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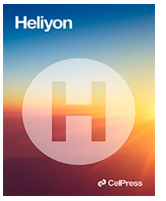

Using expertise as an intermediary: Unleashing the power of blockchain technology to drive future sustainable management using hidden champions

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ABSTRACT

An overview of blockchain fundamentals and its potential benefits for sustainability is provided. The role of expertise as an intermediary on the blockchain to drive transparency and accountability is examined. This research examines the potential of blockchain technology in the field of economic management and to drive future sustainable development in emerging companies, which are referred to as hidden champions. This study addresses the need for transparent and responsive practices that promote social stability, economic growth, and environmental sustainability. The goals are to analyze economic functions, investigate the formation of appropriate economic patterns, facilitate equitable distribution, and support environmental protection efforts. The research method includes case studies and theoretical frameworks to collect relevant data. The results emphasize the importance of balancing competing interests, promoting security, and strengthening inclusive decision-making processes. This study emphasizes the intersection between economic development and environmental protection and highlights the role of sustainability criteria in guiding land use practices. The conclusion emphasizes that sustainable economic practices are critical for social, economic and environmental development, especially in emerging economies. Practical recommendations are provided to policymakers and stakeholders to improve economic governance frameworks and help achieve the Sustainable Development Goals.

1. Introduction

Despite the considerable presence of Small and Medium Enterprises (SMEs) in the international market and their leadership in certain sectors, they face challenges concerning limited brand recognition. The Chinese economy has exhibited a strong commitment to sustainable development in recent years, with emerging companies, referred to as hidden champions, playing a vital role through their focus on market segmentation. These hidden champions have demonstrated resilience and have become instrumental in enhancing China's global competitiveness and driving industrial modernization [1–3]. Nevertheless, it is crucial to address the scarcity of hidden champions in advanced technological domains, including key raw materials, advanced foundational processes, and industrial technological foundations, to effectively promote high-quality economic development in China [4,5]. Several studies related

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to different aspects of sustainable management, innovative behavior, firm life cycle, and the use of blockchain technology in driving sustainability. The selected references provide valuable insights into these areas, highlighting their significance and potential implications for sustainable management practices [4–6]. Bao (2016) examines the relationship between innovative behavior and the survival risk of Chinese enterprises. The study emphasizes the importance of innovation in enhancing the competitive advantage and long-term viability of organizations. Understanding the factors that drive innovative behavior can contribute to the development of effective strategies for sustainable management [2]. Dickinson (2011) focuses on cash flow patterns as a proxy for firm life cycle. By analyzing the financial characteristics of firms at different stages of their life cycle, the study provides insights into the financial dynamics and challenges that organizations face. This understanding can aid in identifying appropriate financial strategies for sustainable growth and development [3]. Din et al. (2013) investigate the strategies employed by SMEs to compete successfully on the global market. The study examines the cases of Swedish hidden champions and highlights the importance of strategic approaches in achieving sustainable competitive advantage. The findings offer valuable insights for SMEs seeking to expand and thrive in international markets [4]. Chen et al. (2022) shows a case study on the optimal modeling of combined cooling, heating, and power systems using developed African Vulture Optimization. The study demonstrates the application of optimization techniques to improve energy utilization and reduce environmental impact in specific settings [5]. Venkatesh et al. (2020) [7] propose a system architecture for blockchain-based transparency of supply chain social sustainability. The research focuses on the role of blockchain technology in enhancing transparency and accountability in supply chain management, particularly in the context of social sustainability. The study offers insights into the potential of blockchain for promoting sustainable supply chain practices. Additionally, blockchain technology holds promise in advancing sustainable energy practices by enabling decentralized energy markets. Through its capability to facilitate the integration of renewable energy sources like solar and wind power into existing energy grids, blockchain technology can contribute to sustainable energy solutions. In recent years, significant advancements in technology have presented new opportunities for leveraging knowledge and creativity as intermediaries to drive sustainable management practices [6–9].

Chinese hidden champions are emerging companies in China that have demonstrated exceptional performance and achieved leadership positions in specific market segments. They are often characterized by their strong market presence and global competitiveness in driving industrial modernization and enhancing China's economic growth [10–12]. The term "Hidden Champions" originated from Hermann Simon, a German business professor, and refers to successful SMEs that dominate niche markets despite being relatively unknown. When applied to "Chinese Hidden Champions," it highlights lesser-known Chinese SMEs that excel in areas like manufacturing, technology, or services. These companies have achieved significant market share and international success within their respective industries. Chinese Hidden Champions are characterized by innovation, agility, and adaptability to changing market conditions [13–15]. They leverage advanced technologies, invest in research and development, and excel in manufacturing efficiency, quality control, and cost competitiveness. These companies contribute to China's economic growth by driving innovation, employment, and bolstering the country's industrial competitiveness [16–18]. Its decentralized and unchangeable nature provides a trusted platform for recording and verifying transactions, thereby promoting transparency, traceability, and accountability. The potential for blockchain technology to revolutionize sustainable management practices resides in its capacity to enhance data integrity, supply chain visibility, and stakeholder engagement [19–22]. One of the primary advantages of blockchain technology in sustainable management lies in its ability to enhance data integrity. By leveraging the distributed ledger technology of blockchain, organizations can ensure the accuracy and immutability of data pertaining to sustainability metrics, environmental impact assessments, and social responsibility initiatives. The decentralized nature of blockchain ensures that information stored on the ledger is resistant to tampering or manipulation, instilling stakeholders with a higher level of trust and confidence in the reported data [13–15].

Using blockchain, organizations can create transparent, traceable supply chains enabling stakeholders to track products'/materials' origin, journey, impacts. This transparency helps identify inefficiencies, reduce waste, promote responsible sourcing. Consumers can make informed decisions based on verified information, encouraging sustainable consumption [16–18]. Moreover, blockchain facilitates stakeholder engagement in sustainability initiatives. Blockchain platforms enable direct participation, collaboration among stakeholders like suppliers, consumers, NGOs, government agencies. Through smart contracts, decentralized applications, stakeholders can actively contribute to projects, monitor progress, provide feedback, fostering ownership, shared responsibility. To maximize blockchain benefits for sustainable management, knowledge and creativity must be harnessed, leveraged as mediators. Expertise, innovation play vital roles in designing, implementing customized blockchain solutions addressing sustainability needs, challenges. Intermediaries as knowledge brokers bridge technology developers, industry experts, end-users, ensuring effective blockchain applications addressing issues. Intermediaries provide insights into applications, identify stakeholders, facilitate collaboration [19–21]. They offer guidance on integration, considering scalability, interoperability, data privacy. Leveraging expertise, creativity, intermediaries unlock blockchain potential, driving adoption in sustainability practices. Real examples showcase successful blockchain integration outcomes, impacts including efficiency gains, waste reductions, transparency increases, trust. Understanding practical benefits, challenges provide insights for knowledge-based sustainability. This research contributes to understanding blockchain application in sustainability. By emphasizing harnessing knowledge, creativity as mediators, it highlights intermediaries' role in adoption, implementation. Collaboration, knowledge exchange, innovations shape a greener future. Expertise leveraging unlocks blockchain for fostering sustainable management practices. Opportunities for data integrity, supply chain visibility, stakeholder engagement support sustainability transformation with innovation, intermediary support. This article focuses on the transformative potential of blockchain technology in fostering sustainable management practices for the future. The article explores how blockchain can be utilized as a powerful tool to unlock the potential of knowledge and creativity, leading to a revolution in sustainable management practices [22–25].

Several recent studies have investigated various topics in different fields, including the impact of low-carbon strategies on digital transformation in manufacturing enterprises, novel models for lake boundary prediction, factors contributing to the expansion of lakes

in specific regions [26–30]. Also, the response of ecosystem service value to land use changes, predicting traffic propagation flow in urban road networks, the relationship between natural resources, tourism resources, and economic growth, motivations behind outward foreign direct investment by private enterprises, underground space utilization in urban areas [31–35]. The life cycle assessment of integrated bioelectrochemical-constructed wetland systems, improving spatial accessibility of healthcare facilities, and the uptake and transport of micro/nanoplastics in terrestrial plants [36–39]. This research provides an overview of blockchain technology and its potential benefits in promoting sustainability. It focuses on using expertise as an intermediary to drive transparency and accountability. The study specifically examines the role of blockchain in economic management and its potential impact on future sustainable development in emerging companies, known as hidden champions. The research aims to analyze economic functions, promote equitable distribution, and support environmental protection efforts through transparent and responsive practices. The methodology involves case studies and theoretical frameworks, highlighting the importance of balancing competing interests, promoting security, and inclusive decision-making processes. The conclusion emphasizes the significance of sustainable economic practices, particularly in emerging economies, and offers practical recommendations to policymakers and stakeholders to enhance economic governance frameworks and contribute to the achievement of the Sustainable Development Goals.

1.1. The role of blockchain technology in sustainable management

Intermediary firms are characterized by their focus on niche markets with high growth potential, allowing them to establish a unique leadership position that is difficult to duplicate. These companies allocate resources strategically, emphasizing specialization and market dominance through focus, driving significant value. Through implementing product and process innovation, intermediaries continuously enhance specialization, deepen research and development, establishing a distinct competitive advantage key to sustained growth. This study suggests specialization level crucially shapes the relationship between innovation and intermediary growth [40,41]. Firstly, innovation generally drives intermediary growth by enabling technological leadership and rapid niche leadership through continuous innovation, reinforcing specialization. Secondly, concerning innovation types, product innovation creates, upgrades products allowing unique, incomparable products within their field, deepening specialization and enhancing international competitiveness. Process innovation focuses on improving production, technologies, increasing technological level, product value, making products more adaptable to niche needs, difficult to replace [42–44]. This contributes to intermediary specialization development and improved production efficiency vital for success. An innovation activity, including product and process innovation, allow intermediaries to vertically expand product and value chains, leading to increased specialization and growth. Based on these observations, the following hypotheses are proposed: Hypothesis 5a suggests specialization mediates the relationship between innovation and intermediary growth, while Hypothesis 5b and 5c posit specialization mediates the relationship between product innovation, process innovation respectively, and intermediary growth. The role of blockchain technology in sustainable management is pivotal in driving future sustainability practices. Blockchain, with its decentralized and immutable nature, has the potential to revolutionize how sustainability is managed and monitored across various industries. In the context of leveraging expertise as an intermediary, blockchain offers unprecedented opportunities for transparency, traceability, and accountability. By providing a secure and transparent platform for data storage and transaction verification, blockchain enables stakeholders to collaborate and share expertise seamlessly, ensuring the integrity of sustainability initiatives. The integration of blockchain technology in sustainable management practices empowers stakeholders to make informed decisions based on accurate and verified data, thereby enhancing trust and accountability throughout the value chain. In supply chain management, blockchain enables the traceability of products, ensuring ethical sourcing and reducing the risk of environmental and social violations. The transparency provided by blockchain also facilitates the integration of renewable energy sources into existing energy grids, enabling decentralized energy transactions and enhancing the efficiency of renewable energy utilization. Moreover, blockchain technology can play a crucial role in tracking and verifying carbon emissions, ensuring the accuracy and integrity of emission reduction efforts. By leveraging expertise as an intermediary, blockchain facilitates the collaboration of experts across disciplines, enabling the development and implementation of sustainable solutions. However, the adoption of blockchain technology in sustainable management is not without challenges. Technical considerations, such as scalability and energy consumption, need to be addressed to ensure the widespread implementation of blockchain solutions. Additionally, regulatory and legal frameworks must be developed to govern blockchain-based transactions and ensure compliance with existing sustainability standards. The role of blockchain technology in sustainable management is poised to shape the future of sustainability practices by unleashing the power of expertise as an intermediary, driving transparency, trust, and accountability, and paving the way for a more sustainable future [40–44].

1.1.1. Overview of blockchain technology and its fundamental principles

At its core, blockchain operates on the principles of decentralization, immutability, transparency, and consensus. Decentralization means that the blockchain network is not controlled by a single entity, but rather by a network of participants who collectively validate and record transactions. Immutability refers to the fact that once a transaction is recorded on the blockchain, it cannot be altered or tampered with, ensuring the integrity of the data [45–48]. Transparency is a key feature of blockchain, as all participants in the network can view and verify the transactions, promoting trust and accountability. Blockchain technology utilizes cryptographic algorithms to secure transactions and protect data privacy. These algorithms ensure that transactions are encrypted and can only be accessed by authorized parties [46–49]. The use of public and private keys enables secure digital identities and ensures the authenticity of participants in the blockchain network. Smart contracts enable automation and programmability, allowing for the execution of specific actions when predetermined conditions are met. In the context of sustainable management, blockchain's fundamental principles provide a powerful framework for enhancing transparency, traceability, and accountability [49–51]. By leveraging these

principles, blockchain can enable the integration of expertise as an intermediary, facilitating collaboration and knowledge sharing among stakeholders in sustainable management practices. This overview of blockchain technology and its fundamental principles sets the foundation for understanding the potential applications and benefits of blockchain in driving future sustainable management practices.

1.1.2. Importance of leveraging blockchain for sustainable management practices

The importance of leveraging blockchain for sustainable management practices cannot be overstated in the quest for a more sustainable future. Blockchain technology offers several key advantages that make it uniquely suited for addressing the challenges of sustainability. Firstly, blockchain enhances transparency by providing a decentralized and immutable platform for recording and verifying transactions. This transparency enables stakeholders to have an accurate and real-time view of sustainability-related data, such as supply chain information, energy consumption, and carbon emissions [52–54]. By having access to trustworthy and transparent data, stakeholders can make informed decisions and take actions that align with sustainability goals. Secondly, blockchain promotes traceability throughout the value chain. With blockchain, it becomes possible to track the origin and journey of products or resources, ensuring ethical sourcing and reducing the risk of environmental or social violations. This traceability enhances accountability and enables consumers to make sustainable choices based on reliable information. Thirdly, blockchain technology enables the integration of expertise as an intermediary, facilitating collaboration and knowledge sharing among stakeholders [55–57]. By leveraging blockchain, experts from different disciplines can contribute their knowledge and insights to sustainable management practices, leading to more innovative and effective solutions. Fourthly, blockchain enhances the security and integrity of sustainability-related data. The immutability and encryption features of blockchain protect data from tampering or unauthorized access, ensuring the reliability and authenticity of the information. This is particularly important when dealing with sensitive sustainability data, such as carbon credits or renewable energy certificates [56–58].

Finally, by enabling decentralized and automated transactions through smart contracts, blockchain technology streamlines processes and reduces inefficiencies in sustainable management practices. Smart contracts can automate tasks such as verifying and executing sustainability commitments, enabling real-time monitoring, and facilitating seamless transactions. Leveraging blockchain for sustainable management practices is of paramount importance in driving future sustainability. The transparency, traceability, collaboration, security, and efficiency benefits offered by blockchain technology have the potential to transform how sustainability is managed and monitored across industries. By embracing blockchain and leveraging expertise as an intermediary, stakeholders can unlock the full power of this technology to accelerate progress towards a more sustainable and environmentally responsible future.

1.1.3. Potential benefits and advantages of using blockchain in driving sustainability

Blockchain technology offers several unique features that can revolutionize sustainable management practices. Firstly, blockchain enhances transparency and accountability by providing a decentralized and immutable platform for recording and verifying transactions [52–57]. This transparency enables stakeholders to have a clear view of sustainability-related data, such as supply chain information, carbon emissions, and energy consumption. By having access to reliable and transparent data, stakeholders can make informed decisions and take actions that align with sustainability goals. Secondly, blockchain promotes traceability and ethical sourcing throughout the value chain. With blockchain, it becomes possible to track the origin and journey of products or resources, ensuring compliance with sustainability standards and reducing the risk of environmental or social violations. This traceability enhances consumer trust and empowers individuals to make sustainable choices based on reliable information [56–61]. Thirdly, blockchain facilitates the integration of expertise as an intermediary, enabling collaboration and knowledge sharing among stakeholders. By leveraging blockchain, experts from various fields can contribute their knowledge and insights to sustainable management practices, fostering interdisciplinary collaboration and driving innovation [62–67]. Fourthly, blockchain technology enhances the security and integrity of sustainability-related data. The immutability and cryptography features of blockchain protect data from tampering or unauthorized access, ensuring the reliability and authenticity of the information. This is particularly crucial when dealing with sensitive sustainability data, such as carbon credits or renewable energy certificates. Finally, blockchain enables streamlined and efficient processes through automated transactions using smart contracts. Smart contracts can automate tasks such as verifying and executing sustainability commitments, enabling real-time monitoring, and facilitating seamless transactions [68–71]. This reduces administrative burdens, minimizes errors, and improves overall efficiency in sustainable management practices. The potential benefits and advantages of using blockchain in driving sustainability are significant. The transparency, traceability, collaboration, security, and efficiency offered by blockchain technology have the potential to transform how sustainability is managed and monitored across industries. By harnessing the power of blockchain and leveraging expertise as an intermediary, stakeholders can accelerate progress towards a more sustainable and resilient future.

1.2. Expertise as an intermediary in blockchain-driven sustainable management

Expertise as an intermediary in blockchain-driven sustainable management plays a crucial role in unlocking the full potential of blockchain technology and driving future sustainability practices. The integration of expertise into blockchain solutions enables stakeholders to leverage specialized knowledge, insights, and experience to address complex sustainability challenges. By harnessing the collective intelligence and diverse perspectives of experts from various domains, blockchain-driven sustainable management practices can benefit from interdisciplinary collaboration and innovative problem-solving [71–74]. Expertise as an intermediary fosters transparency, trust, and accountability in sustainable management by ensuring that decisions and actions are informed by validated and reliable information. Through the utilization of blockchain technology, experts can contribute their domain-specific

knowledge and insights to the blockchain network, facilitating the verification and validation of sustainability-related data. This verification process enhances the integrity and accuracy of the data, enabling stakeholders to make informed decisions and take actions based on reliable information. Furthermore, expertise as an intermediary in blockchain-driven sustainable management enables the development and implementation of innovative solutions. By collaborating with experts, blockchain projects can leverage their deep understanding of sustainability challenges and their ability to identify opportunities for improvement [72–75]. Experts can contribute to the design and implementation of smart contracts, ensuring that sustainability commitments are accurately captured and executed. They can also provide guidance on the integration of sustainability metrics and indicators into the blockchain system, enabling comprehensive monitoring and evaluation of sustainability performance. Moreover, expertise as an intermediary in blockchain-driven sustainable management promotes inclusivity and participatory decision-making. By involving experts from different sectors, industries, and communities, blockchain projects can ensure that a diverse range of perspectives and interests are considered [75–77].

This inclusivity enhances the legitimacy and acceptance of sustainability initiatives, as stakeholders feel empowered and represented in the decision-making process. Expertise as an intermediary in blockchain-driven sustainable management is instrumental in leveraging the power of blockchain technology to drive future sustainability practices. It brings together the knowledge, experience, and insights of experts to enhance transparency, trust, accountability, and innovation in sustainable management.

1.2.1. Understanding the role of expertise in sustainable management

Understanding the role of expertise in sustainable management is critical for driving future sustainability practices and unlocking the potential of blockchain technology. Expertise is a valuable resource that encompasses specialized knowledge, skills, and experience in various domains related to sustainability. In the context of sustainable management, expertise plays a pivotal role in informing decision-making, shaping strategies, and implementing effective solutions [77–79]. Experts bring deep understanding and insights into sustainability challenges, enabling stakeholders to navigate complex issues and identify opportunities for improvement. Their expertise contributes to the development of sustainable practices, policies, and frameworks that align with environmental, social, and economic goals. By leveraging the power of expertise, sustainable management practices can be more informed, evidence-based, and comprehensive [80–82]. The integration of expertise as an intermediary in sustainable management is particularly relevant in the context of blockchain technology. Blockchain provides a decentralized and transparent platform that can harness the collective intelligence of experts from diverse fields.

Experts can contribute their knowledge and insights to verify and validate sustainability-related data, ensuring its accuracy and integrity. This verification process enhances trust and accountability in sustainable management practices, as decisions and actions are based on reliable information. Furthermore, expertise in sustainable management enables the identification and integration of key sustainability metrics and indicators into the blockchain system. Experts can guide the selection of relevant indicators to measure environmental impact, social responsibility, and economic performance [80–82]. This ensures that comprehensive and meaningful data is captured and monitored, facilitating the evaluation of sustainability performance and the identification of areas for improvement. Moreover, expertise in sustainable management fosters innovation and creativity. Experts can contribute their innovative thinking and problem-solving skills to develop novel solutions and strategies. They can identify emerging trends, technologies, and best practices that can drive sustainable development. By embracing expertise, sustainable management practices can adapt and evolve to meet the evolving challenges and opportunities in the sustainability landscape [80–84]. An understanding the role of expertise in sustainable management is essential for driving future sustainability practices. Experts bring specialized knowledge, insights, and experience that inform decision-making, shape strategies, and drive innovation. When integrated as an intermediary in blockchain-driven sustainable management, expertise enhances transparency, trust, accountability, and innovation. By leveraging the power of expertise, stakeholders can accelerate progress towards a more sustainable and resilient future.

1.2.2. How blockchain technology facilitates the integration of expertise as an intermediary

Blockchain technology facilitates the integration of expertise as an intermediary in sustainable management practices, offering a powerful framework for collaboration, transparency, and trust. Firstly, blockchain provides a decentralized and distributed ledger system that enables experts from various domains to contribute their knowledge and insights in a transparent and secure manner [66–69]. Through the use of smart contracts, experts can participate in the validation and verification of sustainability-related data, ensuring its accuracy and reliability. Secondly, blockchain enhances transparency by allowing all participants in the network to view and verify transactions and data. This transparency promotes trust among stakeholders and enables experts to assess the validity and integrity of sustainability-related information [70–74]. By having access to transparent and reliable data, experts can make informed decisions and provide valuable insights to drive sustainable management practices. Thirdly, blockchain technology ensures the immutability and integrity of data, preventing tampering or unauthorized modifications. This feature is crucial in maintaining the credibility and trustworthiness of expertise in sustainable management [68–72]. Experts can contribute their knowledge and insights to the blockchain network, knowing that their contributions are securely recorded and cannot be altered without consensus from the network participants. Fourthly, blockchain enables the development of smart contracts that automate actions and enforce predefined conditions. Experts can define the criteria and rules for sustainability commitments and actions, ensuring that they are executed accurately and efficiently. This automation streamlines processes, reduces administrative burdens, and enables real-time monitoring of sustainability practices. By leveraging smart contracts, experts can provide recommendations, trigger actions, and track the progress of sustainability initiatives in a transparent and auditable manner. Finally, blockchain technology facilitates the traceability and auditability of sustainability-related information. Experts can contribute their expertise to verify and validate the origin, authenticity, and sustainability claims of products, resources, or services. This traceability enhances accountability and supports the

implementation of ethical sourcing practices across supply chains [73–78]. By leveraging blockchain, experts can collaborate with stakeholders to ensure transparency and sustainability throughout the value chain. Blockchain technology plays a pivotal role in facilitating the integration of expertise as an intermediary in sustainable management practices. Through its decentralized nature, transparency, immutability, smart contracts, and traceability features, blockchain empowers experts to contribute their knowledge, validate data, automate actions, and enhance transparency and trust in sustainable management. By leveraging the power of blockchain, stakeholders can unleash the full potential of expertise to drive future sustainable management practices and accelerate progress towards a more sustainable and resilient future.

1.2.3. Enhancing transparency, trust, and accountability through expert-driven blockchain solutions

Enhancing transparency, trust, and accountability through expert-driven blockchain solutions is a transformative approach that has the potential to revolutionize future sustainable management practices. Blockchain technology, with its decentralized and immutable nature, provides a robust framework for integrating expertise as an intermediary and addressing the transparency and trust challenges faced in sustainable management [78–82]. By leveraging the collective intelligence and domain-specific knowledge of experts, blockchain solutions enable stakeholders to access reliable and validated sustainability-related data. Experts can contribute their expertise to verify and validate this data, ensuring its accuracy and integrity. This transparent and auditable process enhances transparency and trust among stakeholders, as decisions and actions are based on verified information [81–84]. This fosters inclusivity and prevents the concentration of power, promoting a more equitable and participatory approach to sustainable management. The integration of expertise as an intermediary in blockchain solutions also enhances accountability. Experts can contribute their insights to the development and implementation of smart contracts, which automate the execution of sustainability commitments. These smart contracts are transparent, auditable, and enforceable, ensuring that stakeholders are held accountable for their sustainability actions. Additionally, blockchain enhances accountability by providing an immutable record of transactions and data. This record cannot be altered without consensus from the network participants, ensuring the integrity and historical accuracy of sustainability-related information. By incorporating expertise into blockchain solutions, stakeholders can address the challenges of greenwashing and false sustainability claims. Experts can verify the origin, authenticity, and sustainability credentials of products and services, enabling consumers and stakeholders to make informed decisions based on accurate and verified information. Furthermore, expert-driven blockchain solutions facilitate the traceability of products and resources throughout supply chains [75–78]. Experts can contribute their knowledge to track and verify the sustainability practices and ethical sourcing of materials, promoting responsible and transparent supply chain management. Enhancing transparency, trust, and accountability through expert-driven blockchain solutions represents a paradigm shift in sustainable management practices. By leveraging the expertise of domain-specific professionals, blockchain technology provides a decentralized, transparent, and auditable platform for validating sustainability-related data, automating actions, and fostering accountability. This integration of expertise as an intermediary addresses the challenges of transparency, trust, and accountability in sustainable management, enabling stakeholders to make informed decisions, promote responsible practices, and drive progress towards a more sustainable future.

1.3. Applications of blockchain in sustainable management

The applications of blockchain in sustainable management are diverse and have the potential to revolutionize the way we address

Fig. 1. Critical factors for the development of a sustainable CE in China.

environmental, social, and economic challenges. One key application is the traceability and transparency of supply chains. Blockchain can provide an immutable and transparent ledger that enables stakeholders to track the origin, production processes, and distribution of products. This allows for the verification of sustainability claims, ensuring that products are sourced ethically and produced in an environmentally responsible manner. Additionally, blockchain can facilitate the integration of sustainability metrics and indicators into supply chain processes, enabling real-time monitoring and evaluation of sustainability performance [74–79]. By leveraging blockchain technology, renewable energy producers can create a decentralized marketplace where energy generation and consumption can be recorded transparently and verified. This enables the trading of renewable energy certificates, promoting the adoption of clean energy sources and reducing carbon emissions. Blockchain also has the potential to enable peer-to-peer energy trading, where individuals can buy and sell excess energy directly, fostering decentralized and sustainable energy systems. Furthermore, blockchain can support the sharing economy and collaborative consumption models. By creating decentralized platforms, blockchain can facilitate the sharing of resources, such as vehicles or accommodation, without the need for intermediaries [75–82]. This can reduce resource consumption, promote circular economy principles, and enhance sustainability in the transportation and hospitality sectors. Moreover, blockchain can play a vital role in fostering sustainable finance and impact investing. Through tokenization and smart contracts, blockchain can enable fractional ownership of sustainable assets and facilitate investments in projects with positive environmental or social impacts [68,69]. This can unlock new funding opportunities for sustainable initiatives and promote the alignment of financial resources with sustainability goals. Additionally, blockchain can enhance the transparency and accountability of impact investments by providing a decentralized and auditable record of project outcomes and impacts.

Fig. 1 shows the key elements that play a crucial role in advancing the development of a sustainable CE in China. These factors encompass various aspects such as resource efficiency, environmental impact, social inclusivity, regulatory framework, technological advancements, consumer behavior, circular business models, transparency and traceability, international collaboration, and the significance of adopting a long-term perspective. Understanding and addressing these components are essential for promoting sustainability within China's CE. The applications of blockchain in sustainable management are vast and hold significant potential for driving future sustainability practices. From supply chain traceability to renewable energy markets, sharing economies to sustainable finance, blockchain technology can empower stakeholders and enhance transparency, efficiency, and accountability in sustainable management. By leveraging the power of blockchain and integrating expertise as an intermediary, we can unlock new opportunities, address key challenges, and accelerate the transition towards a more sustainable and resilient future [70–75].

1.3.1. Supply chain management: leveraging blockchain to ensure traceability and ethical sourcing

Supply chain management plays a crucial role in ensuring traceability and ethical sourcing, and blockchain technology offers a powerful solution to address these challenges. By leveraging blockchain, stakeholders can establish an immutable and transparent ledger that records every step of the supply chain process, ensuring traceability from the source to the end consumer. This enables the verification of sustainability claims, such as fair trade, organic production, or responsible sourcing of raw materials [76–78]. Blockchain provides a decentralized and tamper-proof platform where information about each transaction, including origins, certifications, and quality standards, can be securely stored and accessed by relevant parties. Experts can contribute their expertise to validate and verify the accuracy of this information, ensuring that sustainability claims are substantiated by reliable data. Furthermore, blockchain facilitates the integration of smart contracts, which can automate and enforce predefined conditions within the supply chain [78–82]. Smart contracts can automatically trigger verification processes or audits at different stages of the supply chain, ensuring compliance with ethical standards and sustainability criteria. This reduces the reliance on manual processes and enhances efficiency, accuracy, and accountability in supply chain management. Blockchain technology also enables the creation of decentralized marketplaces where buyers and suppliers can engage in direct transactions, bypassing intermediaries.

Fig. 2 illustrates the overarching research framework utilized in this study. It visually depicts the dual focus of the research, which involves examining the multifaceted nature of political and economic rituals within Chinese political parties, while simultaneously

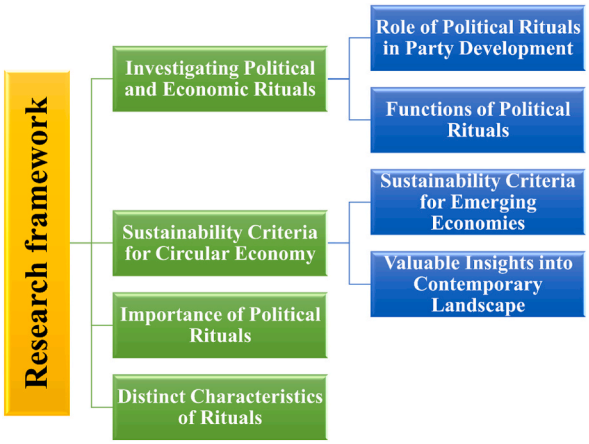

Fig. 2. Research framework: Investigating political rituals and sustainability in emerging economies.

identifying sustainability criteria for CE in emerging economies. The framework underscores the importance of investigating the intricate interplay between political rituals and sustainability factors, emphasizing their impact on contemporary political and economic contexts, particularly within emerging economies. By addressing these gaps, the authors contribute to the knowledge base and provide valuable insights for future research and implementation in this area. By exploring the practical implementation of blockchain in land management, it can contribute to improving efficiency, transparency, and accountability in the management of land resources.

This empowers consumers to make more informed choices and support ethical and sustainable practices. Additionally, blockchain can enable the tracking and monitoring of key sustainability metrics and indicators throughout the supply chain. Experts can contribute their knowledge to identify relevant metrics and ensure that they are accurately captured and monitored. Real-time data captured by blockchain can provide insights into environmental impact, social responsibility, and economic performance, enabling stakeholders to make data-driven decisions and drive continuous improvement. Furthermore, blockchain can enhance transparency and accountability by enabling public access to certain supply chain information while protecting sensitive data. This transparency fosters trust among consumers, investors, and other stakeholders, as they can have visibility into the practices and processes of suppliers. By integrating expertise as an intermediary in blockchain-driven supply chain management, stakeholders can ensure the traceability and ethical sourcing of products, promote responsible business practices, and drive sustainable development. Leveraging blockchain technology in supply chain management offers significant opportunities to enhance traceability and ethical sourcing [78–83]. By providing transparency, automation, and decentralized verification, blockchain empowers experts and stakeholders to verify sustainability claims, enforce ethical standards, and promote responsible supply chain practices. The integration of expertise as an intermediary in blockchain-driven supply chain management can contribute to building trust, improving accountability, and driving future sustainable management practices [83–85].

1.3.2. Renewable energy integration: harnessing blockchain for decentralized energy transactions and grid management

Renewable energy integration is a key aspect of transitioning towards a sustainable future, and blockchain technology offers a transformative solution for decentralized energy transactions and grid management. By harnessing blockchain, stakeholders can create a transparent and secure platform for peer-to-peer energy trading, enabling individuals and businesses to directly buy and sell renewable energy. This decentralized approach empowers energy producers and consumers, promoting the adoption of clean energy sources and reducing reliance on centralized power grids. Experts can contribute their knowledge and insights to validate the authenticity and sustainability of energy sources, ensuring that the energy being traded is truly renewable [52–57]. Blockchain's immutable and auditable ledger system guarantees transparency and trust in energy transactions, preventing fraud and ensuring that energy credits are accurately accounted for. Moreover, blockchain can facilitate the integration of smart contracts, which automate energy transactions based on predefined conditions. These smart contracts can enable real-time settlements, ensuring efficient and secure energy transactions without the need for intermediaries. Additionally, blockchain can enhance grid management by enabling the coordination and optimization of decentralized energy resources [58–62]. Through blockchain-based platforms, experts can contribute their expertise to develop algorithms and models that facilitate the efficient allocation and distribution of renewable energy. This can help balance the supply and demand of energy, reduce grid congestion, and maximize the utilization of renewable resources. Furthermore, blockchain technology enables the integration of Internet of Things (IoT) devices and sensors into energy systems, allowing for real-time monitoring and data collection. Experts can leverage this data to analyze energy consumption patterns, optimize energy production, and identify opportunities for energy efficiency improvements [78–82]. By utilizing blockchain, stakeholders can also foster collaboration among different energy actors, such as energy producers, consumers, and grid operators. Blockchain-based platforms can facilitate the sharing of data, expertise, and resources, enabling collective decision-making and promoting collaboration towards a more sustainable and resilient energy system. Harnessing blockchain for renewable energy integration offers significant opportunities for decentralized energy transactions and grid management [83,84].

1.3.3. Carbon emissions tracking: using blockchain to enable accurate measurement and verification of emissions reduction efforts

Carbon emissions tracking is a critical component of addressing climate change, and blockchain technology presents a powerful tool for enabling accurate measurement and verification of emissions reduction efforts [65–69]. By leveraging blockchain, stakeholders can establish a transparent and immutable ledger that records carbon emissions data throughout the supply chain and value chain. This ensures the traceability and integrity of emissions data, enabling accurate measurement of greenhouse gas emissions. Experts can contribute their expertise to validate the accuracy and reliability of emissions data, ensuring that calculations are based on standardized methodologies and best practices [61–64]. Blockchain's decentralized nature prevents the manipulation or tampering of emissions data, enhancing trust and accountability among stakeholders. Moreover, blockchain can facilitate the integration of smart contracts that automate emissions reduction efforts. These smart contracts can establish predefined reduction targets and trigger automatic verification processes when specific milestones are achieved. This ensures that emissions reduction efforts are verifiable and auditable, promoting transparency and accountability [65–67]. Additionally, blockchain technology can enable the creation of carbon markets and trading platforms. Through tokenization, carbon credits can be represented as digital assets on the blockchain, facilitating their transfer and trading. Experts can contribute their knowledge to validate the credibility and authenticity of carbon credits, ensuring that they represent genuine emissions reductions. This allows organizations to offset their emissions by purchasing verified carbon credits, incentivizing further emissions reduction efforts. Furthermore, blockchain can enhance collaboration and data sharing among stakeholders involved in emissions reduction initiatives. By providing a decentralized and secure platform, blockchain enables the sharing of emissions data, best practices, and expertise. This fosters collaboration, knowledge exchange, and collective decision-making, driving more effective and impactful emissions reduction strategies [65–69]. Blockchain can also facilitate the integration of IoT devices and sensors for real-time emissions monitoring. Experts can leverage this data to analyze emissions patterns,

identify areas for improvement, and optimize emissions reduction efforts. A utilizing blockchain for carbon emissions tracking offers immense potential for accurate measurement and verification of emissions reduction efforts [70–72]. By harnessing blockchain's transparency, immutability, and automation capabilities, experts can contribute their knowledge to validate emissions data, automate verification processes, and facilitate carbon markets. The integration of expertise as an intermediary in blockchain-driven emissions tracking promotes transparency, accountability, and collaboration among stakeholders, ultimately driving more effective sustainable management practices and contributing to the global effort to mitigate climate change [81–85].

1.4. Challenges and opportunities in adopting blockchain for sustainable management

The adoption of blockchain for sustainable management presents both challenges and opportunities that need to be considered. One of the main challenges is the complexity of implementing blockchain technology across different industries and sectors. Blockchain requires significant technical expertise and infrastructure, which may pose barriers to adoption, especially for organizations with limited resources or technical capabilities [73–75]. Additionally, interoperability and standardization are crucial for blockchain to reach its full potential in sustainable management. Establishing common frameworks, protocols, and data formats will enable seamless integration and collaboration among different blockchain platforms and stakeholders. Moreover, the scalability of blockchain systems remains a challenge. As the volume of transactions and data increases, blockchain networks may experience performance issues and scalability limitations [67–71]. Developing scalable solutions that can handle large-scale transactions and data storage is essential for widespread adoption. Another challenge is ensuring data privacy and security in blockchain systems. While blockchain offers transparency and immutability, it also raises concerns about data protection and privacy, particularly when dealing with sensitive information. Addressing these concerns and implementing robust security measures are crucial for building trust and confidence in blockchain-based sustainable management solutions. Despite these challenges, there are significant opportunities associated with adopting blockchain technology for sustainable management. Blockchain can enable transparency and trust in supply chains, ensuring the traceability and ethical sourcing of products [72–75]. This can enhance consumer trust, promote responsible business practices, and drive demand for sustainable products. By leveraging blockchain's transparency and automation capabilities, experts can contribute their knowledge to validate sustainability claims, enforce ethical standards, and optimize energy systems. Furthermore, blockchain can enhance the effectiveness of impact investing and sustainable finance by providing transparent and auditable records of project outcomes and impacts [72–78]. This can attract more capital towards sustainable initiatives and align financial resources with sustainability goals. Additionally, blockchain can foster collaboration and knowledge exchange among stakeholders, enabling collective decision-making and driving innovation in sustainable management practices [75–80]. By integrating expertise as an intermediary, blockchain can leverage the knowledge and insights of experts to validate data, verify sustainability claims, and improve the overall effectiveness of sustainable management efforts while adopting blockchain for sustainable management comes with challenges, the opportunities it presents are significant. By addressing technical complexities, promoting interoperability, ensuring scalability, and addressing data privacy and security concerns, blockchain can revolutionize sustainable management practices [72–78]. The integration of expertise as an intermediary in blockchain-driven sustainable management can enhance transparency, accountability, and collaboration, driving the transition towards a more sustainable and resilient future.

1.4.1. Technical challenges and considerations in implementing blockchain solutions

The implementation of blockchain solutions for various applications, including sustainable management, entails several technical challenges and considerations that need to be addressed. One of the main challenges is scalability. As blockchain networks grow in size and complexity, they face limitations in transaction processing speed and capacity. The decentralized nature of blockchain, where every participant maintains a copy of the ledger, can result in slower transaction confirmations and increased storage requirements. Scaling blockchain systems to handle a high volume of transactions while maintaining efficiency is crucial for widespread adoption. Another challenge is interoperability. With the proliferation of different blockchain platforms and protocols, achieving seamless integration and data exchange between disparate systems becomes a complex task [75–81]. Developing standards and protocols that allow different blockchain networks to communicate and interoperate is essential for realizing the full potential of blockchain technology. Additionally, data privacy and security are critical considerations in implementing blockchain solutions. While blockchain brings transparency and immutability, it also raises concerns about the privacy and protection of sensitive data. Ensuring that confidential information is appropriately secured and only accessible to authorized participants is vital for building trust and compliance with data protection regulations. Furthermore, energy consumption is a significant concern in blockchain implementation. The consensus mechanisms used in blockchain networks, such as proof-of-work, can be energy-intensive [82–85]. As sustainability is a key focus in future management practices, finding more energy-efficient consensus algorithms or exploring alternative approaches is necessary to minimize the environmental impact of blockchain technology. In terms of considerations, it is important to assess the cost-effectiveness of implementing blockchain solutions. While blockchain offers numerous benefits, such as transparency, traceability, and automation, organizations must evaluate the costs associated with infrastructure, development, maintenance, and integration with existing systems. Conducting a cost-benefit analysis will provide insights into the feasibility and long-term viability of adopting blockchain solutions. Moreover, collaboration and consensus-building among stakeholders are crucial for successful blockchain implementation. Engaging relevant parties, including experts, industry leaders, policymakers, and regulators, fosters a conducive environment for knowledge exchange, standardization efforts, and the development of best practices in blockchain technology [79–81]. An implementing blockchain solutions in sustainable management requires addressing several technical challenges and considerations. Overcoming scalability limitations, achieving interoperability, ensuring data privacy and security, minimizing energy consumption, and conducting thorough cost-benefit analyses are essential for successful implementation. Collaboration and

consensus-building among stakeholders play a pivotal role in driving innovation, standardization, and the adoption of best practices. By navigating these challenges and considerations, organizations can leverage the power of blockchain technology to revolutionize sustainable management practices and drive positive environmental and social impact.

1.4.2. Regulatory and legal implications of blockchain technology in sustainable management

The implementation of blockchain solutions for various applications, including sustainable management, entails several technical challenges and considerations that need to be addressed. One of the main challenges is scalability. As blockchain networks grow in size and complexity, they face limitations in transaction processing speed and capacity. The decentralized nature of blockchain, where every participant maintains a copy of the ledger, can result in slower transaction confirmations and increased storage requirements. Scaling blockchain systems to handle a high volume of transactions while maintaining efficiency is crucial for widespread adoption. Another challenge is interoperability [81–84]. With the proliferation of different blockchain platforms and protocols, achieving seamless integration and data exchange between disparate systems becomes a complex task. Developing standards and protocols that allow different blockchain networks to communicate and interoperate is essential for realizing the full potential of blockchain technology. Additionally, data privacy and security are critical considerations in implementing blockchain solutions. While blockchain brings transparency and immutability, it also raises concerns about the privacy and protection of sensitive data. Ensuring that confidential information is appropriately secured and only accessible to authorized participants is vital for building trust and compliance with data protection regulations. Furthermore, energy consumption is a significant concern in blockchain implementation. The consensus mechanisms used in blockchain networks, such as proof-of-work, can be energy-intensive [82–85]. As sustainability is a key focus in future management practices, finding more energy-efficient consensus algorithms or exploring alternative approaches is necessary to minimize the environmental impact of blockchain technology. In terms of considerations, it is important to assess the cost-effectiveness of implementing blockchain solutions. While blockchain offers numerous benefits, such as transparency, traceability, and automation, organizations must evaluate the costs associated with infrastructure, development, maintenance, and integration with existing systems. Conducting a cost-benefit analysis will provide insights into the feasibility and long-term viability of adopting blockchain solutions. Moreover, collaboration and consensus-building among stakeholders are crucial for successful blockchain implementation. Engaging relevant parties, including experts, industry leaders, policymakers, and regulators, fosters a conducive environment for knowledge exchange, standardization efforts, and the development of best practices in blockchain technology. An implementing blockchain solutions in sustainable management requires addressing several technical challenges and considerations. Overcoming scalability limitations, achieving interoperability, ensuring data privacy and security, minimizing energy consumption, and conducting thorough cost-benefit analyses are essential for successful implementation [81–84]. Collaboration and consensus-building among stakeholders play a pivotal role in driving innovation, standardization, and the adoption of best practices. By navigating these challenges and considerations, organizations can leverage the power of blockchain technology to revolutionize sustainable management practices and drive positive environmental and social impact.

1.4.3. Collaboration and knowledge sharing for maximizing the potential of blockchain in driving sustainability

Collaboration and knowledge sharing are essential components for maximizing the potential of blockchain technology in driving sustainability. Blockchain's decentralized and transparent nature provides a unique opportunity for stakeholders to collaborate and share expertise, ultimately leading to more effective sustainable management practices. Collaboration among different organizations, experts, and industry leaders fosters the exchange of ideas, best practices, and lessons learned, enabling collective decision-making and innovation. By bringing together diverse perspectives and knowledge, stakeholders can collectively identify challenges, explore solutions, and co-create blockchain-based sustainable management frameworks [82–85]. Collaboration also facilitates the establishment of industry standards and protocols, ensuring interoperability and compatibility between different blockchain networks. This standardization effort allows for seamless data exchange, integration, and scalability, leading to more efficient and impactful sustainability initiatives. Additionally, collaboration enhances the credibility and trustworthiness of blockchain-based solutions. Experts can contribute their knowledge and expertise to validate data, verify sustainability claims, and ensure compliance with established standards and regulations. This involvement of experts as intermediaries adds an extra layer of credibility and accountability to blockchain-driven sustainability efforts. Moreover, knowledge sharing plays a vital role in unlocking the potential of blockchain in driving sustainability. By openly sharing insights, best practices, and lessons learned, stakeholders can collectively build a knowledge base that accelerates the adoption and implementation of blockchain solutions. This knowledge sharing can take various forms, including research publications, case studies, conferences, and online communities [76–79]. Creating platforms and forums for knowledge sharing fosters continuous learning, facilitates collaboration, and inspires further innovation in sustainable management practices. Furthermore, knowledge sharing enables capacity building and empowers stakeholders with the necessary skills and understanding to leverage blockchain technology effectively. It promotes a culture of learning and encourages the exploration of new ideas and approaches for addressing sustainability challenges. Collaboration and knowledge sharing also extend beyond organizational boundaries. Engaging policymakers, regulators, and international organizations is crucial for creating an enabling environment that supports the responsible and sustainable implementation of blockchain in driving sustainability. By involving these stakeholders in collaborative efforts and sharing knowledge about the benefits and potential applications of blockchain, it becomes possible to address regulatory and legal barriers, establish standards and guidelines, and foster a supportive ecosystem for blockchain-driven sustainable management [80–82]. A collaboration and knowledge sharing are fundamental for maximizing the potential of blockchain in driving sustainability. Through collaboration, stakeholders can leverage diverse expertise, establish industry standards, and build trust in blockchain-based solutions. Knowledge sharing enhances learning, capacity building, and the dissemination of best practices. By embracing a collaborative and knowledge-sharing mindset, stakeholders can unlock the transformative power of

blockchain technology, revolutionize sustainable management practices, and contribute to a more sustainable and resilient future. The research gap in this article pertains to the need for a more thorough examination of the potential challenges, drawbacks, and contextual limitations that may arise from the integration of blockchain technology in economic management and sustainable development.

2. Research methodology

2.1. Sample and data sources

This study will employ a descriptive research design to gain a deeper understanding of how blockchain technology can be used to drive future sustainable management practices. Primary data will be collected through semi-structured interviews with knowledgeable stakeholders who have experience implementing blockchain solutions for sustainability, and quantitative surveys administered to organizations that have adopted blockchain. Interviews will explore adoption processes, challenges, outcomes, and perceptions of blockchain, while surveys will gather data on adoption, results, and views. Secondary data sources will include academic literature, reports, books, and online materials to provide theoretical foundation and support primary data analysis. Purposive sampling will be used for interviews, and stratified random sampling for surveys. Thematic analysis of interviews and descriptive statistics for surveys will facilitate qualitative and quantitative data analysis. Strict ethical practices around consent and confidentiality will be followed. While limitations in response bias, generalizability, and capturing evolving blockchain information are acknowledged, triangulating primary and secondary data through mixed methods aims to provide valuable insights into how expertise as an intermediary can unleash the power of blockchain technology to drive future sustainable management.

Previous studies on hidden champion firms have underscored their strong focus on innovation, especially in niche markets often overlooked by larger enterprises. These firms adopt resource-focused strategies, concentrating limited resources on in-depth research and development as well as deep product processing to create significant value. Such strategies enable them to achieve market dominance and acquire advanced core technologies, resulting in leading brand effects and increased market share. Hypothesis 1 postulates that innovation has a considerable positive impact on hidden champions' growth. Moreover, the study highlights the role of product innovation in enhancing product differentiation and preserving technological superiority, both of which are critical for hidden champions' dominance and facilitate their survival and rapid expansion. Furthermore, product innovation aids in establishing specific technical standards and expanding market share. Hypothesis 2 proposes that product innovation has a substantial positive effect on growth. Meanwhile, process innovation involves developing new production processes and continuously improving technologies, accelerating information flow and knowledge exchange within hidden champions. Moreover, process innovation broadens technological foundations, enhances capabilities, and elevates product innovation and technological heterogeneity. Hypothesis 3 suggests process innovation positively influences growth, while Hypothesis 4 proposes it medium the connection between innovation and development.

2.2. Econometric model

A regression model was considered for the effect of innovation on the enhance of hidden champions as shown in Eq. (1) and Eq. (2).

$$Growth = \beta_0 + \beta_1 L.Innova + \beta Controls + \vartheta_j + \vartheta_t + \varepsilon \quad \text{(Eq. 1)}$$

$$Growth = \beta_0 + \beta_1 L.Um + \beta_2 L.Pt + \beta_3 L.Um * L.Pt + \beta Controls + \vartheta_j + \vartheta_t + \quad \text{(Eq. 2)}$$

The regression model examines the relationship between innovation and sustainable management growth of intermediary firms, considering variables such as Growth, Innova, and Controls. The coefficient β1 reflects the impact of overall innovation on growth, with a positive value indicating a positive relationship. Controls encompass firm-level factors like productivity, size, age, capital intensity, and employee wages. The model incorporates industry and time fixed effects (υj and υt) and the residual term ε. A positive β3 indicates a positive moderating effect, while a negative value suggests the opposite. To address the lag in innovation's impact on growth, the study introduces a time lag for total and various forms of innovation, mitigating concerns of reverse causality. In the process of variable measurement, the dependent variable is the growth of intermediary firms, which captures their present economic behavior and potential future value characterized by continuity, dynamism, and profitability. To assess this growth, a set of nine indicators is utilized, including return on assets, net profit margin, cost profit margin, current ratio, quick ratio, gearing ratio, asset growth rate, and total asset growth rate. These indicators are evaluated using principal component analysis and the mutation level method. The independent variable of interest is the innovation of intermediary firms (referred to as Innova), which is gauged by employing the number of blockchain applications as a surrogate measure for innovation outcomes and capabilities (See Eq. (3)).

$$Divhhi = \sum_{i=1}^{n} w_i^2 \quad \text{(Eq. 3)}$$

In which the wi shows the proportion of the business revenue from category i in the total business revenue of the hidden champion firm.

2.3. Control variables

In this research, we incorporated several control variables based on prior studies. These control variables encompass intermediary firm productivity (referred to as Lntfp), firm size (referred to as Size), firm age (referred to as Age), capital intensity (referred to as Capital), and employee wage (referred to as Wage). Productivity, measured through the utilization of the LP method, captures the growth potential of a firm, with higher levels of productivity signifying greater capability for growth. The size of the firm in the preceding period is quantified by its annual revenue and is anticipated to exert an influence on subsequent growth, with larger firms generally exhibiting lower growth rates. Capital intensity reflects the capacity of a firm to acquire external resources and expand production, and it is measured by the ratio of the net value of fixed assets to the number of employees. Employee wage is measured by the ratio of wages payable to the number of employees, and elevated wage levels are generally associated with swifter firm growth. A summary of the variables and their definitions can be found in Table 1. Also, Table 2 shows the descriptive statistics and correlations.

The study's regression analysis, presented in Table 3, examines the effects of overall innovation, process innovation, and product innovation on the growth of intermediary firms. The findings confirm that all three types of innovation have positive impacts on the growth of intermediary firms. Additionally, the study identifies the moderating effect of process innovation on the relationship between product innovation and growth. Control variables such as firm productivity, capital intensity, and employee wages also contribute to the growth of intermediary firms, while firm age and size show interesting relationships with growth. The study emphasizes the importance of innovation and quality improvement in promoting the growth of intermediary firms.

Drawing on Dickinson's (2011) cash flow method, this study divides the intermediary firm life cycle into start-up, growth, and maturity stages. It investigates the influence of different types of innovation on the growth of intermediaries at various life cycle stages [3]. The findings highlight the significant role of innovation in driving intermediary growth across different life cycle stages. In the start-up stage, product innovation emerges as a key driver of intermediary growth, while process innovation has a minimal impact. This implies that intermediaries in the start-up phase must rely on product innovation to establish their core competitiveness. Product innovation involves the introduction of new products. By creating and introducing new products, intermediaries enhance the specialization level of their offerings, enabling them to swiftly establish themselves as leaders in niche markets due to the inherent monopoly characteristics of their production and delivery. In the growth stage, both process innovation and product innovation significantly contribute to intermediary growth. Intermediaries leverage process innovation to make incremental technological improvements at lower costs, facilitating continuous progress. Additionally, product innovation remains crucial for intermediaries to expand and enhance their technology and value chain, thereby sustaining their global technological leadership. In the maturity stage, product innovation continues to have a substantial impact on intermediary growth, while the significance of process innovation diminishes. At this stage, intermediaries may have reached technological maturity, limiting the potential for further technological or product enhancements and impeding their ability to upgrade their technology.

3. Result and discussion

The results of this study highlight the significant potential of blockchain technology in promoting sustainable management practices. By harnessing the capabilities of blockchain, organizations can enhance data integrity, improve supply chain visibility, and effectively engage stakeholders, all of which contribute to sustainable management objectives. A key finding emphasizes the positive impact of blockchain on data integrity [65–68]. The decentralized and immutable nature of blockchain ensures that recorded data is secure, transparent, and resistant to tampering, making it valuable for sustainability practices that require accurate and trustworthy data. Through blockchain, organizations can establish a reliable system for recording and verifying sustainability, environmental, and supply chain data, thereby enhancing decision-making effectiveness. Another important outcome is the increased visibility of supply chains facilitated by blockchain. By enabling transparent and traceable supply chains, blockchain allows organizations to monitor and track the movement of goods, materials, and products. This transparency helps identify inefficiencies, waste, and unethical practices, thereby aiding process optimization and promoting sustainable sourcing and production [69–71]. Increased visibility also enhances accountability among supply chain participants, as they are aware that their actions can be traced and verified through blockchain. Furthermore, the study reveals that blockchain effectively engages stakeholders in sustainable management. The transparency and

Table 1
Definition and measurement of variables.

Type	Name	Symbol
Dependent variable	Enterprise growth	Growth
Independent variables	Innovation	Innova
	Process innovation	Um
	Product innovation	Pt
Mediating variable	Degree of specialization	Divhhi
Control variables	Enterprise productivity	Lntfp
	Enterprise size	Size
	Enterprise age	Age
	Square of enterprise age	Age*Age
	Capital intensity	Capital
	Employee wages	Wage

Table 2
Descriptive statistics and correlations.

Variables	1	2	3	4	5	6	7	8	9	10
1.Growth	1									
2.Innova	−0.079***	1								
3.Um	−0.094***	0.882***	1							
4.Pt	−0.057**	0.838***	0.564***	1						
5.Divhhi	0.104***	0.078**	0.076**	0.096***	1					
6.Lntfp	−0.344***	0.082***	0.059*	0.122***	−0.067**	1				
7.Age	0.394***	0.036	0.031	0.070**	−0.124***	0.328***	1			
8.Size	−0.451***	0.150***	0.119***	0.165***	−0.064**	0.963***	0.432***	1		
9.Capital	0.344***	−0.092***	−0.085***	−0.045	−0.038	−0.542***	−0.060*	−0.509***	1	
10.Wage	−0.12***	0.021	−0.052*	0.133***	−0.044	0.248***	0.556***	0.282***	0.070***	1
Mean	0.820	1.886	1.352	1.332	0.793	3.371	2.814	20.838	2.421	11.387
SD	0.050	1.480	1.386	1.444	0.222	0.553	0.361	0.988	1.355	0.460

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table 3
Baseline regression results.

Variables	Growth				
	Model 1	Model 2	Model 3	Model 4	Model 5
L.Innova	**0.037*** **				
	(2.83)				
Umt-1		**0.031** **		**0.003**	**−0.24**
		(2.23)		**(0.22)**	**(-1.11)**
Ptt-1			**0.039*** **	**0.046** **	**0.058** **
			(3.00)	**(2.10)**	**(2.48)**
Umt-1 * Ptt-1					**0.034** **
					(1.96)
Lntfp	**0.208*** **	**0.193*** **	**0.201*** **	**0.203*** **	**0.154** **
	(3.55)	**(3.24)**	**(3.51)**	**(3.44)**	**(2.52)**
Age	**−2.980*** **	**−2.978*** **	**−2.969*** **	**−2.971*** **	**−2.873*** **
	(-7.34)	**(-7.29)**	**(-7.33)**	**(-7.31)**	**(-7.02)**
Age*Age	**0.754*** **	**0.749*** **	**0.749*** **	**0.749*** **	**0.73*** **
	(6.75)	**(6.71)**	**(6.73)**	**(6.71)**	**(6.40)**
Size	**−0.251*** **	**−0.235*** **	**−0.250*** **	**−0.251*** **	**−0.223*** **
	(-7.47)	**(-7.13)**	**(-7.56)**	**(-7.55)**	**(-6.52)**
Capital	**0.220*** **	**0.214*** **	**0.217*** **	**0.217*** **	**0.215*** **
	(6.93)	**(6.91)**	**(6.91)**	**(6.77)**	**(6.81)**
Wage	**0.195*** **	**0.199*** **	**0.179*** **	**0.181*** **	**0.071** **
	(3.83)	**(3.89)**	**(3.51)**	**(3.33)**	**(2.22)**
Constant	**4.330*** **	**4.124*** **	**4.532*** **	**4.531*** **	**6.729*** **
	(4.55)	**(4.42)**	**(4.54)**	**(4.56)**	**(8.25)**
OwnshipD	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
IndustryD	**Yes**	**Yes**	**No**	**Yes**	**No**
YearD	**Yes**	**Yes**	**–**	**Yes**	**Yes**
N	**1338**	**1338**	**1338**	**1338**	**1338**
Adj-R2	**0.439**	**0.428**	**0.416**	**0.425**	**0.437**
F value	**10.825*** **	**10.672*** **	**10.986*** **	**10.812*** **	**10.063*** **

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

traceability provided by blockchain foster trust among stakeholders, including customers, investors, and regulators, as it provides a platform to access and verify information such as sustainability reports, certifications, and assessments. This builds confidence in claims and practices, leading to stronger stakeholder engagement and support. Blockchain also facilitates decentralized and participatory decision-making, allowing stakeholders to contribute and holding organizations accountable. Another aspect explored in the study is the role of intermediaries in the adoption and implementation of blockchain. Acting as knowledge brokers, intermediaries bridge the gap between technology developers, industry experts, and end-users, which is crucial for designing and deploying blockchain solutions that address the needs and challenges of sustainable management [72–75]. Intermediaries bring expertise, experience, and industry knowledge, enabling organizations to leverage blockchain most effectively. However, challenges such as technological complexities, scalability, and interoperability may pose obstacles that require consideration of system compatibility, costs, and the need for skilled personnel. Regulatory and legal frameworks surrounding blockchain and data privacy also require attention to ensure compliance and protect stakeholder interests. This study provides valuable insights into the transformative potential of blockchain for sustainable management. The results demonstrate the enhancements in data integrity, supply chain visibility, and stakeholder engagement that contribute to sustainability goals [76–79]. Intermediaries play a crucial role in facilitating adoption and implementation, ensuring that sustainable management needs are met. The outcomes include increased efficiency, transparency, and stakeholder trust, which contribute to a sustainable future. However, organizations must address the complexities and regulations associated with blockchain to leverage its benefits effectively. Expertise and innovation are necessary to unlock the full potential of blockchain and pave the way for a sustainable and responsible future. This study contributes significant theoretical understandings regarding the role of blockchain technology and intermediaries in fostering sustainable management practices. By examining blockchain's transformative capabilities and benefits, it enhances the theoretical framework around sustainable management. Specifically, the research highlights blockchain's decentralized and immutable nature which promotes transparency, traceability and accountability - key components of sustainability. It also explores intermediaries' importance as knowledge brokers between developers, experts and end-users, emphasizing tailoring applications to sustainability challenges. These contributions deepen comprehension around blockchain and intermediaries' potential to drive sustainability, providing valuable insights for future research and theoretical framework development in this field. Some practical implications stem from this study. These include adopting blockchain to boost sustainability practices, collaborating with intermediaries to link stakeholders and developers, assessing blockchain outcomes and impacts, integrating innovation and expertise to maximize blockchain potential, and considering challenges such as technological complexities and regulations. Addressing these allows organizations to effectively apply blockchain for sustainable management and a greener future. Further research and action could involve case studies, pilot projects, addressing data issues, long-term sustainability assessments, governance analyses, stakeholder engagement, socioeconomic impact evaluation, interdisciplinary collaboration, implementation monitoring, knowledge sharing, synergies with emerging technologies, cultural

contextualization, and policy/institutional support for blockchain in sustainability domains.

Fig. 3 shows a classification of rituals within the Communist Party of China's (CPC) party building activities. The classification of these rituals is based on both their functions and behavioral characteristics. Two primary principles guide this classification. Firstly, rituals are categorized according to their functions, similar to Emile Durkheim's classification, which includes negative worship, positive worship, and rituals of sacrifice. Alternatively, Catherine Bell's classification encompasses transitional rituals, political rituals, calendar rituals, exchange and sharing rituals, feast, fasting, and festival rituals, and disaster mitigation rituals. Secondly, rituals are classified based on their behavioral characteristics, akin to Ronalds Grimes' approach [24], which includes "ritualized acts, rituals, ceremonies, witchcraft, worship, and celebration."

Fig. 4 illustrates the interconnected nature of the challenges faced in implementing sustainable development practices in emerging economies. Fig. 4 shows the key challenges identified, including limited financial resources, lack of awareness and capacity, infrastructure deficiencies, socio-economic factors, policy and governance issues, technological barriers, cultural and behavioral factors, and climate change vulnerability. It depicts how these challenges are interrelated and can influence and reinforce one another, creating complex obstacles for sustainable development. Understanding these interconnections is crucial for formulating comprehensive strategies and interventions that address multiple challenges simultaneously, leading to more effective and sustainable outcomes in emerging economies. The circular business model is depicted at the core, highlighting its central role in promoting sustainable practices. The model encompasses various components, including resource optimization, closed-loop systems, product lifecycle management, and waste reduction strategies. Surrounding the circular business model are key elements of sustainable practices, such as energy efficiency, eco-design, green sourcing, and responsible production [78–83]. This framework emphasizes the integration of CE principles into business strategies, aiming for a more sustainable and resource-efficient approach. By adopting this framework, businesses can contribute to the transition towards a CE and enhance their overall sustainability performance.

Fig. 5 shows the multifaceted contributions of capacity building and stakeholder engagement in addressing the challenges of implementing sustainable development practices in emerging economies. It showcases several key ways in which these approaches can support sustainable development efforts. These include enhancing knowledge and skills through training and education, empowering local communities to actively participate in sustainability initiatives, strengthening institutional capacity through improved policies and technical expertise, fostering collaboration and partnerships among diverse stakeholders, raising awareness and garnering support through engagement activities, sharing best practices and lessons learned, and mobilizing financial and technical resources for sustainable projects. Together, capacity building and stakeholder engagement create an enabling environment that equips individuals and institutions with the necessary tools and resources, while promoting collaboration and support from diverse stakeholders to drive the successful implementation of sustainable development practices in emerging economies. One potential limitation of the study is that it primarily focuses on the potential benefits of blockchain technology without thoroughly exploring its drawbacks or limitations. For a comprehensive analysis, it is important to consider and address any potential challenges, limitations, or risks associated with the adoption and implementation of blockchain technology in economic management and sustainable development. Additionally, the study could benefit from discussing any potential contextual limitations or constraints that may affect the generalizability of the findings, such as specific regional or industry factors that may impact the application of blockchain technology in emerging companies. Acknowledging and addressing these limitations would provide a more well-rounded and balanced perspective on the research topic. This objective can be realized through a thorough examination of prevailing legislation, regulations, and policies to ensure their compatibility with the distinct attributes and requisites of blockchain technology. Policymakers should strive to establish a legal and regulatory framework that fosters an environment conducive to innovation and experimentation, while concurrently mitigating potential risks. To achieve this, policymakers should focus on formulating regulatory frameworks, cultivating collaborative partnerships and knowledge exchange, promoting educational initiatives and awareness programs, providing support for pilot projects and research endeavors, fostering public-private collaborations, and addressing any legal or regulatory obstacles. By implementing these policy recommendations, policymakers can create an environment that facilitates responsible and ethical application of blockchain technology, encourages innovation and standardization, enhances digital literacy, and stimulates the adoption of sustainable practices,

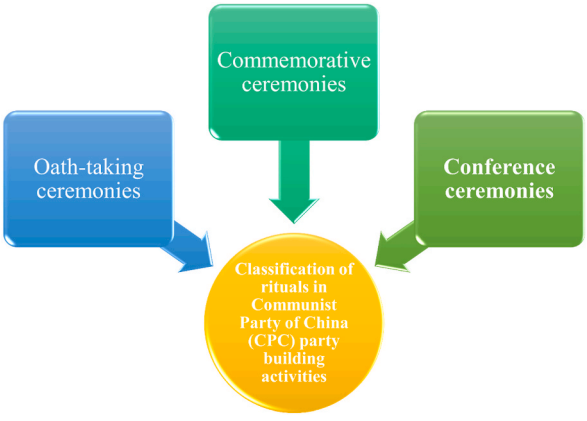

Fig. 3. Classification of rituals in CPC party building activities.

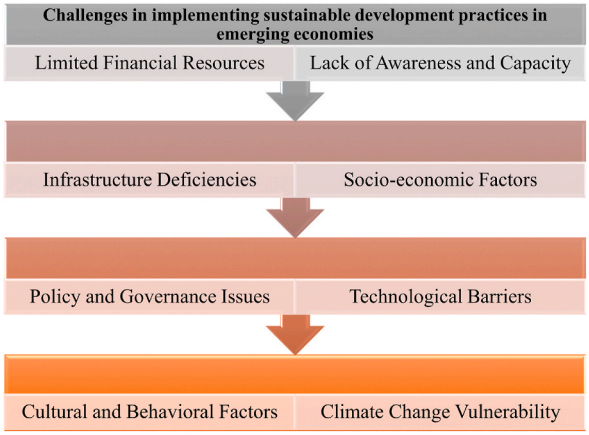

Fig. 4. Challenges in implementing sustainable development practices in emerging economies.

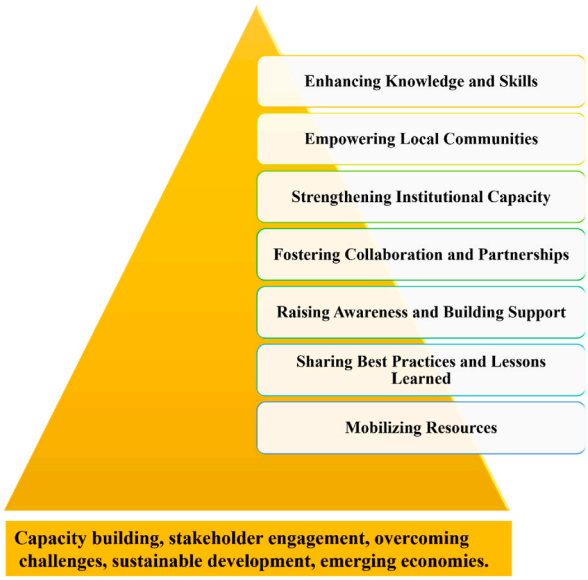

Fig. 5. Capacity building, stakeholder engagement, overcoming challenges, sustainable development, emerging economies.

thereby benefiting society, the economy, and the environment.

4. Conclusion

This study underscores the significant potential of blockchain technology as a powerful tool for sustainable management development in management and economics. It addresses the need for transparent and responsive approaches that promote social stability, economic growth, and environmental sustainability. Through a comprehensive analysis of sustainable economic functions, equitable distribution, and environmental protection measures, the research provides valuable insights into how blockchain technology can enhance these aspects. Embracing these advancements is crucial for achieving a fair, resilient, and sustainable future, regardless of the level of economic development. Emerging findings reveal successful implementations of sustainability and green economy concepts, including promoting green behavior, extending product life cycles, increasing system efficiency, and enhancing monitoring capabilities and corporate performance reporting. These capabilities drive the circular economy by optimizing resource consumption and reducing greenhouse gas emissions throughout the product life cycle. Transparency in material usage, exchange, and reporting opens up new opportunities for implementing circular economy concepts with the support of regulatory and economic forces.

Ethics declarations

Review and/or approval by an ethics committee was not needed for this study because it does not involve animal experiments or

human and behavioral studies. Instead, the study is based on the analysis of existing literature.

Data availability statement

The datasets supporting the conclusions of this study are included within the article. The conclusion of this study is based on the data presented and discussed within the text of the article.

CRediT authorship contribution statement

Xin Zhang: Investigation, Funding acquisition, Data curation, Conceptualization. **Yifei Sheng:** Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Z. Liu:** Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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