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Exploring the impact of AI-driven and blockchain-enabled tax filing systems on smes in the era of technological innovation: A review of benefits, challenges, and adoption barriers

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Abstract

The emergence of blockchain technology and artificial intelligence (AI) presents transformative opportunities for tax compliance, especially for small and medium-sized enterprises (SMEs). These technologies promise to enhance tax system accuracy, efficiency, and transparency. However, their adoption is accompanied by significant challenges and barriers.

This review analyzes the benefits, challenges, and future prospects of integrating AI and blockchain technologies into tax systems, with a focus on their impact on SMEs. It seeks to provide insights into how these technologies can reshape tax compliance and identify areas requiring further research.

The review revealed that AI enhances accuracy and compliance through advanced predictive models and explainable AI, while blockchain ensures transparency and trust with its immutable ledger and smart contracts. Despite these benefits, SMEs face technical and financial constraints, such as high implementation costs and integration complexities. Regulatory and legal challenges, including evolving tax laws and data privacy requirements, further complicate adoption. Additionally, resistance to new technologies and skill gaps within SMEs hinder widespread implementation. Scalability and customization issues also pose significant barriers.

In conclusion, AI and blockchain technologies substantially improve tax compliance but come with notable challenges. These technologies promise enhanced accuracy and efficiency for SMEs, yet overcoming barriers related to cost, integration, and regulation is essential for successful adoption. It was recommended that future research should focus on developing SME-specific solutions, addressing regulatory adaptations, and conducting comparative analyses of traditional versus AI-driven tax systems. By tackling these areas, stakeholders can better support SMEs in leveraging AI and blockchain technologies for more effective and transparent tax compliance.

Keywords: AI-driven tax systems; Blockchain technology; SME tax compliance; Technological innovation

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1. Introduction

Tax compliance is a critical aspect of business operations for Small and Medium-sized Enterprises (SMEs), yet it remains one of the most challenging (Mazwi & Kosongo, 2020). SMEs, which constitute a significant portion of the global economy, often struggle with the complexities of traditional tax filing systems (Bayraktar & Algan, 2019). These systems, typically designed with larger enterprises in mind, are often less suitable for the unique needs of SMEs, which operate with fewer resources and more limited expertise. The intricacies of tax laws, with their constant changes and specific requirements, add to the complexity, creating a significant burden for these businesses (Gopichand, 2017). Many SMEs lack the in-house expertise to navigate these challenges effectively, leading to issues such as errors in tax filings, delayed submissions, and, in some cases, penalties that could otherwise be avoided.

Tax compliance is not just a legal obligation; it is essential for the stability and growth of SMEs (Akubo et al., 2016). Non-compliance can lead to severe financial repercussions, including hefty fines, increased scrutiny from tax authorities, and even legal action (Oladipupo & Obazee, 2016). These consequences can be devastating for SMEs, which often operate on tight margins and cannot afford the financial strain that penalties or legal fees would impose. Furthermore, non-compliance can harm an organization's reputation and make it more challenging to obtain funding, attract investors, or build partnerships, all of which are crucial for long-term success (Paleka & Vitezić, 2023). The pressure to comply with tax regulations, therefore, affects the financial health of SMEs and their ability to grow and compete in the marketplace.

In recent years, the financial sector has witnessed a surge in technological innovations aimed at improving efficiency, accuracy, and accessibility. Among these are mobile banking, cloud computing, and Robotic Process Automation (RPA), which are revolutionizing how financial services are delivered. Mobile banking enhances accessibility but often struggles with security vulnerabilities (Wainana et al., 2023). Cloud computing offers scalability and cost savings but raises concerns about data privacy and compliance (Adeusi et al., 2024). RPA automates routine tasks, yet it lacks the sophistication to handle complex decision-making processes (Flechsig et al., 2022).

These limitations highlight areas where AI and blockchain have shown great promise. AI has the potential to automate tax filing processes by analyzing large datasets, reducing errors, and saving time, which is especially beneficial for resource-limited SMEs (Saba & Monkam, 2024). Blockchain technology enhances the security and transparency of financial data, protecting SMEs from fraud and data breaches (Shoetan & Familoni, 2024). Together, AI and blockchain can revolutionize tax compliance, making it more accurate and secure. However, SMEs can face challenges when adopting them.

This review aims to explore the impact of AI-driven and blockchain-enabled tax filing systems on SMEs, focusing on the benefits, challenges, and adoption barriers these technologies present. The scope of the review encompasses an assessment of how these innovations could transform tax compliance for SMEs, particularly in the context of ongoing technological advancements. By analyzing both the potential advantages and the obstacles to adoption, this review seeks to provide a comprehensive understanding of how AI and blockchain can be harnessed to improve tax compliance for SMEs, ultimately contributing to their long-term success in an increasingly digital world.

2. Overview of Technological Innovation in Tax Filing Systems

2.1. AI and its application in Tax filing

Artificial Intelligence (AI) has quickly become a game-changing technology in several fields, including taxation and financial services (Enunnl, 2024). In tax filing, AI technologies, like automation, machine learning, and Natural Language Processing (NLP), play pivotal roles in enhancing tax procedure accuracy, effectiveness, and compliance.

Machine learning, a crucial subset of AI, is particularly influential in tax filing. It utilizes algorithms that can learn from historical data to identify patterns, predict outcomes, and make decisions with minimal human intervention (Taye, 2023). This capability is invaluable in tax filing, where machine learning algorithms can analyze vast amounts of financial data, detect anomalies, and ensure that tax filings are accurate and compliant with current regulations (Nembe et al., 2024). This is especially beneficial for Small and Medium-sized Enterprises (SMEs) that often lack the resources to navigate complex tax regulations manually. Machine learning can automatically update and adapt to changes in tax laws, ensuring ongoing compliance without requiring constant manual adjustments (Huang, 2018). This adaptability reduces the risk of non-compliance and the associated penalties, offering SMEs a reliable way to manage their tax obligations.

Natural Language Processing (NLP) is another key AI technology that enhances tax filing by enabling systems to understand and interpret human language. In the context of tax filing, NLP can be used to analyze and interpret tax-related documents, such as invoices, receipts, and legal texts (Bommarito et al., 2018). This capability allows for the automatic extraction of relevant information, significantly reducing the time and effort required for manual data entry. For instance, NLP can help identify deductible expenses, ensuring that all eligible deductions are accurately claimed. Additionally, NLP can interact with users more intuitively, providing guidance and answering queries related to tax filing in a conversational style (Maashabi et al., 2022). This is particularly useful for individuals and SMEs with limited tax knowledge, as it makes the tax filing process more accessible and user-friendly.

Automation, powered by AI, further enhances the tax filing process by reducing the need for manual intervention. AI-driven automation can handle repetitive tasks such as data entry, calculation of taxes, and preparation of tax returns with a high degree of accuracy (Farea et al., 2024). This speeds up the filing process and minimizes the risk of human error. Automated systems can also generate alerts for potential issues, such as missed deadlines or discrepancies in financial data, allowing businesses to address problems proactively. By streamlining these processes, AI-driven automation enables businesses to focus more on strategic activities rather than getting bogged down by administrative tasks. This shift from manual to automated processes represents a significant advancement in the efficiency and reliability of tax compliance for businesses of all sizes.

2.2. Blockchain Technology in Tax Processes

Blockchain technology is another groundbreaking innovation with profound implications for tax processes. At its core, blockchain is a distributed, decentralized ledger system that securely, transparently, and immutably records transactions across numerous computers. (Ballamudi, 2016). This technology plays a pivotal role in ensuring transparency, data integrity, and security in tax systems, making it an invaluable tool for modernizing tax compliance.

One of the primary advantages of blockchain in tax processes is its ability to ensure transparency (Han et al., 2023). Every transaction recorded on a blockchain is visible to all participants in the network, creating a transparent and traceable record. In the context of tax filing, this transparency can help both businesses and tax authorities verify transactions, ensuring that all income and expenses are accurately reported (Oats & Tuck, 2019). For example, blockchain can track the flow of goods and services, providing an indisputable record of transactions that can be referenced during tax audits. This level of transparency reduces the likelihood of disputes. It enhances trust between businesses and tax authorities, as all parties can be confident in the accuracy and authenticity of the reported data.

Data integrity is another critical aspect of blockchain technology. Once a transaction is recorded on a blockchain, it cannot be altered or deleted (Dong et al., 2023). This immutability ensures that the financial data used for tax filing is accurate and tamper-proof. In traditional tax systems, data discrepancies can arise due to human error or intentional manipulation, leading to compliance issues. Blockchain's secure and unchangeable ledger mitigates these risks by providing a single source of truth that all parties can rely on (Wang & Liu, 2023). This is particularly important for SMEs, which may face challenges in maintaining accurate records due to limited resources. By ensuring data integrity, blockchain helps SMEs avoid costly errors and potential penalties.

Security is a cornerstone of blockchain technology, making it highly relevant for tax processes that involve sensitive financial information (Jiang, 2024). Blockchain uses cryptographic techniques to secure data, ensuring g that only authorized parties can access and interact with the information (Shi et al., 2020). This level of security is crucial in protecting against cyber threats such as hacking and data breaches, which are common concerns in digital tax systems. For SMEs, which may be more vulnerable to such threats, blockchain provides a robust framework for safeguarding financial data, thereby enhancing overall tax compliance. By integrating blockchain into tax processes, businesses can achieve higher security, ensuring that their financial data remains protected from unauthorized access and tampering.

2.3. Intersection of AI and Blockchain in Tax Compliance

The integration of AI and blockchain technologies presents a robust solution for modernizing tax compliance, addressing the limitations of traditional tax processes (Adelekan et al., 2024). AI excels in analyzing large datasets, automating tasks such as categorizing transactions and calculating taxes. When combined with blockchain's secure and immutable ledger, this integration ensures that all tax-related data is accurate, trustworthy, and tamper-proof. This reduces the risk of errors and fraud, providing both businesses and tax authorities with a reliable record of tax filings.

Efficiency and speed are also greatly improved by this integration. AI-driven automation can handle routine tasks, freeing up time for strategic activities. Blockchain's decentralized nature further streamlines these processes by eliminating intermediaries, thus reducing the time and costs associated with tax compliance ().

Transparency and accountability are enhanced through this combination as well. AI provides real-time insights into tax data, allowing continuous monitoring of compliance status. Blockchain ensures that all transactions are transparent and easily verifiable by tax authorities, fostering trust and reducing the likelihood of disputes and audits (Ballamudi, 2016).

Moreover, the integration of AI and blockchain significantly bolsters the security of tax systems. AI can detect and prevent fraudulent activities by analyzing patterns and identifying anomalies in financial data. Blockchain's secure ledger further protects against both external and internal threats. For SMEs, this integrated approach offers a cost-effective solution for safeguarding financial data.

By leveraging the strengths of both AI and blockchain, businesses can achieve greater accuracy, efficiency, transparency, and security in their tax processes. As these technologies evolve, their integration will become increasingly essential for ensuring compliance in a rapidly digitalizing and complex tax environment.

3. Benefits of AI-Driven and Blockchain-Enabled Tax Systems for SMEs

3.1. Enhanced Accuracy and Compliance

The integration of AI-driven tax systems provides Small and Medium-sized Enterprises (SMEs) with a significant boost in accuracy and compliance (Adelekan et al., 2024). Traditional tax filing processes are often prone to human error, particularly when dealing with the intricate and ever-evolving landscape of tax regulations (Bayraktar and Algan, 2019). SMEs, which typically operate with limited financial resources and expertise, face a heightened risk of making mistakes that can lead to costly penalties. AI technologies, such as machine learning and automation, offer a solution to this challenge by automating complex tax calculations and consistently applying the most current tax laws (Farea et al., 2024).

Machine learning, a subset of AI, excels at analyzing vast amounts of financial data to identify patterns and predict outcomes. (Antwi et al., 2024). When applied to tax filing, these algorithms can detect anomalies, flag potential issues, and ensure that all tax calculations are accurate. For example, AI can automatically categorize transactions, apply relevant tax codes, and generate accurate tax returns, reducing the burden on SMEs to manually process this information. Additionally, AI-driven systems can stay up-to-date with changes in tax laws, automatically adjusting calculations to ensure compliance without requiring constant manual intervention. This level of accuracy is particularly valuable for SMEs, as it reduces the likelihood of errors that could result in financial penalties or audits.

Moreover, AI can enhance compliance by providing SMEs with insights into their tax obligations throughout the fiscal year (Nembe et al., 2024). Instead of scrambling to meet tax deadlines with uncertain calculations, businesses can rely on AI systems to monitor their financial activities in real-time, ensuring that they remain compliant with tax regulations on an ongoing basis. This proactive approach not only minimizes the risk of non-compliance but also allows SMEs to plan their finances more effectively, avoiding unexpected tax liabilities.

3.2. Increased Transparency and Trust

Blockchain technology, when integrated into tax systems, offers unparalleled levels of transparency and trust, which are critical for both businesses and tax authorities. Blockchain operates as a decentralized ledger that records every transaction across a network of computers, ensuring that each entry is permanent, unchangeable, and visible to all participants in the network (Dong et al., 2023). This transparency is particularly beneficial for SMEs, which often face scrutiny regarding the accuracy of their financial records.

A transaction cannot be changed or removed once it has been recorded, thanks to the immutable nature of blockchain (Politou et al., 2023). This characteristic is crucial in reducing fraud and errors in tax filings, as it guarantees the integrity of the data. For SMEs, this means that their financial records are secure and trustworthy, providing a solid foundation for tax filings. The transparency offered by blockchain allows tax authorities to verify transactions quickly and efficiently, reducing the need for extensive audits (Han et al., 2023). This streamlined verification process not only builds trust between SMEs and tax authorities but also reduces the administrative burden on both parties.

Furthermore, the decentralized nature of blockchain eliminates the need for intermediaries, such as third-party auditors or financial institutions, in the tax filing process. This reduction in intermediaries speeds up the process and minimizes the risk of data breaches or unauthorized access. For SMEs, which may not have the resources to invest in advanced cybersecurity measures, blockchain offers a robust framework for protecting their financial data, further enhancing the credibility and security of their tax filings.

3.3. Operational Efficiency and Cost Reduction

The integration of AI and blockchain technologies in tax systems brings significant improvements in operational efficiency and cost reduction, which are particularly beneficial for SMEs (Adelekan, 2024). The capacity of AI to automate repetitive operations is one of its main benefits for tax filing, such as data entry, tax calculations, and the preparation of tax returns. By automating these routine processes, AI speeds up the tax filing process and frees up valuable time for SMEs to focus on more strategic activities, such as business growth and innovation (Abangah, 2024).

Automation also reduces the potential for human error, which is a common issue in manual tax filing processes. Errors in tax filings can lead to delays, penalties, and additional administrative costs (Parycek et al.,2023). By leveraging AI-driven automation, SMEs can significantly reduce these risks, ensuring that their tax filings are accurate and submitted on time. Moreover, AI systems can generate alerts for potential issues, such as discrepancies in financial data or missed deadlines, allowing businesses to address problems proactively before they escalate.

Blockchain technology further enhances operational efficiency by streamlining tax filings' verification and approval process (Han et al., 2023). The decentralized nature of blockchain eliminates the requirement for middlemen, cutting down on the time and expense involved with using them. Additionally, the transparent and immutable nature of blockchain records simplifies the audit process, as tax authorities can quickly verify the accuracy of tax filings without the need for extensive documentation or manual checks.

For SMEs, the long-term cost savings associated with AI and blockchain adoption can be substantial. While the initial investment in these technologies may be significant, reducing labor costs, fewer errors and lower compliance-related penalties can offset this expense over time (Khan et al., 2023). Furthermore, the increased efficiency provided by AI and blockchain allows SMEs to scale their operations more effectively, as they can handle higher volumes of transactions without a corresponding increase in administrative workload.

Hence, these technologies provide a reliable and secure solution for navigating the complexities of tax compliance, allowing SMEs to optimize their resources and focus on growth and innovation. As the digital landscape continues to evolve, SMEs that embrace AI and blockchain in their tax processes will be better positioned to succeed in an increasingly competitive and regulated environment.

4. Challenges and Barriers to Adoption for SMEs

4.1. Technical and Financial Constraints

Small and Medium-sized Enterprises (SMEs) face considerable technical and financial constraints when adopting AI and blockchain technologies. One of the primary challenges is the substantial upfront cost associated with implementing these advanced systems (Kutnetsov et al., 2024). The initial investment required for acquiring software, hardware, and other technological infrastructure can be a significant financial burden for many SMEs. These costs can strain the resources of smaller businesses, making it difficult for them to justify or afford the investment in cutting-edge technologies (Ewuga et al., 2023).

In addition to the initial expenses, ongoing costs associated with system maintenance, updates, and support can further impact an SME's financial stability. Maintaining and updating AI and blockchain systems requires continuous investment, which can be challenging for businesses operating on tight budgets.

(Polas, 2022). The costs of technical support and system enhancements can add up, making it difficult for SMEs to manage their financial resources effectively.

Integration difficulties also present a major barrier. AI and blockchain systems are complex and require seamless integration with existing business processes and software. This integration can be especially challenging for SMEs that rely on legacy systems or have limited IT infrastructure. The technical complexity of these technologies necessitates a high level of expertise, which many SMEs may not possess. As a result, businesses often need to hire specialized staff or consultants to manage the integration process, increasing overall costs.

Moreover, adopting AI and blockchain technologies demands technological infrastructure, such as high-speed internet and secure data storage solutions. Many SMEs may lack the necessary infrastructure, complicating the adoption process and raising the associated costs (Oyeleke, 2024). Implementing these advanced systems can become even more challenging and costly without the proper technological foundation.

4.2. Regulatory and Legal Considerations

Regulatory and legal considerations are another significant challenge for SMEs adopting AI and blockchain technologies. Tax regulations and data privacy laws constantly evolve, and staying compliant with these changes can be daunting for SMEs (Bello, 2024). AI systems must be programmed to adhere to complex tax regulations, which vary by jurisdiction and can change frequently. Ensuring these systems remain compliant requires ongoing updates and adjustments, which can be resource-intensive.

Data privacy laws, such as the General Data Protection Regulation (GDPR) in Europe, impose strict requirements on how businesses handle and protect personal data (Hoofnagle et al., 2019). AI and blockchain systems often involve the processing and storing of sensitive information, raising concerns about data privacy and security. SMEs must ensure that their systems comply with these regulations, which may require additional legal consultation costs and modification of data management practices.

Cross-border issues also pose challenges, particularly for SMEs operating internationally. Different countries have varying regulations regarding tax compliance, data protection, and blockchain use. Ensuring compliance across multiple jurisdictions can be complex and requires careful consideration of local laws and regulations. This complexity can deter SMEs from adopting these technologies, as navigating the regulatory landscape may seem overwhelming.

4.3. Adoption Resistance and Skill Gaps

Resistance to adoption is a significant barrier for SMEs. Many business owners and managers may hesitate to embrace new technologies due to a lack of understanding or fear of the unknown (Roberts et al., 2021). AI and blockchain are relatively new and evolving fields, and some SMEs may struggle to see the immediate benefits or return on investment. This reluctance can lead to slow adoption rates and hesitancy to invest in the resources necessary for successful implementation.

Inadequate technical skills also exacerbate the problem. The successful adoption of AI and blockchain technologies requires specialized knowledge and expertise, which many SMEs may not possess (Soori, 2024). This skill gap can hinder these systems' effective implementation and management, leading to potential inefficiencies and increased costs. SMEs often have limited resources for training or hiring skilled personnel, making it challenging to leverage these technologies effectively.

Cultural hesitancy toward new technologies also plays a role. Traditional business practices and a reluctance to change can impede the adoption of innovative technologies. Some SMEs may prefer to stick with established methods and processes, even if newer technologies offer clear advantages (Zamani, 2022). Overcoming this resistance requires a cultural shift toward embracing technological advancements and recognizing their potential benefits.

4.4. Scalability and Customization Issues

Scalability and customization issues are additional challenges SMEs face when adopting AI and blockchain technologies. These systems must be scalable to accommodate the growth and changing needs of the business. However, many AI and blockchain solutions are designed for larger enterprises and may not easily scale to meet the specific requirements of SMEs. Adapting these technologies to fit the unique needs of smaller businesses can be challenging and may require significant modifications.

Customization is another concern. SMEs often have diverse operations and specific business needs that may not be fully addressed by off-the-shelf AI and blockchain solutions. Tailoring these technologies to fit unique business processes and requirements can be complex and costly (Wallraff et al., 2023). SMEs may need to work closely with technology providers to develop customized solutions, adding to the overall implementation costs.

Overcoming these challenges requires careful planning, resource investment, and a willingness to embrace change. By navigating these obstacles effectively, SMEs can harness the full potential of AI and blockchain technologies, enhancing their efficiency, accuracy, and competitiveness in the digital age.

5. Current Adoption Trends

5.1. Global Adoption Patterns and Regional Insights

Integrating AI and blockchain technologies into tax systems is becoming increasingly prominent among Small and Medium-sized Enterprises (SMEs) globally. Adoption patterns vary significantly across regions, influenced by technological infrastructure, regulatory environments, and economic conditions (Schwaeke et al., 2024).

In North America and Europe, SMEs are at the forefront of adopting these technologies. Advanced technological infrastructure and supportive regulatory environments facilitate the integration of AI and blockchain. For example, SMEs in the UK and Germany utilize AI to automate tax filings, reducing manual errors and ensuring compliance with complex VAT regulations, like *Mika* (Matthew, 2024). The European Union's Digital Economy and Society Index (DESI) underscores the growing use of AI for streamlining tax processes and blockchain for securing transaction records (DESI, 2022).

Conversely, adoption is slower in many developing regions like Africa (Ewuga et al., 2023). Challenges such as limited technological infrastructure, lower digital literacy, and less developed regulatory frameworks contribute to this slower pace. Despite these barriers, progress is being made in some areas, with international aid and investment helping to advance technology adoption.

In Latin America, countries like Brazil and Mexico are gradually adopting AI and blockchain in tax systems. Reports from the Inter-American Development Bank (IDB) highlight that SMEs are starting to use AI for predictive analytics and blockchain for transaction security (IDB, 2018). However, the uptake remains modest compared to more developed regions.

5.2. Notable Case Studies

Several case studies demonstrate how SMEs have successfully implemented AI and blockchain technologies in their tax processes, revealing key outcomes and lessons learned.

5.2.1. Case Study 1: Adoption of AI in Tax Filing at PwC UK

PwC UK, in collaboration with Harvey and OpenAI, developed a cutting-edge AI model specifically trained for the UK tax landscape (PwC, 2024). This initiative marks a significant advancement in the application of artificial intelligence within the professional services sector, particularly for tax filing and advisory services.

The AI model, available to all 2,300 PwC UK Tax professionals, is an AI assistant designed to generate high-quality tax content, leveraging PwC's proprietary tax knowledge and expertise (PwC, 2024). It cross-references and is trained on a wide array of data, including case law, legislation, and PwC's internal intellectual property, which is regularly updated to ensure compliance with the latest tax rules. This approach ensures that the model delivers superior accuracy and transparency compared to publicly available AI models.

The deployment of the AI tool has enhanced the capability of PwC professionals to provide deeper insights, improved transparency, and higher-quality outcomes for clients (PwC, 2024). It has also enabled more efficient processing of complex tax information, allowing PwC to maintain its competitive edge in the professional services market. Additionally, the AI model supports a human-led, technology-powered strategy, ensuring that AI complements rather than replaces human expertise.

PwC's adoption of AI in tax filing demonstrates AI's transformative potential in enhancing service delivery, improving accuracy, and fostering innovation in tax advisory services. This strategic move aligns with PwC's broader objective of leading the professional services market in AI adoption and digital transformation.

5.2.2. Case Study 2: Adoption of AI in Tax Filing at Petrobras

Petrobras, the largest energy company in South America, enhanced the accuracy of its tax filings while reducing administrative workload (Law, 2024). With over 45,000 employees and a history of leveraging AI in its core operations, Petrobras aimed to extend AI's benefits to its administrative processes, including tax, procurement, finance, and HR departments.

To address potential inaccuracies in tax filings and streamline the tax process, Petrobras implemented Automation Co-Pilot for Business Users, a generative AI model powered by Automation Anywhere (Law, 2024). This model was trained using hundreds of pages of the Brazilian tax code and several months of the company's tax data. The AI tool enabled Petrobras to automate its tax filing system, significantly reducing the time required to complete tax filings and eliminating the need for overtime during tax season.

Within three weeks of deploying the AI solution, Petrobras identified US$120 million in savings and achieved unprecedented efficiency by completing tax filings in three days (Law, 2024). The success of the AI tool has encouraged Petrobras to expand its use of generative AI to other business functions, anticipating further savings of over US$1 billion annually.

Petrobras' successful adoption of AI for tax filing demonstrates the transformative potential of AI in streamlining administrative processes, improving accuracy, and achieving significant cost savings across various business functions.

The case studies of PwC UK and Petrobras illustrate the transformative potential of AI and blockchain technologies in optimizing tax filing and administrative processes. While both are large enterprises with significant resources, their successes demonstrate the profound benefits that could be realized if SMEs overcome barriers to adoption. By leveraging AI and blockchain, SMEs can enhance accuracy, reduce costs, and improve efficiency in tax compliance. Embracing these technologies could give SMEs a competitive edge, fostering growth and innovation in a rapidly evolving digital landscape. The challenge lies in overcoming financial, technical, and cultural barriers to unlock these opportunities.

6. Future Prospects and Emerging Research Areas

6.1. Technological Advancements and Innovations

The future of AI and blockchain technologies in tax systems is set to bring transformative changes, significantly enhancing their capabilities and effectiveness. In AI, advancements such as advanced predictive models and explainable AI (XAI) are at the forefront. Advanced predictive models use sophisticated algorithms to forecast tax liabilities and detect potential compliance issues by analyzing historical data and current trends (Broby, 2022). This technology can help SMEs accurately anticipate their tax obligations, allowing for better financial planning and management.

Explainable AI is another promising development. Unlike traditional AI systems, which often operate as 'black boxes', explainable AI provides transparency in decision-making (Sharma et al., 2024). This transparency is crucial for tax systems, where understanding the rationale behind automated tax calculations and compliance checks is essential for building trust and accountability. By clarifying AI decision-making processes, SMEs can more confidently validate the outcomes of their tax systems, thereby increasing their reliance on automated solutions.

Blockchain technology is also advancing with innovations such as smart contracts and decentralized systems (Far et al., 2023). Smart contracts are self-executing contracts in which the agreements are encoded directly into the code. These contracts can automate complex tax-related transactions and agreements, streamlining tax compliance by enforcing tax rules and executing payments based on predefined conditions. This reduces the need for manual intervention and minimizes errors.

Decentralized systems, which distribute data across multiple nodes rather than relying on a single central authority, offer enhanced security and resilience (Wang & Liu, 2023). For tax systems, this means better protection against data tampering and fraud and increased transparency in financial transactions. The decentralized nature of blockchain ensures that data is more secure and less vulnerable to manipulation.

6.2. Integration with Broader Digital Ecosystems

As digital transformation reshapes finance and accounting, integrating AI and blockchain tax systems with broader digital ecosystems will be crucial. The convergence of these technologies with cloud computing, the Internet of Things (IoT), and big data analytics will create a more interconnected and efficient financial environment (Javaid et al., 2024).

Cloud-based solutions provide scalable infrastructure for deploying AI and blockchain technologies, making them more accessible and cost-effective for SMEs (Graepel, 2024). The IoT can offer AI systems real-time data feeds, improving tax reporting accuracy and timeliness. Big data analytics platforms can enable more comprehensive analysis of financial data, leading to better-informed tax strategies and decision-making.

Moreover, integrating tax systems with enterprise resource planning (ERP) systems and financial management tools can streamline information flow across business functions (Gafaar, 2017). This integration facilitates more efficient tax compliance processes and offers a holistic view of financial health, contributing to overall business optimization.

6.3. Research Gaps and Opportunities

Despite these promising developments, several research gaps and opportunities remain in applying AI and blockchain for tax systems. One critical area for further research is SME-specific studies that explore small and medium-sized businesses' unique challenges and requirements in adopting these technologies. Tailoring AI and blockchain solutions to meet SME needs, including issues of scalability and affordability, is essential for widespread adoption.

Regulatory frameworks also need more attention. As AI and blockchain technologies evolve, existing tax regulations may need to be updated to address new compliance challenges. Research into how regulatory bodies can adapt to these technological advancements and how SMEs can navigate evolving regulations is vital for creating a supportive environment for technology adoption.

Comparative analyses of traditional versus AI-driven tax systems present another valuable research opportunity. Evaluating the effectiveness, efficiency, and cost implications of AI and blockchain tax solutions compared to traditional methods can provide insights into their tangible benefits and limitations.

Hence, the future of AI and blockchain in tax systems holds exciting prospects with advancements in predictive modeling, explainable AI, smart contracts, and decentralized systems. Their integration with broader digital ecosystems promises enhanced efficiency and connectivity. Addressing research gaps related to SME needs, regulatory adaptations, and comparative evaluations will be crucial for fully realizing the transformative potential of these technologies in tax compliance.

7. Conclusion

In conclusion, this review highlights the transformative potential of AI and blockchain technologies in revolutionizing SMEs' tax compliance while identifying critical challenges and barriers to their adoption. The integration of AI offers significant advantages, including enhanced accuracy and compliance through advanced predictive models and explainable AI, which simplifies complex tax calculations and decision-making processes. With its immutable ledger and smart contracts, blockchain technology ensures greater transparency and trust in tax systems, mitigating fraud and data tampering risks.

However, the adoption of these technologies is not without its challenges. SMEs face substantial technical and financial constraints, including high implementation costs and the complexity of integrating advanced systems with existing infrastructure. Regulatory and legal considerations also pose hurdles, as compliance with evolving tax regulations and data privacy laws remains daunting. Furthermore, resistance to change and skill gaps within SMEs contribute to slow adoption rates. Scalability and customization issues further complicate the integration of these technologies, particularly for diverse and smaller-scale operations.

These findings have significant implications for SMEs, technology providers, and policymakers. For SMEs, embracing AI and blockchain can improve efficiency, accuracy, and trust in tax processes, but overcoming financial and technical barriers is crucial. Technology providers must focus on developing cost-effective, scalable solutions that cater to SMEs' specific needs. In contrast, policymakers must address regulatory challenges and create supportive frameworks that facilitate technology adoption.

Future research should focus on several key areas. Investigating SME-specific challenges and developing tailored solutions can help address the unique needs of smaller businesses. Further exploration into regulatory adaptations and how they can keep pace with technological advancements is essential. Additionally, comparative studies assessing the effectiveness and efficiency of AI-driven and blockchain-enabled tax systems versus traditional methods will provide valuable insights into their tangible benefits and limitations.

Compliance with ethical standards

Disclosure of conflict of interest

No conflicts of interest/ Competing Interests with publication of the manuscript or an institution or product that is mentioned in the manuscript and/or is important to the outcome of the study presented.

References

[1] Abangah P. Economic impact of artificial intelligence on small and medium Businesses: A Case Study of Inmarkon. 2024. Available from: 10.13140/RG.2.2.34021.82402.

[2] Adelekan OA, Adisa O, Ilugbusi BS, et al. Evolving Tax Compliance in the Digital Era: A comparative Analysis of AI-driven Models and Blockchain Technology in US Tax Administration. 2024;5:311-35.

[3] Adeusi OC, Adebayo YO, Ayodele PA, et al. IT Standardization in Cloud Computing: Security Challenges, Benefits, and Future directions. World J Adv Res Rev. 2024;22(05):2050-7. Available from: https://wjarr.com/sites/default/files/WJARR-2024-1982.pdf.

[4] Akubo D, Achimugu A, Ayuba A. Tax Compliance Behaviour of Small Scale Enterprises in Bassa Local Government Area of Kogi State. J Good Gov Sustain Dev Afr (JGGSDA). 2016;3(1):58-72. Available from: file:///C:/Users/acer/Downloads/507-Article%20Text-927-1-10-20210816%20(1).pdf.

[5] Antwi BO, Adelakun BO, Augustine AO. Transforming financial reporting with AI: Enhancing accuracy and Timeliness. Int J Adv Econ. 2024;6. Available from: file:///C:/Users/acer/Downloads/1229-Article%20Text-2723-1-10-20240615.pdf.

[6] Ballamudi V. Blockchain as a Type of Distributed Ledger Technology. Asian J Humanit Art Lit. 2016;3:127-36. doi: 10.18034/ajhal.v3i2.528.

[7] Bayraktar M, Algan N. The Importance Of SMEs On World Economies. 2019;56-61. doi: 10.36880/C11.02265.

[8] Bommarito M, Katz D, Detterman E. LexNLP: Natural Language Processing and Information Extraction For Legal and Regulatory Texts. SSRN Electron J. 2018. doi: 10.2139/ssrn.3192101.

[9] Broby D. The use of predictive analytics in finance. J Finance Data Sci. 2022;8:145-61. Available from: https://doi.org/10.1016/j.jfds.2022.05.003.

[10] Dong S, Abbas K, Li M, Kamruzzaman J. Blockchain technology and application: an overview. PeerJ Comput Sci. 2023;9. doi: 10.7717/peerj-cs.1705.

[11] Enunnl S. The Transformative Power of Artificial Intelligence: Revolutionizing Industries Across the Globe. 2024.

[12] Ewuga SS, Egieya ZE, Omotoso A, et al. Costs can strain the Resources of Smaller Businesses, making it difficult for them To Justify it afford the Investment in Cutting-Edge Technologies. Eng Sci Technol J. 2023;5:3.

[13] Far SB, Rad AI, Asaar MR. Blockchain and its derived technologies shape the future generation of digital businesses: a focus on decentralized finance and the Metaverse. Data Sci Manage. 2024;6:183-97. Available from: https://doi.org/10.1016/j.dsm.2023.06.002.

[14] Farea M, Al-Ifan B, AL-DUBAI M, AHMAD A, MOHAMED R, Hatamleh A. INTELLIGENT AUTOMATION IN ACCOUNTING AND FINANCIAL REPORTING. J Tianjin Univ Sci Technol. 2024;57. doi: 10.5281/zenodo.12516114.

[15] Flechsig C, Anslinger F, Lasch R. Robotic Process Automation in purchasing and supply management: A multiple case study on potentials, barriers, and implementation. J Purch Supply Manag. 2022;28. Available from: https://doi.org/10.1016/j.pursup.2021.100718.

[16] Gafaar A, Mohmmed M, Eldin F, Osman. INTEGRATION Solution With ERP (Enterprise resource planning systems). 2017.

[17] Gopichand D. Impact of Changes in Tax Law on Small Scale Businesses in India: A Survey-Based Analysis. Int J Res Publ Rev. 2019;5:5201-12. Available from: https://ijrpr.com/uploads/V5ISSUE5/IJRPR27768.pdf.

[18] Graepel T. Cloud-Based Solutions for Small Business Management: Integrating Blockchain, AI, and Social Media Automation. 2024. doi: 10.13140/RG.2.2.23597.91361.

[19] Han H, Shiwakoti RK, Jarvis R, et al. Accounting and auditing with blockchain technology and artificial Intelligence: A literature review. Int J Account Inf Syst. 2023;48. Available from: https://doi.org/10.1016/j.accinf.2022.100598.

[20] Hoofnagle C, Sloot B, Borgesius F. The European Union general data protection regulation: What it is and what it means. Inf Commun Technol Law. 2019;28:1-34. doi: 10.1080/13600834.2019.1573501.

[21] Huang Z. Discussion on the Development of Artificial Intelligence in Taxation. Am J Ind Bus Manag. 2018;8:1817-24. doi: 10.4236/ajibm.2018.88123.

[22] Javaid M, Haleem A, Singh RP, Sinha AK. Digital economy to improve the culture of industry 4.0: A study on features, implementation and challenges. Green Technol Sustain. 2024;2. Available from: https://doi.org/10.1016/j.grets.2024.100083.

[23] Jiang L. The use of blockchain technology in enterprise financial accounting information sharing. PLoS One. 2024;19(2) . doi: 10.1371/journal.pone.0298210.

[24] Khan AA, Laghari AA, Li P, et al. The collaborative role of blockchain, artificial intelligence, and industrial internet of things in digitalization of small and medium-size enterprises. Sci Rep. 2023;13:1656. doi: 10.1038/s41598-023-28707-9.

[25] Kuznetsov A, Sernani P, Romeo L, Frontoni E, Mancini A. On the Integration of Artificial Intelligence and Blockchain Technology: A Perspective About Security. IEEE Access. 2024. doi: 10.1109/ACCESS.2023.3349019.

[26] Law M. Automation Anywhere AI Solution Drives Savings at Petrobras. Technol Mag. 2024. Available from: https://technologymagazine.com/articles/automation-anywhere-ai-solution-drives-savings-at-petrobras.

[27] Mashaabi M, Alotaibi A, Qudaih H, Alnashwan R, Al-Khalifa H. Natural Language Processing in Customer Service: A Systematic Review. 2022. doi: 10.48550/arXiv.2212.09523.

[28] Matthew J. Mika secures €800k to revolutionise accounting and tax filings with generative AI for SMEs. techfunding news.com. 2024. Available from: https://techfundingnews.com/mika-ai-accounting-solution/

[29] Mazwi T, Kosongo KM. Factors that affect tax compliance among small and medium enterprises in Lusaka, Zambia. Int J Finance Account. 2020;3:1-14. Available from: file:///C:/Users/acer/Downloads/415-Article%20Text-1367-1779-10-20200628.pdf

[30] Nembe J, Atadoga J, Mhlongo N, Falaiye T, Odeyemi O, Daraojimba A, Oguejiofor B. The role of artificial intelligence in enhancing tax compliance and financial regulation. Finance Account Res J. 2024;6:241-251. doi: 10.51594/farj.v6i2.822.

[31] Oats L, Tuck P. Corporate tax avoidance: is tax transparency the solution? Account Bus Res. 2019;49(5):565-583. doi: 10.1080/00014788.2019.1611726.

[32] Oladipupo A, Obazee U. Tax knowledge, penalties and tax compliance in small and medium scale enterprises in Nigeria. iBusiness. 2016; 8:1-9. doi: 10.4236/ib.2016.81001.

[33] Oyeleke M. Technological infrastructure and challenges: Integration challenges in implementing AI solutions in legacy systems. 2024.

[34] Paleka H, Vitezić V. Tax compliance challenge through taxpayers' typology. Economies. 2023;11(9):219. doi: 10.3390/economies11090219.

[35] Parycek P, Schmid V, Novak AS. Artificial intelligence (AI) and automation in administrative procedures: Potentials, limitations, and framework conditions. J Knowl Econ. 2024; 15:8390-8415. doi: 10.1007/s13132-023-01433-3.

[36] Polas RSP, Asghar AA, Karim R, et al. Artificial intelligence, blockchain technology, and risk-taking behavior in the 4.0IR metaverse era: Evidence from Bangladesh-based SMEs. J Open Innov Technol Market Complex. 2023;8. doi: 10.3390/joitmc8030168.

[37] Politou E, Casino F, Alepis E, Patsakis C. Blockchain mutability: Challenges and proposed solutions. IEEE Trans Emerg Top Comput. 2019. doi: 10.1109/TETC.2019.2949510.

[38] PwC. PwC UK launches a UK tax AI assistant tool with strategic alliance partners, Harvey and OpenAI. 2024. Available from: https://www.pwc.co.uk/press-room/press-releases/corporate-news/pwc-uk-launch-uk-tax-ai-assistant-tool.html

[39] Roberts R, Flin R, Millar D, Corradi L. Psychological factors influencing technology adoption: A case study from the oil and gas industry. Technovation. 2024;102. doi: 10.1016/j.technovation.2020.102219. Available from: https://www.sciencedirect.com/science/article/pii/S0166497220300912

[40]   Saba C, Monkam N. Leveraging the potential of artificial intelligence (AI) in exploring the interplay among tax revenue, institutional quality, and economic growth in the G-7 countries. AI Soc. 2024. doi: 10.1007/s00146-024-01885-4.

[41]   Schwaeke J, Peters A, Kanbach DK, Kraus S, Jones P. The new normal: The status quo of AI adoption in SMEs. J Small Bus Manag. 2024;1-35. doi: 10.1080/00472778.2024.2379999.

[42]   Sharma NA, Chand RR, Buksh Z, Ali ABMS, Hanif A, Beheshti A. Explainable AI frameworks: Navigating the present challenges and unveiling innovative applications. Algorithms. 2024;17(6):227. doi: 10.3390/a17060227.

[43]   Shi S, He D, Li L, Kumar N, Khan MK, Choo KR. Applications of blockchain in ensuring the security and privacy of electronic health record systems: A survey. Comput Secur. 2020; 97:101966. doi: 10.1016/j.cose.2020.101966.

[44]   Shoetan P, Familoni B. Blockchain's impact on financial security and efficiency beyond cryptocurrency uses. Int J Manag Entrep Res. 2024; 6:1211-1235. doi: 10.51594/ijmer.v6i4.1032.

[45]   Taye MM. Understanding of machine learning with deep learning: Architectures, workflow, applications and future directions. Computers. 2023;12(5):91. doi: 10.3390/computers12050091.

[46]   The Digital Economy and Society Index (DELSI). The Digital Economy and Society Index. 2022. Available from: https://digital-strategy.ec.europa.eu/en/policies/desi

[47]   The Inter-American Development Bank. Artificial intelligence to boost Latin American and Caribbean economies: IDB study. 2018. Available from: https://www.iadb.org/en/news/artificial-intelligence-boost-latin-american-and-caribbean-economies-idb-study

[48]   Wainaina G, Kiyeng D, Masese N. Enhancing security measures for mobile banking applications: A comprehensive analysis of threats, vulnerabilities, and countermeasures in Kenya banking industry. Int J Comput Appl Technol Res. 2023; 12:99-112. doi: 10.7753/IJCATR1208.1014.

[49]   Wang Q, Liu Y. Blockchain for public safety: A survey of techniques and applications. J Safety Sci Resilience. 2023;4(4):389-395. doi: 10.1016/j.jnlssr.2023.09.001.

[50]   Zamani SZ. Small and medium enterprises (SMEs) facing an evolving technological era: A systematic literature review on the adoption of technologies in SMEs. Eur J Innov Manag. 2022;25(6):735-757. doi: 10.1108/EJIM-07-2021-0360.