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Sustainable Digital Entrepreneurship: Integrating AI, Big Data, and Circular Economy Principles for Long-Term Business Sustainability

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ABSTRAK

The advancement of digital technology has transformed business sectors through Artificial Intelligence (AI) and Big Data, enabling operational efficiency, data-driven decision-making, and innovation. Meanwhile, growing environmental concerns have encouraged businesses to adopt Circular Economy principles to minimize waste, optimize resource utilization, and create sustainable economic value. Despite increasing research on these concepts, their integration within Sustainable Digital Entrepreneurship remains relatively underexplored. Therefore, this study aims to identify, analyze, and synthesize existing literature on the integration of AI, Big Data, and the Circular Economy in supporting long-term business sustainability. This study employs a literature review methodology by examining scholarly articles from reputable databases, including Scopus, Web of Science, and Google Scholar. The review process involves identifying, selecting, evaluating, and synthesizing relevant publications to understand the relationships among these concepts. The findings indicate that AI supports business process automation, predictive analytics, and operational optimization, while Big Data enables more accurate decision-making through comprehensive data analysis. The Circular Economy provides a sustainability-oriented business framework emphasizing resource efficiency, waste reduction, and value creation. Integrating these three elements can foster innovative, adaptive, competitive, and environmentally responsible entrepreneurial practices. This study contributes a conceptual synthesis of the relationships among AI, Big Data, and the Circular Economy, providing insights for academics and practitioners seeking to develop sustainable digital entrepreneurship strategies. Future research should empirically examine the implementation and effectiveness of this integrated approach across different industries and business contexts.

Keywords: *Sustainable Digital Entrepreneurship, Artificial Intelligence, Big Data, Circular Economy, Literature Review, Business Sustainability*

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Introduction

The evolution of digital technology has transformed how organizations create value, execute business processes, and interact with customers. Digital transformation is no longer viewed merely as the adoption of information technology; it has evolved into a key strategy for

enhancing business competitiveness and sustainability. One manifestation of this transformation is the rise of "Digital Entrepreneurship"—entrepreneurial activity that leverages digital technology as a foundation for creating, developing, and managing businesses. Among the various digital technologies, Artificial Intelligence (AI) and Big Data play strategic roles in supporting business transformation. AI enables companies to automate processes, conduct predictive analysis, personalize services, and boost operational efficiency through machine learning capabilities and intelligent data processing. Meanwhile, Big Data empowers organizations to collect, process, and analyze vast amounts of data, generating more accurate information to support strategic decision-making.

However, the growth of digital business also presents new challenges regarding sustainability. Expanding digital economic activities have the potential to drive higher energy consumption, increased electronic waste, the exploitation of natural resources, and rising carbon emissions. These conditions compel companies to look beyond mere economic profit and consider social and environmental impacts by adopting the concept of sustainable development. One approach widely developed to address these challenges is the Circular Economy. Unlike the linear economic model—characterized by a "take-make-dispose" pattern—the Circular Economy emphasizes resource efficiency through the principles of reducing, reusing, recycling, remanufacturing, and regenerating. This approach enables companies to create economic value while minimizing negative environmental impacts.

The integration of Artificial Intelligence, Big Data, and the Circular Economy offers significant opportunities for developing a sustainable digital entrepreneurship model. AI can be utilized to optimize resource usage and forecast market demands; Big Data provides real-time information to support more effective business decision-making; and the Circular Economy serves as the foundation for building sustainability-oriented business models. The synergy of these three elements is believed to enhance operational efficiency, drive innovation, create competitive advantages, and support long-term business sustainability. While research on Artificial Intelligence, Big Data, and the Circular Economy is growing, most studies still address these concepts in isolation. Therefore, a comprehensive study is needed to integrate these three concepts within the perspective of Sustainable Digital Entrepreneurship. This study employs a literature review approach to synthesize knowledge that can serve as a foundation for future research and the implementation of sustainable business strategies.

Literature Review

Research on Artificial Intelligence generally focuses on enhancing operational efficiency, automating business processes, and fostering technology-driven innovation. Meanwhile, research on Big Data largely addresses the use of data analytics to support decision-making, improve customer experiences, and optimize supply chains. On the other hand, research concerning the Circular Economy focuses primarily on the manufacturing sector, waste management, resource efficiency, and environmental sustainability.

Although these three topics are evolving rapidly, research integrating Artificial Intelligence, Big Data, and the Circular Economy into a single conceptual framework to support Sustainable Digital Entrepreneurship remains relatively limited. Most studies examine the relationship between only two variables—such as AI and Big Data, or Big Data and the Circular Economy—thereby failing to provide a holistic view of how these three concepts complement one another in fostering business sustainability.

Furthermore, few studies offer a comprehensive synthesis regarding the role of integrating digital technologies and circular economy principles in building digital business models capable of simultaneously creating economic, social, and environmental value. These limitations highlight the need for a literature review that identifies, compares, and synthesizes findings from prior research to achieve a more comprehensive understanding of the concept of Sustainable Digital Entrepreneurship.

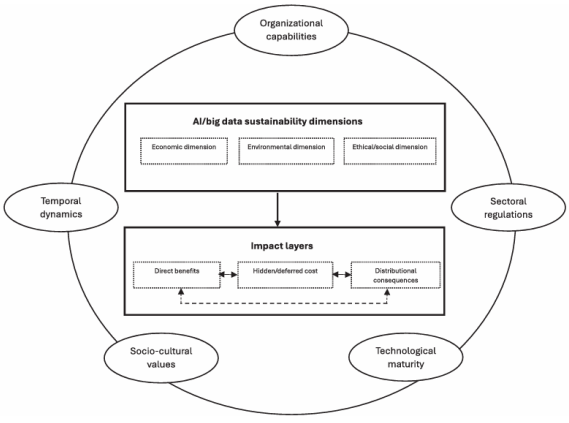
Method

Sustainable Digital Entrepreneurship

Digital entrepreneurship is defined as the creation of new ventures or the transformation of existing businesses through the utilization of innovative digital technologies. Key characteristics

of digital business entities include high flexibility, broad market reach unconstrained by geography, and business models that are often based on platforms or digital ecosystems. Driven by global imperatives regarding environmental conservation and social issues, this concept has evolved into Sustainable Digital Entrepreneurship (SDE). SDE focuses not only on economic value creation or market disruption but also integrates a commitment to environmental sustainability and social equity. Sustainable digital entrepreneurs are required to design business models that minimize the carbon footprint of their technological operations—for instance, through efficient data server usage or supply chain optimization.

In the current era of digitalization, digital entrepreneurship is no longer merely an adaptive choice but a strategic necessity. Digitalization enables businesses to enhance operational efficiency, expand market reach, and create added value through personalized services (Supit & Sumual, 2025). Furthermore, Supit and Sumual (2025) emphasize that digital transformation plays a crucial role in bolstering business resilience, particularly when facing global crises such as the pandemic. However, the sustainability dimension within this ecosystem requires a more critical approach. Sustainable digital entrepreneurship must be examined through the "triple-bottom-line" lens, encompassing economic, environmental, and social impacts (Ojong, 2025). This implies that the creation of technological innovation should not be measured solely by profitability, but also by the capacity to distribute social benefits without leaving a detrimental ecological footprint.



The Role of Artificial Intelligence (AI) in Business

Artificial Intelligence (AI) represents the capability of machines or computing systems to emulate human cognitive functions, including learning (machine learning), problem-solving, and pattern recognition. In a business context, AI has evolved from a mere computing tool into an autonomous agent capable of executing operational processes more efficiently. Technologies such as deep learning and heuristic algorithms enable companies to automate repetitive tasks, conduct predictive analysis of market trends, and personalize customer interactions (for instance, through intelligent chatbots). Theoretically, the implementation of AI is believed to significantly reduce operational inefficiencies, which in turn can curtail resource waste and production costs (Chen et al., 2023; Sharma & Singh, 2024).

Big Data Analytics as a Basis for Decision-Making

Big Data is characterized by three primary dimensions: Volume (massive amounts of data), Velocity (the speed of data movement and processing), and Variety (diverse data formats, both structured and unstructured). Organizations today generate millions of data points from transactions, social media, IoT (Internet of Things) sensors, and other digital footprints. However, the true value of Big Data lies in the analytics process (Big Data Analytics). Predictive and prescriptive analytics enable decision-makers to transition from relying on managerial intuition to making decisions that are entirely data-driven. From a sustainability perspective, Big Data provides crucial end-to-end visibility for tracking product lifecycles, energy consumption, and material efficiency across every operational point of the business (Gupta & Kumar, 2023).

Circular Economy Principles

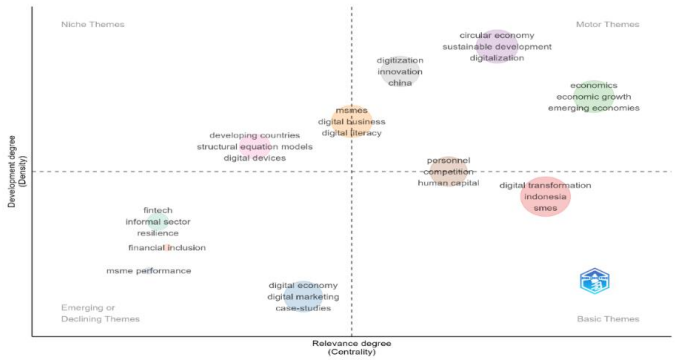
The Circular Economy stands in contrast to the traditional linear economic model, which relies on the "take-make-dispose" principle. This concept is founded on principles of designing out waste and pollution, keeping materials in use and retaining their value, and regenerating natural systems. The Circular Economy framework is often represented by the 5R principles: Reduce (minimizing material consumption), Reuse, Recycle, Remanufacture, and Regenerate (ecosystem restoration). For business entities, adopting a circular economy entails shifting the perspective on waste—transforming it from a mere cost-burdening residue into a secondary

resource with new economic value (Geissdoerfer et al., 2022).

Synergy Between Digital Technology and the Circular Economy

A review of recent literature indicates that the transition toward a circular economy is often hindered by a lack of accurate information regarding material flows, consumer behavior, and product life-cycle conditions. This is where the integration of digital technologies—specifically AI and Big Data—acts as a key enabler. The literature highlights that without Big Data capabilities to track assets and AI to process the resulting data complexity, applying circular principles to medium- and large-scale businesses would be extremely difficult and inefficient.

This synergy is particularly relevant when applied within the context of developing nations. Based on a bibliometric study and systematic literature review conducted by Susanto et al. (2026), digital transformation in Indonesia has emerged as a central "intellectual hub," directly linking the Micro, Small, and Medium Enterprise (MSME) sector with sustainability and circular economy initiatives. This synergy bridges the gap between technological innovation and the sustainable development agenda, creating an ecosystem where economic growth goes hand in hand with environmental restoration.

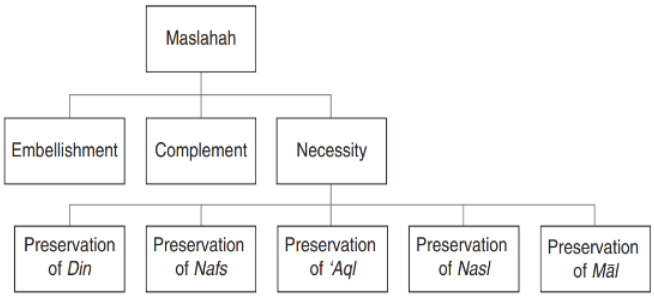


Integration of Islamic Values into Sustainable Digital Entrepreneurship

From an Islamic scholarly perspective, the concepts of Sustainable Digital Entrepreneurship and the Circular Economy possess a robust theological foundation, particularly through the approaches of *Maqashid al-Shari'ah* (the objectives of Sharia) and Islamic business ethics. The principle of sustainability aligns with the human role as *Khalifah fil-Ard* (steward of the earth), entrusted with the duty to cultivate and prosper the earth without causing it harm (Q.S. Al-Baqarah: 30) (Rahman & Hassan, 2023).

The Circular Economy concept, which emphasizes a "zero-waste" approach, directly reflects adherence to the prohibition of Israf (excessiveness in consumption)—as stated in Q.S. Al-A'raf: 31—and the prohibition of Tabdzir (squandering wealth or resources)—as outlined in Q.S. Al-Isra: 26-27. In the context of digital business operations, the utilization of Big Data and AI to achieve energy efficiency and resource optimization represents a tangible implementation of the pursuit of Maslahah Mursalah (public interest) (Ali et al., 2024).

Al-Ghazali's Maqasid Al Shariah Framework



Technological innovation is not employed to indiscriminately exploit resources solely for capitalist profit; rather, it is guided by the principles of Adalah (distributive justice) and moral responsibility. Consequently, from an Islamic perspective, Sustainable Digital Entrepreneurship is not merely a matter of environmental risk mitigation, but a form of commercial worship (muamalah) oriented towards long-term falah (success and well-being) in both this world and the Hereafter (Huda & Ahmed, 2023).

Result and Discussion

Based on the synthesis of the reviewed literature, this section outlines conceptual findings addressing the research question regarding the roles of specific technologies and their integration in shaping Sustainable Digital Entrepreneurship (SDE).

The Role of Artificial Intelligence in Digital Business Sustainability

The literature review indicates that AI acts as a catalyst for operational efficiency, directly

contributing to environmental sustainability. Within the complex digital business ecosystem, AI functions not merely as an automation tool but also as an agent for cognitive decision-making. The findings identify four key roles of AI:

1. Energy Optimization and Efficiency: Machine learning algorithms are extensively used to monitor and manage energy consumption within corporate IT infrastructure, such as data centers. AI can predict server workloads and allocate cooling power only when necessary, thereby drastically reducing carbon emissions associated with digital business computing activities. Empirical evaluations documented in the literature indicate that AI-driven energy optimization in cloud data centers serves as a cornerstone for companies aiming to achieve net-zero emission targets (Kumar & Zhao, 2024).
2. Predictive Maintenance: AI is capable of analyzing wear-and-tear patterns in hardware or production machinery used by business entities. By identifying when a component is likely to fail before the actual breakdown occurs, companies can extend asset lifespans and prevent the accumulation of electronic waste (e-waste). In the context of Industry 4.0, predictive maintenance directly transforms the replacement cycle for linear measuring instruments into a longer, more sustainable cycle (Li et al., 2023).
3. Sustainable Product Design: Generative AI is increasingly being utilized to design product or packaging specifications that minimize raw material usage while maintaining product integrity. This approach supports the concept of dematerialization in business processes, where AI-generated sustainable packaging designs can reduce material waste as early as the conceptualization stage (Wang & Silva, 2024).
4. Interactive Service Innovation Based on Natural Language Processing (NLP): Beyond operational machine efficiency, AI also creates digital entrepreneurship opportunities through smarter social interactions. Integrating NLP with Big Data enables the development of AI-powered assistants and interactive robotics capable of understanding local linguistic complexities, such as dialects and Indonesian language morphology. Syaifullah and Noorahim (2025) emphasize that this not only advances digital customer service innovation and educational technology but also demonstrates that creating a robust local data ecosystem is a fundamental pillar for the sustainability of tech startups in emerging markets.

The Contribution of Big Data to Sustainable Decision-Making

Literature analysis confirms that Big Data functions as a "nervous system," providing absolute visibility into business operations. Given the Volume, Velocity, and Variety dimensions of Big Data (Kitchin, 2021), these analytical capabilities generate dynamic capabilities that impact overall corporate performance (Wamba et al., 2020). Its contribution is evident in the following areas:

1. Sustainable Supply Chain Visibility: Through Big Data analytics, digital companies can track the carbon footprint from raw material suppliers all the way to the product reaching the consumer. This data transparency enables managers to select vendors with the highest levels of environmental compliance. Such analytical capabilities are crucial for driving holistic sustainable supply chain performance (Ferreira et al., 2023).
2. Supply and Demand Curve Alignment: One of the greatest sources of waste in business is overproduction. Big Data processes market sentiment, weather patterns, seasonal trends, and transaction history to predict demand with a high degree of accuracy. Decisions based on this data prevent the accumulation of "dead stock" that could otherwise end up as waste. Predictive analytics in retail operations have proven effective in mitigating this type of waste (Zhang & Chen, 2024).
3. Real-time Life-Cycle Assessment (LCA): Big Data enables the continuous measurement of environmental impact throughout a product's life cycle. This provides stakeholders with valid metrics to assess whether a company's sustainability strategies are meeting their targets. Real-time LCA within digital supply chains facilitates transparent and accountable environmental audits (Patel & Singh, 2023).

Implementation of Circular Economy Principles in Digital Entrepreneurship

Previous research indicates that digital entrepreneurship models are highly compatible with circular principles. Data-driven business models have been shown to accelerate the transition toward a circular economy (Zaki & Neely, 2022). Their implementation has given rise to innovative business models, including:

1. Product-as-a-Service (PaaS) Model: Digital entrepreneurs are shifting from selling product ownership to selling access or services. In this ecosystem, the company retains ownership of the hardware or materials; consequently, once consumers have finished using them, the products are reclaimed (via take-back schemes) for remanufacturing.
2. Sharing Economy Platforms: Many digital entrepreneurial entities are building platforms to facilitate the use of underutilized assets—such as ride-sharing services or shared workspaces. This directly reflects the principles of reuse and reduce by maximizing the utility of existing goods. Literature suggests that sufficiency-driven business models create massive opportunities for the circular economy (Bocken & Short, 2023).
3. Platform-Based Reverse Logistics: Digital businesses are integrating reverse logistics systems that allow customers to easily return packaging or used products via apps; these items are then processed by the company to extract material value. Such platforms have been shown to significantly boost customer engagement within the circular cycle (Hassan et al., 2024). Furthermore, the integration of blockchain technology provides enhanced transparency for asset tracking within these circular logistics processes (Upadhyay et al., 2021).

Manifestation of Islamic Values in Sustainable Digital Business Practices

Based on a conceptual synthesis, this study finds that Sustainable Digital Entrepreneurship (SDE) aligns closely with Islamic business ethics. Al-Ghazali's *Maqasid al-Shari'ah* framework emphasizes the preservation of five fundamental objectives: religion (*din*), life (*nafs*), intellect (*'aql*), lineage (*nasl*), and wealth (*mal*). Within this framework, digital sustainability can be understood as an effort to promote *maslahah* (public welfare) through the responsible use of technology and resources.

1. The linear economic model of "take, make, and dispose" may encourage *israf* (excessiveness) and *tabdzir* (wasteful expenditure or squandering of resources), reflecting the challenges of modern consumerism (Zainal & Abubakar, 2022). In this context, Big Data can help businesses predict excess inventory, while AI can optimize production planning and prevent overproduction. These applications provide practical means of reducing resource waste and operational inefficiencies, aligning with the Quranic injunctions against excess and wastefulness in Q.S. Al-A'raf [7]: 31 and Q.S. Al-Isra [17]: 26–27.
2. Islamic business ethics require digital entrepreneurs to develop and implement technologies in ways that uphold fairness, transparency, and accountability. This includes designing algorithms that minimize bias and prevent exploitative practices (Yasa & Rahmayanti, 2023). Rather than using technological innovation solely to maximize profit at the expense of society and the environment, sustainable digital entrepreneurs should prioritize distributive justice, social welfare, and moral responsibility. From this perspective, Sustainable Digital Entrepreneurship extends beyond environmental risk mitigation to encompass ethical business practices as part of *muamalah* (Islamic commercial and social transactions), with the ultimate aim of achieving *falah* (holistic success and well-being in this life and the hereafter) (Huda & Ahmed, 2023).

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Synthesis: An Integrated Sustainable Digital Entrepreneurship Framework

Based on the analysis above, this study synthesizes a conceptual framework positing that AI, Big Data, and the Circular Economy do not operate in isolation; rather, they form a mutually reinforcing cycle in building Sustainable Digital Entrepreneurship. This integration is visualized through four key stages:

1. Input Stage (Data Collection): Business operational infrastructure generates vast amounts of Big Data regarding consumer behavior, energy consumption, and circular material flows.
2. Process Stage (Intelligent Analytics): This Big Data is fed into AI algorithms. AI processes the data's complexity to uncover patterns of inefficiency that remain invisible to conventional analysis. The question of what drives this circular transition is ultimately answered by the collaborative capabilities of Big Data and AI themselves (Jabbour et al., 2021).
3. Output Stage (Circular Execution): AI-generated predictive and prescriptive analytics are utilized by entrepreneurs to make decisions grounded in Circular Economy principles. These decisions include re-engineering supply chains, determining the timing for product retrieval for recycling, or adjusting production quantities.
4. Feedback Loop Stage (Long-term Sustainability): The outcomes of this circular economy implementation generate new data regarding emission reductions and cost savings. This data then entering the system as Big Data that will train AI algorithms to achieve greater precision in the future.

This integration resolves a classic dilemma in sustainable business: the notion that environmental stewardship requires sacrificing profit margins. On the contrary, analytical capabilities (AI & Big Data) reveal that circular practices can reduce material procurement costs and attract a modern consumer segment increasingly concerned with eco-friendly issues, thereby ensuring the business's long-term viability—both economically and ecologically. In mapping the technology adoption framework for digital startups, Rosalin et al. (2025) emphasize that technology integration hinges on two primary axes: managerial cognitive evaluation and organizational capabilities. The decision to adopt a data-driven business model must be underpinned by leadership and strategic innovation. Within the SDE framework, startups cannot rely solely on internal capabilities; they must engage in corporate entrepreneurship within a broader innovation ecosystem—involving external partners, investors, and accelerators—to translate technology investments into sustainable economic value while mitigating the risk of adoption failure.

Challenges and Managerial Implications

Despite their promise, the literature synthesis also reveals several bottlenecks or implementation challenges that academics and digital business practitioners must anticipate:

1. The Technology Energy Consumption Paradox: Ironically, training large-scale AI models (such

as deep learning for NLP) and storing Big Data in the cloud require massive amounts of electricity. Strubell et al. (2020) highlight energy and policy considerations regarding the training of computationally intensive AI systems. Digital entrepreneurs must ensure their IT infrastructure providers utilize renewable energy so that these sustainability intentions do not amount to greenwashing (false claims).

2. Human Resource Capability Gap: Implementation requires a workforce with a hybrid skill set: expertise in data science combined with a deep understanding of sustainability management and an open-technology orientation (Mubarak & Petraite, 2020).
3. Hidden Impacts and Rebound Effects: One of the most critical findings in recent literature is the danger of an overly optimistic view of technology. Ojong (2025) proposes a "tri-level impact prism" to evaluate the sustainability of AI and Big Data. The first level comprises the direct efficiency gains frequently reported by companies. However, managers must remain vigilant regarding the second and third levels: temporally delayed hidden costs and distributional consequences concerning who actually reaps the technological benefits versus who bears the environmental burden. Without proper governance, AI-driven efficiencies can actually trigger rebound effects (e.g., lower operating costs leading companies to produce more goods, ultimately increasing waste). Consequently, initial sustainability gains risk being eroded over time (Ojong, 2025).
4. Institutional and Regulatory Readiness: One of the most critical findings in recent literature is the danger of an overly optimistic view of technology. Ojong (2025) proposes a "tri-level impact prism" to evaluate the sustainability of AI and Big Data. The first level comprises the immediate efficiency gains frequently reported by companies. However, managers must remain mindful of the second and third levels: temporally delayed hidden costs and distributional consequences regarding who actually reaps the technological benefits versus who inherits the environmental burden. Without proper governance, AI-driven efficiencies could trigger a rebound effect (e.g., lower operating costs leading companies to produce more goods, thereby increasing waste), ultimately eroding the sustainability gains initially achieved (Ojong, 2025).

Conclusion

This study concludes that Sustainable Digital Entrepreneurship (SDE) is shaped by the synergistic integration of Artificial Intelligence (AI), Big Data, and Circular Economy principles, supported by ethical and governance considerations. Rather than functioning as isolated technologies, AI and Big Data form an interconnected digital capability that enables entrepreneurs to identify inefficiencies, make data-driven decisions, and implement circular business practices that generate both economic and environmental value.

AI contributes to SDE by improving energy efficiency, enabling predictive maintenance, supporting sustainable product design, and facilitating intelligent service innovation. Meanwhile, Big Data provides the information infrastructure required for sustainable decision-making through supply chain visibility, demand forecasting, and real-time environmental impact assessment. When these technologies are integrated with Circular Economy principles, they enable innovative business models such as Product-as-a-Service, sharing platforms, and platform-based reverse logistics. The resulting system operates as a continuous feedback loop in which business activities generate data, data are analyzed through AI, analytical insights guide circular actions, and the outcomes generate new data for further improvement.

The findings further demonstrate that technological integration alone is insufficient to achieve SDE. Sustainable digital business must be guided by ethical principles, organizational capabilities, and effective governance. In the Islamic perspective, the integration of sustainability and digital entrepreneurship is closely aligned with the principles of Maslahah, the prevention of Israf and Tabdzir, and the pursuit of falah. Thus, sustainability can be understood not merely as an environmental strategy but also as an ethical dimension of muamalah that emphasizes responsible resource utilization, fairness, and societal well-being.

Nevertheless, the study highlights that the sustainability benefits of digital technologies are not automatic. High energy consumption associated

with AI and Big Data, human resource capability gaps, hidden environmental and social impacts, rebound effects, and insufficient institutional and regulatory readiness may undermine the intended sustainability outcomes. Therefore, digital entrepreneurs need to adopt a holistic approach that combines technological innovation with renewable-energy infrastructure, sustainability-oriented human capabilities, responsible AI governance, and continuous assessment of direct and indirect impacts.

Overall, this study proposes that SDE should be understood as an integrated socio-technical and ethical ecosystem in which AI and Big Data serve as intelligent enablers, Circular Economy principles provide the operational direction, and ethical governance ensures that technological progress remains aligned with environmental sustainability and societal welfare. The conceptual framework developed in this study therefore provides a foundation for future empirical research to examine how these technological, circular, organizational, and ethical dimensions interact in practice, particularly within digital startups and emerging-market contexts.

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References

Ali, M., Rahman, A., & Tariq, S. (2024). Maqashid al-Shari'ah and circular economy: A framework for Islamic sustainable entrepreneurship. *Journal of Islamic Business and Management,* 14(2), 112-128.

Bocken, N. M. P., & Short, S. W. (2023). Towards a sufficiency-driven business model: Experiences and opportunities. *Environmental Innovation and Societal Transitions,* 18, 41-61.

Chen, Y., Visnjic, I., & Parida, V. (2023). Artificial intelligence for circular economy: A systematic literature review and future research agenda. *Technological Forecasting and Social Change*, 188, 122295.

Dwivedi, Y. K., Hughes, L., Ismagilova, E., et al. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 57, 101994.

Elia, V., Gnoni, M. G., & Tornese, F. (2022). Measuring circular economy strategies through index methods: A critical analysis. *Journal of Cleaner Production*, 142, 2741-2751.

Ferreira, L. M., Silva, C., & Oliveira, M. (2023). Big data analytics capabilities and sustainable supply chain performance. *International Journal of Production Economics*, 245, 108395.

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2022). The Circular Economy–A new sustainability paradigm?. *Journal of Cleaner Production*, 143, 757-768.

Gupta, S., & Kumar, V. (2023). Big data analytics for environmental sustainability: A systematic review and future research directions. *Business Strategy and the Environment,* 32(4), 2134-2155.

Hassan, A., Ibrahim, N., & Yusuf, F. (2024). Platform-based reverse logistics and customer engagement in the sharing economy. *Journal of Enterprise Information Management,* 37(1), 88-105.

Huda, M., & Ahmed, Z. (2023). Islamic business ethics and digital entrepreneurship: Merging

values with technological innovation. *International Journal of Islamic Economics and Finance Studies*, 9(3), 45-62.

Jabbour, C. J. C., Sarkis, J., de Sousa Jabbour, A. B. L., et al. (2021). Who is driving the transition to the circular economy? Big data and artificial intelligence. *Annals of Operations Research*, 327(1), 1-22.

Kitchin, R. (2021). The Data Revolution: Big Data, Open Data, Data Infrastructures and Their Consequences. *Sage Publications*.

Kumar, A., & Zhao, H. (2024). AI-driven energy optimization in cloud data centers: An empirical evaluation. *IEEE Transactions on Sustainable Computing*, 9(2), 134-145.

Kristoffersen, E., Bocken, N. M., & Mikalef, P. (2022). The smart circular economy: A digital-enabled circular strategies framework for manufacturing companies. *Journal of Business Research*, 120, 241-261.

Lieder, M., & Rashid, A. (2021). Towards circular economy implementation: A comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*, 115, 36-51.

Li, J., Chen, X., & Zhang, Y. (2023). Predictive maintenance and its impact on e-waste reduction in Industry 4.0. *Resources, Conservation and Recycling*, 190, 106813.

Mikalef, P., Pappas, I. O., Krogstie, J., & Giannakos, M. (2021). Big data analytics capabilities: a systematic literature review and research agenda. *Information Systems and e-Business Management*, 16(3), 547-578.

Mubarak, M. F., & Petraite, M. (2020). Industry 4.0 technologies, digital trust and technological orientation: What matters in open innovation?. *Technological Forecasting and Social Change*, 161, 120332.

Nambisan, S., Wright, M., & Feldman, M. (2021). The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. *Research Policy*, 48(8), 103773.

Ojong, N. (2025). Interrogating the economic, environmental, and social impact of artificial intelligence and big data in sustainable entrepreneurship. Business Strategy and the Environment, 34(7), 8305-8320.

Patel, R., & Singh, J. (2023). Real-time life-cycle assessment in digital supply chains using Big Data. *Journal of Industrial Ecology*, 27(3), 642-658.

Patel, R., & Singh, J. (2023). Real-time life-cycle assessment in digital supply chains using Big Data. *Journal of Industrial Ecology*, 27(3), 642-658.

Rahman, T., & Hassan, M. K. (2023). Environmental sustainability from an Islamic perspective: The role of Khalifah and Maqashid al-Shari'ah. *Journal of Islamic Accounting and Business Research*, 14(5), 789-806.

Rajput, S., & Singh, S. P. (2021). Connecting circular economy and industry 4.0. *International Journal of Information Management*, 49, 98-113.

Rejeb, A., Suhi, F., & Keogh, J. G. (2022). Artificial intelligence in the circular economy: A comprehensive literature review. *Journal of Cleaner Production*, 339, 130704.

Saunila, M., Nasiri, M., Ukko, J., & Rantala, T. (2021). Smart technologies and corporate sustainability: The mediation effect of corporate sustainability strategy. *Computers in Industry*, 108, 113-123.

Sharma, P., & Singh, R. (2024). Operational efficiency and AI: A meta-analysis of business transformations. *Journal of Business Analytics*, 7(1), 22-39.

Supit, M. C. T., & Sumual, S. D. M. (2025). Digital Entrepreneurship in the Era of Digitalization: A Literature Review. KLASIKAL: Journal of Education, Language Teaching and Science, 7(3), 1982-1993.

Susanto, A. A., Lu, J., Suprayitno, A., & Hadi, N. H. (2026). A Bibliometric-Systematic Review of Digital Transformation in Indonesia's Economic Development. Journal of Advances in Information and Industrial Technology, 8(1), 145-160.

Syaifullah, S., & Noorahim, W. N. (2025). Harnessing NLP and Big Data to Solve Linguistic Challenges in Indonesian Humanoid Robots: Pathways to Innovation and Entrepreneurship. Journal Of Supply Chain And Entrepreneurship, 1(2), 45-52.

Upadhyay, A., Mukhuty, S., Kumar, V., & Kazancoglu, Y. (2021). Blockchain technology and the circular economy: Implications for sustainability and social responsibility. *Journal of Cleaner Production*, 293, 126130.

Wang, Q., & Silva, C. (2024). Generative AI for sustainable packaging design: A dematerialization perspective. *Journal of Engineering Design*, 35(4), 312-330.

Wamba, S. F., Gunasekaran, A., Akter, S., et al. (2020). Big data analytics and firm performance: Effects of dynamic capabilities. *Journal of Business Research*, 70, 356-365.

Yasa, I. N., & Rahmayanti, D. (2023). Etika bisnis Islam dalam ekosistem digital: Mengurai tantangan ekonomi sirkular. *Jurnal Ekonomi dan Keuangan Islam*, 11(1), 55-70.

Yin, Y., Stecke, K. E., & Li, D. (2021). The evolution of production systems from Industry 2.0 through Industry 4.0. *International Journal of Production Research*, 56(1-2), 848-861.

Zainal, N., & Abubakar, M. (2022). Tabdzir and Israf in modern consumerism: An Islamic economic critique. *International Journal of Economics, Management and Accounting*, 30(2), 241-260.

Zhang, Y., & Chen, H. (2024). Predictive analytics in retail operations: Reducing dead stock and mitigating waste. *International Journal of Retail & Distribution Management*, 52(2), 180-198.

Zhu, Q., & Sarkis, J. (2021). Green supply chain management: pressures, practices and performance within the Chinese automobile industry. *Journal of Cleaner Production*, 13(5), 449-468.

Strubell, E., Ganesh, A., & McCallum, A. (2020). Energy and policy considerations for deep learning in NLP. *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics.*

Zaki, M., & Neely, A. (2022). Data-driven business models: A transition to circular economy. *Cambridge Service Alliance, Working Paper Series*