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The Role of AI in Digital Market Places: Enhancing E-Commerce of NTFPS to Support Environmental Sustainability

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KEYWORDS
Artificial Intelligence (AI), Digital Marketplaces, (NTFPs), Sustainability, E-Commerce.

ABSTRACT
This paper aims to discover how artificial intelligence (AI) can sustainably change e-commerce for NTFPs in digital markets. The discussions that digital platforms create between consumers, brands, and producers provide a means of creating equilibrium to meet ecological standards. Utilizing technologies such as machine learning algorithms, data analysis, and recommendation systems, digital markets can help ease supply and demand, manage inventory, and engage customers. This study examines the case of the actual successful application of AI in NTFP e-commerce to demonstrate how innovations in these areas can contribute to sustainability, waste minimization, and species conservation. Finally, the outcomes stress the importance of incorporating AI methods in digital markets as a crucial approach to implementing rational consumption and helping people who depend on the NFFRs for their sustenance.

1. INTRODUCTION

The role of artificial intelligence and digital or e-commerce has become the world's fastest-growing market globally. There is a growing trend towards natural and sustainably harvested products worldwide, which is beneficial for NTFPs such as fruits, nuts, seeds, leaves, resins, mushrooms, honey, herbs, and medicinal plants. These products are critically important to rural and tribal communities, as well as indigenous peoples, in India. NTFPs are the second-largest economic income generation source and are valued at US$2.7 billion annually, and 55% of the forest-based employment according to FAO, 2016. But marketing of NTFP is still a problem faced nowadays due to restricted market outlets, poor information, compromised quality, an insufficient supply chain, and resource degradation. For instance, producers in the rural areas of Madhya Pradesh, Chhattisgarh, Jharkhand, and Odisha are fully dependent on regulated markets and make small profits that barely grow (Singh 2017). The Odisha Forest Department (OFD) has also been quite proactively involved in these challenges. Some of their activities include encouraging sustainable management practices in the Odisha Forest Department (OFD) in 2018, which helped NTFP dealers and collectors to get better market access and income. Also, there are some government programs, such as the “Prime Minister’s Employment Generation Program (PMEGP)”, extending financial assistance to NTFP-based enterprises. The Marketing of Minor Forest Produce scheme, launched by the Ministry of Tribal Affairs in 2013, covers fair prices to indigenous producers while promoting sustainable working mechanisms. The Pradhan Mantri Vanbandhu Kalyan Yojana (PMVKY), launched in 2014, aims at the overall development of the tribal populace at the village level.

The research study of AI holds a potential solution and challenges affecting NTFP in digital markets, as it enhances the supply chain. in digital platforms, Artificial Intelligence, and Quality assurances are required. AI helps turn into a logistics advantage and make uplifted NTFP sourcing even more sustainable. For instance, AI can predict consumer demand and crop yield, recommend the right time to harvest, and assess the effects that a product has on the environment (Sharma et al., 2018).

The specific e-commerce market supported by AI comprises market intelligence technology for supply chain optimization, protection, and maintaining the company's quality and consumers' loyalty and satisfaction. The artificial intelligence suspects fraud and detection and bypasses its activities to the admin's exact monitoring of the activities in the marketing activities which easily solving by the AI statistical exports and enhances problems, which creates the necessary level of trust for consumers and sellers. Such an integrated approaches optimizes the time, resource, and effective environmental efficiency

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of NTFP availability decreases costs sufficiently, and aligns market requirements with consumers and sustainability. It's monitoring the sales algorithm and other strategic,

Image No. 1: Image coded by AI-Sources

The model is a closed loop system in which all the modules are in constant communication with the other. The above-mentioned modules are connected to AI, which optimizes every operational aspect of e-commerce for NTFPs. This in fact not only increases efficiency and sustainability but also, more importantly, has positive impacts on the rural and indigenous population economically.

The research consistently found that artificial intelligence (AI) increases market access, enabling producers to obtain real-time information regarding the market, prices, and customers. It can help producers make informed choices, fine-tune their strategies, and ultimately improve their revenue and profitability levels. The integration of AI in the management of digital marketplaces has already benefited the NTFP gatherers of Northeast India predictively; that is, it helps predict demand and avoid excess supply problems (Kumar & Tewari, 2019, p. 56).

1.1 Background: Overview of NTFPs and their importance.

Non-timber forest Products (NTFPs) include all the products of the forests, excluding timber, which has been described as any material that is derived from an origin within a forest ecosystem or directly associated with productive species of a forest. Such products include fruits, nuts, seeds and leaves, resins, mushrooms, honey, and medicinal plant products.

Economic Significance: These NTFPs play a significant role in increasing the income of tribal communities, which food security, and supplies raw materials for different sectors in rural communities. It gives an option from genuine timber that advances the forest security though at the same time fosters financial development. For example, NTFPs provide an income estimated at US$ 2.7 billion annually in India and 55 percent of the total employment in the forestry sector (Singh, 2017).

Category	Details	Value
Income Generation	NTFPs provide an income estimated at US$ 2.7 Billion annually	US$ 2.7 billion
Employment	NTFPs account for 55% of the total Employment in the forest sector	55% of total employment
Contribution to GDP	several countries, NTFPs make a substantial contribution to the national GDP	40% income for tribal households
Employment Generation	NTFPs support over 275 million people in rural areas worldwide	275 million people (FAO, 2021)
Market Potential	The global market for NTFPs is estimated at US$ 88 billion annually	US$ 88 billion annually

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		(ITTO, 2022)
Sustainable Livelihoods	NTFPs-and leaves, Sal seeds, and lac provide sustainable income for Odisha's forest communities, Odisha Forest Development Corporation.	US$ 1 billion OFD
Nutritional Value	NTFPs like fruits, nuts, and leaves are rich in essential nutrients and vitamins	Essential nutrients and vitamins
Biodiversity. Policy support Climate change mitigation	The silviculture products, which include kendu leaves, Sal seeds, and lac are fine income sources that are sustainable for the inhabitants of Odisha's Forest, financed by the Odisha Forest Development Corporation.	Multiple policies supporting NTFPs

Cultural Importance: NTFPs are significant cultural resources for Indigenous and local people. These resources are part of most cultural values, rituals, and spiritual practices of societies. Many serve aspects of preserving cultural practices and play a key role in preserving culture and conserving the natural world (Sharma et al., 2018).

Environmental Sustainability: The use of NTFPs, when practiced as a sustainable method, aids in protecting ecosystems, sustaining ecosystem services, and combating climate change. When stimulating the usage of NTFPs, there is an opportunity to decrease the demand for timber resources and increase the focus on forest preservation (Kumar & Tewari, 2019).

Health and Nutrition: The Most NTFPs contain nutrients and possess health values that improve general health and well-being. It is applied in traditional medical systems and is gradually being discovered for applicable use in contemporary drugs (Rao et al., 2020).

Market Potential: The market potential of NTFPs has been influenced by increased global demand for natural and organic products. Its gains are in value addition and export which expands the economy of the societies depending on the forests (Ghosh, 2021).

1.2 Problem Statement: Challenges in the Traditional Marketing of NTFPs

Limited Market Access: The rural and indigenous population has had limited access to wider markets because of their geographical location and limited physical networks. This limits their power to sell the products from their house at a cheaper price.

Lack of Market Information: Producers face the problem of sampling, that is, they have little information on specific product trends, prices, and customers' preferences.

Quality Control Issues: Quality aspects of NTFPs are often an issue for entrepreneurs due to differences in the harvesting and processing of collected products. This has implications for the marketability and consumers'' perceptions of these products.

Supply Chain Inefficiencies: Typically, the existing supply chains for NTFPs are highly disbursed stimulated by high costs of operations and the longer time that products may take to reach the market.

Sustainable Harvesting Concerns: Most of these values are nonrenewable hence when exploited through unsustainable methods may result in resource depletion and pollution hence a limited supply of NTFPs.

Limited Financial Support: Analyzing the financial situation, it can be mentioned that producers are in a very weak position now, they have almost no access to any financial resources and to credit facilities, therefore they cannot buy better production and marketing conditions.

Regulatory Barriers: Challenges arising from a complex and dynamic legal framework present a major threat to the commercialization of NTFPs.

Awareness and Education: In most cases, consumer awareness and education about the products derived from NTFPs and the potential way they can be used are very poor.

Market Volatility: Similar to most seafood products, prices of NTFP are not so constant since their market swings intermittently. These variations are not easy to predict which puts the producers in a challenge when it comes to managing their activities.

Perishability of Products: Most of the NTFPs are usually perishable and need appropriate handling and marketing structures that are usually wanted in rural regions. This can also lead to post-harvest losses.

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Lack of Branding and Certification: Sometimes, due to a lack of appropriate branding and certification the produce of NTFPs does not fetch premium price in the market. This can also explain why consumers are always eager to go for products that have been certified to conform with existing standards in the market.

Seasonal Availability: This is because many of the NTFPs are produced seasonally and as such sales from these products provide the producers with income that is unpredictable and inconsistent.

Lack of Infrastructure: There are few and poor access roads, poorly developed physical facilities for NTFP storage and processing, and weak information networks in many rural districts.

Cultural Barriers: Language and Cultural barriers are barriers to marketing and communication between the NTFP producers and the intended consumers.

Legal and Policy Issues: Cut and paste from above: Inconsistent or restrictive policies and regulations may hinder the commercialization and export of NTFPs.

Economic Uncertainty: Fluctuations in the world economy, say a recession or change in trade liberalization, affect the market and prices of NTFPs.

2. LITERATURE REVIEW

The literature review has been designed according to the objectives, and national international journal author and guidance may be taken for the fulfillment of the research

In their respective articles Jesse, Wachira, Mwangi. (2024) observes that artificial intelligence (AI), as well as Machine learning (ML), have great impacts on the operation of the new supply chain, as the application of these technologies can improve the accuracy of forecasts, enhance inventory, as well as facilitate risk management. However, it noted three key challenges that constrain adoption; cost, skills, and organizational readiness. Also, Jesse, Wachira, and Mwangi (2024) contend that AI provides some form of insights that enhance the resilience and efficiency of the supply chain.

Xiaoyu and Xue (2023) reviewed how Artificial Intelligence (AI) has brought value in adopting digital technologies in large enterprises, precisely in fields such as supply chain demand estimation, inventory optimization, and risk management, based on deep learning and natural language processing. AI for predictive purposes, when joined with big data, optimizes the decision required at various transportation levels as well as reduces the costs of transportation and transportation efficiency is improved. also supports this general objective as applied to quality control, especially through the ability of artificial intelligence to perform image recognition that enhances defect identification and tracking. However, the researchers continue to embrace issues of data privacy and ethical questions in AI, calling for the right deployment of AI technologies to enhance effective as well as sustainable supply chain management.

Artificial intelligence is now enterprise and changing supply chain and production with better decision-making, and improves productivity, from remote operations. According to Vahedifard, Hassani, Afrasiabi, and Esfe (2022) explained that demand forecast is one of the most important factors that can be potentially enhanced by AI real-time data collection making it possible for the companies to address the market demands and keep the operational costs low. Li (2017) also touches on another priority area referred to as quality management in which AI improves defect detection and image traceability. Logistics research also foregrounds the role of AI in improving the speed, safety, quality, and reliability of delivering goods and services to consumers. That said, while proper usage of AI does bring several benefits, the issues of data security and protection arise as one of the most significant barriers that hinder the long-term applicability of AI to achieve sustainable supply chain optimization.

Madani and Alomar (2022) Reviewed the effects of manufacturing on the environment, especially the developing countries, thus shifting attention toward the environmental consideration in GSCM. In their sample of Chinese industry, they stress export and commerce as preciously linked to enhanced environmental performance. More specifically, little prior research has been carried out on the hierarchy and relationship between GSCM performance indicators in the context of India. Although world literature highlights GSCM drivers, challenges, and responsible sourcing, literature in India's manufacturing sector is limited. This research will therefore seek to address this research question: What are the KPIs for GSCM in the context of Indian industries?

Dwarikadhish Churpal et al. (2020) The research is about to consider the economic issues of NTFP collection in Chhattisgarh, studying the problem of the high costs of gathering these resources. The source of income and nutrition is well documented by Zenebe Reta et al. (2020) who pointed out that NTFPs have an important contribution to the rural tribal household income and food security. In earlier related works, it has been argued that market prices of extracted NTFPs are highly sensitive to transport costs and expenses incurred in processing, middlemen who control the NTFP market, and hence the gross and net income realized by collectors reduces when prices drop (Churpal, 2020). Still, studies have shown that NTFPs do enhance poverty alleviation bringing income to millions in India. Normatively, various deficits in market systems and value-addition processes limit their functional growth and business profitability to the tribal communities.

Carli, Bezuidenhout et. al, (2022) delve into the effects of AI on recent marketing strategies of Professional services firms (PSFs). The literature shows that AI is disrupting PSFs by increasing efficiency, quality of services, and effectiveness of engagement with the clients to help to remain competitive. AI also changes service characteristics, thereby giving rise to

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novel services that transform the service profile. However, AI's effect on the relationship that it has with its clients is a challenge because this is an area that PSFs have always valued because of their prowess. The work demonstrates how AI affects marketing, concerning price strategies, and proposes reassessing the approaches used in marketing. To present these changes and their impact on PSFs' business models, a conceptual model is developed.

As stated by Mahbub, Basha & Shaik (2023), this paper discusses the use of AI in marketing and its adoption. It also demonstrates how the business environment has been affected by AI and helped to enhance the results of marketing efforts. The paper finds voids in the literature about the part of AI in strategy and seeks to fill them. According to qualitative case interviews of 17 marketing executives, this research investigates AI's performance and profit-generation benefits and raises possible ethical issues. The study has practical implications for strategic marketing by revealing how AI is currently redefining and repositioning marketing activities.

In the paper AI Changing Marketing for Marketers, Nashrah, Arshad, et al. (2024) identify how AI is altering marketing. Considering the use of AI can assist marketers in gathering information for making relevant decisions to improve the campaigns and enhance the interaction of consumers with the campaign. However, as the given study demonstrates AI cannot mimic People's Creativity Emotions, and Intelligence all of which are vital for the marketing process. It also delves into issues of privacy and bias and reminds the populace to apply AI the right way. In summary, the integration of AI is going to revolutionize marketing in a bid to complement creativity.

Adebunmi, Okechukwu, et al. (2024) review AI integration in agriculture in their paper, AI in Precision Agriculture: Technology in Achieving Sustainable Farming Systems A Review. The study also brings out the benefit of machine learning in boosting crop monitoring and resource use. Self-driving systems engage satellite imagery, drones, and sensors to offer real-time crop assessment for water, fertilization, and pesticides. Decision support is used by AI to make sustainable decisions by farmers while the use of robotics solves problems of labor shortage. The paper also contains an analysis of ethical issues, the division of the audience, and research recommendations for the future.

In AI for Sustainable Farming, Prof. Arti Sonawane (2024) compares farming with the help of AI and IoT to conventional farming practices. It also addresses change in the traditional approach to integrated systems of control with new and current trends crystalized on AI and IoT such as monitoring of ecosystems, performance and efficiency, and sustainability. Possible areas of difficulty can be the utilization, connections, and data processing of AI and IoT systems. Programs that cover soil health, water usage, and species protection together with measures to curb emissions known as AI sustainable measures are central to managing our planet sustainably. The review realizes that AI has the capability of improving sustainable farming practices but admits that its integration is a challenge.

The paper "Artificial Intelligence in Fisheries and Aquaculture: "AI Applications for Sustainability and Productivity Improvement in Fishery and Aquaculture: A Systematic Review," by Hari Prasad Mohale et al. (2024) the study discusses the authority of AI in improving fisheries and aquaculture sustainability. AI is described as technology that works through experience and is central to labor-saving and productivity enhancement in aquaculture. Cognitive applications in feeding methods, water quality, and harvesting have increased production by a factor of three to eliminate the problem of labor scarcity. Furthermore, AI is helpful for sustainable solutions because it monitors fishing around the world, prevents pirate practices, and protects the seas. Another advantage of applying AI applications is that it saves time because it cuts wastage and brings down operations costs by as much as 30% of the cost incurred. Discussing topics such as overfishing and scarcity of resources, the paper proves that AI is useful when searching for ways to meet the global demand for seafood.

The paper "AI-Perspective: Another paper, "AI for Sustainable Horticulture: Opportunities and Challenges: A Catalyst for Sustainable Horticultural Practices with Artificial Intelligence" by Bafna, et al (2024) also lays down how sustainable horticulture can be transformed using artificial intelligence. It emphasizes the problem of analyzing hyperspectral data by conventional techniques and offers the idea of developing an interactive visualization system with the use of AI technologies for more efficient data analysis. This system improves decision-making for the simple reason that it provides much better visual displays, and the analysis is much simpler. This paper also points out that AI and hyperspectral imaging can contribute to the sustainability of the horticultural resources use and its minimization of wastage.

In the paper of Du-Phuong Ta et al (2024), they present an overview of the advancement of artificial intelligence (AI) in adopting sustainability in the food value chain and its applications in the control, inspection, quality, and sharing of food resources. Applying a documentary systematic review with the "PRISMA" framework, the research reveals themes such as food surveillance which employs image AI technologies to confirm meal quality, and optimization for factoring efficiencies to limit emissions. Moreover, the literature points out issues like change management and highlights the need for growth in the use of AI along the food chain. A good place to start is this piece that gives a good background of what AI is today and its possible ways of promoting sustainability in the food business tomorrow.

In the (2024) paper, Jain & Mitra pay more attention to the ethical concern of AI in terms of customer influence and the pollution of the environment. It stresses and underlines the importance of ethical content curation for artificial intelligence for sustainability in an attempt to improve existing consumer awareness. Employing both qualitative and quantitative data, this paper posits that attitudes to engage in sustainable behaviors can be elicited through AI-produced text and the level of behavior change depends on the credibility of the AI algorithm. The paper also discusses consumers' expectations toward AI platforms for raising awareness of sustainable living while emphasizing ethical resolutions within AI systems.

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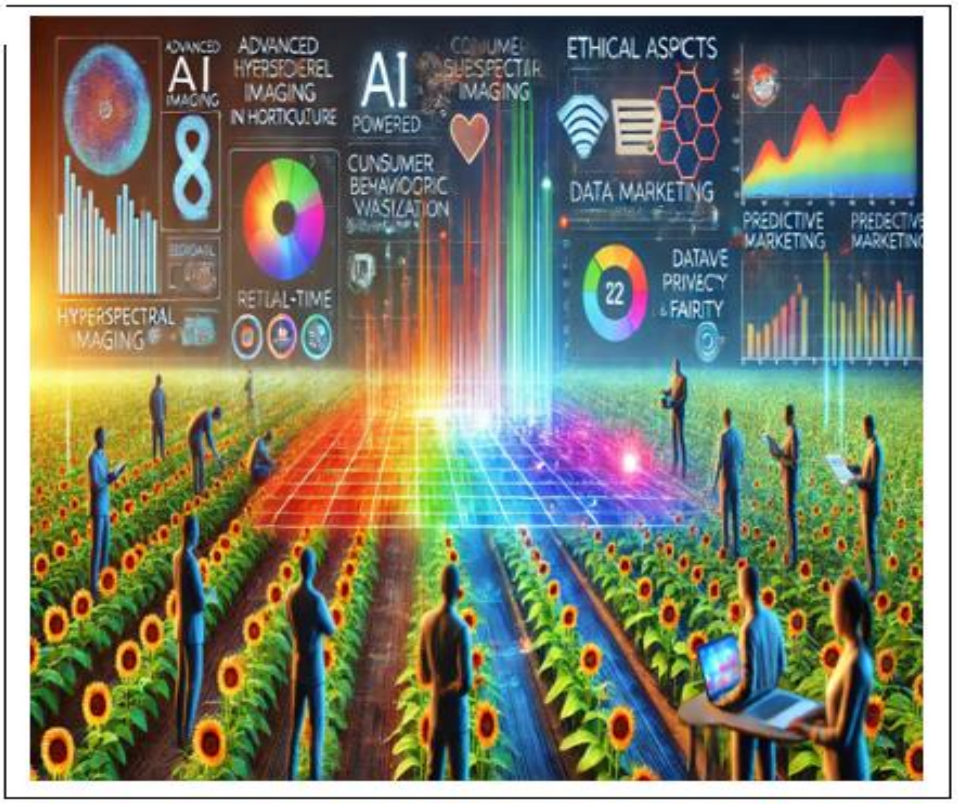

Bafna, M., Singh, et.al (2024) Interactive Hyperspectral Imaging (FigureNo-2), Data Visualization: AI as a Stimulator for a Sustainable Horticulture Sector. It focuses on consumer behavioral analysis and the use of behavioral data, pointing out that prediction is as valuable as action, for example, with proactive marketing. of AI has evolved to enhance consumers' experiences where businesses use real-time data to warrant services. Further, it covers basic and imperative ethical issues like data privacy and fairness of algorithms that are compulsory for correcting AI applications. provides insights for practitioners, researchers, and businesses on how AI-driven innovation could create new opportunities to redesign strategic landscapes and create more customer value while avoiding the misuse of powerful tools

NTFPs and their Economic Value

Aspect	Details
Economic Value	Provides income to rural and forest-dependent communities.
	Key products: medicinal plants, wild fruits, bamboo, honey, mushrooms, essential oils.
	Contributes to local employment in harvesting, processing, and trade.
	Vital source of income during economic hardships.
Cultural Significance	Integral to daily life, used in food, medicine, rituals, and craft-making.
	Example: bamboo for furniture and herbal remedies in local healthcare.
Environmental Benefits	Sustainable harvesting practices promote forest conservation.
	Reduces reliance on timber extraction, preserving biodiversity.
	Supports agroforestry, integrating NTFPs with crops for ecological sustainability.
Global Economic Impact	Widely traded internationally (e.g., turmeric, gum Arabic, essential oils).
	Brings in foreign exchange earnings for many developing countries.
Challenges	Over-exploitation and unsustainable harvesting practices.
	Lack of regulation and poor market access for small-scale producers.
	Climate change, land use changes, and urbanization threaten habitats of key NTFP species.

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Sustainability Strategies	Certification schemes (e.g., Fair Trade, Organic) encourage sustainable practices.
	Community-based management systems for local resource control.
	Market linkages to connect local producers with broader, more equitable supply chains.

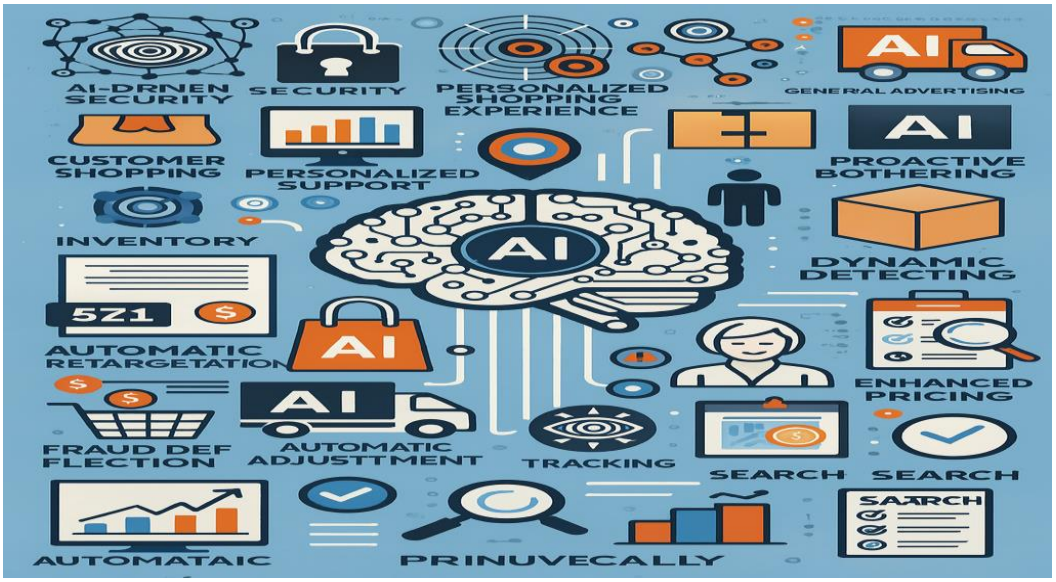
This table can be used to support your research and analysis on the value of NTFPs in sustainable development, tribal economies, and conservation practices. It encapsulates the multi-dimensional role of NTFPs while also addressing the challenges and strategies for ensuring their sustainable use

The Table No. 04: Scholar Recurses of Secondary data

3.1: Digital Marketplaces and E-commerce Trends

Currently, (Figure No-3) a study highlighting digital marketplaces and its linkages of e-commerce, online transactions are being facilitated through the implementation of online marketplaces, including Amazon and eBay. The notable trends include mobile Commerce which is on the rise owing to the increased use of mobile phones and AI based on personalization which seeks to better the overall consumer experience through the use of AI to come up with precise recommendations. Sustainability and strategy unification also play crucial roles, the case aims to implement the sales of products, that possess environmental care attitudes and constant integration of channels. The popular technologies of augmented and virtual reality are prominent in delivering the shopping experience and social and voice commerce emerge through social media apps and usage of voice assistant devices. Blockchain technology enhances the general security of transactions and live commerce provides real-time shopping. Such trends are contributing to the evolution of the enhanced more individualized and safer e-shop environment

Image No-5: Image coded by AI Microsoft Visual



[1] In this study, the words "app" and "platform" are used interchangeably.

Image No. 6: Own sources

New significant shifts are occurring in the Digital marketplace and e-commerce platforms based on new technologies such as AI to personalize the shopping experience, fitting the consumer's unique choices. M-commerce is especially on the rise since people use their mobile phones to make purchases. Social commerce integration is slowly turning social networks into stores; voice commerce is revolutionizing the way people shop using voice search and assistants. Another capability that is being employed in the enhancement of shopping is Augmented Reality (AR) which helps customers to have the feel of the products before making their purchase. This is reducing customer experience sales growth and penetration in the market by a healthy margin. In the future, the advent of AI technologies will give birth to new markets, the application of which will be accompanied by problems like protecting individuals' right to privacy and concerns about the fair treatment of algorithms in e-commerce.

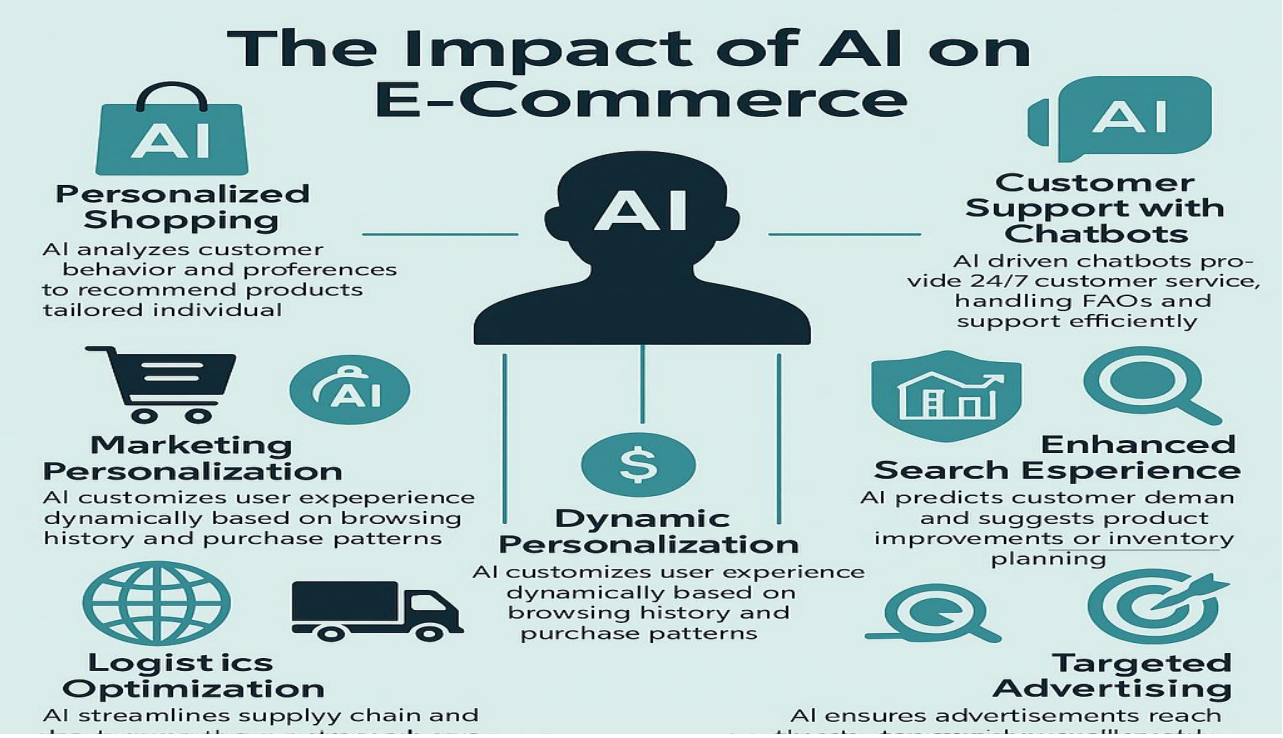


Image No-7. The figure indicates that AI is integrated into each effective area of e-commerce management automatically (Coded by Scholar)

3.2: Role of AI in E-commerce

Artificial Intelligence (AI) has further assumed greater significance in e-commerce as the digital market space has increased across countries. Machine learning, natural language processing, predictive analytics, are all types of AI technologies changing the way companies speak to their customers, manage their inventory, and personalize their purchases. Whether it is a chatbot and virtual assistants that can improve customer service to the recommendation engines that can boost the sales by offering a personalized product suggestion, AI has the ability to make operations smarter, faster, and more efficient. Sellers can use AI tools in demand forecasting, dynamic pricing, detection of frauds, and optimization of supply chains. At tribal and rural level, like in the sale of Non-Timber Forest Products (NTFPs), AI can facilitate the market gaps by helping to better target the products, market intelligence and by facilitating logistics. Because e-commerce forms one of the most viable sources of sustainable livelihood, and inclusive trade, to be able to develop adaptive, data-driven, and fair digital marketplaces, comprehending the role of artificial intelligence is critical.

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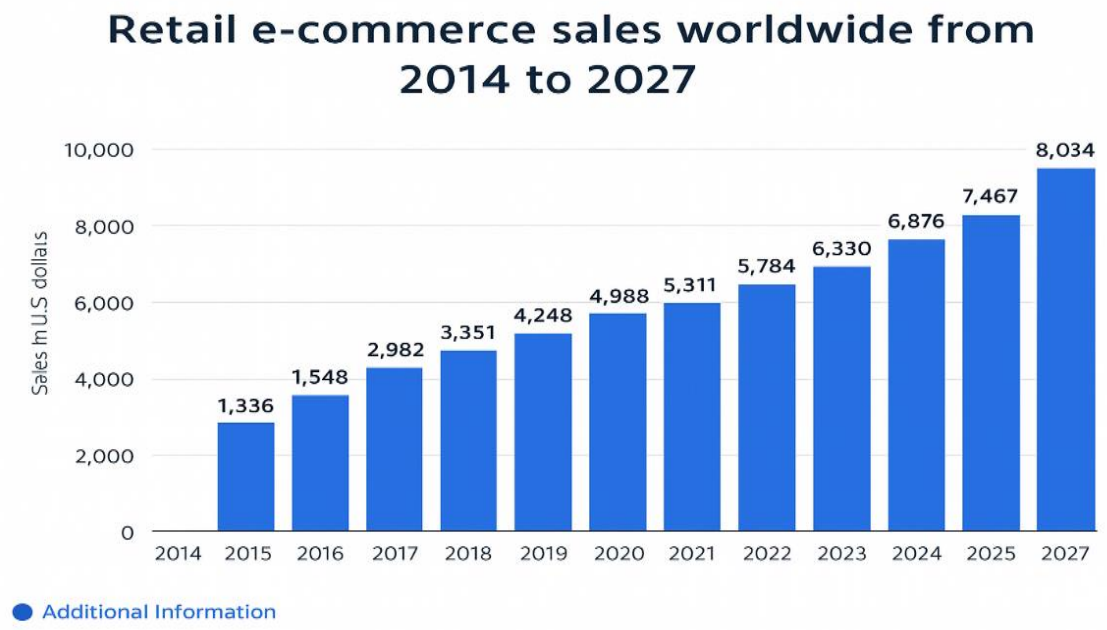


Table No.8: sources is digitaldoughnut.com, (Gaurav Sharma)

The bar graph represents as Retail e-commerce sales around the world between 2014 to 2027 depicts an accurate path of retail e-commerce sales worldwide and a constant and profound increase in e-commerce retail sales over time. The base year of the sales is 2014, and since then, the sales have increased gradually by 2023 which are now $6,330 billion. This positive trend is associated with the fact that retail is rapidly becoming digitalized, especially since 2019 when, thanks to the COVID-19 pandemic, the progress toward e-commerce was boosted in the world. This growth is projected to maintain in the upcoming years when it is expected to have the sales of up to 6,876 billion dollars in 20214, 7,467 billion dollars in 2025, and 8,034 billion dollars in 2027. The statistics reveals the increasing role of e-commerce in the worldwide economy and emphasizes the necessity of combining such technologies as artificial intelligence, digital marketing, and logistic. This tendency is huge opportunity to the developing world and producers in the rural areas, and tribal communities who sell Non-Timber Forest Products (NTFPs) to enter the world market anThe bar graph known asRetail e-commerce sales around the world between 2014 to 2027 depicts an accurate path of retail e-commerce sales worldwide and a constant and profound increase in e-commerce retail sales over time. The base year of the sales is 2014, and since then, the sales have increased gradually by 2023 which are now $6,330 billion. This positive trend is associated with the fact that retail is rapidly becoming digitalized, especially since 2019 when, thanks to the COVID-19 pandemic, the progress toward e-commerce was boosted in the world. This growth is projected to maintain in the upcoming years when it is expected to have the sales of up to 6,876 billion dollars in 20214, 7,467 billion dollars in 2025, and 8,034 billion dollars in 2027. The statistics reveals the increasing role of e-commerce in the worldwide economy and emphasizes the necessity of combining such technologies as artificial intelligence, digital marketing, and logistic. This tendency is huge opportunity to the developing world and producers in the rural areas, and tribal communities who sell Non-Timber Forest Products (NTFPs) to enter the world market and take part in inclusive e-commerce in general.take part in inclusive e-commerce in general.

4. ARTIFICIAL INTELLIGENCE (AI) TRANSFORMING E-COMMERCE

Artificial Intelligence (AI) is revolutionizing the e-commerce business where it is making the platforms to become smarter, faster, and more personalized. In my opinion, AI can bring outstanding contribution in seven key fields. It allows the recommendation of individualized products based on user behavior and preferences and helps increase customer engagement and sales greatly. Virtual assistants and chatbots supported by AI provide customer support at all times of day and night without any impact on human effort and provide customer support with high quality. Market trends and user-related data are used in the dynamic pricing algorithms that can keep businesses competitive and profitable. In supply chain and inventory management, AI will improve their forecasting and reduce the stock-related problems. Image recognition technologies allow for increased naturalness of the shopping experience (it now relies on visual search tools). Another aspect through which artificial intelligence enhances security is by detection of frauds and anomalies in real-time. The final advantage is that it empowers brands to provide customer segmentation tools so that targeted customers can be reached effectively and with high accuracy. All in all, it is not merely the area of efficiency that AI is improving but redefining the very veil of modern e-commerce, even the prospects of rural and indigenous producers, such as the ones of NTFP trade evolution

4.1 Supply Chain Optimization: AI algorithms for inventory management

The left visualization shows how an AI-driven supply chain could best integrate with technology for advanced supply inventory management. It has a sophisticated/advanced stock/warehouse to demonstrate how other industries can implement

[1] In this study, the words “app” and “platform” are used interchangeably.

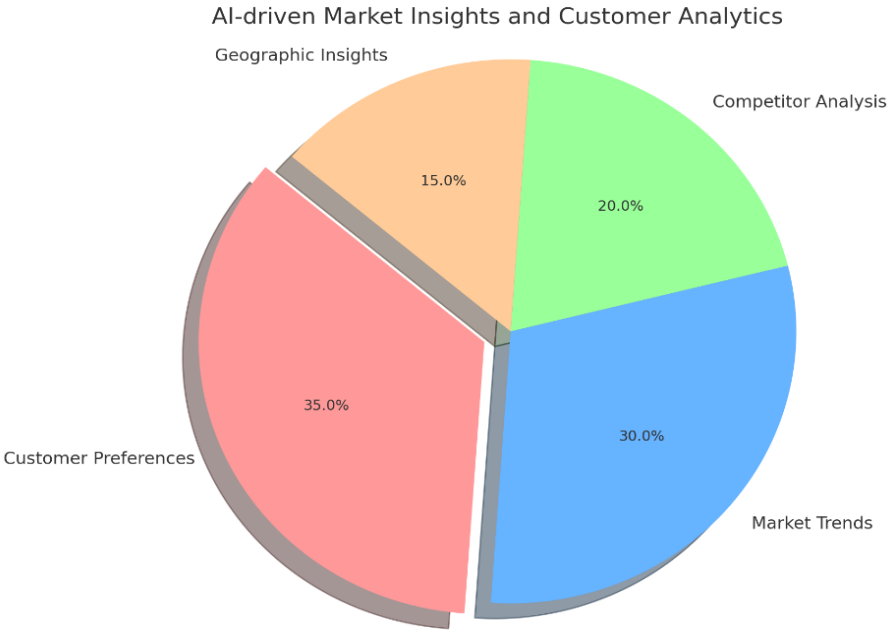
AI, robotics, and analytics to support/optimize their processes.

Image Sources DEL-E AI coded

Image No.9: sources digitaldoughnut.com, (Gaurav

The left pie chart highlights AI-driven market insights: 35% customer preferences, 30% market trends, 20% competitor analysis, and 15% geographic insights, enabling businesses to personalize strategies and enhance competitiveness.

Image No-4. Sources DEL-E AI-coded by Scholar



4.3 Sustainable Harvesting: AI in monitoring and promoting sustainable practices.

The table showcasing AI-driven sustainable harvesting practices:

Order of Implementation	Sustainable Practice	AI Application
1	Resource Assessment	Satellite imagery and sensors to monitor resource availability.
2	Harvesting Limits	Predictive models to determine sustainable harvest quotas.
3	Biodiversity Monitoring	Machine learning for identifying species diversity and trends.

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4	Ecosystem Health Analysis	AI-driven analytics to assess environmental changes and risks.
5	Stakeholder Engagement	Social media and NLP to gauge community feedback.

This outline is the step-by-step approach to integrating AI for sustainable harvesting practices.

5. CASE STUDIES

5.1 Successful Integration of AI in NTFP Marketplaces

Successful Integration of AI in Non-Timber Forest Products (NTFP) Marketplaces: A Case Study of Odisha and India Non-Timber Forest Products (NTFPs) provide a unique source of income in the rural setup, especially among forest fringe dwellers. These products as medicinal plants, fruits and nuts, honey, fibers, and others are very significant as sources of income, food security, and cultural significance. The understanding of the economic potential of AI creates a perfect opportunity to solve problems related to supply chains, access to the market, and sustainable development of NTFP sources through the integration of AI into the existing NTFP marketplaces.

Case Study 1: Odisha Tribal Products (Online sales & Logistical support) (TRIFED's model AI-Driven E-commerce Techniques)

The Tribal Cooperative Marketing Development Federation of India (TRIFED), was incorporated in 1987 to boost the marketing of Tribal Non-Timber Forest Products (NTFPs); however, the organization has been active in the adaptation of new-age technologies like AI and digital platforms for efficient marketing of the sourced products. Topographic maps are employed to predict consumer preferences and market trends for famous NTFPs like Mahua flowers, Sal seeds, and Tendu leaves using AI tools for disclosing even more competitive prices to consumers due to flexible prices formulated by TRIFED. This integration has increased market access by offering tribal producers a direct connection to the urban and international markets and price determination through fickle and volatile that standard price cannot exploit the producers. Consequently, revenue increase has been experienced whereby tribal producers enhanced their incomes as they explored new markets and obtained better price offers.

Case study 2: Implemented in 2018 by the Ministry of Tribal Affairs Van Dhan Vikas Kendra scheme (MTA-VDVKS) is also for the promotion of NTFP processing and marketing for enhancing the earning capabilities and promoting sustainable economic growth of tribal people. It has promoted demand forecasting, quality monitoring, and optimum pricing through the use of AI tools that have made sustainable the efficiency level of different ventures owned by tribes. Services such as seasonal availability prediction of NTFPs like Tamarind, Amla, Mahua, and Honey More than 250 pluses of non-timber forest products can be powerful tools in evaluating market supply and the need for bringing together or control in the next production cycle. Also, using trends in the market, AI offers help in determining the best price so that there are proper profits without the need for an intermediary conman. This technology has also helped in conserving and preserving some of the resources by avoiding over-utilization, maintaining a balanced ecology, and helping the tribe groups in India increase their income, better markets for their produce, and better quality.

Case Study 3: Conference Paper 4: AI for Medicinal Plants Certification and Traceability (India)

Currently, the major consumer of medicinal plants is India which is ranked among the largest markets globally, but it shares some of the challenges that affect global certification, traceability, and sustainable sourcing of medicinal plants. The National Medicinal Plants Board (NMPB) has overcome these challenges by incorporating the uses of AI technologies in the tracing and certification of medicinal plants such as Shilajit and Withania coagulans. Advanced technologies including; blockchain and image recognition help producers to identify the origin, quality, and farming period of these plants, Thus, the integration has brought changes to the industry. in global market access by enhancing confidence in Indian medicinal products to increase exportation. Sustainability assurance is also another of the benefits because the technology assists in the tracking of the harvests, and the supplies to ensure that the medicinal plants are sourced sustainably to promote biodiversity. In addition, certified products have higher prices in the international markets, meaning revenue for producers has improved and enhanced the sufficiency of this ecosystem.

Case study 4: Currently, the Chhattisgarh State Minor Forest Produce Co-operative Federation (CSMF) engages AI startups to support better effective supply chain management services for NTFPs. AI-based solutions enhance supply chain management, determine optimal transportation pathways for NTFPs including Tendu leaves, Chironji nuts, and Kachnar bark, and forecast the demand in addition to suggesting the right time to harvest them. The implemented technology helps to save on logistics expenses, optimizes harvesting, and helps with time and type of demand for the products, enhancing environmental sustainability by barring further incorrect over-prediction.

Case study-5: In Odisha, the OFDC has automated its NTFP marketing platform by incorporating Artificial intelligence and machine learning to assist with its decision-making, pricing strategies, and resource mobilization for the tribal population. AI is employed with the supply chain of forest products such as Sal seeds, Mahua flowers, Honey, and Tendu leaves in which the market trend and the desired timeframe are delineated to know the perfect time of collection; along with that it also provides accurate knowledge about the best price on supplying the said forest products and the most appropriate method of preservation. Further, AI tools check the quality of products through image recognition and machine learning to make sure that only quality products are sold in the market. This has promoted market access by expanding the market beyond the local

[1] In this study, the words "app" and "platform" are used interchangeably.

producer level, price optimization by charging appropriate prices based on the current information, and resource optimization by estimating demand and supply and making relevant arrangements. In addition, resolution through the use of AI encourages sustainable use of resources and makes harvest of NTFPs consistent with the periodic availability of those resources. By so doing, the OFDC has boosted the income and viability of tribal NTFP business ventures, as well as a best practice for other areas looking for ways to improve both bottom line and ecological returns.

Following the case study, some national and international authors suggested their point from the different aspects of how artificial intelligence incorporates with the non-timber forest product For AI and Market Dynamics McCarthy, J., & Minsky, M. (1955): Innovators in Artificial Intelligence whose work is among the first to set the tone for all applications of the shape that complements marketplaces. Some of them made their earlier theoretical contributions that provided the basis for today's modern AI systems., Brynjolfsson, E., & McAfee, A. (2017): In the course of their The Second Machine Age the authors look at how information technology especially in the aspects of artificial intelligence and automation is changing traditional industries of goods and service market place., Varian, H. R. (2014): Being professed for his work on the subject, of predictive analytics and its uses in market economics. It provides information for further research on how the model can predict consumer behavior, demand variation, and demand pricing in NTFP markets.

5.2: For NTFP Sustainability

Shackleton, C. M., & Pandey, A. K. (2014): Their research offered the data that is essential to understanding the economic and ecological importance of NTFPs and implications for sustainable use and management of these resources especially for income-generating activities of households in rural and forested areas. Otta, A. B. Well, known for his research about the market of NTFP specially devoted his research to the analysis of the role and importance of NTFPs to tribal people of Odisha. A scan of the literature shows that Otta has reviewed the market structure and trading patterns for the NTFPs and enormously advanced the knowledge of the local economy. Neumann, R. P., & Hirsch, E. (2000): Their work on the commercialization of NTFPs discusses the social and economic effects of integrating NTFPs into global markets, and how is commercialization a positive and a negative thing for local communities.

5.3: For AI in Agriculture and Forest Management.

Georgescu, P., & Srinivasan, V. (2020): Their research focuses on AI applications in agriculture, including precision agriculture techniques that are relevant to managing forest resources like NTFPs. They discuss how AI can optimize resource use, ensuring sustainable harvesting and conservation. Pant, S., & Samal, P. K. (2008): These researchers have explored sustainable practices in NTFP harvesting, particularly in the Himalayan region, with a focus on integrating technology and AI to monitor ecosystems and ensure sustainable extraction practices.

5.4: For AI-Driven E-commerce

Turban, E., & King, D. (2018): Their work on e-commerce and digital marketing strategies provides a framework for integrating AI into online platforms. These strategies can be applied to the NTFP sector, enabling producers and buyers to interact efficiently and transparently. Berman, B., & Evans, J. R. (2020): In their research on digital marketing and e-commerce, they emphasize AI's role in creating personalized consumer experiences. This concept can be applied to the NTFP market, offering targeted recommendations for consumers interested in sustainable and organic products.

5.5: AI and Tribal Development

Sahu, G., & Rout, S. K. (2019): Their work involves the socio-economic advancement of those tribes hence; In the implementation of that mandate particularly by embracing technology. Both of them have explained how AI tools can help tribal producers by providing them with improved market access and resource utilization. Sundar, N. (2018): Sundar's research interest is in the application of technology in the management of tribal resources specifically, there's an effort to incorporate the use of AI as well as other digital tools in the sustainable sales management of NTFPs, lifting the standards of living of tribesmen without further detriment of their resources.

5.6: Forest Policy and Economics:

Additional Notes:

For further exploration, articles and case studies from Forest Policy and Economics often provide in-depth analyses of AI's role in sustainable resource management, forest policy implementation, and the economic impacts of NTFPs in local and global markets.

6. COMPARATIVE ANALYSIS OF AI-DRIVEN VS TRADITIONAL APPROACHES

6.1: Benefits of AI in NTFP E-commerce

Benefit	Explanation	Impact
Enhanced Market Insights	AI provides real-time data on consumer preferences, market trends, and seasonal demand for NTFPs.	Helps producers plan marketing and production strategies effectively.
Price Optimization	Analyzes market trends and demand-supply dynamics to recommend fair and competitive pricing.	Ensures better profits for producers and fair prices for consumers.

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Improved Quality Control	Uses image recognition and machine learning to assess product quality.	Builds consumer trust and enhances the market value of NTFPs.
Demand Forecasting	Predicts market demand for NTFPs through AI-driven analytics.	Reduces waste and ensures a steady supply aligned with market needs.
Streamlined Logistics	Optimizes transportation, inventory tracking, and storage management.	Reduces operational costs and ensures timely delivery of products.
Market Accessibility	AI-powered platforms connect tribal producers directly to urban and international markets.	Expand market reach and reduces dependence on intermediaries.
Personalized Marketing	Targets specific consumer groups based on preferences and behavior using AI.	Increases customer engagement and boosts sales.
Sustainable Practices	Analyzes resource availability and aligns harvesting with ecological cycles.	Promotes biodiversity conservation and ensures long-term resource availability.
Increased Revenue	Eliminates middlemen, improves quality, and expands market access for tribal producers.	Enhances livelihoods and economic empowerment for tribal communities.
Transparency & Traceability	Uses blockchain and AI for tracking the origin, processing, and distribution of NTFPs.	Increases consumer trust and adds value to tribal products.

6.2 Challenges and Limitations

There are common problems in areas of problem with the adoption and implementation of AI due to differences in geographical locations and context. The Technology Acceptance Model (TAM) and a Resource-Based View (RBV) give structural guidelines on AI acceptance; on the other hand, the Dynamic Capabilities Theory gives insight into adaptability in AI implementation. Nevertheless, the following findings provide a hint of departure between AI's hypothetical value and that demonstrated in the actual world, and ultimately conclude that there is still a large research gap in regional adoption factors. (Jesse, Wachira, Mwangi-2024)

7. CONCLUSION

The Application of AI in the economy platform for NTFP is changing the face of the sector, market access, supply chain management, and the environment. It must be noted that through the help of advanced applications of artificial intelligence like Blockchain and image recognition techniques are used for the certification and tracking of high-demand products like Shilajit and Withania coagulans. These systems monitor the source, quality, and practices of the harvest of NTFPs, which increases the level of accountability, and thereby, the international confidence in Indian medicinal and forest products. AI brings a step to supply chains by using forward demand, ordering stock, and undertaking deliveries of products efficiently, cutting expenses and unnecessary consumption. Marketing intelligence leads to improved market and consumer information and thus increases the probability of the firm selling its products and services thus increasing its revenue. Interactive elements like recommendation engines enhance customer satisfaction while digital self-serve advertising enhances a product's visibility in domestic and export markets. Sustainability is another sector where the above advancements affect. AI assists in overseeing and controlling the process of picking that contributes to maintaining the bio-diversity and Organic NTFPs today are branded and command a high market, improving the financial base of tribal people and also reducing pressure on forests. Blockchain for example makes the system more transparent helping consumers have faith in the products they are consuming, their authenticity, and their proper sourcing. The process that this paper evidences as being driven by AI brings together the goals of economic development and ecological sustainability. By creating market opportunities on a global scale, supporting the development of the rights and capacities of tribal people, and advocating environmental responsibility, AI places NTFPs on the list of effective tools for sustainable development and ethical consumption. The use of such technologies guarantees sustainable development as it attends to the three major global concerns; economic development, conservation of biodiversity, and the needy persons.

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[1] In this study, the words "app" and "platform" are used interchangeably.

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[1] In this study, the words "app" and "platform" are used interchangeably.