformation in the field of talent identification which we are008 seeing to be almost a science. Machine learning algorithms we see to be at the core of this which study past data to determine what performance indicators play into future success. Also, unlike what we have seen from traditional stats methods which are pretty much a set thing, AI systems improve with each input of more data. In sports we are seeing AI used in many different data sources which traditional methods may not have touched wear able tech, motion tracking, physio monitoring, and video-based performance analysis. Also, we have computer vision which is allowing for the automatic evaluation of movement which in turn gives us an objective look at biomechanics which may not have been seen with the naked eye. These systems also identify the fine motor and energy changes that may go by a human observer.Predict in large part what AI does in talent identification. We see that which players will rise to elite status via study of growth over time instead of single performance points. Also, we have seen that this is in agreement with present day thoughts which stress long term development and growth variation. Also, AI improves on human bias. What we get from the algorithms is data based instead of subjective. Also, AI systems are able to go through thousands of athletes at the same time thus expanding what we look at beyond what traditional scouting can do which in turn improves inclusion. But AI models are very much at the mercy of data quality and representativity. Poor or biased data will cause poor results. Also, we have to pay attention to issues of privacy, data rights, and transparency which must be addressed in sports policy.

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Comparative Theoretical Analysis

A theoretical look at AI based and traditional talent identification methods we see that they have very different foundational bases. Traditional methods base themselves in empirical and human experience and present a constructivist view which is that understanding is a product of what we see and do. AI on the other hand has a positivist and data centered approach which puts forward variables that can be measured and which feed into predictive models. Also we see that which method does best is a matter of which issue is at hand traditional methods do very well in terms of context analysis but have a hard time with scale and consistency. AI methods on the other hand have great analytical power but may not do as well with social and psychological details. Instead of putting these methods in a zero-sum game we see that they play into different aspects of talent identification.From a systems theory perspective, talent identification functions most effectively when diverse information sources interact within an integrated framework. Human expertise provides interpretive meaning, while AI supplies analytical precision. The convergence of these elements enhances decision-making reliability.

Discussion

AI\'s growing role in sports is a piece of larger social trend which is towards data-based decision making. We see that predictive models which include multi-dimensional variables which aren't available to past methods improve in terms of accuracy. Also we note that early identification of talent which tech can help in, allows for interventions in which athletes are at very formative stages which in turn increases their chances for long term success. But also, it is important to note that there is a tendency to think that tech can fully take over the role of human evaluators. We still have a way to go in terms of putting into algorithms psychological resiliency, creativity, and social adaptability. Also, coaches' role in understanding the context in terms of environment and culture in which an athlete functions is very important.

Economic issues play a role in how things play out. We see that high tech costs and infrastructure needs may put some breaks on the growth of sports systems in the developing world which in turn may widen global gaps. Also we see that a balanced approach which puts access and ethical issues at the fore is what is required. In the sports science we are seeing a trend towards hybrid models which put AI and coaching together. These models use AI as a support to the coach which is to say they see it as a tool which supports human decision making which in turn preserves human input while improving the analysis.

Implications for Sports Science and Physical Education

The role of AI in talent identification is a game changer for sports organizations, coaching education and physical education programs. We see that which is founded on research and data improves the fair and transparent design of athlete selection processes. Also we note that in academic institutions' adoption of AI for tracking student fitness growth and identifying talent at young ages. For the coaches' role in all of this, tech literacy is a new must have skill. What we also see is that which of the coaches' which are able to interpret data and do analysis see to have better collaboration with sports scientists and analysts. At the same time as we adopt tech we must also develop ethical practices which will in turn support responsible use of the athlete data.

Future Research Directions

Future we should see more of large-scale studies which report back over time on the performance of AI models in diverse populations and sports settings. Also we see value in research that puts psychological variables into the picture which in turn may improve prediction accuracy. Also of great importance is the development of low-cost AI solutions for use in grass roots sports which is a key element of equal sports development around the world.

Conclusion

Art in which we put forward that AI has brought a transformational element to the field of sports talent identification by means of which we see very precise, predictive and in-depth evaluation of athletes' potential. On the other hand, to what is put forth by coaches' experience and what is known from practice still today play key role in providing context which tech alone can't bring to the table.As opposed to a zero-sum game between these two approaches we see that the evidence supports a hybrid of the two which plays to the strength of technology as well as human judgment. Also, this is in the line of present theories that put out that athlete development is a complex process that is also adaptive in nature and very much a long-term game. We see thus that the future of talent identification is in the hybrid models which see tech and human elements work together, which also see science as a force which augments what is at the core human in sport.

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Original Article

Modern the Transformative Role of Artificial Intelligence and Data Analytics in Sports

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Abstract

Artificial Intelligence (AI) and Data Analytics Have Emerged As Transformative Forces in Modern Sports. These Technologies Enable The Systematic Analysis Of Large Volumes Of Data To Enhance Athletic Performance, Minimize Injury Risks, And Improve Strategic Decision-Making. AI-Driven Systems Process Inputs from Sensors, Cameras, and Wearable Devices to Generate Actionable Insights Regarding Player Efficiency, Biomechanics, And Tactical Patterns. Additionally, Predictive Models Assist In Injury Prevention By Identifying Risk Factors Through Historical And Real-Time Data. Beyond Performance, AI Contributes To Fan Engagement By Offering Personalized Experiences And Real-Time Analytics. Despite These Advantages, Challenges Such As Data Privacy, Ethical Concerns, And The Integration Of Technology With Traditional Coaching Remain Significant. This Paper Examines The Applications, Future Potential, And Ethical Implications Of AI And Data Analytics In Sports.

Keywords: Artificial Intelligence, Data Analytics, Sports Technology, Performance Analysis, Injury Prevention

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Introduction

The evolution of sports has been significantly influenced by technological advancements, particularly Artificial Intelligence and Data Analytics. These tools facilitate evidence-based decision-making by analyzing real-time and historical data. Coaches, analysts, and athletes increasingly rely on such technologies to enhance performance and optimize strategies. AI systems utilize data collected from cameras, sensors, and wearable devices to evaluate various performance parameters, including speed, accuracy, and movement patterns. For instance, in football and basketball, AI models analyze gameplay data to identify strengths and weaknesses, enabling targeted training interventions. Similarly, in cricket and tennis, analytics help refine techniques and tactical approaches.

Injury prevention is another critical area where AI plays a vital role. By monitoring physiological and biomechanical data, these systems can predict fatigue and potential injury risks. Furthermore, AI enhances fan engagement through personalized content, automated highlights, and immersive technologies such as virtual reality. The integration of AI has also influenced sports economics, including talent scouting, marketing, and revenue forecasting.

Current Applications of AI in Sports

AI and data analytics are widely applied across multiple domains in sports, including performance evaluation, injury prevention, tactical planning, and audience engagement. These technologies are utilized at both professional and amateur levels, demonstrating their broad applicability and effectiveness.

Performance Analysis

AI-driven performance analysis provides detailed insights into athlete and team dynamics. Advanced techniques such as computer vision and machine learning allow for precise tracking of player movements and actions during games and training sessions.

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In sports like football and basketball, AI systems evaluate passing accuracy, positioning, and tactical efficiency. Tennis analytics platforms measure shot speed, ball trajectory, and player positioning to enhance gameplay. Similarly, in athletics, motion-capture technologies help athletes improve speed, coordination, and overall performance.

These analytical tools enable coaches to identify patterns that may not be visible through

Injury Prevention

Preventing injuries is a major concern in sports, and AI offers effective solutions through predictive analytics. By analyzing biomechanical data, workload, and physiological indicators, AI systems can detect early signs of potential injuries.

Wearable devices play a crucial role by collecting data related to heart rate, movement, and muscle stress. AI algorithms process this data to assess fatigue levels and recommend appropriate recovery strategies. This proactive approach not only reduces injury risks but also extends athletes' careers.

Additionally, AI assists in rehabilitation by designing personalized recovery programs based on

Strategy Optimization

AI enhances strategic planning by analyzing historical data and identifying patterns in opponents' behavior. Coaches use predictive models to develop effective game plans and counter-strategies.

In team sports, AI evaluates formations, player roles, and tactical trends to optimize performance. Real-time analytics further support in-game decision-making, such as substitutions and tactical adjustments. Simulation models allow teams to test different scenarios before actual matches, improving preparedness and adaptability.

While AI provides valuable insights, human expertise remains essential for interpreting data and making final decisions.

Fan Engagement

AI has revolutionized the way fans interact with sports. Personalized content recommendations, automated highlight generation, and real-time statistics enhance the viewing experience.

Technologies such as chatbots and virtual assistants provide instant updates and engage fans interactively. Augmented Reality (AR) and Virtual Reality (VR) create immersive experiences, allowing fans to experience matches in innovative ways.

By analyzing user preferences, AI ensures tailored content delivery, thereby increasing audience satisfaction and loyalty.

Future Trends

The future of sports will be increasingly driven by AI and advanced analytics. Real-time data processing will enable immediate feedback during games and training sessions. Smart equipment and sensor-based systems are expected to provide more accurate and detailed performance metrics.

AI-powered coaching tools may act as virtual assistants, offering instant feedback and adaptive training plans. Simulation technologies will allow teams to practice in virtual environments, improving strategic planning.

Furthermore, AI is likely to play a significant role in talent identification by analyzing performance data across large populations, helping discover emerging athletes.

Ethical Considerations

Despite its benefits, the use of AI in sports raises several ethical concerns. Data privacy is a major issue, as sensitive information related to athletes' health and performance is collected and analyzed. Ensuring secure and ethical data usage is essential.

Another concern is fairness in competition. Unequal access to advanced technologies may create disparities between teams. Additionally, excessive reliance on AI could reduce the importance of human judgment and intuition in coaching.

Transparency, accountability, and proper governance are necessary to address these challenges and ensure responsible use of AI in sports.

Conclusion

Artificial Intelligence and Data Analytics have significantly transformed the sports industry by enhancing performance, reducing injuries, improving strategies, and engaging fans. These technologies are now integral to modern sports systems.

However, the essence of sports still lies in human skill, creativity, and decision-making. The most effective approach involves a balanced integration of technology and human expertise. By addressing ethical challenges and ensuring responsible implementation, AI can continue to positively shape the future of sports.

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Original Article

Artificial Intelligence in Sports Training: A New Pace Driven by Technology

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Abstract:

The objective of this article was to shed light on the new momentum driving sports training, powered by artificial intelligence and technology. Today, AI is being utilized extensively within the sports world. This technology tailors specialized training regimens for each individual athlete. Artificial Intelligence (AI) and adaptive algorithms are generating personalized training programs based on the specific needs of every player, and training regimens are being developed precisely upon these principles. AI is being employed to identify signs of fatigue and to prescribe appropriate training interventions. This helps save the athletes' time and prevents injuries that often occur during practice sessions. It has emerged as a highly promising solution. For the next generation of athletes, AI represents the future; its purpose is to facilitate victory not merely through brute force, but by working smarter while simultaneously safeguarding against injuries.

Keywords: *AI, Sports, Training, Technology*

Introduction:

Today, a digital revolution is sweeping across all sectors, opening up new avenues for progress through the application of AI. AI, now ubiquitous across various fields, iaproving to be equally beneficial within the realm of sports. Just as rapidly as the sports world is evolving, so too is the performance of the athletes themselves. Every athlete is driven by an intense desire to win a pursuit for which they are now undergoing training utilizing a diverse array of modern methodologies. In the contemporary era, the margin between victory and defeat has narrowed significantly, with outcomes often appearing to be decided by mere milliseconds or millimeters. There was a time when athletes relied heavily on rigorous practice, and the making of a great player depended solely on sheer hard work and accumulated experience.

In contrast, athletes today are being groomed not merely on the playing field, but on the foundation of binary codes and data analytics. Through the integration of Artificial Intelligence and data analytics, the very landscape of the sports world has been completely transformed. In the past, coaches were solely responsible for devising strategies; however, in the modern era, athletes are trained based on insights derived from AI and data analysis. This approach enables the precise identification of an athlete's potential, allowing them to be presented to the world as veritable "super-humans." Historically, athletes were selected primarily based on their innate natural talents; yet today, thanks to this digital revolution, AI is being utilized to address and rectify individual weaknesses, thereby forging the ultimate "super-athlete." Furthermore, Artificial Intelligence facilitates the monitoring of athletes' physical exercises and movements, enabling targeted interventions to enhance their performance and technique. Specialized systems have also been developed to assist athletes in their preparation for various sporting activities. In the pursuit of success within the world of sports and games, the application of Artificial Intelligence has emerged as nothing short of a boon. Moreover, Artificial Intelligence is playing a pivotal role in both optimizing athletic performance and mitigating the risk of injuries.

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Today, across the globe, Artificial Intelligence is being utilized to provide athletes with state-of-the-art training, to gather insights into their overall physical and mental well-being, and to address their specific weaknesses. Nowadays, adjustments to athletes' training regimens are being made based on their body's physiological responses. We live in a competitive era where sports are no longer confined solely to physical prowess and on-field practice; rather, the outcome victory or defeat is now frequently determined off the field, by computer screens and algorithms.

Individualized Player Training:

In the past, coaches used to provide a single, standardized training regimen for all players; however, the very definition of training has undergone a complete transformation today, such that a one-size-fits-all approach is no longer applied. Currently, numerous AI-driven applications and systems are available that facilitate the precise analysis of each player's physical capabilities, history of injuries, and current physical condition. Based on each individual's potential and aptitudes, customized training programs are designed specifically for them. Furthermore, smart wearables equipped with smartwatches and various cutting-edge sensors have been developed to monitor players. These devices track metrics such as heart rate, oxygen levels, and sleep patterns, thereby enabling an assessment of how prepared each player is for upcoming competitions.

Preventing Injuries among Athletes:

Athletes face numerous obstacles in their sporting careers, the most significant of which are injuries. Injuries sustained by athletes can potentially jeopardize their entire future. Therefore, utilizing AI models, predictions are generated to identify the specific types of physical activities an athlete engages in, thereby determining when their risk of injury is highest; appropriate preventive measures are then implemented to mitigate these risks. Athletes perform a variety of physical movements and skill drills, during which their biomechanical data is analyzed to assess their running and jumping techniques, and to identify the specific types of injuries to which they are most susceptible. If an athlete exhibits signs of fatigue or physical imbalance, the coach prescribes rest to minimize the risk of sustaining serious injuries.

Real-Time Performance Analysis:

During competitions and matches, numerous sensors and high-speed cameras are deployed to capture data regarding a player's performance. This enables a precise analysis of the players' performance while the game is still in progress. A runner's performance, for instance, is analyzed by determining their running speed, stride length, and the positioning and angles of their legs. Similarly, in cricket, the speed of the ball and the batsman's performance can be analyzed in real-time. Data analytics assists coaches in adjusting their strategies during a live match. Through this technology, coaches gain insights into the current state of the game and the opposing team's weaknesses, thereby helping them determine which player would be most advantageous to field at any given moment.

Scouting for Talented Players:

In the world of sports, data analytics enables the precise evaluation of athletes by conducting a thorough analysis of their performance—from their early days right up to the present. This process has made the selection of talented players significantly more transparent. Rather than selecting players based on their performance in just two or three matches, their capabilities are assessed by analyzing data spanning several years and involving thousands of athletes worldwide; consequently, only those players who truly possess exceptional talent are ultimately selected.

Building Mental Toughness in Athletes through VR Simulation:

Due to the modern technological revolution, the need for athletes to visit actual fields to practice their skills has diminished. This is largely because Virtual Reality (VR) technology is now being utilized, enabling athletes to mentally rehearse specific scenarios and performances within their own minds. They can repeatedly practice handling various situations that may arise during a competition, thereby gaining experience on how to effectively navigate and resolve such critical moments. For instance, VR technology is employed to enhance a batter's decision-making abilities and mental concentration by allowing them to virtually simulate and practice facing a spinner's deliveries.

Precise Nutrition and Recovery Timelines for Every Athlete:

In today's modern era, the application of AI is constantly expanding; it is no longer confined solely to training regimens. Instead, by analyzing athletes' physical capabilities and internal physiological systems, AI is now being utilized to determine precisely what each athlete should consume and to formulate their specific nutritional charts. Through the analysis of blood samples and metabolic data, AI acquires comprehensive information, which then serves as the basis for creating personalized diet plans for each athlete—plans designed to facilitate rapid recovery and ensure optimal energy levels on match days.

Conclusion:

Artificial Intelligence and Data Analytics have revolutionized the world of sports, enabling the development of athletes with more scientific precision and enhanced capabilities. While competition has historically been driven by the skill and spirit of the athletes themselves, it is equally true that technology empowers them to push

beyond their limits and break records. Moving forward, leveraging these technologies will be crucial for athletes and teams to advance; only then can they secure top rankings and achieve victory.

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Original Article

Future Perspectives on Use of Artificial Intelligencea in Enhancing Sports Skills

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Abstract

With The Rapid Development Of Artificial Intelligence (AI) Technology, Particularly In Sports Field, The Application Of AI Has Shown Significant Potential. This Study Explores the Impact of AI on Athlete's Sports Skill Acquisition, Aiming To Address Athlete's Difficulties In Systematically Mastering Specialized Sports Skills. AI Not Only Offers Innovative Teaching Models And Evaluation Systems For Physical Education, But Also Enhances Teaching Efficiency That Enables Personalized Instruction, And Improves Athlete's Performance. AI's Role Becomes Even More Crucial, As It Assists in Developing Scientific Exercise Plans through Precise Motion Data Analysis, Thereby Promoting Both Physical and Mental Health. Furthermore, AI Technology Can Drive Innovation In The Content Skill Learning, Providing Robust Support For Their Performance. Studies Indicate That AI Has Optimized The Skill Acquisition Process, Spurred The Innovation Of Curriculum Content, And Facilitated The Transformation Of Teaching Models, Injecting New Momentum Into The Sustainable Development Of Sports Skills. Results Show Most Athlete's Support AI Role In Recognizing Movement Concepts, Mastering Technical Details And Enhancing Skill Mastery When Combined With Real Practice. However, Challenges Exist: Requiring In-Depth Contextual Dialogue For Personalized Content, Geographical Restrictions On Tool Access, And Potential Over-Reliance Leading To Rigid Movements. By Utilizing AI Athlete's Can Increase Its Potential Use In Sports Applications, And Enact Changes Upon The Nature Of Game Its Visualization, And Repeatability. Findings Highlight The Expertise Required For Using AI Related To Daily Practice Its Implications, Relevance Of Latest Technology And Also Shares Future Research Prospects Regarding AI Applications Sports Skill Acquisition.

Keywords: *Artificial Intelligence, Sports Skill Acquisition, Technology.*

Introduction

Currently, little is known about Scientific and technological advancement for implementation of modern technology in the AI era. Worldwide Gen Z are using AI in sports skill learning which is comprehensive process involving coordinated development of sports techniques, tactical awareness, etc. Gen Z interactions with AI-based applications have become a part of everyday life & has aroused student's imagination and aspirations. AI technology has advanced so quickly that its use in physical education has moved from experimentation to practical application. However, many of them face difficulties in systematically mastering and effectively improving specialized sports skills. Hence exploring new method suitable for students' skill learning is the need of hour. Emergence of AI technology has provided new pathways for enhancing the efficiency and quality of sports skill learning. Although AI cannot demonstrate direct tactile feedback like a teacher or coach, it can leverage its vast knowledge base and powerful reasoning abilities making optimal support for enhancing sports skill learning & improves engagement and performance by enabling personalized teaching modifications based on athletes learning progress and abilities. The aim of research is to deeply explore the interaction methods between students and actual impact of this technology on their sports skill development. By conducting interviews and practical investigations to gather data, it primarily analyzes how students use AI based technology to understand movement techniques, plan personal training, and correct technical errors, exploring deeper information about their acceptance levels. To enhance the comprehensiveness and reliability of the data, this study also broadly collects quantitative information about users' evaluations of satisfaction levels and usage preferences of new technology.

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This research can be significant to physical education teachers, sports course designers, educational technology developers, and sports education researchers by gaining an in-depth understanding of students' perceptions and experiences to better integrate artificial intelligence technology into sports courses & promote for the development of more effective auxiliary tools, and improve the practicability teaching methods. AI-powered motion analysis further improves the quality of physical education by enabling accurate, data-driven instruction methods. Motion recognition systems track students' movements in real time, providing precise feedback and helping them improve their techniques. However, little research has been conducted to date on applying AI in various sports courses despite its importance in preparing for future education systems as AI has great potential to prevent sports injuries because of this, AI-driven curriculum reforms have become widely accepted more customized and flexible.

Objectives of the study

Perceptions & it's impact of using AI for sports skill acquisition

Attitude & limitations towards using AI for sports skill acquisition.

The degree of improvement in sports skill learning, and their preference tendencies towards AI inherent functions and guidance.

Research Methods

A. Research Design

This study adopts a qualitative research design to explore AI impact on student physical skill acquisition providing comprehensive and targeted qualitative data. The data was collected by conducting interviews and practical investigations. By analyzing data meaningful clustered themes and keywords were extracted.

B. Research Subjects

The research subjects were undergraduate students of both genders with the age range entirely distributed between 18-23 years of Amravati City from different colleges affiliated to SGB Amravati University who had participated in any ICT tourney in present academic session. In selection of subjects age, gender, professional background, degree of sports participation were fully considered to further ensure overall representativeness of the respondents.

Data Analysis

Focusing on enhancing athletic performance, this paper explores how AI is transforming various physical education courses. AI-powered systems tailor training intensity and minimize injury risks by providing personalized learning experiences based on individual performance in specific sports. Immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR) make any sport more efficient and enjoyable. Observations also show that AI helps athletes improve their skills by analyzing movement biomechanics, identifying inefficient motion patterns, and assessing muscular imbalances and movement deviations. Increasing the use of AI literacy modules could benefit students in underserved areas. Empirical evidence suggests that AI-driven VR and AR applications can evaluate players' fitness and continuously track students' exercise data, aiding performance improvement through customized sports training. Compared to traditional training methods, studies reveal that AI-assisted training enhances strength, endurance, and coordination by allowing timely adjustments to training plans to ensure optimal progress. The development of AI-enabled smart sports facilities in the region is recommended to facilitate easier access to sports resources. However, the successful adoption of AI technologies in teaching may be challenged by varying levels of AI literacy among educators.

Conclusion

AI integration in sports is advancing public health initiatives, transforming instructional models, and enhancing teaching quality. Personalized training programs are made possible by AI-driven data analysis and intelligent assessments, which maximize student performance and reduce injuries. By removing long-standing obstacles in sports fields use of immersive technologies like VR and AR increases participation and engagement. In order to promote fair access to high-quality physical education, AI is also changing public health initiatives, teacher preparation, and resource distribution. AI's uses in sports education will grow as it develops promoting more intelligent & efficient training techniques and bolstering national fitness programs. Universities can promote innovation in sports by utilizing AI's capabilities, which will ultimately lead to a healthier society. Additionally, the results showed that the time spent by college students on sports skill learning varied significantly depending on their purposes, with most having approximately less than 2 years of sports skill learning experience. By extracting usable effective information data from the interview text system, the study identified data development trends and operational patterns. The keyword theme clustering analysis comprehensively revealed the participants' sports skill learning experiences, including the value of sports skill learning, realistic challenges, learning tool usage, and the influences of factors such as gender and major. The study not only enriched the existing knowledge system but also provided practical references for future research on college students' sports skill learning. In summary, this research provides certain content presentation for understanding college students' attitudes, limitations, and impacts of using AI in sports skill acquisition. It believes that college students can use AI to assist sports skill learning to a certain extent, but practical challenges exist in the specific usage process. For this research, it must be recognized that the research conclusions need to be interpreted and referenced

within specific sample volumes and the specialized background of students' sports skill acquisition, and a cautious attitude should be maintained regarding the broad applicability of the results. To better refine the findings, future research should extensively incorporate college student groups from different levels and learning projects, attempting to cover more learning levels to comprehensively grasp the mechanism of AI's impact on college students' sports skill acquisition. Simultaneously, clarifying AI's long-term effectiveness in sports skill acquisition should be listed as research content, continuously expanding its connotative scope and gradually incorporating other sports learning content to seek a more comprehensive understanding of AI's influence and role in college students' sports skill acquisition. By studying these contents, future research can provide paradigmatic support for different population types using AI chat bots (such as AI) to assist sports skill acquisition, further offering a richer perspective for AI applications in physical education.

Discussion

The survey shows that most college students believe using AI can facilitate sports skill acquisition, displaying a clear supportive tendency towards AI & recognizing its significant role in skill learning. These students believe that AI can help them in the sports skill learning process, including understanding movement concepts, mastering movement details, recognizing movement similarities and differences, strengthening movement memory, clarifying tactical components, and improving technical proficiency. A particularly noteworthy aspect in the survey results is that participants emphasized that after using AI to learn sports skills or generate a training plan, practicing in real-world space according to AI's recommendations can lead to a greater degree of skill mastery. AI's control over sports skill learning details can better address the weak points typically taught in class, such as timing of force application, movement angles, and release angles. Through context-specific settings tailored to individual students, learners can obtain personalized analytical insights. Some college sports skill learners believe that detailed theoretical deconstruction combined with real-world practice has significantly enhanced their skill acquisition. It is important to note that in the survey results, AI's impact on college students' sports skill learning effectiveness is more pronounced in providing guidance for movement correctness and creating precise personal learning plans and strategies. Simultaneously, based on respondents' feedback, several influencing factors were summarized, including: tool convenience, innovative search experience, recommendations from instructors or classmates, detailed analysis of basic sports skills, comprehensive coverage of sports skills, and the ability to provide targeted advice based on different contexts and individual needs. However, the specific investigation also revealed certain practical challenges faced when using AI to acquire sports skills. Through the survey, some respondents feedback that to obtain more personalized content when using AI, more contextual dialogue with the tool is needed to output the desired results, but initially, its functionality cannot be well utilized. Additionally, geographical reasons may lead to tool output restrictions and slow website access. Few respondents believe it might limit their understanding of sports skills, gradually forming rigid movements, and becoming overly dependent on AI's output, unable to properly focus on the actual status of their sports skill acquisition in practice.

The above research article comprehensively presents the diverse results of sports person using AI for sports skill acquisition, providing important references for attitudes, advantages, challenges, and related impacts of such tools. It clarifies attitudes and methods of using artificial intelligence software like AI for learning, enables understanding of the usage scenarios and functions of such tools, and can effectively address the challenges of sports skill learning, thus providing an important foundation for developing targeted strategies.

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Original Article

Indian Sports Industry and Employment

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Abstract: -
Sports are an inseparable part of human life and are not limited only to physical development, but are also closely associated with social, cultural, and economic development. In India, traditional sports such as wrestling, kabaddi, kho-kho, and mallakhamb have been practiced since ancient times. However, for a long period, sports were viewed merely as a hobby, entertainment, or a supplementary component of education. Sports were not considered an important source of employment or a professional career. With globalization, the media revolution, private investment, professional competitions, and technological advancement, the nature of the sports sector has undergone a fundamental transformation over the last two to three decades. Today, sports have emerged as an independent industry (sports industry), generating significant economic turnover, employment opportunities, and entrepreneurship. The impact of the sports industry is not limited to athletes alone but is clearly visible in media, advertising, manufacturing, tourism, fitness, and technology sectors.
In this context, it becomes extremely important to study the development of the Indian sports industry, its structure, economic significance, and especially its role in employment generation.

Introduction: -

The sports industry in India is no longer merely a means of entertainment; it has become an important economic and employment-generating sector for the country. Over the past decade, this sector has played a significant role in economic growth, employment generation, production and exports, technological development, and lifestyle changes. The expanded commercial nature of the sports industry, professional leagues, competitive team structures, media rights, brand sponsorships, and increasing consumer engagement have made this industry an integral part of India's economic development.

Scope and Economic Value of the Indian Sports Industry

The scope of the Indian sports industry has expanded far beyond athletes and competitions to include business, marketing, media, technology, manufacturing, and tourism.

Key Industry Statistics

Estimated Market Size: The current value of the Indian sports industry is approximately USD 19 billion (around ₹1.5 lakh crore) and is expected to reach USD 40 billion by 2030.

Nearly 80% of this value comes from the cricket industry, while other sports such as football, kabaddi, volleyball, and badminton are also growing steadily.

The sports goods manufacturing sector is currently valued at approximately USD 6.7 billion and is projected to grow to USD 11 billion.

India's sports economy has crossed the USD 2.1 billion mark, registering a growth of 13.4% compared to the previous year.

These figures clearly indicate that sports have become a significant component of the national economy.

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Concept and Nature of the Sports Industry

The sports industry refers to the collective group of all economic and commercial activities related to sports. It includes not only athletes and competitions but also the following components:

Professional sports competitions and leagues
Sports organizations and administrative bodies
Sports broadcasting, media, and advertising
Sports goods and equipment manufacturing
Training, coaching, and sports academies
Stadiums, events, and league management
Fitness, sports technology, and data analytics

The integrated functioning of all these components forms a comprehensive economic system known as the sports industry.

Development of the Indian Sports Industry

In the post-independence period, the development of sports in India remained relatively limited. Although the government provided some support, there was a lack of a professional and commercial approach. However, after the economic liberalization of the 1990s, the sports industry gained new momentum. Private media, satellite television, brand sponsorships, and exposure to international competitions led to significant capital investment in sports.

The popularity of cricket accelerated this process. The Board of Control for Cricket in India (BCCI) emerged as one of the richest sports organizations in the country and established a modern model of sports management.

Professional Leagues and the Sports Industry

Professional leagues have been the major driving force behind the growth of the sports industry in India. Among them, the Indian Premier League (IPL) has played a crucial role by transforming cricket into a fully commercial sport. The success of the IPL inspired the launch of professional leagues in football, kabaddi, badminton, and hockey.

These leagues have resulted in:

Regular income for athletes
Employment opportunities for coaches, referees, and support staff
Expansion of media, advertising, and branding sectors
Increased domestic and international investment

As a result, the commercial network of the sports industry has become stronger and more structured.

Economic Importance of the Sports Industry

The Indian sports industry is considered one of the fastest-growing industries today. Significant revenue is generated through sports events, broadcasting rights, sponsorships, ticket sales, digital platforms, and brand endorsements. Globally, sports industries contribute substantially to national GDPs. Although India's contribution is currently lower, the growth potential is enormous due to a young population, increasing middle-class purchasing power, and rapid digital expansion.

Types of Employment in the Sports Industry

The Indian sports industry plays a vital role in employment generation. Employment in this sector can be broadly classified into two categories:

(A) Direct Employment

Direct employment refers to jobs directly associated with sports activities:

Professional athletes
Coaches and fitness trainers
Referees and technical officials
Sports academy staff
Stadium and event management personnel

(B) Indirect Employment

Indirect employment is generated through the expansion of the sports industry:

Sports journalism and commentary
Sports media, camera, and production services
Advertising, branding, and sponsorship
Event management and tourism
Sports goods manufacturing and sales

The number of indirect employment opportunities is significantly higher than direct employment.

Sports Goods Industry and Employment

India is one of the world's leading producers of sports goods, including cricket bats, balls, hockey sticks, footballs, and sportswear. Traditional sports manufacturing hubs have developed in parts of Uttar Pradesh, Punjab, and Maharashtra.

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This industry provides employment to millions of skilled and semi-skilled workers and plays a crucial role in employment generation in rural and semi-urban areas.

Sports Technology and Modern Employment

Technological advancement has created new employment opportunities in the sports industry. Emerging roles in the sports-tech sector include:

Performance data analysts
Sports app and software developers
Digital fitness platforms
Virtual coaching and online training
Fan engagement and social media management

According to studies by India Brand Equity Foundation (IBEF), sports technology is expected to become a major employment-generating sector in the future.

Social and Educational Impact

The growth of the sports industry has brought positive social changes. Sports are now viewed as a viable career option rather than just a hobby. Courses in sports management, sports science, physiotherapy, and nutrition are gaining popularity. Awareness regarding health, fitness, and active lifestyles has increased. Youth from rural areas are also gaining opportunities at national and international levels through sports.

Challenges Facing the Sports Industry

Despite its growth, the Indian sports industry faces several challenges:

Inadequate infrastructure and facilities, especially in rural areas
Social mindset that does not yet consider sports as a stable career
Need for advanced training systems and expert support staff
Limited sports facilities in remote regions
Shortage of trained coaches and professionals
Uneven financial investment across different sports
Social insecurity related to sports careers

Addressing these challenges can significantly accelerate employment-oriented growth in the sports industry.

Benefits and Social Impact of the Sports Industry

Contribution to the Economy:

Globally, sports contribute approximately 2–4% to GDP, while in India it is currently around 0.5%. However, this contribution is expected to grow rapidly due to professional leagues, sponsorships, and sports technology.

Lifestyle Changes:

Increased focus on physical fitness, health awareness, gyms, fitness coaching, yoga, and outdoor sports.

Social Transformation:

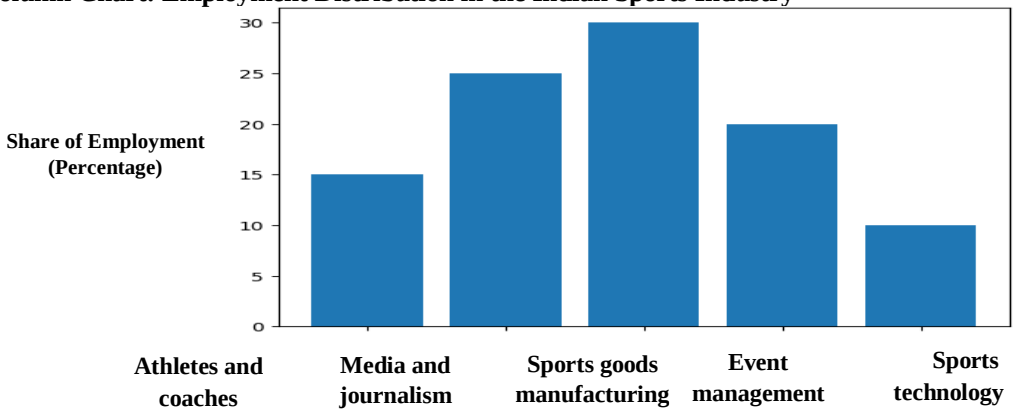
Sports careers are becoming more socially acceptable due to coaching institutes, sports academies, and youth programs.

Conclusion: -

The Indian sports industry has emerged as a significant pillar of entertainment, economic growth, and employment generation. Professional leagues, media expansion, technological integration, and the sports goods industry have created millions of direct and indirect employment opportunities. With appropriate policies, improved infrastructure, sports education, and a positive shift in social attitudes, the sports industry will play an even more vital role in India's economic and social development.

Over the past decade, the Indian sports industry has achieved remarkable progress in terms of economic value, employment opportunities, business expansion, and social acceptance. However, further improvements in quality training, infrastructure, global competitiveness, policy reforms, and social mindset are essential for sustainable growth.

Column Chart: Employment Distribution in the Indian Sports Industry



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What the Chart Shows:
The column chart illustrates the distribution of employment across various sectors of the sports industry.
X-Axis:
Types of employment in the sports industry
Athletes and coaches
Media and journalism
Sports goods manufacturing
Event management
Sports technology
Y-Axis:
Share of employment (percentage)
Key Observations:
Sports goods manufacturing has the highest share of employment.
Media, journalism, and event management also generate substantial employment.
Although athletes and coaches represent a smaller share, their role is crucial.
Sports technology is an emerging and rapidly growing employment sector.
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Original Article

Soil parameter of some farms of Akoli BH, Baggi, Both and Dabha in Pandarkawada region for development of Plant growth

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Abstract:
Agriculture soil parameter is very important for development of soil and plant growth. The physicochemical study of territory is very significant because both physical and chemical properties which bear upon the soil productivity. The quality of soil and availability of water are essential factor for the good yield of the crop. Hence it is necessary to analyze some quality parameters of the soil to determine the quality of soil. The present work has been carried out to study some parameters of soil samples collected from pandarkawada taluka region and district yavatmal, maharashtra. The soil characterization was carried out for the parameters like PH, conductivity, TDS, organic carbon, available nitrate nitrogen, calcium and magnesium. The variation of values observed in the different parameters due to the soil quality in different farms for used of plant grouth of akoli bh, baggi, both and dabha village
Keywords: Parameters, PH, Conductivity, TDS.

Introduction:

Spatial heterogeneity of soil micronutrients in shivalik foothill zone of himachal pradesh: a cross-site investigation of soil fertility[1]. Predicting soil organic matter from colour indices: economic and technical feasibility in semi-arid agricultural soils[2.] Traditional methods of soil analysis often involve laboratory intensive processes and can be time-consuming, limiting their practicality for large-scale agricultural operations. In this paper some method which are applicable for farmer to increases the quality of soil. The effects of various land use types on particular physicochemical characteristics of the soil in mante watershed, south regional government of ethiopia[3]. Application of soil moisture probe in optimizing the parameters of a land surface model[4]. Some selected soil sample from Viroda is a town in Burhanpur district of India state of Madhya pradesh. Mostly agricultural crops is found in Viroda village is as follows Banana, Cotton, Maize, Wheat, Jawar, and Haldi. Banana is one of the most important crops in Viroda village[5]. Evaluating microbial action is fundamental for understanding supplement cycling, decay cycles, and in general soil organic wellbeing[6]. In this reseach paper the used soil is in different farms of Akoli BH, Baggi, Both and Dabha village of Pandarkawada taluka region and District Yavatmal. This soil is not getting polluted due to no industrial waste problem in this region. All samples were collected in winter season. Analysis of soil in carried out for the studies of various parameters like pH. Conductivity, TDS, Organic Carbon, Available Nitrate Nitrogen, Calcium and Magnesium.

Material and Methodology:

We collect soil sample as per the requirement of farmer. The soil samples were collected from different village of Pandarkawada taluka region, District Yavatmal Maharashtra at the time of month November-December 2025 from different sampling stations. Soil samples V_1, V_2, V_3 and V_4 were collected in the depth of 0-30 cm from the surface of soil from Akoli BH, Baggi, Both and Dabha villages were collected for analysis[7] as shown in the Table 1.

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Table 1: Soil samples from different sampling stations

Name of Village	Akoli BH,	Baggi,	Both	Dabha
Sample Site	V_1	V_2	V_3	V_4

The soil samples were preserved in polythene bags for further analysis[8]. The chemicals and reagents used for analysis were of A. R. grade. Method used for Estimation of parameters physicochemical analysis were carried out in the laboratory of department of chemistry, collage of Engineering & Technology District, Akola, (M.S), India, are shown in the Table 2

Table 2: Method used for Estimation of Some Parameters.

S.N.	Parameter	Method
1	Colour	By viewing Soil
2	Moisture	By weighing
3	pH	pH-Metry
4	Conductivity	Conductometry
5	Available Nitrate Nitrogen	Titration
6	Alkalinity	Titration
7	Total Dissolved Solid	TDS Metry
8	Organic Carbon	Titration
9	Calcium	Titration
10	Magnesium	Titration

Result and Discussion:

Physicochemical parameters just like a Colour, Moisture, pH, Conductivity, Alkality, Total Dissolved Solid, Organic Carbon, Calcium and Magnesium of soil samples[9,10] are presented in Table 3.

Colour: In the earth soil there is lot of colour soil sample but some presented Soil samples are V_1, V_2, V_3 and V_4 are Brown in colour.

Moisture: The moisture content value ranges from 17.73% to 20.10% It is clear from result sample V_3 have highest moisture content than samples V_1, V_2, V_3, V_4 and V_5.

PH: The pH of soil is one of the most important physicochemical Parameter. It affects minerals nutrient soil quality and much microorganism activity. The pH was observed in the ranges from 6.9 to 8.2 The samples V_1 and V_3 are very slightly alkaline and samples V_2 and V_4 are medium alkaline.

Conductivity: The measurement of conductivity is for measure the current that given a clear idea of soluble salt present in the soil. Conductivity depends upon the dilution of soil suspension. The conductivity vales range from 0.18 μS to 0.46 μS. Conductivity of sample V_3 is less as compared to samples V_1, V_2 and V_4.

Available Nitrate Nitrogen: Available nitrate nitrogen in the soil from 290 to 410 kg/hectare. The soil sample V_4 has high nitrate nitrogen as compared to samples V_1, V_2, V_3.

Alkalinity: Alkalinity was observed in the ranges from 198% to 561% Alkalinity of sample V_2 is less as compare to samples V_1, V_3 and V_4.

Total Dissolved Solid (TDS): TDS values for soll sample ranges from 209 to 376 Soil sample V_1 has lowest TDS as compared to V_2, V_3, and V_4.

Organic Carbon: Organic carbon is the index for nitrogen content in the soil. The source of organic carbon in the cultivated soil included crop residue, animal manure, cover crops, green manure and organic fertilizer etc. Organic carbon values range from 0.16% to 0.28% Organic carbon of sample V_4, is high as compared to samples V_1, V_2, and V_3.

Calcium: Calcium ranges from 400ml/100gm to 420ml/100gm Soil sample V_4 have high calcium content as compared to samples V_1, V_2, and V_3.

Magnesium: Magnesium available to plants as the ions Mg^{2+} it content in the soil samples ranges from 8ml/100gm to 42ml/100gm. Sample V_1, contains less amount of magnesium

Table 3: Physicochemical parameters of Soil sample

S.N.	Soil Parameters	V_1	V_2	V_3	V_4	IAS Soil Analysis
1	Colour	Brown	Black	Faint Black	Black	Visual Assessment
2	Moisture (%)	18.5	17.5	18.05	21.52	17-30% Per Crop
3	pH	7.4	7.6	6.79	7.16	6.0 -8
4	Conductivity	0.59	0.42	0.21	0.32	< 0.8 Ds/M
5	ANN (kg/ha)	392	405	622	512	Variable

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6	Alkalinity (%)	213	191	361	566	Variable
7	TDS	204	378	345	287	< 1000 PPM
8	Organic Carbon (%)	0.11	0.18	0.14	0.21	0.1-3%
9	Calcium (ml/100gm)	401	411	402	415	Variable
10	Magnesium (mg/100gm)	06	05	04	05	Variable

[IAS- Agriculture Standard, ANN-Available Nitrate Nitrofen, TDS-Total Dissolve Solid.]

Conclusion:

On the basis of this study farmers can used plant growth study of various idea about the fertilizers and nutrients needed to soil for increase the percentage yield of crops. From all conclusion physicochemical analysis of soil different values for various farms.

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Original Article

Role of physics in its reduction relate to global warming: A review

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Abstract

This essay explores how science, particularly thermodynamics, plays a central role in global warming. The phrase "global warming" refers to the gradual warming of the earth's climate system that has been seen since the pre-industrial era (between 1850 and 1900) as a result of human activity, particularly the burning of fossil fuels, which raises the concentrations of heat-trapping greenhouse gases in the atmosphere. Although the latter word refers to both naturally occurring and man-made warming and its impact on our world, the terms are often used interchangeably. It is most often quantified as the average rise in the global surface temperature of the earth. The foundation of the earth sciences is physics. Understanding the earth's underlying structure and the natural processes that impact its surface, such earthquakes and volcanic eruptions, requires it. These subjects, as well as other facets of earth physics. Additionally, physics offers a foundation for studying both short-term weather and long-term climate change, as well as for comprehending the dynamic interactions between the atmosphere and the seas. Environmental stewardship requires this knowledge in order to handle issues like lake acidification and urban air pollution as well as natural disasters like hurricanes and floods. The study of energy and how it changes is a major component of physics, and energy is at the core of significant environmental problems. The way the sun's energy influences the motion of the atmosphere and seas, which in turn influences how energy is distributed globally, shapes the climate. The urge to produce energy is the main factor influencing how people affect the environment. The fundamentals of physics must be integrated with chemistry, geology, atmospheric and oceanic science, and biology in order to comprehend the complexity of the environment and successfully handle issues. Understanding the fundamentals of physics has been essential to advancement in three fields: energy production and the environment, environmental monitoring and improvement, and the ocean-atmosphere system. Our knowledge of the extraordinary concentration of energy involved in extreme weather patterns that contribute to global warming will continue to advance in the years to come. This advancement will result from a mix of direct measurement, computer simulation, and theoretical modeling, all of which rely on physics tools and are carried out by researchers trained in physics methodology. At that point in time, it was believed that, on time scales shorter than decades, ocean And Atmospheric Variability Were Mostly Independent Of One Another.

Keyword- *Global warming, Physics, Reduction, Climate change, Carbon flow*

Background

The theory and practice of weather forecasting, which used a time scale of six to ten days, had been the focus of atmospheric research until the 1980s. Understanding the prevalent instability of large-scale, mid-latitude events as a consequence of an examination of the Navier-Stokes fluid dynamic equations served as the foundation for weather forecasting. Meanwhile, in the seas, the focus was on trying to comprehend the physical mechanisms that explained heat and mass movement in situations like the Gulf Stream and ocean basin circulations. The ocean and atmosphere are linked on considerably shorter time periods, as has been discovered more lately.

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Long-term variations in the typical weather patterns that have come to characterize local, regional, and global climates on Earth are referred to as climate change. The phrase is synonymous with a wide variety of observable outcomes resulting from these changes. Human activities, especially the burning of fossil fuels, are the main cause of the changes in Earth's climate that have been seen since the early 20th century. These activities raise the amount of heat-trapping greenhouse gases in the atmosphere, which raises the average surface temperature of the planet. Global warming is the term used to describe these increases in temperature caused by human activity.

Climate change may also be caused by natural processes, such as external forcings like volcanic activity, changes in the Sun's energy output, and fluctuations in Earth's orbit, as well as internal variability like cyclical ocean patterns like El Niño, La Niña, and the Pacific Decadal Oscillation. Scientists track and investigate past, current, and future climate change using theoretical models in addition to ground, air, and space data. Key indicators of climate change are demonstrated by climate data records, including rising sea levels, ice loss in mountain glaciers and at Earth's poles, changes in the frequency and intensity of extreme weather events like hurricanes, heat waves, wildfires, droughts, floods, and precipitation, as well as changes in cloud and vegetation cover, to mention a few.

The growing knowledge of the El Niño phenomena in the Pacific Ocean led to this insight. This phenomenon, a large-scale oscillation, is the result of a number of positive and negative feedbacks between the ocean and the atmosphere and is what causes the climate system in the Pacific to become unstable. The comprehension of this phenomena, which is based on the combined fluid dynamics of the atmosphere and ocean, points to the climate system's predictability. In addition to the weather time scale of 6–10 days, predictability has also been shown on the El Niño-coupled ocean-atmosphere instability time scale of 6 months–1–2 years, which is an interannual time scale. Since the groundbreaking research on the El Niño phenomenon, it has been shown that the planet's major monsoon systems are likewise coupled ocean-atmosphere phenomena on the same time scale, meaning that the same joint dynamics and thermodynamics of the atmosphere and ocean govern their development.

A growing percentage of the environmental issues confronting humanity are those that call for improved human activity management to lessen its detrimental effects on natural systems. Due to the growing and more affluent human population, issues of this kind occur increasingly often. However, our increased capability and a better understanding of the impacted systems also allow us to handle them more successfully. to measure the influence of people. These issues can occur on many different scales, ranging from a single room where radon or organic pollutants are deteriorating the air to an urban airshed where pollutants are building up more intensely during specific seasons to the global stratosphere, where nitrogen oxides and chlorofluorocarbons are changing the chemical composition of the atmosphere. A well-known example of using physical science to comprehend how humans alter a natural system is the finding that chlorofluorocarbons destroy stratospheric ozone. Determining the specifics of this issue has required combining knowledge of fluid physics, radiation transport, and the chemistry of heterogeneous processes.

Burning fossil fuels has changed the planet's carbon cycle, which contributes to global warming. By changing the global hydrological cycle, rising carbon dioxide levels seem to encourage the production of other greenhouse gases. Numerous disciplines are used to comprehend global warming and the resulting climate change. To comprehend the nature of the fundamental climate system that underlies these climatic shifts, geophysical fluid dynamics is required. In addition, the dynamics and thermodynamics of the climate system actively include the chemical and biological cycles.

Concurrent advancement on multiple fronts is necessary for the effective management of human interaction with an environmental system: knowledge of the system without human influence, knowledge of how human impact alters the system, and knowledge of the steps that can be taken to lessen this impact, such as switching from one energy production method to another. Understanding the functioning of environmental systems that are especially susceptible to human influence, such as the chemistry of the stratosphere and the thermal behavior of lakes, has advanced significantly in recent decades. Thanks to a mix of theory, modeling, simulation, and measurement, many of these systems are now well understood.

Finding tracer atoms in environmental samples at low quantities is one of the finest methods for assessing the influence of human activity on the climate. Similar to how short-lived radioactive nuclei are used as tracers for the study of biological systems, different long-lived radioactive nuclei also function as such tracers. The knowledge of how radioactive elements develop, decay, and are detected has led to the employment of these tracers. With the development of ever-more-sensitive detection tools, this approach to environmental monitoring has grown in importance.

Keeping an eye on the surroundings

An essential instrument for environmental measurements is accelerator mass spectrometry (AMS). AMS accelerates and detects tracer atom concentrations in environmental samples using nuclear methods. Its sensitivity makes routine measurements that would otherwise be challenging or impossible.Earth's atmosphere and surface are continuously bombarded by cosmic rays from other parts of the galaxy, creating persistent radioactive "cosmogenic nuclei." The quantity of 14C present decays with a half-life of 5700 years because carbon in biological materials is not restored from the environment once an animal or plant dies. The amount that remains gives an indication of the object's age. The length of time that material containing other cosmogenic nuclei has been protected from cosmic rays and the environment may be ascertained in a similar way. How long an aquifer's water has been free of contaminants from

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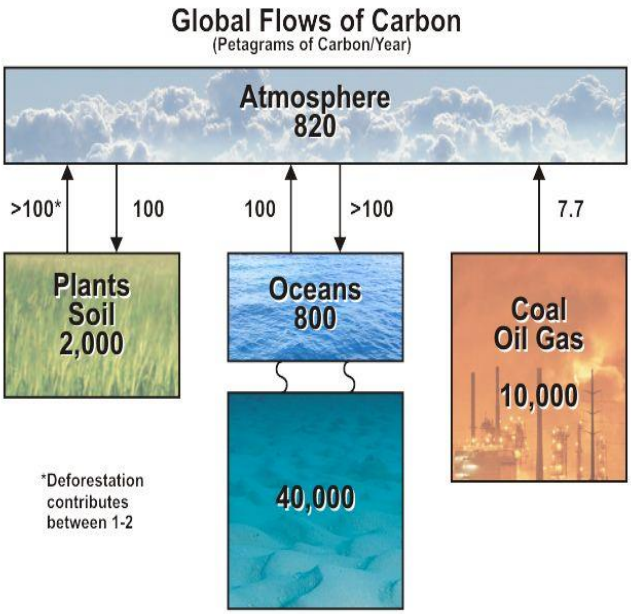
younger groundwater is determined by measuring the concentration of the long-lived isotope 81Kr in the Great Artesian Basin in Australia.

The study of large-scale environmental processes is done using cosmogenic nuclei. AMS has measured the quantity of 10Be in ice cores and discovered a correlation with solar activity. This association might enable research on solar activity going back 10,000 years, as opposed to the 400-year record that is now accessible. The extent to which climatic fluctuation is caused by solar variation may then be ascertained. Understanding the characteristics of oceanic circulation, which significantly affects climate, is the focus of other AMS observations. Northern Europe's temperature would drop if the Atlantic's northward-flowing currents stopped. Drop from 5 to 10 degrees Celsius. Growing greenhouse gas emissions are thought to have the potential to trigger such a shift. Greenland ice core oxygen isotope contents indicate that significant changes were typical close to the end of the previous ice age. These significant alterations were worldwide in scope, according to dating of organic glacial remains in New Zealand using 14C.

Atmosphere of cosmic rays, nitrogen 14, carbon 14 Because of gas exchange, carbon 14 reaches the ocean. Through conveyor circulation, carbon 14 enters the deep oceans. Nitrogen 14 is produced by the breakdown of carbon 14 once every 62 years. Radioactive 14C is transported from the atmosphere into the abyss, where it decays gradually, by cold, salty water that falls to enormous depths, as shown above. The condition of the oceanic current system is assessed using radiocarbon dating. Scientists create computer simulations of the climate system called climate models in order to better understand the causes and consequences of global warming and forecast future warming. Climate models are designed to mimic how the seas and atmosphere react and interact, as well as to take into consideration both natural and man-made changes to the land surface. They explain hundreds of variables that affect Earth's climate and adhere to the conservation of energy, mass, and momentum—three basic principles of physics.



A physics viewpoint on global warming

Despite the complexity of the models, thorough testing using actual data refines them into effective instruments that enable researchers to investigate our knowledge of the climate in ways that would not be feasible otherwise. In order to better understand Earth's current climate and forecast future climate concentrations that will remain within the range of plausible emissions of the 21st century, scientists experiment with the models by removing greenhouse gases released by the burning of fossil fuels or altering the Sun's intensity to see how each affects the climate. According to the simulations, the average surface temperature of the Earth will rise along with greenhouse gas emissions as global fossil fuel use continues to increase. By the end, average surface temperatures might increase by 2 to 6 degrees Celsius, depending on the scenario. Emission projections for global surface warming (C) from +1 to 1900 differences between modelsLow growth (B1), moderate growth (AIB), and high growth (A2) Constant CO 2100 for the year 2000.

Water vapor is the biggest feedback. Among the potent greenhouse gases is water vapor. Water vapor really contributes almost two-thirds of greenhouse warming, which is a major component in maintaining Earth's temperatures within a livable range, due to its abundance in the atmosphere. However, when the temperature rises, more water vapor escapes the surface and enters the atmosphere, which may raise the temperature even more. How much water vapor will be in the atmosphere in a warming planet is the issue that scientists pose. Temperature and water vapor concentration are now at an average equilibrium or balance in the atmosphere. Water vapor concentrations rise to restore balance when temperatures rise because the atmosphere can hold more water vapor. Will that pattern persist as the temperature rises further? The amount of extra warmth brought on by the water vapor feedback is ultimately determined by the quantity of water vapor that enters the atmosphere. The water vapor feedback is rapidly absorbed by the atmosphere. As temperatures have increased in recent decades, the majority of the atmosphere has so far maintained a nearly steady equilibrium between temperature and water vapor concentration. Water vapor may double the warmth brought on by carbon dioxide alone if this trend continues, as many models predict it will.

Changes in the carbon cycle are more intricate on land

Soils, particularly the melting Arctic tundra, may release methane or stored carbon dioxide into the atmosphere under a warmer climate. As trees burn or decay, more carbon is released into the atmosphere as a result of more frequent fires and insect infestations. However, in some ecosystems, higher carbon dioxide levels may promote

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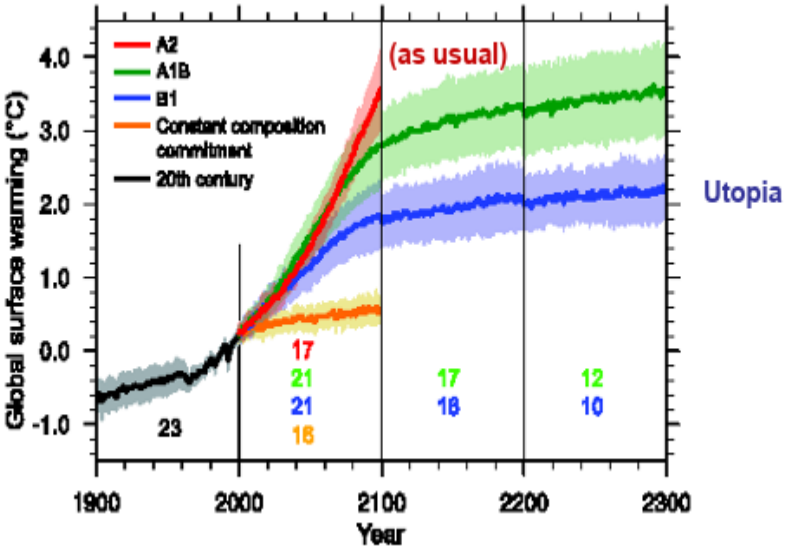
plant growth, enabling those plants to absorb more carbon from the atmosphere. However, when temperature, nitrogen, and water levels restrict plant development, this impact could be lessened. Additionally, when carbon dioxide levels rise to a point where photosynthesis is saturated, this impact could lessen. It's unclear how much more carbon dioxide plants can remove from the atmosphere and how long they could do so because of these issues.

The effects of climate change on the land carbon cycle are very complicated, but generally speaking, as plants reach saturation—the point at which they can no longer absorb more carbon dioxide—and other growth restrictions take place, as well as as land begins to contribute more carbon to the atmosphere through warming soil, fires, and insect infestations, land carbon sinks will become less effective. As a consequence, global warming will accelerate and atmospheric carbon dioxide levels will rise more quickly. According to some climate models, land and ocean carbon cycle feedbacks will raise global temperatures by more than one degree Celsius by the year 2100.

Situations of Emissions

By putting several potential future scenarios through climate models, scientists are able to forecast the range of expected temperature increases. The most important source of uncertainty in climate projections is because scientists are unsure of the decision's individuals will make to reduce greenhouse gas emissions, even if part of this uncertainty is from our incomplete understanding of climate feedbacks. The higher projections are predicated on the idea that global fossil fuel use would continue to rise per person, or what experts refer to as "business-as-usual."



Referenced to the 1980-1999 Average Temperature Solid lines: average of all models used. The number of models used depends on the emission scenario; shaded area is the standard deviation of the models. Gold curve is for Zero emissions beyond 2100.

More conservative projections are derived from scenarios where a large portion of today's fossil fuel burning is replaced by ecologically benign technology like fuel cells, solar panels, and wind energy. The Earth's response to increases in greenhouse gasses takes decades to millennia. Long after emissions are decreased, carbon dioxide and other greenhouse gases will still be present in the atmosphere and contribute to ongoing warming. Furthermore, a large portion of the extra energy produced by Earth's warming has been used to warm the ocean's top layers. Long after greenhouse gas emissions have ceased to rise, the heated ocean will continue to warm the lower atmosphere, much like a hot water bottle on a chilly night. Because of these factors, the effects of lower greenhouse gas emissions won't be seen right away. The earth would continue to warm by around 0.6 °C over the course of the next century due to greenhouse gases already present in the atmosphere, even if concentrations of these gases stabilized today.

The environment and energy production

Enhancements in energy efficiency, many of which are physics-based, have a direct impact on environmental quality. From the kerosene lamp to the incandescent bulb to the fluorescent light, lighting efficiency has significantly grown. The use of thin-film coatings that include knowledge from atomic physics has significantly boosted window thermal resistance, which directly affects the energy needed for space heating and cooling. Another example of physics in action is the oxygen sensor used in automotive exhaust, which allows for much reduced emissions of nitrogen oxides, carbon monoxide, and hydrocarbons. This category also includes metal recycling: Many advancements in materials science have contributed to the growing competitiveness of secondary metals production, or recycling, in comparison to primary metals production.

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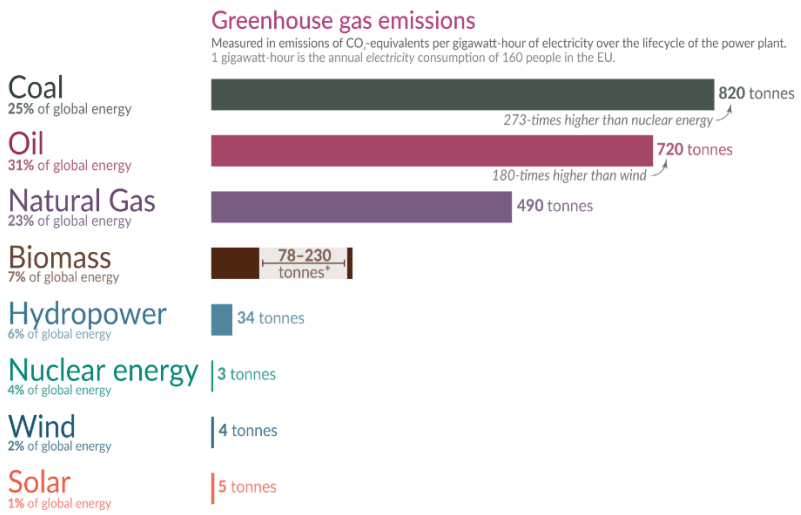

Alternative energy generation methods' attractiveness and substitutability are also crucial. Carbon dioxide is an inevitable byproduct of energy production from fossil fuels. The two main options are renewable energy (which may take many different forms, such as wind, hydropower, photovoltaic cells, and solar thermal energy) and nuclear power (both nuclear fission and nuclear fusion). All of these alternative technologies are the subject of ongoing research and development projects worldwide. Each has advantages and disadvantages. It is much more probable that an industrialized civilization will be sustainable if people keep exploring a wide range of energy generation possibilities.

The global energy system will need comprehensive carbon management as long as fossil fuels continue to dominate energy production. Scientists from all across the globe are already considering and paying attention to carbon control solutions. A significant class of tactics include chemically breaking down fossil fuels into carbon dioxide and hydrogen in order to separate their carbon and energy contents. As a waste product, the carbon dioxide would need to be removed from the atmosphere; for instance, it may be pumped to saline aquifers located deep below. The two most ecologically friendly secondary energy carriers, electricity and hydrogen, would power the world's industries, automobiles, buildings, and appliances in some combination. Making a hydrogen economy safe and inexpensive would need significant advancements in fields where physics is essential, such as better materials for hydrogen fuel cells and molecular techniques for hydrogen storage.

In summary

Earth has often warmed and cooled throughout its lengthy history. When the Sun's energy fluctuated, the planet's surface or atmosphere altered, or the planet got more or less sunlight as a result of minute changes in its orbit, the climate changed. However, within the last century, human activity has begun to affect Earth's climate. The field of environmental science is quite multidisciplinary. The primary focus is on the biological sciences, chemistry, applied mathematics, geology, oceanography, and physics. Physics has a wide range of applications, including direct support for energy production and environmental initiatives, indirect support through fundamental research, the provision of technological spin-offs from research initiatives, and the development of a technically literate populace that can address environmental challenges. The basis is provided by fundamental studies in atmospheric and oceanic physics.

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Original Article

Studies in Stability Constant of PR (Iii), ND (Iii) And GD (Iii) Metal Ions Complexes with Some Substituted Schiff's Bases In 70% Dioxane-Water Medium PH-Metrically

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Abstract:-

The Interaction of PR(III), ND(III) And GD(III) Metal Ion With Ligands, L_1 :- 2'-Hydroxy, 3'-Bromo,5'chloro-4-Methoxy-N[Orthonitro phenyl]Chalcone Imine & L_2 :- 2'-Hydroxy,5'chloro-4-Methoxy-N[Orthonitrophenyl] Chalcone Imine Have Been Studied At 0.1M Ionic Strength PH-Metrically In 70% Dioxane-Water Mixture By Bjerrum Method As Adopted By Calvin Wilson. The Data Obtained Were Used To Estimate & Compare The Value Of Proton-Ligand Stability Constant (PK) And Metal-Ligand Stability Constant (Log K) Using Half Integral & Pointwise Calculation Method .It Is Observed That Metal Ions Form 1:1 Complexes With L_1 & L_2.

Keywords:- Metal ions PR (III), ND (III),and GD (III), Ligands L_1 & L_2 (substituted Schiff;s Bases)

Introduction

The stability constant for the metal complex is widely used in many fields such as biological processes, analytical processes, pharmaceuticals, etc. Metal complex play a very important role in nature.

Thorat et al[1] studied, substituted 3,5-diaryl isoxazoline complexes in 70% dioxane solvent media pH-metrically. Rajput[2] & Deshmukh[3] have work with substituted pyrazoline, pyrazole, isoxazolines & isoxazoles. Raghuwanshi et al[4] have been work on, Spectrophotometric Investigation of Conditional Stability constant & confirmation of complex formation of Cu(II) complexes with substituted chalcones & isoxazolines.

Thile[5] studied complex formation between Cr(III), Nd(III) & Pr(III) metal ions and substituted hydroxyl chalcones at 0.1M ionic strength pH- metrically. Thakur et al[6] have also done some work on stability constant of complexes with Cr (III) metal ions. Meshram et al[7], Studies on formation constant of Co(II), Ni(II), Cr(III) & Fe(III) ion complexes with some heterocycles by pH-metrically, spectrophotometrically & refractometrically.

Rathode et al[8], have studied effect of dielectric constant of dioxane-water mixture on proton-ligand dissociation constant & formation constant of Cu(II) complexes with1,3-diphenylthiazines pH-metricallyat 0.1M ionic strength. pH-metric studies of synthesized ligand 1-(2-hydroxyphenyl)-3-phenylpropane-1,3- dione with Fe(III), Cd(II), Co(II), Ni(II), Zn(II) cation at 0.1M ionic strength has studied by Sonkamble[9] .

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Deshmukh et al[10] Stuided on transition metal ligand stability constant with some substituted pyrazoline pH-metrically. The pH-metric study of synthesized heterocyclic compound isoxazoline with Cu(II) &Fe(III) metal ion have been done by Mane et al[11].Pund etal[12],Studies on interaction between La(III) & Nd(III) metal ions & 1-(4-hydroxy-6-methyl pyrimidino)-3-substituted thicarbamide at 0.1M ionic strength pH-metrically. Target Recognition by Catechols of hydrogen bonding & Mn/Mg Chelation to HIV-1 Integrese Inhibition[13].

Schiff's Bases have importance & applicability in all fields of scientific interest like medicines, biology, agriculture industry & analytical chemistry. In view of the analytical application of Schiff's Bases and confirmation of dissociable hydroxyl group (-OH), it is necessary to know the physio-chemical properties.

So present study deals with complex formation between Pr(III), Nd(III) and Gd (III) metal ions with Schiff's Bases and determination of stability constants pH-metrically by Calvin-Bjerrum titration technique.

Materials and Methods

The solution of ligants L_1 & L_2 were prepared in 70% Dioxane-water mixture. The solution of NaOH, HNO_3, KNO_3 and metal ions $Pr(NO_3)_3$, $Nd(NO_3)_3$, and $Gd(NO_3)_3$were obtained from BDH grade chemicals. The NaOH solution was standardized with oxalic acid, kept in pyrex vessel and used as a titrant for pH titrations.The 1.0 M KNO_3 solution were prepared to maintain the 0.1 M ionic strength of the solution. The metal nitrates were used to prepare the metal solution and were standardized by usual procedure.

Measurements: All measurements were carried out at 30 ± 0.1^{0}C. Systronic microprocessor based pH meter with magnetic stirrer and combined glass and calomel electrode assembly used for pH measurements. The sensitivity of pH is 0.01 units. The instruments could read pH in the range 0.00 to 14.00 in the step of 0.005. The pH meter was switched ON for half an hour before starting the titration for initial warm up of the instrument. It was calibrated before each titration with an aqueous standard buffer solution of pH 7.00 and 9.20 at (30 ± 0.10^{0}C) prepared by dissolving Cambridge buffer tablets in distilled water. The hydrogen ion concentration was measured with combine glass electrode.

Procedure:-

Experimental procedure involves following three set of titrations carried out with standard NaOH solution (0.1M) in presence of inner atmosphere by bubbling a contant flow of nitrogen gas. Data obtained from the titration was used to plot a graph between volume of NaOH and pH values, they are called acid, ligand and metal titration curves.

Free acid titration (HNO_3, 1 x 10^{-2}M)

Free acid + ligand titration (20 x 10^{-4}M)

Free acid + ligand + metal ion titration (4 x 10^{-4} M)

Result And Discussion

Substituted Schiff's Bases are considered as monobasic acid having only one replaceable H^+ion from –OH group.

$$HL \rightleftharpoons H^+ + L^-$$

It is observed from titration curve for all the system that ligand curves start deviating from free acid (HNO_3) curves at about 2.20 and deviated continuously upto pH-11.The deviation shows that dissociation of– OH group in substituted Schiff's Bases.

Proton-ligand formation number n_A were calculated from acid titration curve (A) and acid ligand titration curve (A+L) by standard method. It was found that values of Δn_A decreases with increased pH of solution due to replacement of H^+ ion from –OH group. The photon ligand formation number were calculated by Irving and Rossotti expression.

$$n_A = \gamma - \{(V_2 - V_1)(E^0 + N)/(V^0 + V_1)T_L^0\}$$

Where,

$V^0$is the initial volume of solution, $E^0$and $T_L^0$are initial concentrations of mineral acid and ligand respectively, V_1,V_2 are the volumes of alkali of normality N during acid and ligand titration of given pH, γ is the replaceable protons from the ligand.

Table.1:- Determination of Δn_AValues

pH	V1(ml)	V2 (ml)	V2–V1(ml)	ΔnA
1.00	0.22	0.32	0.10	0.8581
1.20	0.30	0.48	0.18	0.7450
1.40	0.41	0.61	0.20	0.7173
1.60	0.45	0.68	0.23	0.6753
1.80	0.46	0.69	0.23	0.6753

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2.00	0.47	0.72	0.25	0.6471
2.20	0.48	0.75	0.27	0.6190
2.40	0.49	0.77	0.28	0.6050
2.60	0.50	0.79	0.29	0.5909
2.80	0.52	0.82	0.30	0.5770
3.00	0.52	0.84	0.32	0.5650
3.20	0.53	0.86	0.33	0.5360
3.40	0.54	0.90	0.36	0.4920
3.60	0.57	0.95	0.38	0.4250
3.80	0.57	0.99	0.42	0.4050

System – Ligand (L_1) Medium–70% Dioxane-water T_L^0=20 x10^{-4}M
E^0=1 x10^{-2}M Temp.= 30 ± 0.1°C N=0.10N μ=0.1M V^0=12.5ml

Table. 2 :- Determination of Δn_A Values

pH	V_1(ml)	V_2(ml)	V_2–V_1(ml)	Δn_A
1.40	1.19	1.23	0.04	0.9443
1.60	1.30	1.36	0.06	0.9166
1.80	1.42	1.51	0.09	0.8753
2.00	1.55	1.68	0.13	0.8203
2.20	1.62	1.80	0.18	0.7516
2.40	1.70	1.90	0.20	0.7244
2.60	1.76	1.98	0.22	0.6972
2.80	1.81	2.05	0.24	0.6700
3.00	1.83	2.11	0.27	0.6290
3.20	1.85	2.15	0.30	0.5878
3.40	1.88	2.20	0.32	0.5606
3.60	1.90	2.24	0.34	0.5333
3.80	1.90	2.26	0.36	0.5059
4.00	1.90	2.30	0.40	0.4510
4.20	1.90	2.34	0.44	0.3960
4.40	1.90	2.41	0.51	0.3000

System – Ligand (L_2) Medium–70% Dioxane-water T_L^0= 20 x 10^{-4}M
E^0=1 x10^{-2}M Temp.= 30 ± 0.1°C N=0.10N μ=0.1M V^0=12.5ml

The proton-ligand stability constant pK value of ligand were calculated by algebraic method pointwise calculation and also estimated from formation curve fig-1-2 Δn_A Vs pH (Half integral method) by noting pH at which n_A = 0.5.

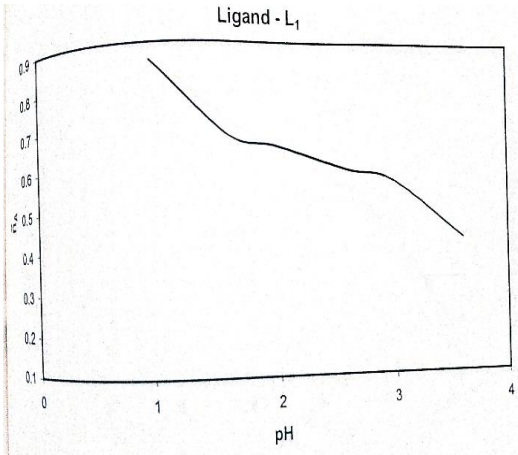

Fig.1:-Plot between Δn_A Vs pH, System: L_1

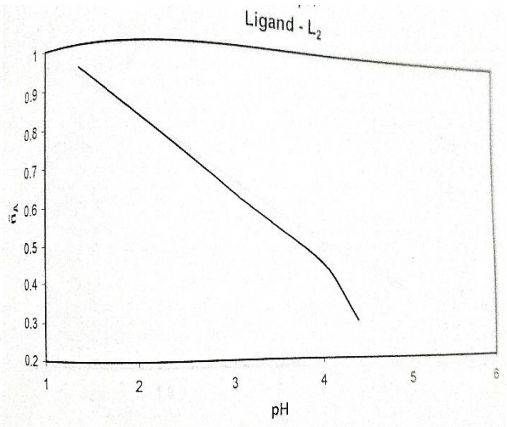

Fig.2:-Plot between Δn_A Vs pH, System: L_2

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Table.3.Determination of Proton-Ligand Stability Constants (pK)

Ligands	Proton-Ligand Stability Constants (pK)	
	Half Integral Method	Pointwise Calculation
L_1	3.70	3.7932 ± 0.03
L_2	3.80	3.8260 ± 0.05

The metal-ligand formation number ($\bar{n}$) were calculated by standard method, which increase with increase pH by using the following expression. The metal-ligand stability constant (logK) were determined by half integral method by plotting $\bar{n}_A$Vs pH at n = 0.5 and 1.5 showing1:1 formation of complex. The metal- ligand stability constant values are given in table.4.

$$\bar{n}=\{(V_3-V_2)(N+E^0)/(V^0+V_2)T^0M$$

Table.4 :- Determination of Metal ligand Stability Constants

System	log K_1	log K_2	logK_1 - logK_2	logK_1 / logK_2
Pr (III) - L_1	4.68	3.79	0.89	1.23
Nd (III) - L_1	4.58	4.17	0.41	1.10
Gd (III) - L_1	3.99	3.09	0.90	1.29
Pr (III) - L_2	4.85	4.45	0.40	1.10
Nd (III) - L_2	4.65	3.85	0.80	1.21
Gd (III) - L_2	4.75	4.05	0.70	1.17

Conclusion

It was observed from above table.4 that logK1 values are greater than log K_2 values for all metal complexes. The difference between log K_1 and K_2 is greater than 1 which shows the formation of stepwise complex. If the difference is smaller than 1 then that shows the formation of simultaneous complexes. The higher values of ratio (logK_1/logK_2) indicate the more stable stepwise complex formation.

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Original Article

Properties of Di-Sodium tartrate dihydrate in the presence of urea and An investigation of the physiochemical and thermochemical potassium chloride at 308.15 °C and 1 atm.

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Abstract:
In Terms of Solute–Solute And Solute–Solvent Interactions, Thermodynamic Properties Help To Characterize The Structure And Behaviour of Solutions. Understanding The Behaviour of Mixed Electrolyte And Non-Electrolyte Systems Is Essential In Chemical, Pharmaceutical, And Biological Processes. Di-Sodium Tartrate Dihydrate Is Widely Used In Food And Pharmaceutical Industries. Urea, A Non-Electrolyte, Affects Hydrogen Bonding Networks, While Potassium Chloride, A Strong Electrolyte, Alters Ionic Interactions. Thus The Primary Goal Of This Study Is To Examine The Effect Of Electrolytes (KCL) And Non-Electrolytes (Urea) On The Solvation Behaviour of Di-Sodium Tartrate. Parameters Such As Density, Viscosity, Surface Tension, Conductance Refractive Index, And Apparent Molar Volume Were Evaluated To Understand Solute–Solute And Solute–Solvent Interactions. The Study Reveals That Di-Sodium Tartrate Dihydrate Exhibits Strong Interactions in Aqueous Urea and Potassium Chloride Systems. Urea Weakens Hydrogen Bonding While Kcl Enhances Ionic Strength, Leading To Complex Structural Modifications In The Solution. These Findings Are Useful in understanding industrial and biochemical solution behaviour.

Keywords: Di-Sodium Tartrate Dihydrate, Urea, Potassium Chloride, Physicochemical Properties, Thermochemical Analysis.

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Introduction:

The study of the physicochemical properties of electrolytes and non-electrolytes in aqueous media is essential for understanding the intricate nature of molecular interactions in biological systems.[1,2] Di-sodium tartrate dihydrate ($C_4H_4Na_2O_6.2H_2O$), a salt of a dicarboxylic acid, is frequently used in biochemical and pharmaceutical industries as a buffer and food additive. Understanding its behaviour in the presence of co-solutes like urea and potassium chloride (KCl) provides unique insights into solute–solvent and solute–solute interactions. **Urea** is a widely used non-electrolyte in protein denaturation studies, known for its ability to significantly alter the hydrogen-bonding structure of water.[3-5] Conversely, **potassium chloride (KCl)** is a strong electrolyte that introduces competing ions, affecting the solubility and electrostriction behaviour of the primary salt. The primary objective of this study is to measure the **density (ρ) conductance (G)**, Surface Tension (γ) **viscosity (η)**, and **refractive index (n)** of these mixtures at a controlled temperature of **308.15 K** and a pressure of **1 atm**. These experimental parameters allow for the derivation of several thermodynamic properties[6-8]:

Transport properties: Viscosity data is analysed using the Jones-Dole equation to identify "structure-making" or "structure-breaking" abilities of the solutes.

Refractive index: This provides information on the molar refraction and the electronic polarizability of the solution components.

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Electrical conductance: This is used to investigate ionic mobility and the degree of ion association in the presence of the hydrotropic agent, urea. By examining these properties at **308.15 K**, this research aims to elucidate the competing effects of ionic and non-ionic co-solutes on the structural arrangement of water around the tartrate ion, contributing to the broader understanding of solvation dynamics in mixed aqueous systems.

This study investigates the molecular interactions and thermodynamic stability of **Di-Sodium Tartrate Dihydrate (DSTD)** in aqueous solutions containing **Urea** (a protein denaturant) and **Potassium Chloride (KCl)** (a strong electrolyte).

Experimental section:

Material:

Di-sodium tartrate dihydrate (DSTD), Urea, and KCl were of analytical grade (purity > 99%).

Binary and ternary mixtures were prepared by mass using an analytical balance with a precision of **± 0.0001 g** (or **0.1 mg**). All solutions were prepared using **double-distilled, deionized water** with a specific conductance of less than **1 × 10^{-6} S·cm^{-1}**.

Method:

All weighing was made on an Contech balance with accuracy (±0.001 gm). The density measurement was within ± 0.1 kgm^{-3}. Mathematically, density (ρ\rhoρ) is calculated as the mass (m) of a substance divided by its volume (V): ρ=mV

Viscosity denotes opposition to flow. The reciprocal of the viscosity is called the fluidity, a measure of the ease of flow

The viscosity measurements were carried out using thoroughly cleaned dried Ostwald's viscometer [9-13].

$$\eta = \frac{\rho \times t \times \eta_0}{\rho_0 \times t_0}$$

Surface tension is the tendency of liquid surfaces at rest to shrink into the minimum surface area possible. Surface tension is measured with the help of Stalagnometer.By comparing the number of drops (n) and density (**[ρ**) of a test liquid against water, the surface tension is determined.

Conductance, or electrical conductance, measures a material's ability to conduct electricity, essentially showing how easily an electrical current can flow through it. It is the opposite of electrical resistance, mathematically expressed as 1/R.

Refractive index of liquid mixture was measured with the help of Abbe's refractometer specially designed to measure the refractive index of transparent liquid, solution and solid ranging from 1.3000 to 1.70 by direct reading. While determining the refractive index initially the refractometer was calibrated with a glass piece provided with the instrument.

N1. Sin a1= N2. Sin a2

N1 and N2 are the refractive indices of the media in the sides of ideal boundary face, where a1 is incident angle, is refractive angle.

Table 1: Density, Surface tension, Viscosity, Conductance and Refractive Index of DSTD with water and Aq. urea

Concentration	**Density [ρ]**	**Surface Tension(γ)**	**Viscosity (η)**	**Conductance (ms)**	**Refractive Index (n)**
DSTD+ water					
0.02	1.096	81.2476	0.0089	3.51	1.334
0.04	1.1	75.4797	0.0088	6.78	1.333
0.06	1.104	78.2518	0.0086	9.68	1.335
0.08	1.106	79.2559	0.0088	11.72	1.336
0.1	1.109	82.6960	0.0093	14.3	1.336
DSTD+ aq. CO-SOLUTE Urea0.01M					
0.02	1.099	63.5713	0.0083	3.65	1.334
0.04	1.104	70.1560	0.0087	6.04	1.335
0.06	1.106	77.9566	0.0090	8.2	1.335
0.08	1.109	79.0362	0.0092	10.29	1.337
0.1	1.112	68.3022	0.0093	12.5	1.337
DSTD + aq. CO-SOLUTE Urea 0.05M					
0.02	1.101	75.5483	0.0088	3.56	1.334
0.04	1.103	73.7208	0.0090	6.26	1.335

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0.06	1.104	69.8052	0.0091	8.56	1.336
0.08	1.108	65.5650	0.0091	10.7	1.336
0.1	1.111	62.8533	0.0091	12.8	1.337
DSTD + aq. CO-SOLUTE Urea 0.1					
0.02	1.101	69.6155	0.0085	3.76	1.335
0.04	1.103	68.4041	0.0085	6.68	1.335
0.06	1.105	64.4998	0.0086	9.18	1.336
0.08	1.108	64.3778	0.0088	11.86	1.336
0.1	1.111	60.7279	0.0089	14.12	1.337

Table 2: Density, Surface tension, Viscosity, Conductance and Refractive Index of DSTD with water and Aq. KCL

Concentration	Density [P]	**Surface Tension**	**Viscosity**	**Conductance (ms)**	**Refractive Index**
DSTD+WATER					
0.02	1.096	81.2476	0.0089	3.51	1.334
0.04	1.1	75.4797	0.0088	6.78	1.333
0.06	1.104	78.2518	0.0086	9.68	1.335
0.08	1.106	79.2559	0.0088	11.72	1.336
0.1	1.109	82.6960	0.0093	14.3	1.336
DSTD + aq. CO-SOLUTE KCL0.01M					
0.02	1.099	65.9400	0.0086	4.86	1.3320
0.04	1.101	64.8474	0.0086	8.47	1.3325
0.06	1.106	63.6935	0.0087	11.02	1.3330
0.08	1.109	63.5767	0.0090	13.57	1.3340
0.1	1.111	62.5816	0.0091	15.92	1.3345
DSTD + aq. CO-SOLUTE KCL0.05M					
0.02	1.101	63.9710	0.0082	9.91	1.3325
0.04	1.104	65.9272	0.0084	12.86	1.3340
0.06	1.108	71.4665	0.0081	15.06	1.3340
0.08	1.11	67.5425	0.0082	17.15	1.3345
0.1	1.112	66.4049	0.0084	19.45	1.3350
DSTD + aq. CO-SOLUTE KCL 0.1M					
0.02	1.105	67.5538	0.0089	15.36	1.3340
0.04	1.107	72.8556	0.0090	17.31	1.3345
0.06	1.11	68.8382	0.0091	19.72	1.3350
0.08	1.112	67.6642	0.0093	21.3	1.3355
0.1	1.115	66.9000	0.0092	23.2	1.3360

Figure 1. Viscosity of DSTD with water and Aq. urea and Aq. KCL

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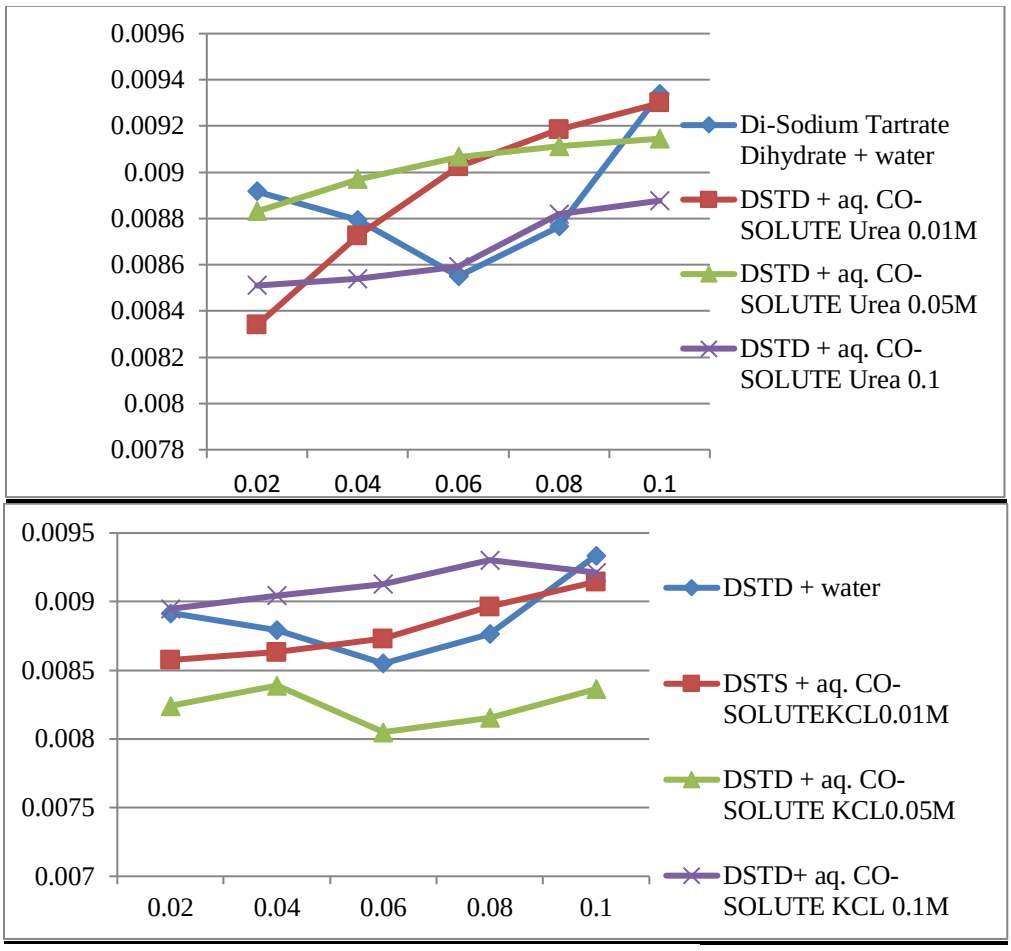
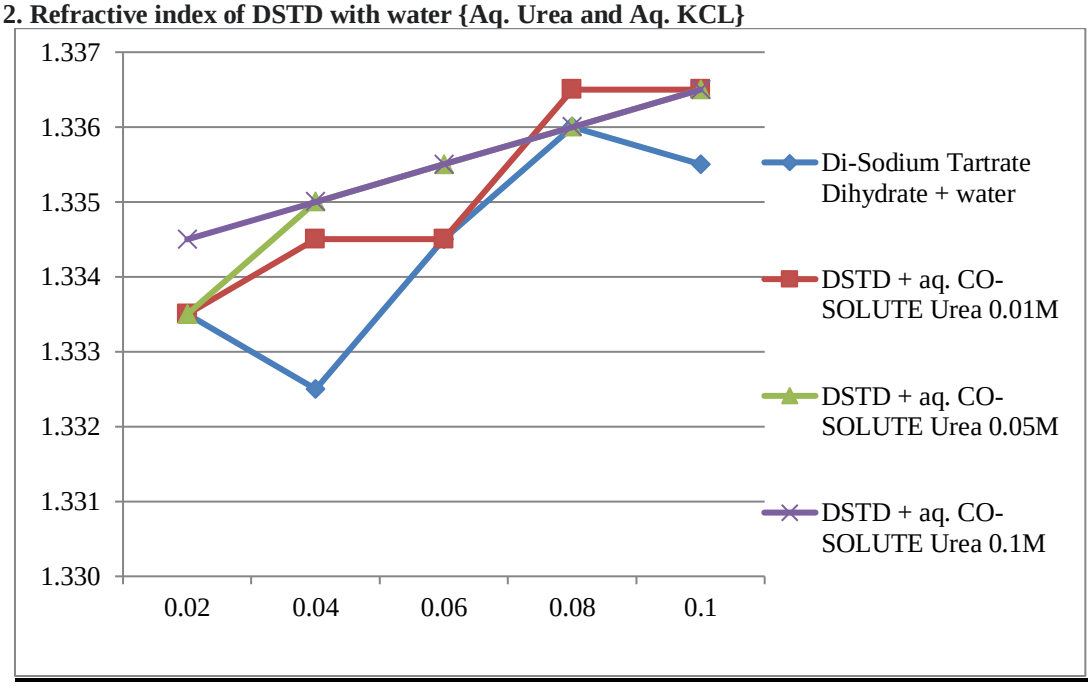


Fig 2. Refractive index of DSTD with water {Aq. Urea and Aq. KCL}



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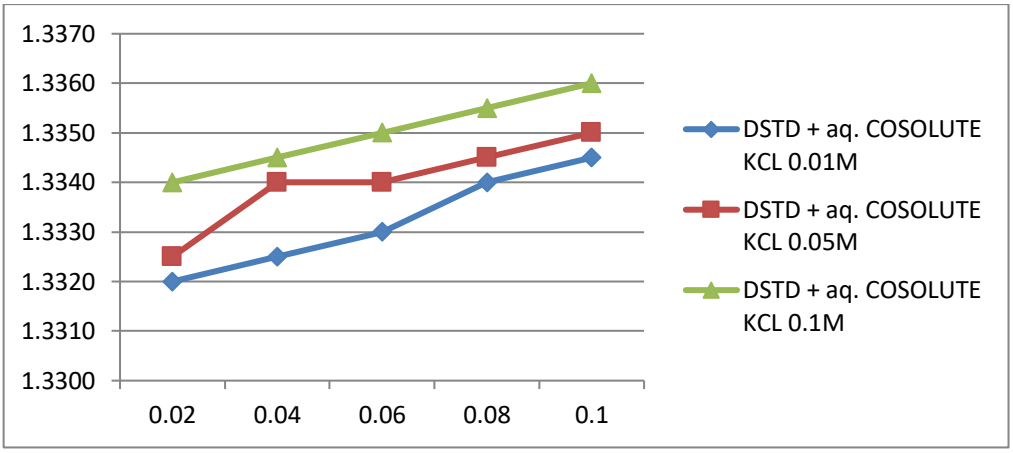

Results and Discussion:

Density increases with increases concentration of solute and cosolute also at specific temperature and pressure condition. **Higher concentration leads to a higher viscosity measurement** of binary solution of solute solvent Viscosity increases with increases concentration. Surface tension decreases with increases concentration which shows different type of molecular interactions between molecules. Conductances increases with increases concentration is an evidence of presence of ions in solution mixture. The refractive index data shows linear dependence over the drug concentration at studied temperatures, which is well in accordance with the data obtained from volumetric study.

Refractive index of studied solution increase with increasing in the concentration of solute as well as cosolute which indicates that increase compactness. The values for DSTD increase with increasing concentration of Urea. This suggests that Urea acts as a "structure breaker," releasing water molecules from the hydration shell of the tartrate ion into the bulk, thereby increasing the apparent volume. Conversely, the addition of KCl leads to a decrease in due to the high electrostriction caused by and ions[14-21].

Conclusion:

The investigation at **308.15 K** reveals that:

Strong ion-solvent interactions dominate the DSTD-KCl-Water system.

Urea promotes the dehydration of DSTD, increasing the free volume of the system.

The thermochemical stability of Di-Sodium Tartrate is enhanced by the presence of KCl due to the strengthening of the ionic atmosphere.

These findings are essential for processes involving the stabilization of tartrate-based buffers in the presence of common impurities or additives.

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Original Article

Nanotechnology-Driven Reinforcement of Polymer Composites

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Abstract

Polymer composites reinforced with nanomaterials have emerged as advanced materials with improved mechanical, thermal, electrical, and functional properties. Nanotechnology allows the incorporation of nanoscale fillers such as carbon nanotubes, graphene, nanocellulose, metal oxides, and layered silicates into polymer matrices to produce polymer nanocomposites. Due to their high surface area and strong interfacial interactions with polymer chains, nanoparticles significantly enhance the performance of conventional polymers. The reinforcement mechanism in polymer nanocomposites depends on filler dispersion, polymer–filler interaction, and the formation of percolation networks within the matrix. This paper reviews the fundamental principles of nanotechnology-based reinforcement in polymer composites, fabrication techniques, major nanofillers used, and emerging applications in aerospace, biomedical engineering, electronics, and energy storage devices. The study highlights recent developments and challenges in achieving homogeneous dispersion and strong interfacial bonding between polymer matrices and nanomaterials.

Keywords: - Polymer, reinforcement mechanism, recent developments, etc.

Introduction

Polymers are widely used due to their lightweight, flexibility, corrosion resistance, and ease of processing. However, conventional polymers often exhibit low mechanical strength, limited thermal stability, and poor electrical conductivity, restricting their application in advanced engineering sectors. Nanotechnology enables reinforcement of polymer matrices through the incorporation of nanofillers, producing polymer nanocomposites with enhanced properties. Nanofillers, ranging from 1–100 nm in size, possess unique physical and chemical characteristics due to their nanoscale dimensions. These characteristics include high aspect ratio, large surface area, and quantum effects, which significantly influence polymer matrix behaviour. The key mechanism for property enhancement is the strong interfacial interaction between nanofillers and polymer chains, which facilitates efficient load transfer and reduces polymer chain mobility.

Recent advances have demonstrated that polymer nanocomposites reinforced with nanofillers can achieve mechanical properties comparable to metals, while retaining advantages like low density and corrosion resistance. These materials are increasingly used in aerospace, electronics, automotive, and biomedical applications.

Mechanisms of Nanotechnology-Driven Reinforcement

2.1 Load Transfer Mechanism

Nanofillers efficiently transfer stress from the polymer matrix, increasing tensile strength and modulus. The high aspect ratio of CNTs and graphene sheets provides an extensive interface for stress transfer.

2.2 Interfacial Interaction

The large surface area of nanofillers allows for strong physical or chemical bonding with polymer chains. Functionalization of fillers further enhances interfacial adhesion, reducing crack propagation under stress.

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2.3 Barrier Effect

Nanofillers restrict polymer chain mobility and hinder molecular diffusion, improving thermal stability, chemical resistance, and mechanical performance. The tortuous path created by nanoparticles increases resistance to gas and liquid permeation.

2.4 Multifunctional Reinforcement

Certain nanofillers, such as graphene and CNTs, impart electrical conductivity and thermal conductivity along with mechanical reinforcement, enabling multifunctional applications.

Types of Nanofillers Used for Reinforcement

3.1 Carbon Nanotubes (CNTs)

Carbon nanotubes are among the most effective nanofillers used in polymer reinforcement. CNTs possess exceptional tensile strength, electrical conductivity, and thermal stability. When incorporated into polymers such as epoxy, polystyrene, and polyethylene, CNTs significantly improve mechanical and electrical properties.

Their high aspect ratio and strong interaction with polymer chains enable efficient load transfer, leading to improved stiffness and tensile strength.

3.2 Graphene and Graphene Oxide

Graphene is a two-dimensional nanomaterial composed of a single layer of carbon atoms arranged in a hexagonal lattice. Due to its extraordinary mechanical strength and electrical conductivity, graphene has become a widely used reinforcement material in polymer composites.

Graphene-reinforced polymer nanocomposites exhibit:

High mechanical strength

Improved thermal conductivity

Enhanced electrical conductivity

These materials are used in flexible electronics, sensors, and energy storage devices.

3.3 Nanocellulose

Nanocellulose is a biodegradable and renewable nanomaterial obtained from plant sources. It has attracted attention as an environmentally friendly reinforcement material in polymer composites.

Nanocellulose offers advantages such as:

High mechanical strength

Biodegradability

Low density

Nanocellulose-reinforced polymer composites have potential applications in packaging, biomedical devices, and environmentally sustainable materials.

3.4 Metal Oxide Nanoparticles

Metal oxide nanoparticles such as:

TiO_2

ZnO

Al_2O_3

are frequently used in polymer nanocomposites to improve thermal stability, flame resistance, and photocatalytic properties. These nanofillers also enhance UV resistance and mechanical durability of polymer materials.

Fabrication Techniques

4.1 Solution Mixing

Nanofillers are dispersed in a solvent along with the polymer. After uniform dispersion, the solvent is evaporated to obtain the nanocomposite. This method ensures good filler dispersion but is limited by solvent selection and scale-up issues.

4.2 Melt Blending

A widely used industrial technique where polymer melts are mixed with nanofillers using extrusion or high-shear mixing. This method is scalable and environmentally friendly but requires precise control to prevent filler agglomeration.

4.3 In-Situ Polymerization

Nanofillers are dispersed in monomers, followed by polymerization. This technique yields strong interfacial bonding and homogeneous dispersion but is complex and sensitive to reaction conditions.

4.4 Electrospinning

Used for polymer nanofibers reinforced with nanofillers, producing mats or fibres with high surface area and controlled morphology, suitable for biomedical and filtration applications.

Characterization Methods

5.1 X-Ray Diffraction (XRD)

XRD is employed to analyse crystallinity, interlayer spacing, and phase identification in polymer nanocomposites.

5.2 Scanning Electron Microscopy (SEM)

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SEM provides morphological analysis, showing filler dispersion, particle size, and interface quality.

5.3 Transmission Electron Microscopy (TEM)

TEM reveals nanoscale distribution of fillers and interfacial interactions at high resolution.

5.4 Mechanical Testing

Tensile, flexural, and impact testing quantify improvements in strength and modulus due to nanofiller reinforcement.

5.5 Thermal Analysis

Differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) evaluate thermal stability and glass transition temperature improvements.

Applications

Aerospace: Lightweight, high-strength composites for structural components

Electronics: Conductive polymer composites for flexible electronics and sensors

Biomedical: Nanocomposite scaffolds, drug delivery carriers, tissue engineering

Energy Storage: Nanofiller-reinforced polymer electrolytes for batteries and supercapacitors

Packaging: Barrier-enhanced nanocomposite films for food and pharmaceuticals

Challenges in Polymer Nanocomposite Reinforcement

Despite significant advancements, several challenges remain:

Agglomeration of nanoparticles

Poor dispersion within polymer matrices

Weak interfacial bonding

High production cost

Developing efficient functionalization techniques and scalable fabrication methods remains an active area of research.

Optimizing nanofiller dispersion for uniform properties Functionalizing nanofillers to enhance polymer-filler interfacial bonding

Future Research Directions

Development of scalable, cost-effective fabrication methods

Environmental impact and biodegradability assessments

AI-assisted design for high-performance multifunctional composites

Conclusion

Nanotechnology has revolutionized the field of polymer composites by introducing nanoscale reinforcements that significantly improve mechanical, thermal, and electrical properties. Polymer nanocomposites offer promising opportunities for advanced engineering applications. Continued research on nanoparticle dispersion, interfacial bonding, and scalable manufacturing methods will further enhance the performance and commercial viability of these materials.

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Original Article

Synthesis of Derivatives of Chromone by Vilsmeier–Haack Formylation

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Abstract

Chromones Represent An Important Class Of Oxygen-Containing Heterocyclic Compounds Widely Distributed In Nature. These Compounds Possess A Benzopyranone Framework And Exhibit Diverse Biological Activities Such As Antioxidant,Anticancer, Anti Inflamatory And Anti Allergic Properties. The Present Study Focuses On The Synthesis Of Chromone Derivatives Using The Vilsmeier–Haack Formylation Reaction. The Introduction Of A Formyl Group Enhances The Chemical Reactivity And Pharmacological Significance Of These Derivatives. Various Derivatives Were Synthesized And Characterized Using Spectroscopic Techniques Including Ft-Ir, ^1h Nmr, And Mass Spectrometry. The Results Confirmed The Successful Synthesis Of Desired Compounds With Good Yield And Purity.

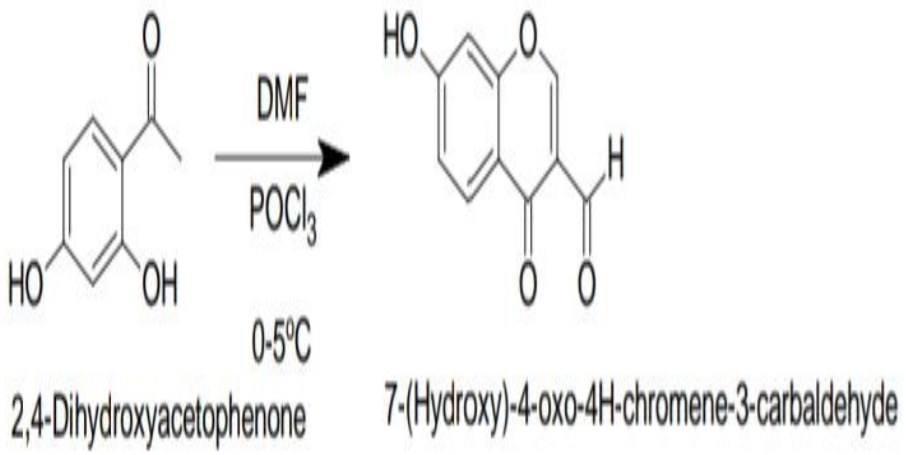
Keywords: *Chromone, Vilsmeier–Haack Reaction, Formylation, Heterocyclic Chemistry, Spectroscopy, Medicinal Chemistry.*

1. Introduction

Heterocyclic compounds play a crucial role in modern organic and medicinal chemistry due to their wide range of biological activities. Among these, chromones have attracted significant attention because of their structural diversity and pharmacological importance.

Chromones consist of a \gamma-pyrone ring fused with a benzene ring, Chromones consist of a \gamma-pyrone ring fused with a benzene ring, forming a benzopyranone system.

Chemical modification of the chromone nucleus is an area of active research, as introducing functional groups like aldehydes significantly alters biological activity. The Vilsmeier–Haack reaction is one of the most efficient methods for introducing formyl groups into aromatic and heterocyclic compounds. This reaction involves the formation of an electrophilic reagent from dimethylformamide (DMF) and phosphorus oxychloride (POCl_3).



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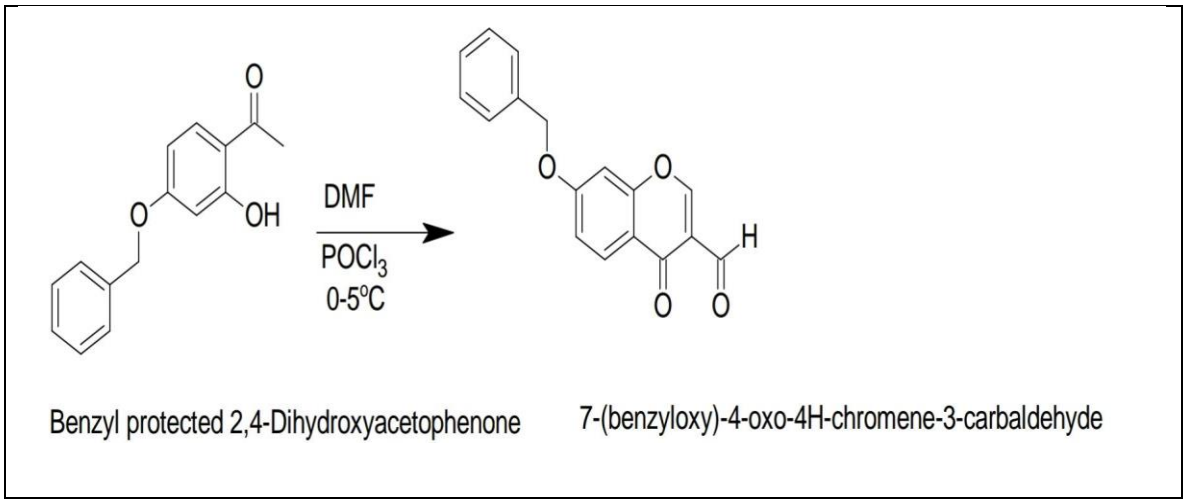
2. Materials and Methods

2.1 Reagents.

All chemicals used were of analytical grade. Main reagents included 2,4-dihydroxyacetophenone, dimethylformamide (DMF), phosphorus oxychloride (POCl_3), ethanol, ethyl acetate, and n-hexane.

2.2 Synthesis Procedure

The Vilsmeier–Haack reagent was prepared by adding POCl_3 to DMF under ice-cold conditions with constant stirring. The substrate (2,4-dihydroxyacetophenone) was added dropwise to the reaction mixture. After completion, the mixture was quenched with ice-cold water to precipitate the product. The crude product was purified using column chromatography.



3. Result Discussion

3.1 Physical and Spectroscopic Data

The synthesized chromone derivatives were obtained as light yellow solids. The melting points were found to be above 122°C, indicating high purity.

FT-IR Analysis: Showed characteristic peaks for carbonyl (C=O) at approximately 1680 cm^{-1}, confirming the presence of the aldehyde group.

^1H NMR Analysis: Provided detailed information about the proton environment. The aldehyde proton appeared as a singlet around \delta 9.5 ppm, while aromatic protons were observed in the range of \delta 6.5–8.5 ppm.

Mass Spectrometry: Confirmed the molecular weight of the synthesized compounds, validating their structure.

NMR and Mass Spectral Characterization of Synthesized Chromone Derivatives

^{1}H NMR and Mass Spectral Data

Sr. No.	Compound Name	Molecular Feature	^{1}H NMR (δ ppm, $CDCl_3$)	Multiplicity	Coupling Constant (J, Hz)	Proton Assignment	Remarks
1	7-(Benzyloxy)-4-oxo-4H-chromene-3-carbaldehyde (Schiff base precursor)	Aldehyde (–CHO)	9.56	s	—	–CHO proton	Characteristic aldehyde peak
2	Same	Aromatic proton	8.16	d	8.795	Ar–H	Ortho-coupled aromatic proton
3	Same	Aromatic proton	7.88	d	5.772	Ar–H	Aromatic system
4	Same	Phenyl ring (benzyl	7.39	m	—	5H (Ar–H)	Multiplet for benzyl phenyl

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		group)					
5	Same	Aromatic proton	6.96	d	2.199	Ar–H	Meta coupling
6	Same	Aromatic proton	6.57	d	6.046	Ar–H	Weak coupling

Mass Spectral Characterization

Sr. No.	Compound Name	Molecular Formula	Molecular Weight (g/mol)	Molecular Ion Peak (m/z)	Ion Type	Key Fragment Peaks (m/z)	Fragment Assignment
1	7-Hydroxy-4-oxo-4H-chromene-3-carbaldehyde	$C_{10}H_6O_4$	190.15	190	M^+	162, 134, 106	Loss of CO (–28), sequential ring fragmentation
2	7-(Benzyloxy)-4-oxo-4H-chromene-3-carbaldehyde	$C_{17}H_{12}O_4$	280.28	281	$[M+H]^+$	252, 224, 91	Loss of CO, benzyl cleavage, tropylium ion (m/z 91)
3	Schiff base derivative (Aniline substituted chromone)	$C_{23}H_{17}NO_3$	355.39	356	$[M+H]^+$	278, 250, 91	Loss of aniline moiety, chromone core fragmentation

Mass Spectal Interpretion

The mass spectra of the synthesized chromone derivatives showed characteristic molecular ion peaks confirming their molecular weights. The compound 7-hydroxy-4-oxo-4H-chromene-3-carbaldehyde exhibited a molecular ion peak at m/z 190 corresponding to its molecular formula $C_{10}H_6O_4$.

The benzyloxy-substituted derivative displayed a prominent $[M+H]^+$ peak at m/z 281, consistent with the calculated molecular weight (280 g/mol). A significant fragment at m/z 91 corresponds to the tropylium ion, confirming the presence of a benzyl group.

The Schiff base derivative showed a molecular ion peak at m/z 356 ($[M+H]^+$), supporting its proposed structure. Fragmentation peaks at lower m/z values indicate cleavage of the imine linkage and chromone ring system.

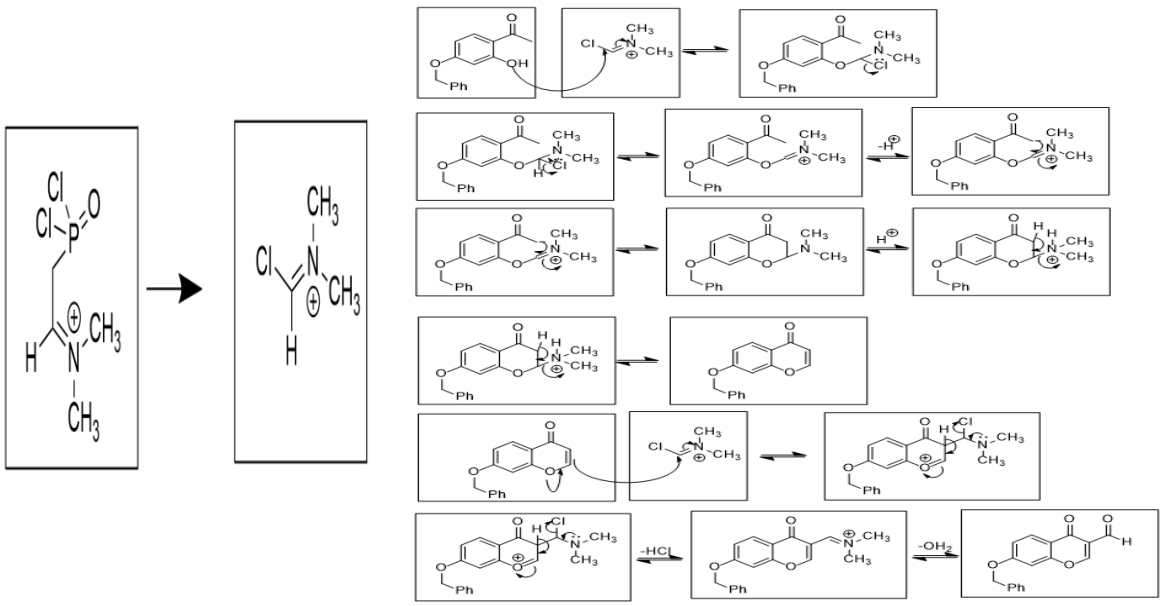
These results strongly support the successful synthesis of the targeted chromone derivatives.

3.2 Reaction Mechanism

The reaction mechanism involves the formation of a Vilsmeier reagent, which acts as an electrophile and attacks the chromone nucleus. This results in the introduction of a formyl group at the desired position.

4. Conclusion

The present study successfully demonstrates the synthesis of chromone derivatives using the Vilsmeier–Haack formylation reaction. The introduction of formyl groups enhances the chemical and biological properties of these



derivatives, making them valuable for pharmaceutical applications. Future research may focus on evaluating the biological activity.

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Original Article

Molecular interaction studies of ternary mixture of cis -potassium dioxalatodiaquo chromate (III) dihydrate complex in propanol-water at different temperatures

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Abstract

In Present Study, The Densities (P), Ultrasonic Velocities (U) And Viscosity(η) In A Ternary Liquid Mixture Of Cis –Potassium dioxalatodiaquo Chromate (Iii) Dihydrate Complex With Propanol In Water Have Been Measured At 303.15, 308.15 And 313.15 K Respectively, At Different Concentrations By Using Densitometer, Ultrasonic Interferometer, And Viscometer Respectively. The Measured Data Have Been Used To Compute The Various Thermo-Acoustic Parameters Using The Standard Relations Namely, Adiabatic Compressibility (B_s), Intermolecular Free Length (L_f), Specific Acoustic Impedance (Z),Wada Constant (W), Molar Sound Velocity(R), Relative Association (R_a), Apparent Molar Compressibility (Φ_β),Apparent Molar Volume(Φ_V)Viscosity Relaxation Time (Γ),Absorption Coefficient, Internal Pressure (π),Free Volume (V_f),Gibb's Free Energy (ΔG) And Specific Refraction (R), Etc. The Nature And The Relative Strength Of The Intermolecular Interaction Between The Components Of The Liquid Mixtures Have Been Successfully Investigated By Ultrasonic Method. The Results Have Been Interpreted In Terms Of Solute-Solvent And Solvent-Solvent Interaction.

Keywords: *Thermo-Acoustic Parameters, Cis –Potassium dioxalatodiaquo Chromate (Iii) Dihydrate Complex, Ultrasonic Velocity, Density, Adiabatic Compressibility, Ternary Mixture.*

Introduction:

The determination of various physical properties by ultrasonic method is a non-destructive technique and used for wide range of application in pharmaceutical, medical field process industries, consumer industries, physical chemistry, solution chemistry, biochemistry, chemical engineering, and process control for understanding of many phenomena in solutions and liquid systems [1]. Ultrasonic sound velocity measurements have been used to study the nature of molecular interactions in various ternary liquid mixtures. Much of work has been done in solutions of polymers, pharmaceutical materials, amino acids, electrolytes and non-electrolytes. Many researchers for solution studies of organic compounds [2] have utilized this technique, so the application of ultrasonic method is found in the field of pharmacological activity and various areas which have been identified for their great potential for future. Ultrasonic velocity, density, viscosity and other acoustic parameters such as adiabatic compressibility, intermolecular free length, specific acoustic impedance, and relative association constant are very useful parameters to know the molecular interactions in pure liquids, aqueous solution and liquid mixtures [3-7]. The study of thermodynamic properties of mixtures provides good measure of solute –solvent interactions. The experimental data of thermo acoustical properties of liquid and liquid mixtures are fascinating and highly fundamental and practically important in chemical industry and engineering design [8]**.** Present research work reported the results of ultrasonic study of the ternary mixture of *cis* –potassium dioxalatodiaquo chromate (III) dihydrate complex with propanol-water solvent in entire composition range, at three different temperatures.

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From the experimental values of ultrasonic velocity (u), density (ρ),viscosity(η) various thermo acoustical parameters such adiabatic compressibility (β_s), Intermolecular free length (L_f), Specific acoustic Impedance (Z),Wada constant (W), molar sound velocity(R), relative association (R_A), apparent molar compressibility (Φ_β), apparent molar volume (Φ_V)viscosity relaxation time(Γ), absorption coefficient, internal pressure (π),free volume (V_f), and Gibb's free energy (ΔG) have been estimated using standard relations. These thermo-acoustic parameters of pure components and mixtures are being used to investigate the molecular packing, molecular motions and various intermolecular interactions and their strength, influenced by the size in pure components and in the mixtures [9]. The results are interpreted in predicting nature and strength of molecular association between the components of the liquid mixtures.

Materials and Methods

Materials: In present study, *cis* -potassiumdioxalatodiaquo chromate (III) dihydrate complex and solvent propanol (Hi-Media) spectroscopic reagent (SR) grade was used without further purification.

Method: The sample was measured using digital electronic balance (Model SHIMADZU AUY-220, Japan,) with precision of ±0.1 mg. The required ternary mixtures were prepared over the entire range of compositions in propanol - water solvent and kept in air tight flask. The densities of pure liquids and ternary mixtures were measured with portable digital densitometer (Anton Paar, DMA-35, Austria).The average uncertainty in measurement in the measured density is ± 5×10^{-3} kgm^{-3}. The ultrasonic velocity of pure and liquid mixtures was measured using multi-frequency ultrasonic interferometer (Model: F-81S, Mittal Enterprises, New Delhi,) operating at 2 MHz's frequency at five different temperatures and overall accuracy of ±2 m/s.The instruments was calibrated by measuring the velocity of benzene and carbon tetrachloride. In the present work, Ostwald viscometer (10 ml) is used to measure the viscosity of pure liquid and mixtures and efflux time was measured using a RACER digital chronometer within a precision of ± 0.01 sec. The measured values are agreed closely with literature values.

The density (ρ), ultrasonic velocity (u) viscosity (η) and R.I. of pure liquids and ternary mixtures were measured at 303.15, 308.15 and 313.15 K. The temperature was controlled through the water circulating around the liquid cell using thermostatically controlled High Precision water bath MSW-274(Macro scientific work pvt. Ltd. Delhi) with an uncertainty of ± 0.3°c.

Theory and Calculations:

The Data of Density (P), ultrasonic velocity (u) and viscosity (η) has been used to evaluate many acoustical parameters by using the following standard expressions for understanding solute-solvent, solvent-solvent interaction and structural changes.

(i) **Adiabatic compressibility:-** $\beta_s = \frac{1}{\rho_s u_s^2}$ ————(1)

Where ρ_s =density of solution, u_s = sound velocity.

(ii) **Intermolecular free length** (L_f):- $L_f = K\sqrt{\beta_s}$ ————(2)

Where 'K' is a temperature dependent constant known as Jacobson constant [m].

(iii) Specific acoustic impedance (Z):- $Z = u_s \rho_s$ ————(3)

(iv) Wada's constant (W):- $W = \left(\frac{M}{\rho_s}\right) \cdot \beta_s^{\frac{1}{7}}$ ————(4)

Where 'M' molar mass of the solution.

(v) Molar sound velocity or Rao's constant (R) :- $R = \left(\frac{M}{\rho_s}\right) \cdot u_s \, 1/3$ ————(5)

(vi) Relative association (R_A):- $R_A = \left(\frac{d_s}{d_o}\right)\left(\frac{u_o}{u_s}\right)^{1/3}$ ————(6)

Where ρ_o = density of solvent, u_o = velocity of solvent

(vii) Apparent molar compressibility (Φ_β): $\Phi_\beta = \left(\frac{1000}{m\rho\beta}\right)(\rho_o\beta - \rho\beta_o) + \left(\frac{\beta_0 M}{\rho_0}\right)$ —(7)

(viii) Apparent molar volume (Φ_V):- $\Phi_V = \left(\frac{1000}{m\rho\beta}\right)(\rho_o - \rho) + \left(\frac{M}{\rho_0}\right)$ ——(8

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(ix) Relative viscosity(η):- $$\eta = \left[\frac{d_s t_s}{d_w t_w}\right]\eta_w \quad (9)$$

(x) Viscosity relaxation time :- $$\Gamma = \frac{4\eta}{3\rho u^2} \quad (10)$$

(xi)Absorption coefficient: $$Abs_{coeff}(a/f^2) = \frac{8\pi^2\eta}{3\rho \times u^2} \quad (11)$$

(xii) Internal pressure (π_i) :- $$\pi_i = bRT\left(\frac{K\eta}{u}\right)^{1/2}\left(\frac{\rho^{2/3}}{M_{eff}^{7/6}}\right) \quad (12)$$

(xiii) Free volume (V_f):- $$V_f = \left(\frac{M_{eff}u}{K\eta}\right)^{3/2} \quad (13)$$

'k' is temperature independent constant equal to 4.28×10^9 for all liquids.

(xiv) Gibb's free energy (ΔG) was calculated from the relation;

$$\Delta G = KT\log\left(\frac{KT\Gamma}{\hbar}\right) \quad (14)$$

'K' Boltzmann constant, 'ħ' is Planck constant and Γ relaxation time.

Results And Discussion:

The experimental values of density, ultrasonic velocity, viscosity of *cis* -potassiumdioxalatodiaquo chromate (III) dihydrate complex with propanol in water are presented in Table **1**. The some of the calculated thermo-acoustics parameters are given in Table 2.

Table 1: Density (ρ), ultrasonic velocity (u), adiabatic compressibility (β_s), intermolecular free length (L_f), acoustical Impedance (Z), Wada's constant (W), Rao's constant (R), relative association (R_A), apparent molar compressibility (ϕ_β), apparent molar volume (ϕ_V) cr IN 5% propanol at different temperatures.

Conc	ρ kg.m^{-3}	u m s^{-1}	β_s 10^{-11} m^{2}N^{-1}	L_f 10^{-11} m	Z x10^6 kg. m^{-2}s^{-1}	W m^3 Pas$^{-8/7}$ mol^{-1}	R	R_A	$\phi_\beta \times 10^1$ m^{2}n^{-1}	ϕ_V m^3 mol^{-1}
T=303.15K										
0.000	1716.4	4364	3.0592	1.1477	7.4904	8.4641	1162.55	1.0041	_	_
0.001	1717.6	4320.1	3.1195	1.1589	7.4202	8.4346	1150.05	1.0041	5.7854	2.0449
0.002	1716.4	4315.2	3.1288	1.1607	7.4066	8.4369	1149.55	1.0038	2.8947	0.5559
0.003	1708.4	4227.2	3.2757	1.1876	7.2217	8.4211	1131.38	1.0060	1.9389	-7.5397
T=308.15K										
0.000	1719.3	4291.2	3.15857	1.1769	7.3779	8.4114	1141.23	0.9817	_	_
0.001	1706.8	4436.8	2.97631	1.1424	7.5727	8.5452	1188.59	0.9817	5.8122	-11.6528
0.002	1703.2	4389.6	3.04708	1.1559	7.4764	8.5345	1178.43	0.9832	2.9123	-15.5428
0.003	1682.8	4374.4	3.10549	1.1669	7.3612	8.6146	1188.58	0.9725	1.9650	-36.0376
T=313.15K										
0.000	1722	4366	3.0465	1.1646	7.5183	8.4416	1159.30	0.9934	_	_
0.001	1722.8	4460.1	2.9179	1.1398	7.6839	8.4898	1183.73	0.9934	5.7522	1.6407
0.002	1712.8	4439.2	2.9627	1.1485	7.6035	8.5208	1185.07	0.9892	2.8904	-8.6454
0.003	1704.8	4432.1	2.9861	1.1530	7.5558	8.5512	1188.72	0.9851	1.9365	-16.7408

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Table 2: Viscosity (η), viscosity relaxation time (τ), Abs coefficient, internal pressure (π_i), free volume (V_f) and Gibbs free energy (ΔG) of cr IN 5% propanol at different temperatures.

Conc.	η x 10^{-3} Nsm^{-2}	τ x 10^{-14} s	$\alpha/f^2 \times 10^{14}$	π_i x10^5 Pa	V_f x10^{-3} m^3mol^{-1}	ΔG x10^{-21}
T=303.15K						
0.000	1.20	4.8948	4.8946	2.6123	8.4488	-2.1337
0.001	1.33	5.5320	5.5318	2.7654	7.1318	-1.9113
0.002	1.30	5.4233	5.4231	2.7343	7.3676	-1.9473
0.003	1.25	5.4595	5.4594	2.7005	7.5762	-1.9352
T=308.15K						
0.000	1.19	5.0116	5.0115	2.6263	8.3423	-2.0951
0.001	1.36	5.3970	5.3969	2.7478	7.1785	-1.9582
0.002	1.30	5.2816	5.2815	2.6971	7.5589	-1.9981
0.003	1.22	5.0516	5.0515	2.5964	8.2713	-2.0804
T=313.15K						
0.000	1.14	4.6307	4.6305	2.5511	9.1307	-2.24731
0.001	1.23	4.7854	4.7853	2.6226	8.4120	-2.18558
0.002	1.19	4.7008	4.7007	2.5756	8.7776	-2.21909
0.003	1.13	4.4991	4.4990	2.5041	9.4631	-2.30143

From the table 1

Density, ultrasonic velocity decreases and viscosity decreases with increase in concentration of solute. The linear behavior with increase in velocity with concentration indicates the interaction between unlike molecule, which suggests weak solute-solvent (dipole-dipole) interaction between the component molecules. As density decreases the number of solute particles in the given region decreases [10]. It shows reverse trends in ultrasonic velocity and density with increase in temperature show molecular forces are weakening at high temperature. The change in ultrasonic velocity can be explained by a model presented by Eyring and Kincaid [11]. The increase in ultrasonic velocity is structure making type.

Increase in concentration of *cis* -potassiumdioxalatodiaquo chromate (III) dihydrate complex results the linearly increases in adiabatic compressibility and free length. This trend supports weak solute-solvent interaction and suggests aggregation of solvent molecules around solute molecules [12,13]. The magnitude of adiabatic compressibility and free length decreases with increase in temperature, it clearly reveal that interaction become stronger at higher temperature [14]. The specific acoustic impedance is the parameter related to the elastic properties of the medium. The specific acoustic impedance is the impedance offered to the sound wave by the components of the mixture. In present investigation, specific acoustic impedance decrease with increase in concentration. This trend further supports that there was no possibility of molecular interaction due to H-bonding between solute-solvents and solvent-solvent molecules which restrict the free flow of sound waves [15]. The specific acoustic impedance is directly proportional to density, ultrasonic velocity and inversely proportional adiabatic compressibility [16].

The molar compressibility (Wada's constant) and Molar sound velocity (Rao′s constant) nonlinearly decreases with increase in concentration which indicates that the magnitude of molecular interaction is enhanced in the system, which indicate interaction between solute-solvent molecule increases. This leads to tight packing of the medium by increases the molecular interactions [17].

Relative association is the measure of extent of association of components in the medium. The relative association is depends on either breaking up of the solvent molecules on addition of solute to it or the salvation of present ions. The relative association non-linearly decreases with increase in concentration.

The apparent molar compressibility and apparent molar volume decreases with increase in concentration which indicates interaction between solute-solvent molecules enhanced. Some values are positive due to the compressibility of solvent due to the weak electrostatic force in the vicinity of ions. This trends supports that the availability of more number of components in a given regions of space. This leads to tight packing of the medium and there by increases the interactions [18].

The viscosity relaxation time is the time required for the excitation energy to appear as translational energy. In present work viscosity relaxation time non-linearly decreases with increase in molar concentration and decreases with increases in temperature. Where, with increase in temperature, it shows the instantaneous conversion of excitation energy to

translational energy. This indicates strong molecular interaction between the solute and solvent molecules, where it show the instantaneous conversion of excitation energy to translational energy [19]. Absorption coefficient decreases with increase in concentration and this trend suggest that the extent of complexity decreases with increase in concentration [20].

The internal pressure is a measure of cohesive forces between the constituent's molecules in liquids. The internal pressure is an inverse function of free volume. The internal pressure for a given system decreases with increase in concentration of solute, which indicate decrease in London force (cohesive forces) which leading to breaking the structure of solute. This suggests there is a weak interaction between the solute and solvent molecules. (or there is an decrease in the extent of complexation with increase in concentration [21]**.**

The free volume increases with increase in concentration of solute and temperature. This increasing trend is due to stronger intramolecular interaction than intermolecular interaction which attribute to lose packing of molecules inside the shield, this suggest weak molecular interaction in components of mixtures [22]. The Gibb's free energy decreases with increase in molar concentrations of *cis* -potassiumdioxalatodiaquo chromate (III) dihydrate complex and non-linearly increases with increase in temperatures. The increase in Gibbs free energy (ΔG) with temperature suggests longer time for rearrangement of molecules in the mixture [23]. The decreasing positive values of Gibbs free energy (ΔG) suggest the molecular dissociations [24].

Conclusions:

From the present investigation experimental values of density, ultrasonic velocity, viscosity and related acoustic parameter values indicate that thermodynamic parameters are sensitive to molecular interactions for ternary liquid mixtures at different concentrations and at varying temperatures. Thus it is conclude that in mixture of studied compound, both solute-solute and solute-solvent interaction is existed. Some parameters specially, free length and adiabatic compressibility indicate strong interaction between solute-solvent molecules in the studied system.

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Original Article

The Role of Green Chemistry in Reducing Environmental Pollution: A Sustainable Approach

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Abstract

Environmental pollution has become a major global concern due to rapid industrialization, urbanization, and the excessive use of hazardous chemicals. Traditional chemical processes often generate toxic waste, consume large amounts of energy, and rely on non-renewable resources, thereby contributing significantly to environmental degradation. Green chemistry provides a sustainable alternative by promoting the design of safer chemical products and processes that minimize or eliminate the use and generation of harmful substances. This paper presents a comprehensive analysis of the principles of green chemistry and their role in pollution reduction. It also explores key applications in industrial sectors such as pharmaceuticals and agriculture, supported by relevant case studies. Furthermore, the environmental and economic benefits, along with existing challenges in implementation, are discussed. The study highlights the importance of adopting green chemistry practices to ensure sustainable development and environmental protection.

Keywords: green chemistry, environmental pollution, sustainable development, renewable resources, waste minimization, biodegradable materials, eco-friendly technology.

Introduction

Environmental pollution is one of the most pressing challenges faced by modern society. The rapid growth of industries, increased consumption of natural resources, and improper waste disposal have led to severe contamination of air, water, and soil. Conventional chemical processes play a major role in this problem, as they often involve hazardous substances, inefficient energy use, and the generation of large quantities of waste. In response to these challenges, green chemistry has emerged as an innovative and sustainable approach. Also known as sustainable chemistry, it focuses on preventing pollution at its source by redesigning chemical processes and products. Unlike traditional methods that treat pollution after its formation, green chemistry emphasizes waste prevention, energy efficiency, and the use of renewable resources. The concept of green chemistry was introduced by Paul Anastas and John Warner in the late 20th century. It is based on twelve guiding principles that aim to reduce environmental impact while maintaining economic efficiency. This paper aims to provide a detailed understanding of these principles and their applications in reducing environmental pollution.

Principles of Green Chemistry

Green chemistry is guided by twelve fundamental principles that serve as a framework for designing environmentally friendly chemical processes:

Prevention of Waste: It is more effective to prevent waste formation than to treat or clean it after production.

Atom Economy: Chemical reactions should be designed to maximize the incorporation of all reactants into the final product, minimizing waste generation.

Less Hazardous Synthesis: Chemical processes should use and produce substances with minimal toxicity to humans and the environment.

Designing Safer Chemicals: Chemical products should be designed to achieve their intended function while being non-toxic.

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Safer Solvents and Auxiliaries: The use of auxiliary substances such as solvents should be minimized or replaced with safer alternatives.
Energy Efficiency: Chemical processes should be conducted at ambient temperature and pressure to reduce energy consumption.
Use of Renewable Feedstocks: Renewable raw materials should be preferred over non-renewable resources wherever feasible.
Reduction of Derivatives: Avoid unnecessary derivatization steps that increase waste and complexity.
Catalysis: Catalytic reactions are preferred over stoichiometric reactions because they are more efficient and generate less waste.
Design for Degradation: Chemical products should break down into harmless substances after use.
Real-Time Analysis: Analytical methods should be used to monitor processes and prevent the formation of hazardous substances.
Inherently Safer Chemistry: Chemical processes should be designed to minimize risks such as explosions, fires, and toxic releases.
These principles collectively promote sustainability and environmental protection in chemical industries.

Applications of Green Chemistry in Pollution Reduction

3.1 Green Solvents and Reaction Media

Traditional organic solvents are often toxic and volatile, contributing to environmental pollution. Green chemistry promotes the use of safer alternatives such as water, ionic liquids, and supercritical carbon dioxide. These solvents reduce toxicity and improve process safety.

3.2 Catalysis and Process Efficiency

Catalysts play a crucial role in green chemistry by increasing reaction efficiency and reducing energy requirements. Biocatalysts, enzymes, and heterogeneous catalysts enable cleaner production processes with minimal waste generation.

3.3 Energy Conservation

Energy-efficient reactions are a key aspect of green chemistry. Processes designed to operate under mild conditions significantly reduce energy consumption and greenhouse gas emissions.

3.4 Development of Biodegradable Materials

Green chemistry supports the development of biodegradable polymers such as polylactic acid (PLA). These materials decompose naturally, reducing long-term environmental pollution caused by plastics.

hazardous waste. Techniques such as atom economy and process optimization help achieve cleaner production.

3.6 Use of Renewable Resources

Fuels and promotes sustainability.

Case Studies

4.1 Green Chemistry in Pharmaceutical Industry

The pharmaceutical industry traditionally generates significant chemical waste. The adoption of green chemistry has led to more efficient and environmentally friendly drug synthesis processes.

For instance, enzymatic catalysis and solvent-free reactions have reduced waste generation and energy consumption. The green synthesis of drugs such as pregabalin and sitagliptin demonstrates how innovative methods can enhance efficiency while minimizing environmental impact.

4.2 Green Chemistry in Agrochemical Industry

Agriculture heavily relies on chemical fertilizers and pesticides, which can harm the environment. Green chemistry has introduced eco-friendly alternatives such as biopesticides and biofertilizers.

Biopesticides derived from natural sources are less toxic and biodegradable. Controlled-release fertilizers improve nutrient efficiency and reduce soil and water contamination. These innovations support sustainable agricultural practices.

Benefits and Challenges

5.1 Environmental Benefits

Reduction in pollution levels
Conservation of natural resources
Lower greenhouse gas emissions
Protection of biodiversity
Improved public health

5.2 Economic Benefits

Reduced production and waste management costs
Increased process efficiency
Creation of green jobs and industries
Development of new markets for sustainable products

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5.3 Challenges

High initial investment costs
Lack of awareness and technical expertise
Resistance to adopting new technologies
Limited availability of green alternatives

Future Prospects of Green Chemistry

Green chemistry is expected to play a vital role in the future of sustainable development. Advances in nanotechnology, biotechnology, and renewable energy will further enhance its applications. Government policies, industrial collaboration, and increased awareness will accelerate its adoption.

The integration of green chemistry with circular economy concepts can lead to efficient resource utilization and waste minimization, ensuring long-term environmental sustainability.

Conclusion

Green chemistry provides a powerful and sustainable approach to reducing environmental pollution. By focusing on safer processes, efficient resource use, and waste prevention, it addresses the root causes of environmental degradation. The successful implementation of green chemistry principles can significantly improve environmental quality while supporting economic growth. As global environmental challenges continue to intensify, adopting green chemistry is not just an option but a necessity for a sustainable future.

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Original Article

Preparation and Characterization of Nanocrystaline Ferric Oxide Using Aloe Vera Leaves and Its Antibacterial Activity

Ravina Gopalrao Pawar
Matoshree Vimalabai Deshmukh Mahavidyala, Amravati.

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Abstract

An eco-friendly green synthesis of ferric oxide nanoparticles using leaf extract of aloe vera was investigated. The characteristics of the obtained ferric oxide nanoparticles were studied using uv-visible spectrophotometer, ftir, SEM with edx, xrd. The synthesized ferric oxide nanoparticles were effectively utilized for the antibacterial activity and antioxidant studies. The maximum zone of inhibition was found to be high in gram negative bacteria when compared to gram positive bacteria. This green method of synthesizing ferric oxide nanoparticles could also be extended to fabricate other industrially important metal oxides. This simple, low cost and greener method for development of nanoparticles may be valuable in environmental, biotechnological and biomedical applications. Thus the present study proven the biological approach of synthesis of ferric oxide nanoparticles using aloe vera leaf extract appears to be eco friendly and cost effective alternative to conventional chemical and physical methods and would be suitable for developing large scale production. As a result, the green synthesis using aloe vera leaf extracts can be economic and effective method for the synthesis of ferric oxide nano particles.

Introduction

Nanoparticles are the simplest form of structures with sizes in the range of 1-100 nm. In principle any collection of atoms bonded together with a structural radius of less than 100 nm can be considered as a nanoparticle. They are a link between bulk materials and atomic or molecular structures. Nanoparticles have different chemical and physical properties than bulk materials such as lower melting points, higher surface area, mechanical strength, specific optical properties and specific magnetizations. In the presence of chemical agents the interfacial and surface properties can be modified. Indirectly, such agents can stabilise against coagulation and aggregation by maintaining particle charge and by modifying the outermost layer of the particle. In the past decade, the synthesis of iron oxide nanoparticles has been intensively developed not only for its fundamental scientific interest but also for many technological and biomedical applications.

Iron oxide nanoparticles have been of great interest, not only for fundamental properties caused by their multivalent oxidation states but also for their super paramagnetic, high force, low Curie temperature, high magnetic susceptibility, etc. Release of iron oxide nanoparticle into the environment interact with air, water and soil often causes change in the surface properties of the particles which can result in particle aggregation or changes in particle charge and other surface properties. Various surface modifications are being done for making these non bio degradable nanoparticles more biocompatible. The iron oxide nanoparticles must be pre-coated with chitosan which is a biopolymer that increases their stability, biodegradability, and non-toxicity in the physiological medium and also to achieve combined properties of high magnetic saturation, biocompatibility and interactive functions on the surface. Nanotechnology is a scientific field that has recently expanded due to its applications in pharmaceutical and personal care products, industry and agriculture. Fe_2O_3 nano particles of different sizes ranging from 22 to 56 nm were synthesized chemically by a modified sol-gel method.

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Pure alpha phase particles as well as particles with admixture of alpha and gamma phase were obtained and identified by x-ray and Mössbauer measurements. Different size and phase controlling parameters have been identified. The average size of the particles decreases with increased annealing temperature of the gel and decreases with the increase in the concentrations of the (citric acid). The annealing temperature affects the relative fractions of the two phases and consequently the magnetization of the particles. The magnetization of the particles (Ms) and coercively (Hc) increase consistently with the increase in the annealing temperature.

For the same relative amount of the two phases, the coercively (Hc) and the moment of the particles increase with the decrease in the size of the particles, indicating the role of surface effects in the magnetic behaviour.

Physical and chemical methods are being used extensively for production of metal and metal oxide nanoparticles. However, this production requires the use of very reactive and toxic reducing agents such as sodium boron hydride and hydrazine hydrate, which cause undesired detrimental impacts on the environment, plant and animal life it supports. Researchers continue efforts to develop facile, effective and reliable green chemistry processes for the production of nano materials. Various organisms act as clean, eco-friendly and sustainable precursors to produce the stable and well functionalized nanoparticles. These may include bacteria, actinomycetes, fungi, yeast, viruses, etc.

The viewpoint of the basic research, iron (III) oxide is a convenient Compound for the general study of polymorphism and the magnetic and structural phase Transitions of nanoparticles. The existence of amorphous Fe_2O_3 and four polymorphs (alpha, beta, gamma, and epsilon) is well established the synthesized Iron oxide nanoparticles were effectively utilized for the antibacterial activity and antioxidant studies. The maximum zone of inhibition was found to be high in Gram negative bacteria when compared to Gram positive bacteria. This green method of synthesizing Ferric Oxide nanoparticles could also be extended to fabricate other industrially important metal oxides.

Applications of Nanoparticles:

The potential applications of nanotechnology in different fields are the following:

Safer Solvents and Auxiliaries: The use of auxiliary substances such as solvents should be minimized or replaced with safer alternatives.

Energy Efficiency: Chemical processes should be conducted at ambient temperature and pressure to reduce energy consumption.

Use of Renewable Feedstocks: Renewable raw materials should be preferred over non-renewable resources wherever feasible.

Reduction of Derivatives: Avoid unnecessary derivatization steps that increase waste and complexity.

Catalysis: Catalytic reactions are preferred over stoichiometric reactions because they are more efficient and generate less waste.

Design for Degradation: Chemical products should break down into harmless substances after use.

Real-Time Analysis: Analytical methods should be used to monitor processes and prevent the formation of hazardous substances.

Inherently Safer Chemistry: Chemical processes should be designed to minimize risks such as explosions, fires, and toxic releases.

These principles collectively promote sustainability and environmental protection in chemical industries.

Applications of Green Chemistry in Pollution Reduction

3.1 Green Solvents and Reaction Media

Traditional organic solvents are often toxic and volatile, contributing to environmental pollution. Green chemistry promotes the use of safer alternatives such as water, ionic liquids, and supercritical carbon dioxide. These solvents reduce toxicity and improve process safety.

3.2 Catalysis and Process Efficiency

Catalysts play a crucial role in green chemistry by increasing reaction efficiency and reducing energy requirements. Biocatalysts, enzymes, and heterogeneous catalysts enable cleaner production processes with minimal waste generation.

3.3 Energy Conservation

Energy-efficient reactions are a key aspect of green chemistry. Processes designed to operate under mild conditions significantly reduce energy consumption and greenhouse gas emissions.

3.4 Development of Biodegradable Materials

Green chemistry supports the development of biodegradable polymers such as polylactic acid (PLA). These materials decompose naturally, reducing long-term environmental pollution caused by plastics.

hazardous waste. Techniques such as atom economy and process optimization help achieve cleaner production.

3.6 Use of Renewable Resources

Fuels and promotes sustainability.

Case Studies

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Original Article

Chemical analysis of soil samples to evaluate the soil fertility status of semi-arid region of three villages of Warud Taluka, district Amravati, Maharashtra.

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Abstract

Soil Is A Fundamental Natural Resource That Determines Agricultural Productivity And Ecological Balance. The Warud Region Of Amravati District In Maharashtra Is Well Known For Citrus Cultivation, Especially Oranges. This Study Focuses On The Physico-Chemical Analysis Of Soil Samples From Warud Region And Evaluates Their Fertility Status Using Graphical Interpretation. Parameters Such As Ph, Electrical Conductivity (EC), Organic Carbon, Nitrogen (N), Phosphorus (P), And Potassium (K) Are Analyzed. The Results Reveal That Soils Are Predominantly Black Cotton Soils (Vertisols), Slightly Alkaline, With Moderate Fertility But Deficiencies In Nitrogen And Phosphorus. Graphical Analysis Helps Visualize Variations Across Samples And Highlights Soil Management Needs.

Introduction

Soil is abiotic factor of our environment and it is influenced by climatic and biotic factors acting on it. It forms the intermediate zone between the atmosphere and the lithosphere. Soil is the uppermost weathered layer of the earth's crust in which are found mixed type of organisms and products of their death and decay. The plants are anchored in the soil for their growth. It is complex organization made up of inorganic matter, organic matter, soil organisms, soil moisture, soil solution etc. Soil contains about 50-60 % mineral matter, 25-35% water, 15-25% air and little percentage of organic matter .The productivity of an ecosystem depends upon the quality of soil. The parameters of soil are some above and some below the permissible limit that affect the quality and productivity.[1] The soil quality thus may be defined as the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity, to maintain and enhance water and air quality and also support health and habitation.[2] It possess certain distinctive physical, chemical and biological qualities which permit it to support plant growth. Vidarbha soils are mainly derived from Deccan basalt and are dominated by black cotton soils, known for high clay content and shrink-swell behavior. The Warud region, located in the Vidarbha zone of Maharashtra, is agriculturally significant due to its citrus orchards. The productivity of crops depends largely on soil properties such as texture, structure, nutrient availability, and moisture retention.Understanding soil characteristics in Warud helps farmers optimize fertilizer use and improve crop yield.

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Material and Methods

Location of study area

Amravati district is situated between 20 ° 32 and 21.46 north latitude and 76° 37 and 78° 27 east longitude. Amravati city is located at 20.93 ° N 77.75 ° E. It has a tropical wet and dry climate with hot, dry summers and mild to cool winters, Summer lasts from March to June, Monsoon season from July to October and Winter from November to March.

Selection Of Site:

Soil samples collected from 5 different agricultural sites (0–20 cm depth) , Village A (Satnoor) , Village B (Warud region) , Village C (semi-arid agricultural zone

Location: Warud Tehsil, Amravati District, Maharashtra

Climate: Semi-arid tropical

Rainfall: ~800–1000 mm annually

Major Crops: Orange (Citrus), soybean, cotton

The region's agriculture heavily depends on soil fertility and irrigation practices

3.1 Sample Collection

The soil samples were collected from five (5)different places of three villages A, B and C in the winter season. Random sampling method used .To collect soil samples, cleaned polythene bags were used. While collecting soil samples the upper layer of vegetation, surface litter, stones stubble if any were cleared away and then layer of soil immediately below (0-20 cm) is collected.Soil depth is a root space and the volume of soil from where the plants fulfill their water and nutrient demands. (The top six inches of soil has the most root activity and fertilizer application is generally restricted to this depth). The soil samples were immediately brought into laboratory for the estimation of various physicochemical parameters like pH was recorded by using Digital pH meter. Specific conductivities were measured by using digital conductivity meter. The chemical characteristics viz. soil pH.electrical conductivity, total soil organic carbon, organic matter, total nitrogen, phosphorus, potassium, zinc, sulphur, and Iron has been determined by routine standard procedure.(Black, 1965) .

Standard soil testing procedures were followed:

1.pH meter for acidity/alkalinity , 2.Conductivity meter for EC 3.Kjeldahl method for nitrogen 4.Spectrophotometric method for phosphorus . During the analysis the following parameters were determined. Such as pH ,Electrical Conductivity (EC) Organic Carbon (%) ,Nitrogen (kg/ha) ,Phosphorus (kg/ha) ,Potassium (kg/ha).

RESULTS AND DISCUSSION

The result obtained during the investigations carried out in the field and laboratory, are reported as below in table and discussed further.

Sample	pH	EC (dS/m)	Organic Carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
S1	7.8	0.45	1.30	250	21	**450**
S2	8.1	0.50	1.45	270	23	**480**
S3	7.6	0.40	1.35	260	22	**460**
S4	8.3	0.55	1.60	290	24	**520**
S5	7.9	0.48	1.50	275	23	500

Table 1: Physicochemical Parameters of 5 soil Samples.

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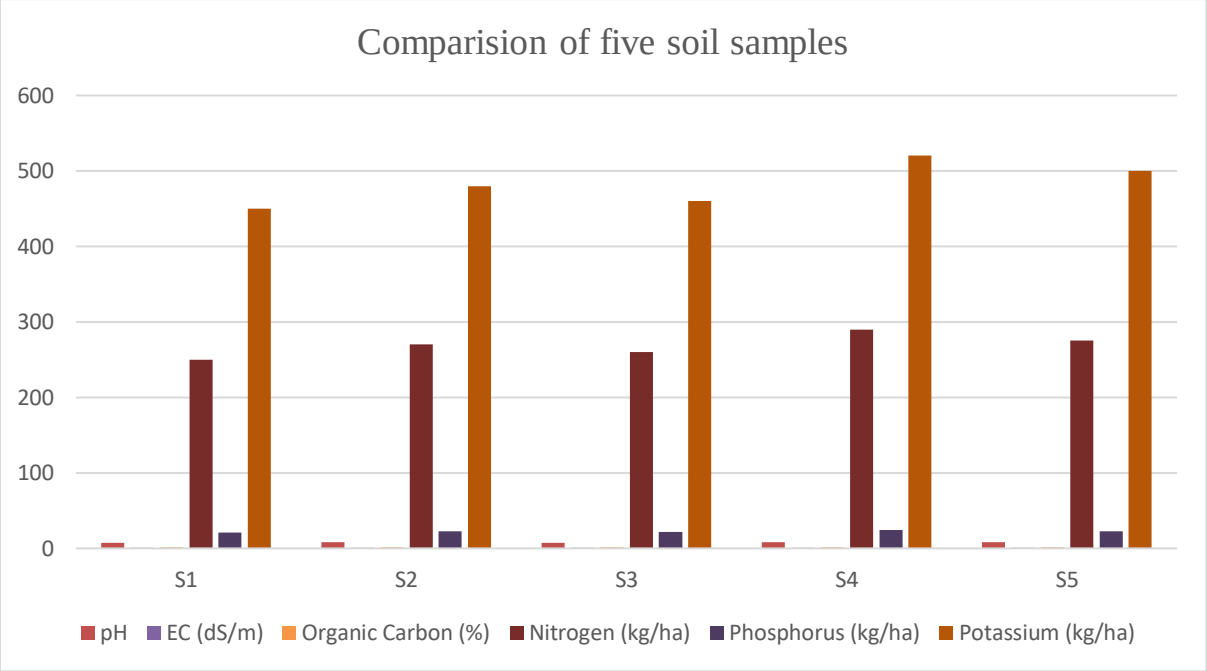

Fig: 1, Graphical analysis of parameters of Soil Samples.

Soil pH refers to the acidity or alkalinity of the soil. It is a measure of the concentration of free hydrogen ions (H+) that are in the soil. The most significant property of soil is its pH level it affects on different parameters of soil. To analyse the kind of soil, pH is an important factor. If the pH is less than 6 then it is said to be an acidic soil, the pH ranges from 6 - 8.5 then it is a normal soil and if it is greater than 8.5 then it is said to be alkaline soil. Different parameters of soil samples was studied. The pH of soil is one of the most important physicochemical parameter. It affects quality and activity of soil dwelling microorganisms. The value of pH were found varied in different farms [3].

Soil with pH greater than 7.0 are considered to be alkaline soils. The ideal soil pH range for most of the agricultural crops is between 5.8 and 6.5. The pH of soils particularly important in determining the availability and uptake of Ferrous.[4] High pH condition of soil reduces the availability of Iorn. Iron may be the limiting factor in a cropping system. If Fe is not soluble then plants exhibit deficiency symptoms regardless of the amount of the nutrient actually present.[5] The pH range of 6.8 to 8.0 has been recommended optimum for plants growth. The above 7.5 value of pH shows basic nature of soil. pH is an important parameter as it measures availability of nutrients like Fe, Mn, Zn and Cu which are more available in acidic soil than alkaline soil. Soil with pH 6.8 to 7.5 is considered to have most of the nutrients available for plants.All the soil samples shows pH greater than 7.5 Indicates slightly alkaline soil . Suitable for most crops but may affect nutrient availability Observation: Increasing pH reduces phosphorus availability.

Electrical conductivity is also a very important property of the soil. It is a measure of ions present in solution. The electrical conductivity of a soil solution increases with the increased concentration of ions. It is a very quick, simple and inexpensive method to check health of soils.

Lowest electrical conductivity value (.40 dS/m) was noted in sample 3, while sample 2 showed highest electrical conductivity value (.50 dS/m). such type of results regarding electrical conductivity of soil was recorded.[6] The Conductivity study of soil samples shows variation in conductivity values between 0.08 mhos to 1.15 mhos , this value suggest normal soil. The electrical conductivity is one of the simplest ways to assess fertilizer levels in the soil, yield potential and soil salinity status, also suitability. The yield reduction is proportional to the increase in the electrical conductivity level. The measurement of electrical conductivity is to determine amount of salts soluble in soil. Electrical Conductivity ranges from 0.40 – 0.55 dS/m indicates low salinity . Means all samples fall within safe limits and good for irrigation.

Organic carbon is a crucial factor for soil fertility and structure. Organic carbon range from 1.30 – 1.60% indicates moderate fertility. Higher OC improves soil structure and water retention. Cultivation of citrus tree is recommended.

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Micronutrients are essential for plant growth and development, even though they are required only in small quantities in plant tissues [7]. A deficiency in these nutrients negatively impacts plant nutrition, potentially leading to reduced productivity. Among the seventeen essential elements for plant growth, eight are classified as micronutrients, such as boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), and nickel (Ni). These elements perform key roles in the production of hormones, enzymes, and other biochemical compounds necessary for normal growth and development [8] . Out of these only Nitrogen , Phosphorous and Potassium have been studied.

Available Nitrogen :

Nitrogen helps the plant for rapid growth, increasing seed and fruit production. It also improves the quality of leaf and forage crops. So it is important that the N level is to be maintained within the prescribed limits of sufficient range by proper use of nitrogen fertilizers. It is a part of all living cell which is an important part of protein, enzymes, metabolic processes involved in the transfer of energy[9]. In these samples N varies from 250-290 kg/ha which is Deficient to medium level

Available Phosphorous:

It is present in the plant nuclei and acts as energy storage. P ranges from 21-23 kg/ha which is slightly low. Use of phosphate fertilizers, manures can be recommended in a suitable amount.

Available potassium:

It plays a key role in the physiological process and is vital to the plant growth from protein synthesis to maintain plant water balance[10]. Available K in all soil samples found to be medium to high 450-520 kg/ha which might be due excess use of potassium fertilizer.

Conclusion

The physicochemical study of parameters is important to agriculture for plants growth and soil management. It is concluded that the physicochemical Analysis of soil samples under study shows different concentrations of various parameters at different sitesThe slightly alkaline nature and nutrient deficiencies, especially nitrogen and phosphorus, must be addressed through scientific farming practices. Graphical analysis highlights variability among samples and supports decision-making for fertilizer application.. These studies give information about nature of soil, present nutrient in soil, according to this information farmer arrange the amount of which fertilizers and nutrients needed to soil for increase the percentage yield of crops.The following recommendations can be given to farmes in this region.1.Use nitrogen-rich fertilizers (urea, compost) , 2. Apply phosphorus fertilizers (DAP, SSP) ,3.Increase organic matter (green manure, vermicompost) ,4.Regular soil testing for sustainable farming ,5.Adopt drip irrigation to maintain soil health .

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Original Article

Screening Of *Phyllanthus Niruri* for Secondary Metabolites

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Abstract

Medicinal plants remain a cornerstone of traditional and modern therapeutics due to their rich repository of bioactive compounds. The present investigation was undertaken to evaluate the phytochemical composition, functional group characterization, and chromatographic fingerprinting of Phyllanthus niruri leaf extracts. The plant material was subjected to extraction using aqueous and ethanolic solvents followed by qualitative phytochemical screening. Fourier Transform Infrared (FTIR) spectroscopy was employed to identify functional groups, while High Performance Thin Layer Chromatography (HPTLC) was utilized to generate fingerprint profiles. The study revealed the presence of key secondary metabolites such as alkaloids, phenolics, flavonoids, tannins, steroids, and saponins. FTIR spectra confirmed characteristic functional groups including hydroxyl, carbonyl, and alkene moieties. HPTLC analysis demonstrated distinct separation patterns with reproducible RF values, indicating the presence of multiple phytoconstituents. These findings validate the pharmacological potential of P. niruri and support its traditional medicinal applications.

Keywords: *Phyllanthus niruri, Phytochemicals, FTIR spectroscopy, HPTLC, Medicinal plants, Secondary metabolites*

Introduction

Plants have served as a primary source of therapeutic agents since ancient times, contributing significantly to healthcare systems across civilizations. The reliance on plant-derived compounds continues in modern pharmacology, where a substantial proportion of drugs are either directly obtained from plants or inspired by natural molecules. *Phyllanthus niruri*, commonly referred to as "stone breaker," is a small herbaceous plant belonging to the family Phyllanthaceae. It is widely distributed in tropical and subtropical regions and holds a prominent position in traditional medicine systems such as Ayurveda. The plant is reputed for its hepatoprotective, antidiabetic, antimicrobial, and antiurolithic properties. The biological efficacy of medicinal plants is primarily attributed to their secondary metabolites, including alkaloids, flavonoids, tannins, and saponins. Therefore, systematic phytochemical evaluation is essential for understanding their therapeutic potential. Modern analytical tools such as FTIR spectroscopy and HPTLC provide reliable approaches for identifying functional groups and generating chemical fingerprints, respectively.

2. Materials and Methods

2.1 Plant Material Collection and Authentication

Fresh leaves of *Phyllanthus niruri* were collected from Amravati district, Maharashtra. The plant was taxonomically authenticated using standard floras. The collected samples were thoroughly washed, shade-dried, and pulverized into fine powder.

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2.2 Preparation of Extracts

Approximately 25 g of powdered plant material was extracted separately using distilled water and ethanol. The extraction process was carried out under controlled conditions, followed by filtration through Whatman filter paper. The filtrates were concentrated by evaporation at 30–40°C and stored at 4°C for further analysis.

2.3 Preliminary Phytochemical Screening

Qualitative phytochemical analysis was performed using established standard protocols to detect the presence of various secondary metabolites. The tests included:

Alkaloids: Mayer's, Wagner's, and Hager's tests
Phenolic compounds: Lead acetate test
Tannins: Ferric chloride test
Flavonoids: Alkaline reagent test
Saponins: Foam test
Steroids/Terpenoids: Sulfuric acid test
Proteins and amino acids: Biuret and Ninhydrin tests

2.4 FTIR Spectroscopic Analysis

FTIR analysis was performed using the KBr pellet technique. Dried extract samples were mixed with potassium bromide and compressed into pellets. Spectral analysis was conducted in the range of 400–4000 cm^{-1} to identify characteristic functional groups.

2.5 HPTLC Fingerprint Analysis

HPTLC profiling was carried out using silica gel 60 F254 plates. The ethanolic extract was applied in different concentrations (2–14 µL) as bands. The mobile phase consisted of chloroform: ethanol: ethyl acetate: acetone (7:3:3:4). The developed plates were visualized under UV light at 254 nm and 366 nm. RF values and peak areas were recorded.

3. Results

3.1 Phytochemical Screening

The qualitative analysis indicated the presence of several important phytoconstituents. Alkaloids were detected through positive reactions in Wagner's and Hager's tests. Phenolic compounds and tannins were abundantly present in both extracts. Flavonoids were predominantly observed in the ethanolic extract, suggesting solvent-dependent extraction efficiency. Saponins and steroids were also identified, whereas proteins and amino acids were largely absent.

Sr No.	Chemical test	Distilled water	Ethanol
1.	Alkaloids		
	Mayer's test	-	+
	Wagner's test	+	+
	Hager's test	+	-
2	Phenolic compound lead acetate test	+	+
3	Tannins test	+	+ blue black color
4	Proteins test	-	+
5	Amino acid test	-	-
6	Reducing sugar test	-	-
7	Glycosides test	-	-
8	Flavonoid test	-	+
9	Phenol test	Black color appear	+
10	Coumarins test	+	-
11	Resins test	-	-
12	Steroids test	+	+
13	Saponin test	+	+

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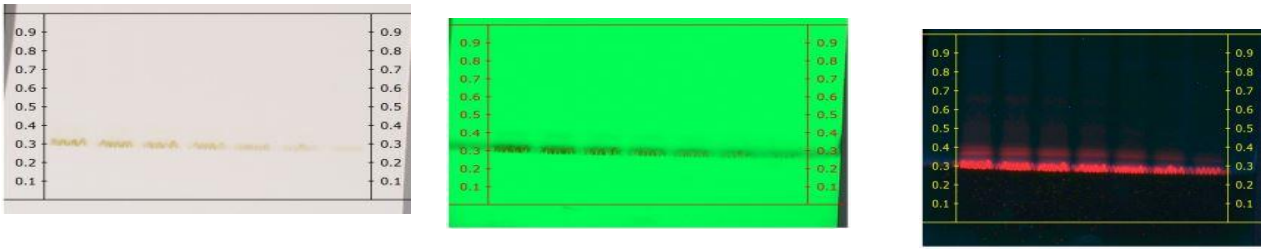
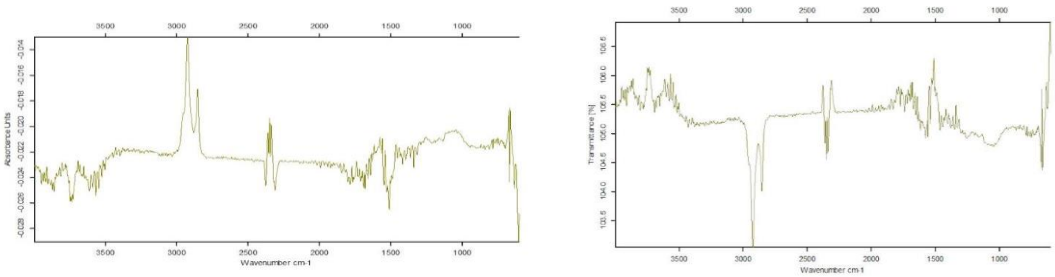


3.2 FTIR Analysis

FTIR spectra revealed multiple absorption peaks corresponding to different functional groups. Broad peaks in the region of 3700–3500 cm^{-1} indicated the presence of hydroxyl groups, suggesting alcohols or phenols. Peaks around 2900 cm^{-1} corresponded to C–H stretching vibrations. The presence of carbonyl groups (C=O) was indicated by peaks near 1800 cm^{-1}, while bands around 1500 cm^{-1} suggested aromatic or alkene structures. These findings confirm the presence of diverse organic compounds contributing to biological activity.



HPTLC Profiling

HPTLC analysis produced well-resolved chromatograms with distinct bands at both UV wavelengths. The observed RF values indicated the presence of multiple phytoconstituents with varying polarity. Prominent peaks with significant area percentages were recorded around RF values of approximately 0.33 and 0.46. The reproducibility of the chromatographic pattern confirms the reliability of the method for fingerprint analysis and quality control.

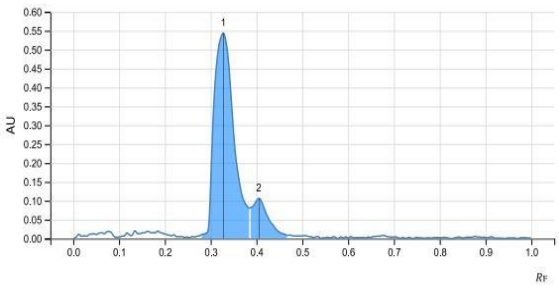


Figure 1a, 1b, 1c HPTLC profile of the ethanolic in 2, 4, 6, 8, 10, 12, and 14 µL extracts of *Phyllanthus niruri* observed at 254 and 366 nm range.

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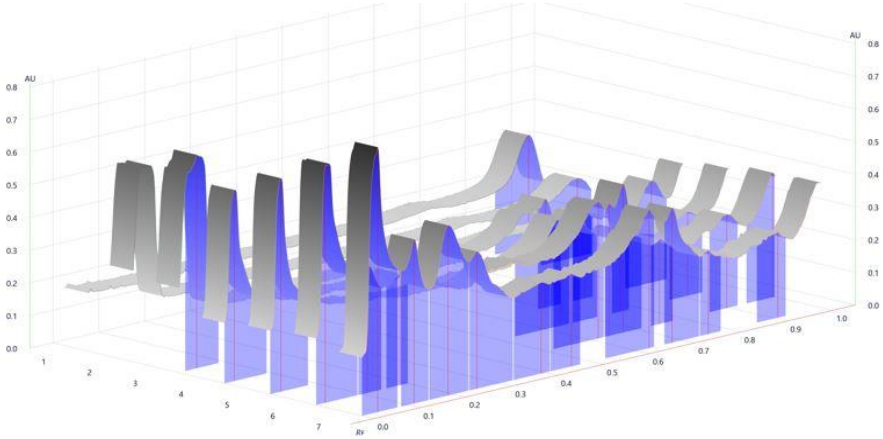

Figure 2: 3Dimensional finger print ethanolic extract of Phyllanthus niruri showing different peaks of phytoconstituents.

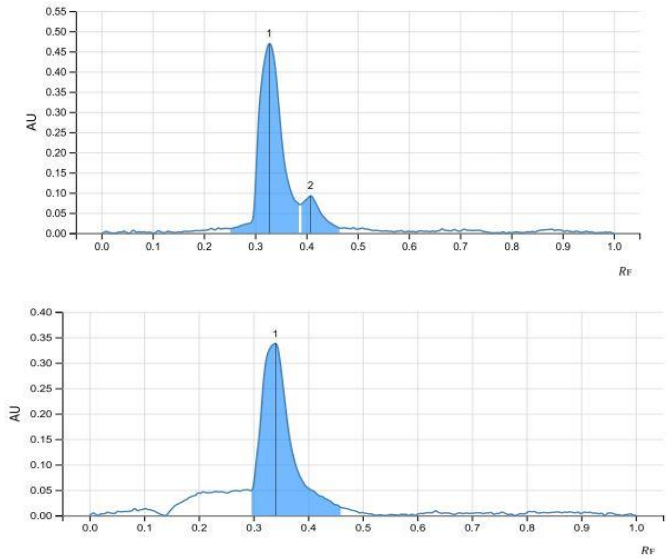

Figure – 3a Densitogram and corresponding R_F values of 2 µL ethanolic extract of *Phyllanthus niruri* for different phytoconstituents at 254 nm range.

Peak	Start		Max			End		Area	
#	R_F	H	R_F	H	%	R_F	H	A	%
1	0.295	0.0487	0.340	0.3383	100.00	0.461	0.0151	0.02175	100.00

Figure 3b: Densitogram and corresponding R_F values of 4 µL ethanolic extract of *Phyllanthus niruri* for different phytoconstituents at 254 nm range.

Peak	Start		Max			End		Area	
#	R_F	H	R_F	H	%	R_F	H	A	%
1	0.268	0.0064	0.332	0.5817	84.48	0.390	0.0940	0.03118	86.88
2	0.392	0.0937	0.405	0.1068	15.52	0.473	0.0158	0.00471	13.12

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Figure 3c. Densitogram and corresponding R_F values of 6 µL ethanolic extract of *Phyllanthus niruri* for different phytoconstituents at 254 nm range.

Peak	Start		Max			End		Area	
#	R_F	H	R_F	H	%	R_F	H	A	%
1	0.284	0.0206	0.329	0.5141	83.29	0.384	0.0791	0.02640	84.88
2	0.384	0.0791	0.406	0.1032	16.71	0.466	0.0137	0.00470	15.12

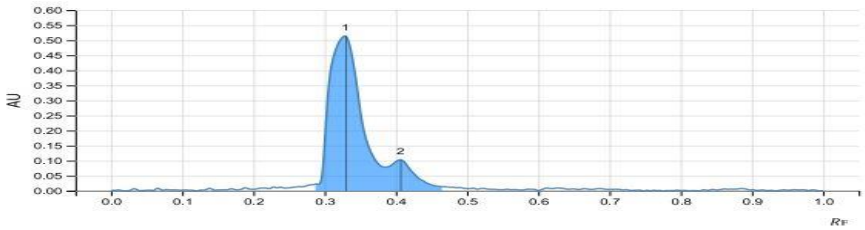
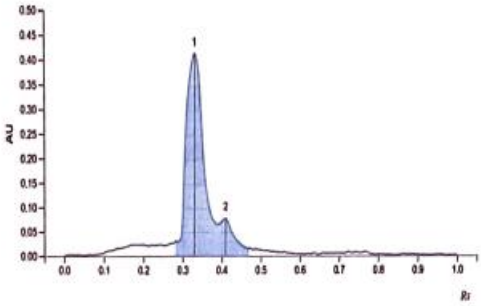


Figure 3d. Densitogram and corresponding R_F values of 8 µL ethanolic extract of *Phyllanthus niruri* for different phytoconstituents at 254 nm range.



Peak	Start		Max			End		Area	
#	R_F	H	R_F	H	%	R_F	H	A	%
1	0,250	0,0111	0,327	0,4690	83,58	0,387	0,0707	0,02447	85,69
2	0,389	0,0707	0,408	0,0922	16,42	0,468	0,0121	0,00409	14,31

Peak	Start		Max			End		Area	
#	R_F	H	R_F	H	%	R_F	H	A	%
1	0.277	0.0082	0.327	0.5439	83.62	0.384	0.0812	0.02736	85.73
2	0.385	0.0812	0.405	0.1065	16.38	0.468	0.0082	0.00455	14.27

Figure 3e. Densitogram and corresponding R_F values of 12 µL ethanolic extract of *Phyllanthus niruri* for different phytoconstituents at 254 nm range.

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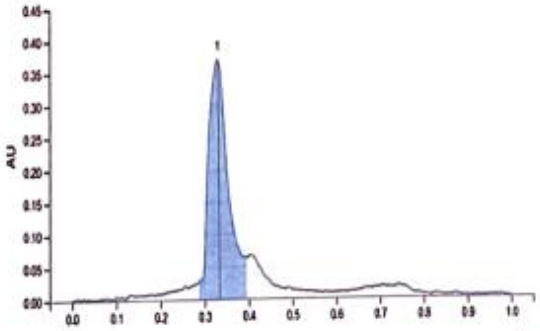

Peak #	Start		Max			End		Area	
	R_F	H	R_F	H	%	R_F	H	A	%
1	0.287	0.0261	0.334	0.3706	100.00	0.395	0.0638	0.01950	100.00

Figure 3f. Densitogram and corresponding R_F values of 14 µL ethanolic extract of *Phyllanthus niruri* for different phytoconstituents at 254 nm range.

4. Discussion

The present study highlights the rich phytochemical composition of Phyllanthus niruri, which supports its extensive use in traditional medicine. The presence of phenolic compounds and flavonoids suggests strong antioxidant potential, while alkaloids and saponins contribute to antimicrobial and therapeutic effects.

FTIR analysis provided insight into the functional groups responsible for biological activity, whereas HPTLC profiling established a characteristic chemical fingerprint of the plant extract. These analytical approaches are crucial for standardization, authentication, and quality assurance of herbal drugs.

5. Conclusion

This investigation confirms that Phyllanthus niruri is a valuable medicinal plant rich in bioactive secondary metabolites. The integration of phytochemical screening, FTIR spectroscopy, and HPTLC analysis offers a comprehensive approach for evaluating plant-based compounds. The findings substantiate the traditional medicinal claims and highlight the potential of the plant for future pharmaceutical development.

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Original Article

Dr. Babasaheb Ambedkar's Agricultural Thoughts and Work

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Abstract

Has been the dorsum of the Indian economy, so far pre-independence farmers faced challenges such as Lang fragmentation, indebtedness, low productivity, and outdated technology. Dr. Babasaheb Ambedkar study these structural issues, emphasizing that agriculture is essential for economic development and social justice. He not only focused on social justice but also critically analyzed the difficulties of Indian agriculture. He advocated land reforms, modernization, collective farming, and integration with industry, along with active state support through irrigation, credit, markets, and technical education, especially for small and marginal farmers. His agricultural aim goes beyond production, visioning at rural reconstruction, economic equality, and social transformation, allotting a practical framework for sustainable and equitable rural development in India.

Keywords: *Agriculture, Indian economy, pre-independence, land fragmentation, structural issues, rural reconstruction, Economic equality, social transformation, Sustainable development*

Introduction

The foundation of the Indian economy is based on agriculture. In the pre-independence period, Indian agriculture was unsettled by many issues such as the zamindari system, land fragmentation, indebtedness, low productivity, and outdated technologies. These farming community was economically weak and socially exploited.Dr. Babasaheb Ambedkar were not merely considered social justice but also critically conducted in-depth research of the structural defects in Indian agriculture. According to him, agriculture is not merely a livelihood but a dorsum of the nation's economic progress. Therefore, it was necessary to elevate agriculture to the status of industry, implement land reforms, and improve farmer's living standards through state intervention.In his complete study of Indian society, Dr. Ambedkar viewed the agricultural sector not merely from a production perspective but also within the framework of social justice, economic equality, and sustainable development. Since India has traditionally been an agrarian country, he strongly believed that the overall progress of the nation is impossible without improving rural economy and the condition of the farming community. Dr. Ambedkar analyzed major problems in Indian agriculture—land fragmentation, the prevalence of smallholders, traditional technology, insufficient irrigation, and farmers trapped in moneylenders' debts. He suggests that land is a national asset and emphasized scientific planning, collective farming, and agriculture policies linked to industrialization. According to him, balancing agricultural modernization with industrial development could reduce rural poverty He emphasized the need for active government involvement. Through planning, irrigation facilities, credit systems, market structures, and technical education, the state should authorize farmers. He especially stressed protective policies for small and marginal farmers. Thus, Dr. Babasaheb Ambedkar's agricultural perceptions went beyond mere production enhancement, aiming at social transformation, economic equality, and rural restructuring. Studying his agricultural perspective can provide broader and more equitable direction to India's rural development policies.

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His agricultural thoughts were not restricted to the theoretical ideas; through various writings, speeches, and policy suggestions, he provided practical guidance. Therefore, an integrated study of his thoughts and work is of paramount importance.

Definitions

Although Dr. Babasaheb Ambedkar did not provide a separate disquisition exclusively on agriculture, his writings and speeches reveal an understandable agricultural philosophy. Based on his thoughts, the following definitions can be formulated:

1. **Land as a National Asset**
   "Land is not only a private property but it is a national asset, and its use must serve societal welfare and principles of equality."
   This emphasizes scientific land planning, state-controlled reforms, and social justice.
2. **Nationalization and Collective Farming**
   "To remove the pitiable condition of Indian agriculture, nationalization of land and implementation of collective farming are necessary."
   The aim was to reduce fragmentation among small and marginal farmers and increase productivity.
3. **Balance between Agriculture and Industrialization**
   "Rural poverty cannot be removed utterly unless surplus agricultural labor is diverted to the industrial sector."
   Relieving pressure on agriculture and promoting industrialization was a central view.
4. **Agricultural Reform for Economic Democracy**
   "If political democracy is to survive, the foundation of economic democracy must start with agricultural reform."
   Agricultural reform was seen as a fundamental tool for socio-economic transformation.

Agricultural thoughts and work refer to Dr. Ambedkar's philosophy and efforts regarding ownership of land, farming methods, land reforms, credit systems, industrial linkages, and farmer welfare.

Objectives

Dr. Babasaheb Ambedkar viewed agriculture in terms of social justice, economic equality, and national development. His key objectives were:

1. Nationalization and Equitable Distribution of Land
   Recognize land as a national asset, ensure equitable distribution, and curb exploitation.
2. Prohibition of Land Fragmentation
   Encourage collective or cooperative farming to address small and marginal farmers' problems.
3. Agricultural Production Increase and Modernization
   Increase productivity through irrigation, improved seeds, mechanization, and technical education.
4. Suppression of Rural Poverty
   Reduce population pressure on agriculture and provide alternative employment through industrialization.
5. Economic Empowerment of Farmers
   Free farmers from moneylenders' debt through credit systems, market reforms, and state intervention.
6. Establishment of Economic Democracy
   Strengthen the foundation of political democracy by establishing economic equality through agricultural reforms.
7. Social Justice and Equality
   They provide land and employment opportunities to Dalits, marginalized, and landless communities.
8. Planned Agricultural Development
   Implement planned agricultural programs, infrastructure, and development projects through active government involvement.

Assumptions

Dr. Babasaheb Ambedkar's agricultural thoughts are based on several fundamental assumptions:

1. Land is a National Asset
   Land is not just a private property but a national resource which will be used for societal welfare.
2. Fragmentation Causes Poverty
   Small, divided plots do reduce the productivity and leave farmers economically weak.
3. Industrialization is Essential for Agricultural Reform
   Relieving population pressure on agriculture requires the industrial development.
4. Active Government involvement is Necessary
   The government plays a crucial role in planning, credit systems, irrigation, and market structures.
5. Economic Democracy Predate Political Democracy
   Political democracy cannot survive without an agricultural reform and economic equality.

Policies and Strategic Initiatives

Although Dr. Babasaheb Ambedkar was not an agriculture minister, his writings, policy suggestions, and

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administrative work reflect an understandable direction for an agricultural development. The major policies and strategic initiatives are as follows:

1) Nationalization of Land and Collective Farming (State Socialism – 1947)
In "States and Minorities" (1947), he suggests that the idea of nationalization of land and collective or cooperative farming.
Objective: To prevent fragmentation, increase productivity, and provide land rights to the landless.
2) Diminishing Pressure on Agriculture through Industrialization
He emphasized shifting surplus agricultural labour to the industrial sector to reduce rural poverty.
Balanced development of agriculture and industry was the core of his policy approach.
3) Land Reforms and Equitable Distribution
To stop misuse under zamindari and intermediary systems.
Government involvement is to ensure the land rights for landless and marginalized groups.
4) Irrigation and Water Resource Development
During his tenure in the Viceroy's Executive Council (Labour Member, 1942–46), he emphasized water policy.
He supported the concept of large multipurpose projects—e.g., Damodar Valley Corporation (1948).
Objective: To increase irrigation, flood control, and electricity generation—key infrastructure for agricultural growth.
5) Institutional Credit and Market Structure for Farmers
Liberation from moneylenders and promotion of cooperative institutions. Strengthening credit, storage, and marketing systems through government planning.
6) Planned Economy
Scientific planning of agriculture, infrastructure development, and emphasis on technical education.
Agricultural reforms were considered essential for achieving economic democracy.

Beneficiaries of Ambedkar's Agricultural Policies

Dr. Ambedkar's agricultural ideas directly or indirectly benefited to various farmer groups:

1) Landless Agricultural Laborers
Focusing on nationalization of land and reforms provided direction for granting land rights. This created an opportunity for ownership, security, and stable income.
2) Small and Marginal Farmers
Measures like preventing fragmentation, promoting cooperative farming, and institutional credit helped improve productivity and bargaining power.
3) Dalits and Marginalized Communities
Land reforms and equal rights to resources opened opportunities in agriculture for historically underprivileged groups.
4) Indebted Farmers
Relief from moneylenders and access to cooperative credit systems, can reduce financial burden.
5) Non-irrigated Farmers
Water resource development and multipurpose projects expanded their irrigation facilities, benefiting dryland farmers.
6) Families with Surplus Labor
Industrialization created an alternative employment opportunity for rural youth, diminishing pressure on agriculture.

Benefits for Agro-Tourism — Analysis

Dr. Ambedkar's agricultural ideas are based on equality, planning, industrialization, and active government involvement, it is highly relevant for modern agro-tourism development:

1) Land Reforms and Equality → Inclusive Agro-Tourism
Equitable land distribution allows marginalized communities to participate in agro-tourism, ensuring that benefits are not limited to large farmers.
2) Collective/Cooperative Farming → Group-Based Tourism Projects
Farmers can jointly develop agro-tourism centers offering accommodation, local cuisine, farming experiences, and handicrafts.
3) Industrialization and Alternative Employment → Supplementary Income
Rural youth can find employment in tourism management, agro-processing, handicrafts, and dairy.
Agro-tourism becomes a complementary business alongside farming.
4) Government involvement and Planning → Government Support
Government schemes, subsidies, training, and infrastructure promote agro-tourism. Proper planning can ensure sustainable rural development.
5) Irrigation and Infrastructure → Attractive Rural Environment
Improved water resources and infrastructure can create green, enlarged farms that attract the tourists.
6) Social Justice → Preservation of Local Culture

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Agro-tourism provides a platform for the Dalits, tribals, and marginalized communities to showcase their art, culture, traditions, and cuisine, ensuring both economic empowerment and cultural preservation.

Conclusion

1. Agricultural Reform is the Key to Social Justice
   Without equality in agriculture and land reforms, social inequality cannot be reduced.
2. Land is a National Asset, Not Just Private Property
   Land must be used for social welfare and equitable distribution.
3. Empowerment of Small and Marginal Farmers is Essential
   Collective/cooperative farming and government involvement are essential to address fragmentation, indebtedness, and low productivity.
4. Agricultural Development is Incomplete without Industrialization Industrial growth is essential to reduce population pressure on agriculture.
5. Active Role of the State is necessary
   State intervention is necessary in planning, irrigation, credit, markets, and technical education.
6. Economic Democracy is a Precondition for Political Democracy
   True democracy can survive only when economic equality is achieved alongside with political rights.

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