Communication in Physical Sciences, 2026, 12(8): 2411-2423

Embedded Finance and Sustainable Business Models: Conceptualizing the Role of AI-Driven Automation in Reshaping Cross-Sector Value Creation and Programme Delivery

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Received: 22 November 2025/Accepted: 3 December 2025 /Published: 13 December 2025
https://dx.doi.org/10.4314/cps.v12i8.19

Abstract: *This conceptual paper examines how embedded finance and AI-driven automation enable sustainable business models and cross-sector value creation. The authors investigated the capacity of the digital-first fintech services to break the traditional, centralized financial models of banking that introduced the financial products (payments and lending) into the non-financial platforms. This approach is particularly relevant for sustainable business models in sectors such as renewable energy and social enterprises where access to capital was cumbersome in the past. The theoretical framework offered in the paper has AI playing the role of an accelerator through delivering real-time insights, dynamic risk management, and autonomous workflow to bridge the gap between financial inclusion and environmental, social, and governance (ESG) goals. It was also noted that AI-based systems saved as much as 60 percent of transaction costs and time wasted to deliver a service, which took days and some seconds with an automated data integration process. However, the paper identified a Strategic Frontier where the high-impact applications, such as alternative credit scoring of the unbanked, required a high level of ethical control to remove the threat of algorithmic bias. Lastly, the paper discovered that the paradigm shift from "banking as a destination" to "banking as a feature was a major source of organisational resiliency and an inclusive development.*

Keywords: *Embedded Finance; AI-Driven Automation; Sustainable Business Models; Financial Inclusion; ESG Integration.*

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1. 0 Introduction

Embedded finance has emerged as a major transformation in modern financial services, integrating financial products directly into non-financial digital platforms. in a fashion that makes them more accessible and enables new methods of creating value. Clement (2025) also states that traditional banking has long been characterized by a centralized institution, brick-and-mortar branches and manual operations, which is costly and limited in scalability (and especially in the emerging markets) and slow in terms of innovation. This model was disrupted by the rise of fintech, which offered digital-first services, and embedded finance has gone a step further to offer a seamless integration approach to the incorporation of financial services; payments,

lending, and insurance, directly capturing the daily life experience of users in e-commerce checkout, ride-hailing apps, or agri-tech services (Egbuonu, 2024; Ugwo & Chikezie, 2024). This shift is highly relevant in case of sustainable business models, in which access to capital becomes cumbersome in cases where they need to make a difference in areas like renewable energy, agriculture, and social businesses. Omoseebi, *et al*. (2025) live up to these claims by asserting that embedded finance will drive more effusive and sustainable models by lowering entry barriers that are sustainable in the context of environmental, social, and governance (ESG) goals.

To draw this change graphically, the development of the financial services can be represented by a horizontal timeline infographic with key milestones. As Nkechika (2022) indicated, the history of the mobile money platforms follows (e.g., the M-Pesa in the late 2000s) that liberalized the underserved regions since the beginning of the 2008 global financial crisis, which exposed the frailty of the traditional banking system and initiated regulatory changes and digital alternatives. The BNPL (Buy Now, Pay Later) trend was introduced in the middle of the 2010s, and such companies as Affirm and Klarna are examples of how non-banks can install credit at the checkout (Soetan & Mogaji, 2024). Development of AI-powered embedded finance (predictive analytics, real-time decisioning, new agentic AI systems;) is the new frontier in the future (since 2020s) and capable of autonomous and hyper-personalized services to scale to high levels.

To this timeline, Lakkaraju (2025) speculated a plain bar chart that compares the levels of friction, which also brings out the paradigm shift further. In the traditional banking model, price (e.g. origination fees) and time (days/weeks to approvals) is a huge challenges. Embedded finance radically addresses these frictions: cost of transactions can be reduced to 3060 percent through automation, time to service is reduced from days to seconds through automatic data integration and AI-owned underwriting (Kuo & Lee, 2024). This efficiency does not just enhance user adoption, but it enables sustainable models to expand at a rapid pace by giving impact-based programmes the capital to be impacted without the dragging overheads.

Lastly, the intersection of embedded finance and AI-based automation represents a transformative development that has the potential to change the value creation and programme delivery across the cross-sector. Ekundayo (2024) argues that stakeholders can build circular economies, outcome-based finance, and inclusive growth by incorporating into sustainability-oriented platforms smart financial applications into sustainability-oriented platforms. The paper contextualizes the idea of AI as the accelerator; it offers real-time insights, dynamic risk management, and autonomous workflow, which will close the gap between financial inclusion and sustainable outcomes and leave a gap in the current literature because all three are significantly disconnected at the time.

Despite extensive studies on embedded finance, sustainable business models, and artificial intelligence independently, limited research has conceptually integrated these domains to explain how AI-driven embedded finance reshapes cross-sector value creation and programme delivery. Existing literature largely treats financial innovation, sustainability transitions, and intelligent automation as separate research streams from different area of expertise (Ajiboye *et al*., 2025). Therefore, this study aims to develop a conceptual framework that explains the role of AI-driven embedded finance in enabling sustainable business models and enhancing cross-sector programme delivery.

The study contributes theoretically by integrating financial technology innovation with sustainability theory and AI automation, offering a multidisciplinary perspective relevant to policymakers, fintech developers, and sustainability practitioners.

2.0 Literature Review and Theoretical Foundations

2.1 Embedded Finance

Embedded finance refers to the seamless integration of financial services, e.g. payments, lending or insurance, into the interface of non-financial software (Kadam, *et al*., 2024). Banking-as-a-Service (BaaS) and API-based infrastructure can help businesses to provide the customer with a native banking experience without them leaving their ecosystem.

According to Odihe & Aro (2025), the ecosystem operates through a layered structural architecture, which links the traditional controlled capital to the current digital touchpoints. It is in the non-financial platforms (the "Front-end") that possess the customer relationship that is central to it, according to Iheanachor, *et al*., (2023). The platforms are linked to Embedded Finance Infrastructure providers (the "Enablers"), who manage the complicated technical integrations and regulatory compliance. These enablers, in their turn, are above the Licensed Financial Institutions (the "Back-end") which present the balance sheets in the real world and licenses (Onuoha, 2023). These layers can be used by the platform to communicate value to the end-user as shown in the diagram through instant credit at checkout, gig-worker insurance as a subset of it, or automated digital wallets.

2.2 Sustainable Business Models

The sustainable business models redefine value creation by moving beyond profit-centric approaches to Triple Bottom Line (TBL): People, Planet, and Profit (Hartmann, 2020). The models have environmental stewardship and social equity as part of the core value proposal unlike the models that are based on the returns to shareholders. With the example of the circular economy, the linear process of take-make-dispose would be changed to a closed-loop process with the waste being designed out of the process. According to Qeke, *et al*. (2021this transition requires firms to reconsider their supply chains, by choosing regenerative materials and product-as-a-service (PaaS) designs that encourage durability and repairability over planned obsolescence.

To represent these transformations, the Sustainable Business Model Canvas modifies the classical model of Osterwalder by introducing the environmental and social impact layers (Kabala, 2024). Under this extended perspective, Customer Relationships are Co-creations or Community Engagements, and Cost Structures are extended to Environmental Costs, including carbon footprints or resource depletion (Mili & Loukil, 2023). The Circular Economy loops also transform the canvas and portray the mechanism of recirculation of biological and technical nutrients (Venkatesh, 2022). The offering is reconceptualized as a sustainable lifecycle solution rather than a standalone product. because it may be considered in the redesigned canvas below, but a sustainable solution, which takes into account its lifecycle, including eco-design and ethical sourcing, and end-of-life recovery.

2.3 AI-Driven Automation

Financial automation, based on AI, has transcended the simplicity of rule-based automation, which is characterized by rule-based logic, and is instead characterized by complex Agentic Workflows, which can think and act autonomously (Desai, 2025). This is the intelligent engine of the embedded finance that can process high volumes of unstructured data; transaction history, social media sentiment, or

real-time KYC (Know Your Customer) documents, to produce an immediate financial decision (Ikeh, 2022). Systems can now extend beyond data retrieval to orchestration, wherein the AI can now talk to the banking APIs and make payments, alter credit limits or identify fraudulent behavior in milliseconds, essentially eliminating the human bottleneck of high-volume financial processes (Decker, 2025).

In order to improve transparency in understanding system operations of such systems, the architecture can be described as a multi-layered pipeline which converts raw data into actionable outcomes. Machireddy (2023) ascertains that it starts with the Data Source layer (APIs, PDFs, SQL databases) that fuels a Vector Database to give the AI a long-term memory and domain-specific context. This context is then processed by the LLM and reasoning loops are used in the determination of the best course of action. Lastly, Adenuga, *et al/* (2024) proposed that an orchestration layer (e.g. Lang-Chain or a specialized middleware) manages the flow between the intent of the AI and the result to make sure that all automated actions, processes such as loan approval or portfolio rebalancing are performed within rigid regulatory and safety thresholds.

3. 0 Conceptual Framework

3.1 The Embedded Finance Ecosystem

A central transformation in modern finance is the transition from "banking as a destination" to "banking as a feature It is a symbiotic relationship whereby traditional financial institutions are the regulated financial infrastructure, while digital platforms serve as customer-facing service interfaces (Biluš, 2025). Fig. 1 illustrates the integrative conceptual framework showing how embedded finance infrastructure, AI-driven automation, and sustainable business models interact to enable cross-sector value creation and programme delivery. Samuel-Ogbu (2022) states that the most important translator is the Embedded Finance Infrastructure layer, which translates legacy banking systems (e.g., COBOL-based infrastructures) into developer-friendly APIs.

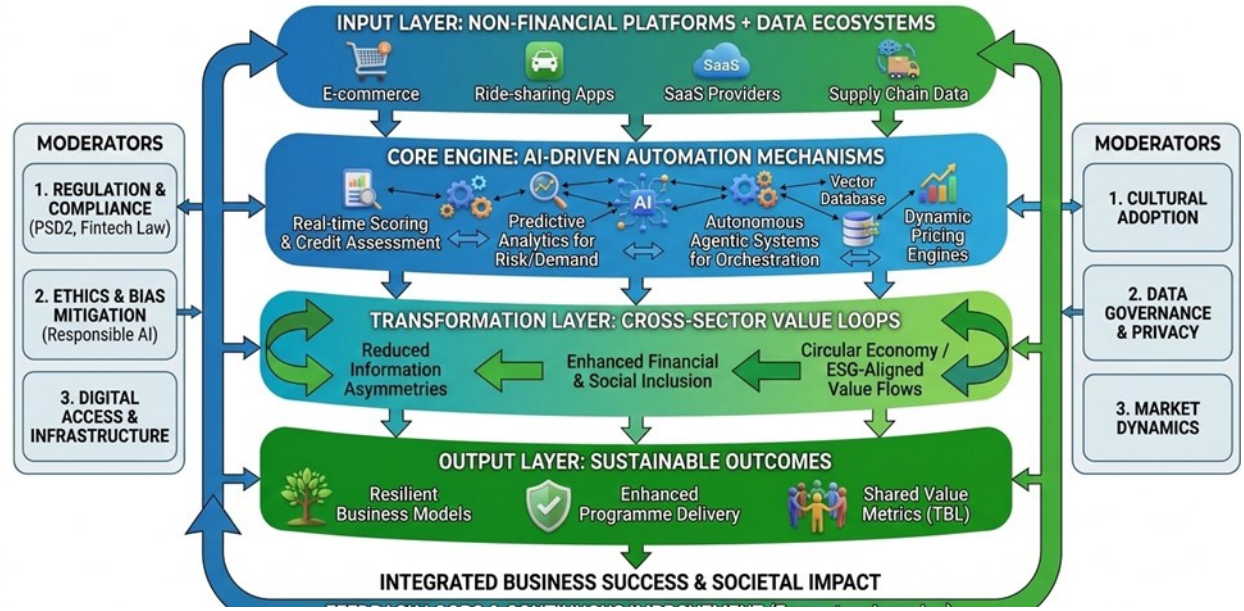

Fig. 1: Integrative Conceptual Framework (Clement, 2025)

This allows a retail location, e.g., to offer point-of-sale lending (BNPL) or built-in insurance at the point of necessity, instantly, without requiring traditional bank-based application processes..

3.2 Sustainable Business Model Canvas (SBMC)

Traditional ways of doing business usually view the impacts of the environment and social impacts as externalities, which are expenses or gains that are not captured in the balance sheet (Ukpong, *et al*., 2024). The Triple Bottom Line dimensions are internalized within the Sustainable Business Model Canvas in the Sustainable Business Model Canvas. It facilitates the transition from a linear value chain to a circular value system where the Value Proposition involves the regeneration of resources. In this case, Key Partners would be expanded to NGOs or recycling cooperatives, and Revenue Streams would be altered to Service Fees (Product-as-a-Service). Elom (2024) presented this visualization by debunking the myth that sustainability is not merely an extension of corporate social responsibility (CSR)(Corporate Social Responsibility), but a reorganization of the entire firm in terms of how it creates and distributes value over its lifecycle.

Fig. 2 presents the AI automation maturity levels in embedded finance, highlighting the progression from rule-based automation to intelligent agentic systems capable of autonomous financial orchestration.

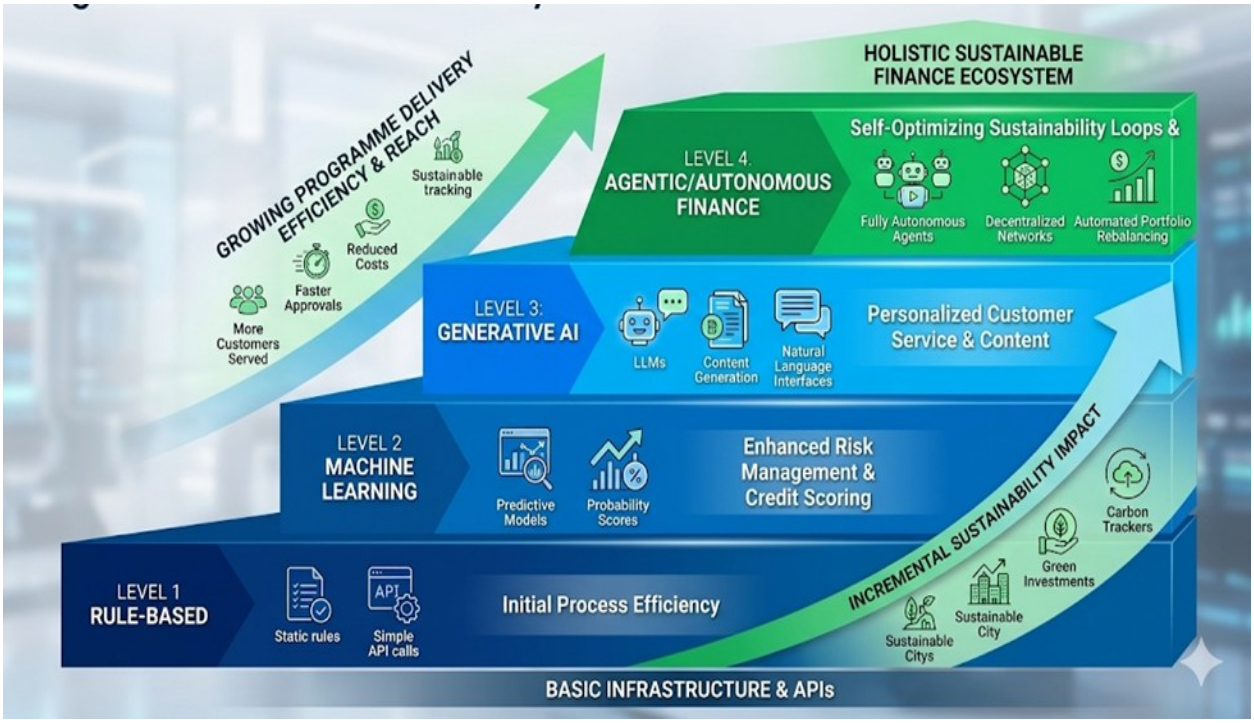

Fig. 2: AI Automation Maturity Levels in Embedded Finance (Camilleri, 2024)

3.3 AI-driven ıFinancial Orchestration Architecture

In order to improve transparency in AI decision-making in finance, we are supposed to think of it as a stack of architectural layers, rather than a single chatbot. This stream demonstrates how heterogeneous and unstructured data can be transformed into high-stakes financial decisions. According to Adabara *et al*. (2025), the AI is capable of making reason based on compliance and risk parameters through the use of Vector Databases and Agentic Systems and

then performs a task. The Orchestration Layer is the most crucial component to fund since it functions as a governance mechanism ensuring model reliability and regulatory compliance and that all the actions taken (a wire transfer or a credit limit increase) fall within the set regulatory guardrails (Uzoamaka, *et al*., 2025). This type of architecture is compatible with Autonomous Finance, where the system autonomously executes decisions aligned with predefined user goals and regulatory constraints based on the goals of the user. Fig. 3 illustrates cross-sector value creation flows enabled by AI-driven embedded finance, demonstrating how data, financial services, and sustainability outcomes circulate across interconnected ecosystems.

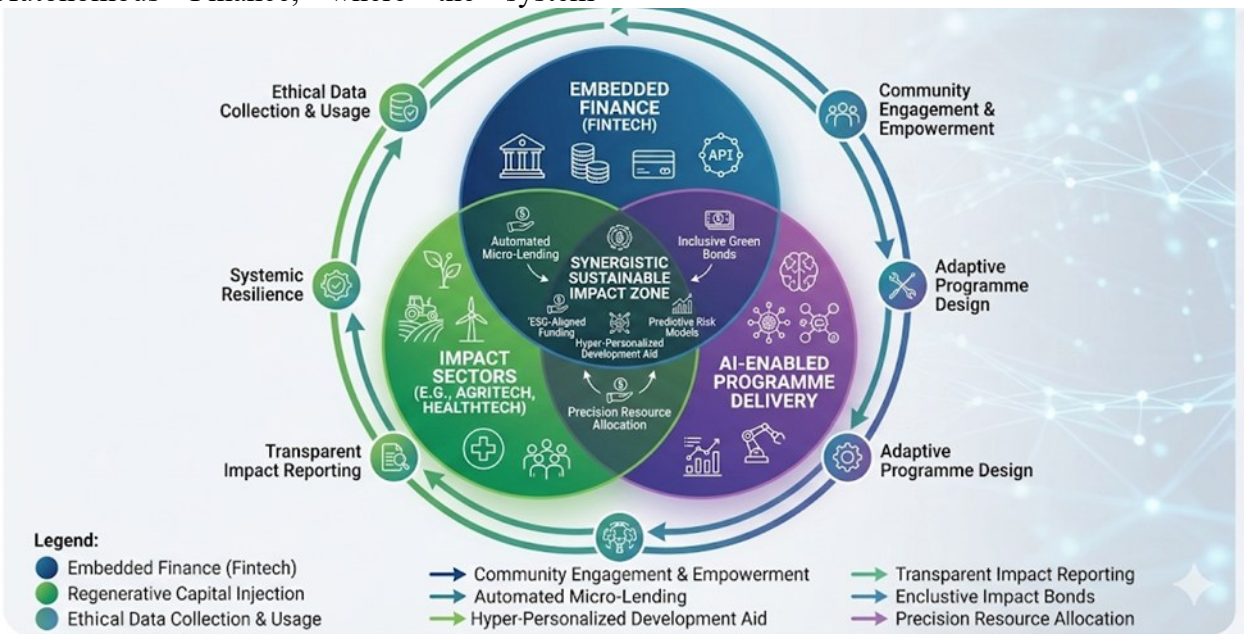

Fig. 3: ***Cross-Sector Value Creation Flows (*****Wu & Yun, 2024*****)**

4. 0 Propositions

The conceptual framework is articulated through four core research propositions, which identify the cause and effect linkages of the technological integration and sustainable business outcomes. The central idea of this model is that the transition from traditional financial services to the embedded, AI-driven systems is one of the key sources of organizational resilience. The framework proposes that AI Automation Maturity (rule-based versus agentic) is a decisive mediator between non-financial platform data and the effectiveness of programme delivery (Wu and Yun, 2024). Besides, the model suggests that the moderators that are required are Regulatory Compliance and Ethical AI Governance, without which the positive impact of automation on social inclusion and ESG-oriented value flows can be diminished or even negative.

In accordance with Camilleri (2024), the structural model below illustrates these relationships in the form of a moderated mediation path, conceptually aligned with Partial Least Squares Structural Equation Modeling (PLS-SEM) logic. . The Core Engine of AI Automation in this conceptual direction has a positive impact on the relationship between the Embedded Finance (the Independent Variable) and Sustainable Outcomes (the Dependent Variable). The side panels represent the Boundary Conditions or moderators that determine the intensity and direction of these paths. Collectively, these propositions suggest that the success of the

modern programme management is not a simple result of applying new tools, but the management of the interaction of the data, intelligence and socio-ethical constraints.

Core Research Propositions

1. P1 (Direct Path): With the incorporation of embedded finance into a non-financial platform, the financial services of underserved groups will be significantly improve financial accessibility for underserved populations.
2. P2 (Mediation): The platform data is linked to offering inclusive, real-time financial products through AI-driven automation mechanisms (predictive analytics and autonomous agents).
3. P3 (Moderation): The extent to which Ethical Governance regulates the positive impact of AI automation on sustainable end results ought to be factored in; the more visible it is, the higher the trust-value loop.
4. P4 (Feedback Loop): Feedback mechanisms continuously improve
5. The AI core engine (already improved by the attainment of sustainable outcomes, being the measures of the circular economy) is an additional way of introducing regenerative capital.

5. 0 Discussion

The transition from traditional banking systems to AI-based environments is one of the key disconnections between financial services and the old institutions. The traditional finance has a destination-based model with a high overhead and strict credit scoring, which inherently restricts financial inclusion and scalability . Embedded finance (without AI) is a breaker of this by embedding services in non-financial platforms, such as insurance at a travel checkout; enhancing cost-effectiveness and coverage, respectively, corresponding to the findings of Adegbite (2025). Nonetheless, even in the absence of AI, these systems continue to be based on a fixed set of rules and simple thick file datasets, which may lack the complexity needed to create profound sustainability change or reach even the unbanked.

Enhancing social and environmental initiatives is a multiplier effect of the introduction of AI-driven embedded finance. Using machine learning to predict alternative data (e.g. utility payments or harvest cycles) significantly expands financial inclusion , and allows hyper-automated scalability. On the one hand, this model has the greatest sustainability effect due to the possibility of real-time monitoring of ESG and lending with a green goal, on the other hand, it simultaneously increases governance and ethical risks. The same is true of Okonkwo, *et al*., (2024). The black box characteristic of AI and the possible algorithmical bias presents a critical trade-off between enhanced effectiveness and the demand of more advanced digital regulation.

Comparative Analysis: Financial Ecosystems

To further interpret the implications of the proposed framework, a comparative evaluation of financial ecosystem models is presented. The radar chart below visualizes the performance of each model. Note how AI-driven systems expand multidimensional value creation performance across most dimensions, albeit with a higher risk profile.

Risk-Benefit Matrix: AI in Sustainable Finance

To navigate the "Risk Exposure" highlighted above, the following matrix categorizes AI applications by their potential impact on sustainability versus their inherent operational and ethical risks.

Table 1 summarizes the impact–risk assessment matrix categorizing AI applications in sustainable embedded finance according to their potential sustainability impact and operational risk exposure.

Embedded finance that is AI-based is an efficient sustainability device even though it is a complex socio-technical continuum. In the article of Juned and Usmani (2025), the immediately deployable applications represent the implementation "sweet spot of implementation with the least risk and the greatest impact i.e. automated ESG (Environmental, Social, and Governance) data collection at the point of sale. These tools provide the business with the ability to observe the carbon footprint of the transactions without creating significant change to the underlying financial risk. Ajuwon, *et al*., (2024) explain that the initiatives that are most impactful and risky are those that could offer microloans to green entrepreneurs who are not in the banking system utilizing AI; this is the initiative that has the highest chances of inclusion globally and the highest risk of uninformed black box exclusion.

Table 1: Impact / Risk Assessment Matrix

Impact / Risk	Low Risk	High Risk
High Impact	**The Sweet Spot:** Automated ESG reporting; energy-efficient transaction routing.	**Strategic Frontier:** Predictive credit for unbanked "green" SMEs; high bias risk but high social gain.
Low Impact	**Efficiency Gains:** Basic AI chatbots for sustainable product FAQs; low complexity.	**Avoidance Zone:** Over-engineered predictive models for minor metrics that consume excessive compute power.

(Juned & Usmani, 2025)

Such efficiency gains must be offset by operational risks in the implementation of a strategy. Akano, *et al*., (2024) also believed that even though AI can greatly decrease the cost of compliance monitoring of green bonds, the exposure to the risk is large when the non-traditional data is selected in the wrong direction by the AI model. A sustainable embedded financial system is intended to transform applications located in the high-risk "Strategic Frontier" to the low-risk "Sweet Spot" and with better data transparency and human-in-the-loop control (Namadi, 2023). This will ensure that the quest of scalability is not done at the expense of ethical integrity and socio-economic sustainability.

Risk-Benefit Matrix: AI in Sustainable Embedded Finance

The following matrix categorizes AI deployments based on their potential to drive sustainability goals versus their technical and ethical risk profiles.

Table 2 presents the sustainability AI quadrant matrix, classifying artificial intelligence deployments based on their contribution to sustainability outcomes and associated operational complexity.

Table 2: **The impact of artificial intelligence on the sustainability and operational efficiency of small and medium-scale businesses. Sustainability AI Quadrant Matrix**

Quadrant	Description	Key Examples
High Impact / Low Risk	The "Sweet Spot": High ROI with manageable ethical or financial exposure.	Automated ESG transaction tagging; energy-efficient cloud payment routing.

High Impact / High Risk	Strategic Frontier: Maximum potential for change but requires heavy governance.	Alternative credit scoring for the unbanked; autonomous "Green" portfolio rebalancing.
Low Impact / Low Risk	Efficiency Gains: Incremental improvements to existing processes.	AI chatbots for sustainable product FAQs; automated back-office "paperless" workflows.
Low Impact / High Risk	Avoidance Zone: High complexity or compute cost for minimal sustainability gain.	Over-engineered predictive models for minor office utility metrics; high-frequency "green" trading.

6.0 Conclusion

The evolution of management thought—from Taylor's Scientific Management emphasizing efficiency to contemporary contingency and human-centred perspectives—demonstrates a progressive shift toward flexibility and integrative organizational approaches. Examples from leading Nigerian organisations such as Interswitch and the Dangote Group illustrate that, *while classical management structures provide foundational organizational discipline*, it is the Systems and Behavioral theories that will help a company survive in the uncertain environment (Dare, 2022; Nosike and Ojobor, 2023). We no longer see the Nigerian worker as a factor of production; but rather, as the key engine of innovation in organizations. The development of these historical theories provides a powerful set of instruments to work in the peculiarities of the Ogas culture, the insufficiency of infrastructure, and the colorful informal economy that characterizes the Nigerian business environment.

In the future, the research agenda should shift to the new frontier of the Digital-Classical hybrid, which is a combination of efficiency found in Taylor and Artificial Intelligence. Future research should be done on the impact of Algorithmic Management on worker motivation in the Nigerian "gig economy" (e.g. Bolt or Chowdeck drivers) and how the Unity of Command as proposed by Fayol can persist in the age of decentralized autonomous organizations (DAOs). The world urgently needs the Indigenous Management Theory which officially records the effectiveness of Igbo Apprenticeship System (Igba-Boi) as a competitive model of human capital formation and risk management which can compete on the global scale (Okeke, *et al*., 2025). Researchers need to examine ways in which these indigenous arrangements can be updated to improve corporate governance in the emerging tech and manufacturing industries in Nigeria (Onoh, *et al*., 2023).

In order to visualize these transitions into the future, researchers ought to create simulation-based scenario charts, including AI Adoption Curves in Nigerian SMEs. The use of these what-if images would map how automation would affect the job positions, and anticipate where the Taylorist automation would actually take up the place of human labor, and where the Behavioral management would be even more essential in the process of human-machine interaction regulation. A brief outline of our trip to the digital future out of the industrial past is given below.

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Declaration

Consent for publication

Not Applicable

Availability of data and materials

The publisher has the right to make the data public

Conflict of Interest

The authors declared no conflict of interest

Ethical Considerations

Not applicable

Competing interest

The authors report no conflict or competing interest

Funding

The author declared no source of funding

Authors' Contributions

Emurode Williams conceptualized the study, developed the theoretical framework, and led the overall writing and coordination of the manuscript. Aniedi Ojo contributed to the literature review, conceptual development, and critical revision of the intellectual content. Deborah Warmate supported the development of the sustainability and business model analysis and participated in manuscript drafting and refinement. Chidinma Jonah contributed to the discussion, synthesis of cross-sector implications, and final editing of the manuscript. All authors reviewed, approved, and agreed to the final version of the manuscript.