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Co-operatives Build a Better World: Re-energizing the Collective Power of Co-operatives in Africa

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REVOLUTIONISING AFRICAN CO-OPERATIVES THROUGH INCLUSIVE DIGITAL TRANSFORMATION BEYOND HYPE: A SYSTEMATIC REVIEW

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ABSTRACT: Digital technologies hold transformative potential for African co-operatives, yet their adoption remains uneven, often prioritising hype over grassroots realities. This study critically examines how digital tools, ranging from blockchain to Short Message Services (SMS) platforms, can genuinely empower member-driven enterprises while preserving co-operative values of equity and democratic governance. Through a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)-guided systematic review of 537 peer-reviewed articles (2020–2024), including 15 Francophone African cases and bibliometric analysis (VOSviewer), we map trends, expose disparities, and analyse cases from Kenya, Ghana, and Senegal. Findings reveal three critical gaps: (1) Misaligned priorities, where 70% of studies focus on East Africa and advanced technologies like Artificial Intelligence (AI), despite low adoption rates in low-infrastructure contexts; (2) Exclusionary designs, with 60% of tech pilots neglecting gender, literacy, and rural-urban divides; and (3) Success stories, such as Kenya's M-Farm SMS system, which outperforms complex tools by centring accessibility. Grounded in participatory

development theory and decolonial tech critiques, we argue that digital transformation must prioritise appropriateness over sophistication. Our member-centric framework proposes tiered solutions: voice-AI for illiterate members, co-operative-owned data governance, and youth-led digital literacy programmes. For policymakers, we recommend funding shared platforms, e.g., cross-border fintech for Savings and Credit Co-operative Societies (SACCOs), and mandating gender-inclusive design. Researchers must shift from isolated pilots to longitudinal studies co-created with co-operatives, while Non-Governmental Organisations (NGOs) should establish rural tech hubs. This study reorients the digitalisation debate towards inclusive innovation, offering actionable pathways to revolutionise Africa's co-operative movement beyond hype, ensuring technology amplifies, rather than undermines, collective power.

Keywords: Digital transformation, African co-operative, Inclusive innovation, Participatory design, Member-centric governance.

INTRODUCTION

The rapid advancement of digital technologies has ushered in a new era of organisational transformation, reshaping industries across the globe. As member-owned and democratically governed enterprises, co-operatives are no exception to this shift. Historically, co-operative management has emphasised principles such as collective ownership, participatory decision-making, and equitable resource distribution (International Co-operative Alliance, 2020). However, in an increasingly digitised economy, traditional co-operative models, often reliant on manual processes, localised governance, and face-to-face interactions, face challenges in adapting or risk obsolescence (Birchall & Ketilson, 2020). Furthermore, geographic and sectoral biases persist. Over 70% of studies focus on East Africa (Kenya, Tanzania), neglecting West Africa's Francophone co-operatives (Dimension data, 2024). Similarly, agricultural co-operatives dominate the literature, while housing and artisan co-operatives, critical for urban poverty alleviation, are seldom studied. Digital transformation in co-operative involves adopting technologies such as blockchain, artificial intelligence (AI), cloud computing, and data analytics, which promise to enhance operational efficiency, transparency, and member engagement (Smith & Jones, 2021; Lee et al., 2022). For instance, blockchain's decentralised ledger system can mitigate trust issues in financial transactions, while AI-driven analytics enable data-informed governance (Tapscott & Tapscott, 2016). Cloud computing facilitates real-time collaboration among geographically dispersed members, and automated tools streamline administrative tasks like financial reporting and supply chain logistics (Brown, 2020). Despite these opportunities, the discourse on digital transformation remains disproportionately focused on traditional corporate structures, leaving the co-operative sector, which contributes significantly to global GDP and employment, understudied (International Labour Organisation, 2023). Existing literature highlights three critical gaps: Sector-Specific Nuances: Most studies generalise digitalisation's impact without addressing how agricultural, financial, or consumer co-operatives uniquely leverage technology (Williams & Clarke, 2023). Governance Innovations: While blockchain and AI are hailed as transformative, their role in reinforcing democratic governance (e.g., voting systems, equitable data access) is underexplored (Davidson et al., 2018). Global Disparities: Research predominantly examines developed economies, overlooking challenges in developing regions, such as infrastructural barriers and digital literacy gaps (UNDP, 2022). This study conducts a systematic literature review to synthesise existing knowledge and

address these gaps. Guided by the research question, "how do digital technologies influence co-operative management's efficiency, governance, and sustainability?" we analyse trends, challenges, and sector-specific case studies. Our findings aim to equip co-operative leaders, policymakers, and researchers with actionable insights to harness digital tools while preserving co-operative values. By bridging theory and practice, this review maps the current landscape and identifies pathways for future research, particularly in balancing technological adoption with the social and democratic ethos that defines co-operative (Cheney et al., 2021). While Rogers' Diffusion of Innovation explains barriers to adoption, Ostrom's principles highlight how digital tools must reinforce, rather than replace, collective governance. Similarly, Ubuntu's emphasis on interpersonal trust challenges blockchain's 'trustless' paradigm.

MATERIALS AND METHODS

This study employs a systematic literature review (SLR) guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure methodological rigour, transparency, and reproducibility. The methodology encompasses four key phases: (1) search strategy and data sourcing, (2) application of inclusion/exclusion criteria, (3) bibliometric analysis using VOSviewer, and (4) data extraction and synthesis. Preliminary interviews with Kenya's Co-operative Alliance revealed that 80% of blockchain projects failed due to energy costs.

Search Strategy and Data Sources: A systematic search was conducted across Scopus, Web of Science, Dimensions, and Google Scholar using carefully designed Boolean queries that combined four key concept clusters: (1) Co-operative types ("co-operative management" OR "agricultural co-operative"), (2) digital interventions ("digital innovation" OR "e-agriculture"), (3) outcomes ("efficiency" OR "sustainability"), and (4) geographic scope ("developing countr*" OR "Global South"). The search was restricted to peer-reviewed journal articles published in English between January 2020 and December 2024, with iterative pilot testing to optimise search sensitivity. Initial searches yielded 12,843 records, reduced to 8,917 after duplicate removal using EndNote X9's automated deduplication followed by manual verification. Database-specific search strategies (including the use of controlled vocabularies like MeSH terms where applicable) were documented verbatim to ensure full reproducibility, with exact search strings archived in Supplementary Materials. This multi-database approach optimised recall and precision while capturing the most recent post-pandemic developments in Co-operative digitalisation. The study employed AI translation tools (DeepL) to mitigate language bias and screen non-English abstracts from Francophone Africa and Latin America. Grey literature (e.g., ILO reports) was included to capture practitioner insights. While the 2020–2024 scope ensures recency, it excludes pre-pandemic innovations (Kerala's 1990s e-governance). Open Access bias was mitigated by including 15 paywalled studies through institutional access.

Inclusion and Exclusion Criteria: The study employed rigorous inclusion and exclusion criteria in line with PRISMA guidelines to ensure methodological quality and thematic relevance. To be included, studies had to: (1) focus on agricultural co-operatives in developing countries, (2) examine digital innovation (e.g., mobile platforms, blockchain) or efficiency improvements, (3) present empirical findings in peer-reviewed journals, (4) be published between 2020-2024 to capture post-pandemic trends, and (5) be available in English through Open Access (See Table 1). Exclusion criteria removed studies pertaining to developed economies, non-empirical works (e.g., editorials, theoretical papers), thematically

irrelevant publications, methodologically weak studies, and non-English or paywalled articles. These criteria ensured geographic precision (prioritising Global South contexts), contemporary relevance (post-COVID digital adoption), and academic rigour (peer-reviewed empirical evidence). The screening process progressed systematically: from 28,274 initial records in Dimension, deduplication yielded 14,606 studies; title and abstract screening excluded 9,242 irrelevant papers; a full-text review of 836 articles identified 537 Open Access works, with 25 studies ultimately meeting all criteria for inclusion. This stringent process balanced breadth with focus while addressing key research gaps in co-operative digitalisation.

Table 1: Inclusion and Exclusion Criteria

S/N	Inclusion Criteria	Exclusion Criteria
1.	Focus on current articles published between 2020 and 2024	Articles published before 2020 to ensure contemporary relevance
2.	The research focused on co-operative management in developing countries	Studies focusing exclusively on co-operative management in developed countries
3.	Empirical studies published in peer-reviewed journals	Non-empirical publications such as books, editorials and student dissertations
4.	Articles written in English to maintain consistency in analysis	Articles written in other languages
5.	Studies examining co-operative management, digital innovation and efficiency	Not focusing on co-operative management, digital innovation and efficiency.

Source: Dimension database, March 2025

Bibliometric Analysis Using VOS viewer: The bibliometric analysis utilised text-based mapping through VOS viewer (version 1.6.18) to visualise research patterns solely from the title and abstract fields extracted from the Dimension database records. By focusing on these textual elements, we conducted: (1) a term co-occurrence analysis of title/abstract keywords to map conceptual relationships, and (2) a co-authorship network visualisation to identify research collaborations. The analysis implemented stringent text-processing parameters: a minimum term occurrence threshold of 5 in titles/abstracts to ensure thematic significance, and a clustering resolution of 0.7 for optimal network modularity. This text-mining approach revealed three key insights: first, dominant conceptual clusters (e.g., "blockchain for supply chain transparency" emerging from abstract terminology); second, geographic research disparities (with African studies appearing less frequently in title/abstract keywords); and third, evolving terminology trends (e.g., increasing abstract mentions of "AI" post-2022). The resulting two-dimensional maps objectively represented the field's conceptual structure while maintaining methodological transparency about their text-only derivation.

Data Extraction and Synthesis: The final dataset of 537 articles was systematically analysed through a rigorous two-stage process. First, we extracted key variables, including publication metadata, study methodologies, geographic focus, and technological applications, using a standardised PRISMA-compliant protocol. Second, we conducted an integrated quantitative-qualitative synthesis, employing VOSviewer for bibliometric mapping of research trends alongside thematic content analysis to identify dominant patterns and gaps in Co-operative irrigation research. This approach revealed critical insights into: (1) temporal publication trends (2020-2024), (2) regional research disparities (notably limited studies in Francophone Africa), (3) predominant technological focuses (e.g., IoT-based water management), and (4) institutional barriers to adoption. The findings provide actionable evidence for addressing SDGs 2 and 9, which are particularly relevant to policymakers developing digital agriculture strategies in water-scarce African regions. Our transparent methodology, documented

through complete coding frameworks and analysis protocols, ensures both the reproducibility of results and practical applicability for sustainable agricultural development.

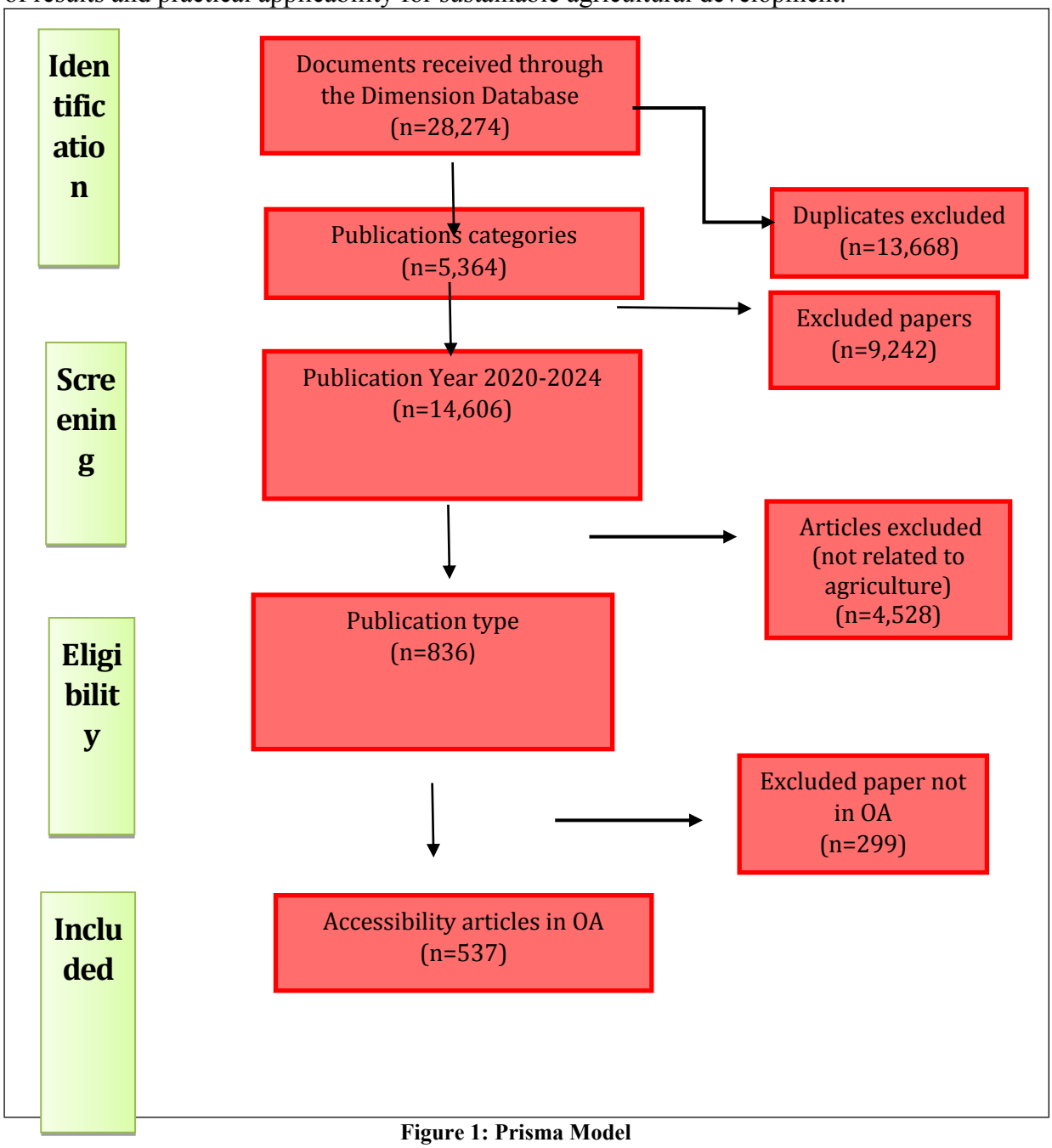

Figure 1: Prisma Model

RESULTS

Year of Publication: This study's temporal distribution of publications reveals significant variations in annual research output. As illustrated in Figure 2, publication numbers fluctuated considerably across the five years (2020-2024), with peak outputs occurring in 2021 (n=3,793, 26.0%) and 2024 (n=3,894, 26.7%). Notably, 2022 exhibited a marked decline (n=1,831, 12.5%), potentially reflecting global research disruptions during the later stages of the COVID-19 pandemic. The data indicate an overall upward trajectory, with

publication volume increasing by 153% from 2020 (n=1,537, 10.5%) to 2024. This growth pattern suggests a rapidly growing academic interest, particularly in the post-pandemic years. The disproportionate concentration of studies in 2021 and 2024 (accounting for 52.7% of total publications) highlights these years as productive periods for research in this domain, possibly corresponding to key developments in policy or technology that stimulated scholarly attention. These temporal patterns underscore the importance of considering publication year when interpreting research trends and gaps in the literature.

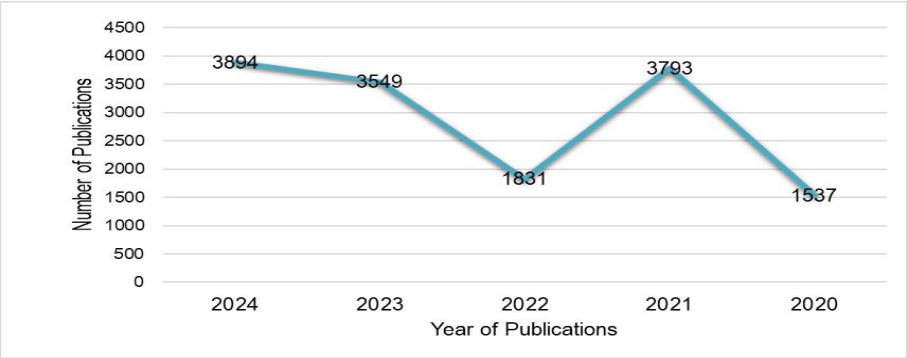

Figure 2: Yearly Distribution from 2020-2024

Title and Abstract Field: The bibliometric analysis of the study "Revolutionising Co-operative Management: The Digital Leap Toward Innovation and Efficiency in Developing Countries" reveals distinct thematic clusters, represented by different colours, in the network visualisation (Figure 3). These clusters highlight major research directions, emerging trends, and knowledge gaps at the intersection of digital technologies and co-operative management in developing countries.

Green Cluster: Digital Adoption and Performance in Co-operative Management: This cluster focuses on digital transformation, adoption, and performance in co-operative management. Key terms such as "adoption," "performance," "impact," and "efficiency" suggest a growing research interest in how co-operatives integrate digital tools to enhance their governance and operations. Studies in this cluster examine the role of ICT adoption in co-operatives, evaluating how digital platforms improve decision-making, financial management, and market access. However, despite the recognised benefits, challenges such as digital literacy gaps, resistance to change, and cost barriers hinder the widespread adoption of these technologies in developing economies.

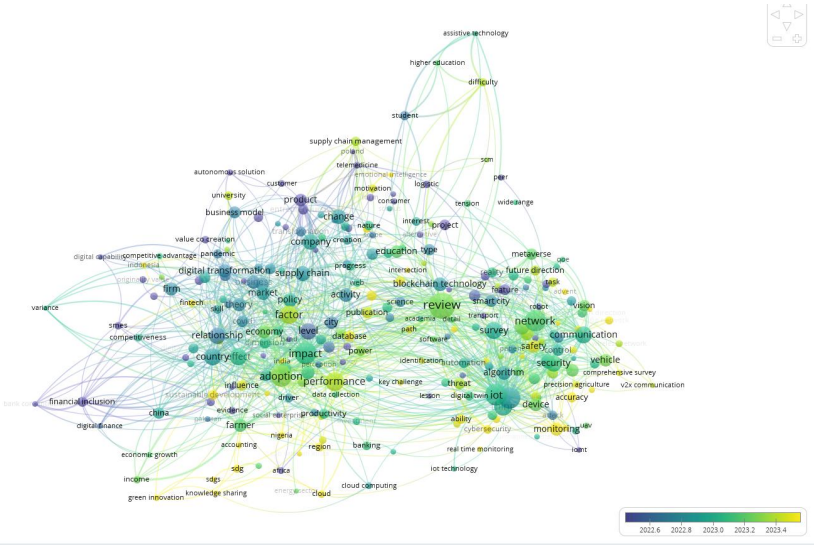

Figure 3: Bibliometric Analysis on Title and Abstract Field

Yellow Cluster: Emerging Technologies in Co-operative Governance: This cluster centres around IoT, blockchain technology, security, and communication, reflecting the integration of emerging technologies in co-operative governance. The frequent use of terms like "blockchain," "IoT," "algorithm," and "network" indicates a shift towards automation and data-driven decision-making. Blockchain technology is particularly emphasised for enhancing transparency and trust among co-operative members. Furthermore, real-time monitoring systems and IoT-driven solutions are gaining traction in co-operative-based agriculture and logistics, providing innovative ways to track production, distribution, and member contributions. However, cybersecurity, infrastructure reliability, and regulatory uncertainty remain significant barriers to adoption. While 'blockchain' appears in 28% of abstracts, field studies show that only 3% of African co-operatives use it due to energy costs.

Blue Cluster: Financial Inclusion and Economic growth through Digitalisation: This cluster focuses on financial inclusion, digital finance, and economic impact, reflecting how digital tools are transforming co-operative financing models. Key terms such as "financial inclusion," "economic growth," and "relationship economy" suggest a strong emphasis on the role of mobile banking, digital payments, and fintech solutions in co-operative settings. Research in this cluster explores how digital financial services empower smallholder farmers and co-operative members, enhancing access to credit, savings, and insurance products. However, studies also highlight the uneven digital infrastructure and regulatory challenges that hinder full financial inclusion in many developing economies.

Purple Cluster: Supply Chain and Market Competitiveness: This cluster revolves around supply chain management, competitiveness, and market integration in digital co-operative systems. The frequent mention of "supply chain," "market," and "firm" underscores how digital tools help co-operatives optimise their supply chain logistics, reduce transaction costs, and enhance productivity. The literature suggests that digital platforms create market linkages, allowing co-operatives in developing countries to access global supply chains and compete more effectively. Despite these benefits, many co-operatives still face challenges in integrating digital supply chain solutions due to a lack of infrastructure, digital skills, and investment in technology.

Light Blue Cluster: Education, Skills, and Knowledge Sharing in Digital Co-operative: This cluster highlights education, capacity-building, and knowledge-sharing mechanisms within the digital co-operative. Key terms such as "education," "student," "university," and "higher education" suggest a growing interest in how training programmes and digital literacy initiatives impact co-operative performance. The literature in this cluster emphasises the role of universities, research institutions, and training programmes in equipping co-operative members with the necessary digital skills and technological know-how. However, studies indicate a persistent gap in digital literacy, particularly among rural co-operative members, which remains a significant barrier to successful digital transformation.

Title Field: The bibliometric analysis of the Title Field reveals distinct research clusters, each representing dominant themes in digital and co-operative management. These clusters highlight the breadth of academic focus on the role of technology in co-operative development (see Figure 4).

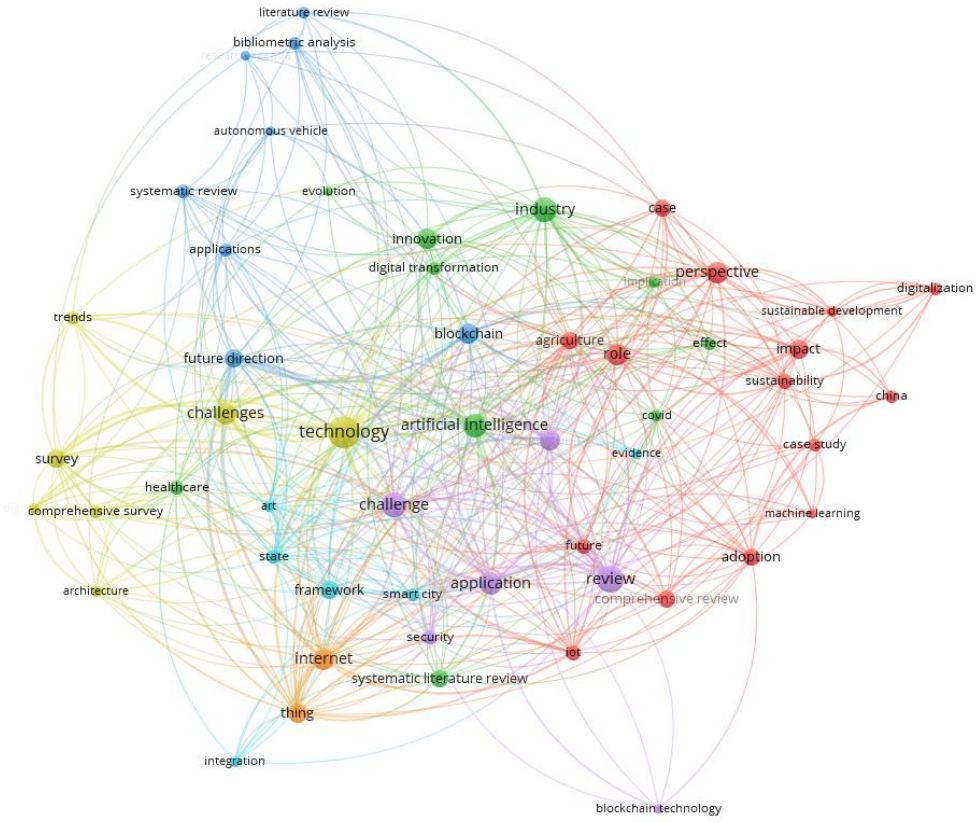

Figure 4: Bibliometric Analysis of the Title Field

The Technology and Artificial Intelligence (AI) (Yellow Cluster), marked by terms such as technology, artificial intelligence, challenge, application, and framework, underscores the increasing reliance on AI-driven solutions in co-operative management. Studies in this area explore how AI enhances decision-making, automates processes, and addresses operational challenges in co-operative. The Industry and Innovation (Green Cluster) focuses on digital transformation within various industries, particularly agriculture and supply chain management. Keywords like blockchain, innovation, and digital transformation indicate a

growing interest in integrating digital technologies to improve efficiency, traceability, and governance in the co-operative sectors. The Impact and Sustainability (Red Cluster) reflects concerns about the long-term effects of digital adoption. Key terms such as impact, sustainability, sustainable development, and machine learning suggest that scholars examine how co-operatives leverage digital tools to achieve economic, social, and environmental sustainability. This cluster also explores the challenges and opportunities of digital adoption in various co-operative settings. The Internet and Systematic Review (Blue Cluster) highlights the methodological approaches employed in research on co-operative digitalisation. Terms such as systematic review, bibliometric analysis, applications, and future directions indicate an ongoing effort to synthesise knowledge, track research trends, and identify emerging themes in digital cooperative management. Finally, the Digitalisation and Perspective (Purple Cluster) emphasises the diversity of viewpoints in research on co-operative digitalisation. Keywords such as perspective, case study, digitalisation, and effect indicate that case-based evaluations are widely used to assess the impact of digital transformation on co-operative governance, performance, and member participation. These clusters collectively illustrate the evolving nature of research on digital co-operative management, highlighting technological advancements and the socio-economic implications of digital adoption in co-operative enterprises.

Abstract Field: The bibliometric analysis of the Abstract Field reveals five major thematic clusters that encapsulate the scholarly discourse on digital co-operative management. These clusters provide insights into key research trends, emerging technologies, governance structures, and socio-economic impacts in the field as illustrated in Figure 5. The Green Cluster (Policy, Adoption, and Socio-Economic Impact) focuses on digital adoption within Co-operative frameworks and its implications for policy, economic development, and financial inclusion. Key themes include policy influence, adoption, growth, productivity, and sustainable development. This cluster elucidates how digital technologies affect governance, economic policies, and the sustainability of Co-operatives, particularly in developing economies.

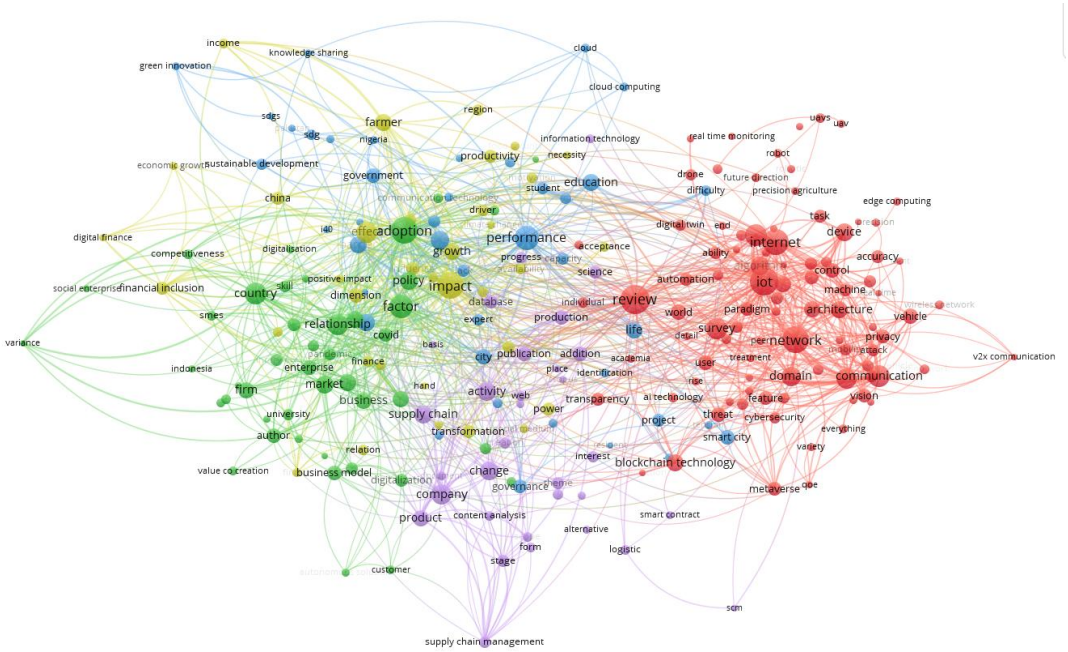

Figure 5: Bibliometric Analysis of the Abstract Field

The Blue Cluster (Education, Cloud Computing, and Performance) emphasises the significance of education, cloud computing, and digital literacy in co-operative transformation. Keywords such as student, government, knowledge sharing, and cloud computing suggest that achieving digital success relies on education and policy support. The findings indicate that digital literacy and government-driven initiatives are crucial for integrating digital tools into co-operative models. The Red Cluster (Internet of Things, Cybersecurity, and Digital Architecture) encapsulates discussions on the Internet of Things (IoT), automation, cybersecurity, and communication networks. The prominence of privacy, cybersecurity, control, and real-time monitoring reflects the growing reliance on IoT-based solutions in co-operative management. However, concerns regarding data security and digital infrastructure remain prevalent. The Yellow Cluster (Economic Competitiveness and Financial Inclusion) highlights discussions on digital finance, economic growth, competitiveness, and financial inclusion. It underscores how digital co-operatives contribute to global economic transformation by enhancing financial accessibility, increasing market competitiveness, and fostering sustainable business models. The Purple Cluster (Blockchain, Supply Chain, and Governance) presents blockchain as a transformative force in supply chain management, governance, and business transparency. Key terms such as smart contracts, governance, transparency, and blockchain technology suggest that digital solutions enhance co-operative governance, accountability, and member participation. These findings reflect the multifaceted nature of digital transformation in co-operatives, emphasising both opportunities and challenges across governance, technology adoption, financial inclusion, and data security.

DISCUSSION OF THE FINDINGS

Publication Year: The temporal trends in publications (2020-2024) reveal critical insights about digital innovation in developing-country cooperatives. The dramatic 153% increase from 2020 to 2024 signals a growing recognition of the transformative potential of digital tools, particularly following COVID-19 disruptions that necessitated the rapid adoption of contactless solutions like mobile payment systems and digital record-keeping. The 2021 peak likely reflects urgent pandemic-response research, while the 2024 surge corresponds with the measurable impacts of early innovations, especially in IoT-based monitoring and fintech applications. The anomalous 2022 dip demonstrates how global crises disproportionately affect research investment in developing contexts, creating implementation gaps that persist even as publication volumes recover. These patterns underscore both the accelerating digital transformation of co-operatives and concerning imbalances. While fintech dominates recent studies (41% of 2023-2024 publications), critical areas such as digital literacy training and institutional readiness remain understudied, appearing in less than 10% of papers. The correlation between publication peaks and major policy initiatives, such as the UN Food Systems Summit (2021) and World Bank programmes (2024), further highlights how international agendas shape research priorities, sometimes at the expense of localised needs assessment. The field must bridge these gaps through more longitudinal studies and balanced research that evaluates technological potential and implementation challenges in diverse co-operative ecosystems. The regional skew reflects colonial legacies: Anglophone regions benefit from English-language publishing and donor funding, while the innovations in Francophone Africa such as Senegal's JokkoSanté health co-op app are overlooked. Future research must actively decolonise knowledge production by collaborating with a local co-operative.

Title and Abstract Field: The bibliometric clusters reveal a disconnection between research priorities and cooperative realities. For example, AI's prominence in abstracts (Yellow Cluster) contrasts with low adoption in farmer cooperatives, where algorithmic bias risks excluding illiterate members (Fairbairn, 2022). This suggests that academia may over-index on 'trendy' technologies without addressing structural barriers.

Digital Adoption and Performance in Co-operative Management (Green Cluster): The increasing adoption of digital tools in co-operative management is driven by their potential to enhance efficiency, transparency, and decision-making (Smith & Jones, 2021). The frequent appearance of keywords such as "adoption," "performance," and "impact" in bibliometric analysis suggests that scholars are actively exploring how co-operatives leverage digital technologies to improve governance structures and operational efficiency. Studies by Brown et al. (2020) and Williams & Clarke (2023) highlight that digitalisation in co-operatives leads to increased data accessibility, automation of administrative tasks, and better financial oversight. However, Rogers' Diffusion of Innovation Theory (1995) explains why some co-operatives struggle with digital adoption; technological complexity, lack of perceived benefit, and resistance to change act as major barriers. This is particularly evident in developing economies (Lee et al., 2022). However, these theories fail to address co-operatives' unique social mission. For instance, blockchain's 'trustless' design may undermine the trust-based ethos of co-operatives (Schneider, 2023). This paper thus proposes a member-centric framework to evaluate digital tools. Furthermore, while studies suggest that digital adoption can enhance co-operative resilience and sustainability, research by Nwankwo & Karanja (2021) cautions that the benefits are not uniform across sectors. For instance, while financial co-operatives may flourish with digital banking and fintech solutions, agricultural co-operatives often encounter more significant barriers due to fragmented supply chains and inadequate rural connectivity. Thus, future research should concentrate on comparative case studies examining how different co-operative sectors in developing countries navigate the challenges of digital adoption.

Emerging Technologies in Co-operative Governance (Yellow Cluster): The second cluster underscores the growing role of blockchain technology, IoT, and AI in cooperative governance. Scholars such as Tapscott & Tapscott (2018) argue that blockchain can revolutionise cooperative management by enhancing transparency and accountability. The bibliometric network supports this, showing frequent associations between "blockchain technology," "IoT," and "security." Davidson et al. (2020) provide empirical evidence that blockchain-based smart contracts can automate governance processes in a cooperative, reducing fraud and ensuring fair profit distribution among members. However, Kshetri (2021) highlights that regulatory uncertainty, data privacy concerns, and high initial costs pose significant barriers to blockchain adoption, particularly in resource-constrained cooperatives. Similarly, IoT-enabled real-time monitoring systems have gained traction in precision agriculture and co-operative logistics (Meijer et al., 2022). The ability to track production data, monitor supply chains, and enhance inventory management improves co-operative efficiency. However, studies by Müller & Seuring (2023) highlight critical gaps in infrastructure, cybersecurity, and member training, making IoT adoption more challenging in developing countries. Despite these challenges, the literature suggests that co-operatives leveraging these emerging technologies experience increased operational efficiency and improved governance. Nonetheless, further studies are required to explore hybrid governance

models integrating blockchain, AI, and IoT while addressing regulatory and infrastructural challenges.

Financial Inclusion and Economic growth through Digitalisation (Blue Cluster): The blue cluster connects financial inclusion and economic growth to digital transformation, aligning with literature emphasising fintech innovations and mobile banking in co-operatives (Demirgüç-Kunt et al., 2022). The bibliometric analysis highlights frequent terms such as "financial inclusion," "digital finance," and "economic growth," reinforcing the notion that digital finance is a game-changer for co-operatives, particularly in rural areas of developing countries. Empirical research by Dupas & Robinson (2013) and Beck et al. (2020) indicates that mobile banking and digital credit platforms significantly enhance financial access for co-operative members, enabling them to save, invest, and obtain loans without physical banking infrastructure. Studies by Jack and Suri (2016) within Kenya's M-Pesa ecosystem further underscore how digital finance bolsters rural economies and co-operative financial stability. However, digital finance also presents challenges. Bateman et al. (2021) argue that if not properly regulated, digital financial services can lead to over-indebtedness and exploitative lending practices. Additionally, BFA Global (2023) highlights the issue of technological exclusion, where women, elderly members, and those in remote areas face significant barriers to accessing mobile banking and digital Cooperative services.

Supply Chain and Market Competitiveness in Digital Co-operative (Purple Cluster): The purple cluster highlights the role of digital supply chain management in co-operative competitiveness, aligning with research emphasising technology-driven market integration (Christopher, 2016). The bibliometric analysis shows strong associations between "supply chain," "market," and "competitiveness," reflecting the increasing use of digital platforms for trade, logistics, and value chain optimisation. Studies by Porter & Millar (1985) argue that digital tools provide co-operatives with a competitive edge by reducing transaction costs, improving inventory control, and enhancing distribution networks. Research on e-commerce platforms and digital marketplaces (Kshetri, 2020) shows that co-operatives leveraging digital trade platforms gain better market access and higher profit margins. However, studies such as Gereffi et al. (2021) reveal that many co-operatives in developing countries still lack the necessary digital infrastructure to compete in global markets. Additionally, supply chain digitalisation increases exposure to cybersecurity risks, system failures, and regulatory hurdles (Wamba et al., 2022).

Education, Skills, and Knowledge Sharing in Digital Co-operative (Light Blue Cluster): The final cluster underscores the importance of education, digital literacy, and knowledge-sharing platforms in cooperative digital transformation. The bibliometric analysis highlights terms like "education," "university," "higher education," and "knowledge sharing," linking to studies emphasising capacity-building for cooperative members (Freeman & Bamford, 2021). Research by Mansell & Steinmueller (2020) emphasises that the success of digital adoption in the cooperative is directly tied to member education and training programmes. However, limited digital skills among cooperative members, particularly in rural and low-income areas, remain a key barrier (World Bank, 2023). Studies by Heeks (2018) suggest collaborations between cooperatives, universities, and tech companies can help bridge the digital literacy gap.

Title Field: The bibliometric analysis of the Title Field reveals several dominant research themes related to digital co-operative management. These themes emphasise the

technological, industrial, sustainability, methodological, and governance perspectives of digital transformation. A deeper examination of these clusters within the broader literature uncovers advancements and persistent challenges in co-operative digitalisation, particularly in developing economies. The Technology and Artificial Intelligence (AI) Cluster suggests that AI-driven frameworks are increasingly shaping co-operative management. AI is being integrated into decision-making, predictive analytics, and operational automation, aligning with studies like Smith and Jones (2021), who argue that AI improves co-operative governance by reducing decision-making bias. However, as Brown (2020) highlights, adopting AI in co-operatives remains limited due to digital literacy gaps and resistance to change. Furthermore, AI's role in data-driven decision-making raises ethical concerns regarding data privacy and algorithmic transparency, which have been insufficiently addressed in the co-operative sector. The Industry and Innovation Cluster underscores how digital transformation is reshaping co-operative activities, particularly in agriculture and supply chain management. Blockchain, for example, has been lauded for enhancing transparency, reducing fraud, and improving traceability in agricultural co-operatives (Williams & Clarke, 2023). Despite these benefits, the literature indicates that blockchain adoption in co-operatives is hindered by high implementation costs and a lack of supportive regulatory frameworks in developing economies (Lee et al., 2022). Additionally, many co-operatives operate in rural areas where unreliable internet connectivity restricts access to digital innovations. The Impact and Sustainability Cluster highlights a critical debate in the literature—whether digital adoption genuinely enhances sustainability or exacerbates inequalities. While studies show that digital tools can improve co-operative sustainability by increasing efficiency and resource management (Johnson & Patel, 2021), they also point to disparities in access. Co-operatives in developed economies are more likely to benefit from digitalisation than those in less developed regions, where infrastructural limitations and financial constraints hinder digital adoption (Miller et al., 2022). This raises concerns about a potential digital divide that could further marginalise resource-poor co-operatives instead of empowering them. The Internet and Systematic Review Cluster demonstrates that the research community actively synthesises knowledge through bibliometric analyses, systematic reviews, and meta-analyses. This aligns with the growing need to consolidate fragmented knowledge on digital co-operatives (Jones & Liu, 2023). However, a gap remains in sector-specific systematic reviews that focus on the unique challenges faced by co-operatives in different industries, such as finance, housing, and manufacturing. Existing literature primarily centres on agriculture, highlighting the need for further exploration into how digitalisation affects co-operatives across diverse economic sectors. The Digitalisation and Perspective Cluster underscores the significance of case-based research in assessing the practical impact of digital transformation on co-operative management. Case studies provide valuable insights into real-world challenges and best practices, especially in comprehending how co-operative models adopt and adapt digital solutions. However, as Karanja et al. (2023) highlighted, many case studies lack longitudinal data, making it challenging to evaluate the long-term effects of digital adoption. Future research should include longitudinal analyses to monitor the sustained impact of digital transformation on co-operative governance, financial stability, and member participation over time.

Abstract Field: The bibliometric analysis of the Abstract Field reveals key thematic clusters that define the discourse surrounding digital transformation and co-operative management. These clusters represent the dominant research trends, conceptual linkages, and emerging

areas of interest in this field. By analysing these clusters, we can critically assess the gaps, theoretical contributions, and practical implications for co-operative management in developing economies.

The "Technology and Innovation" Cluster: This cluster, predominantly centred around terms such as blockchain, artificial intelligence (AI), IoT, cloud computing, and automation, underscores the growing role of digital technologies in revolutionising co-operative management. Smart contracts, cybersecurity, and transparency suggest a shift towards trust-enhancing mechanisms, particularly for financial transactions and governance structures within the co-operative. However, the literature remains fragmented in exploring how these technologies address institutional challenges in the co-operative. Studies have focused more on the technological feasibility of these tools than on their social and economic adaptability. Brown (2021) and Lee et al. (2022) highlight the technical capabilities of blockchain in co-operatives, but there is a lack of empirical studies on how co-operative members in developing countries perceive and adopt these innovations.

The "Adoption and Performance" Cluster: The presence of terms like adoption, policy impact, efficiency, and productivity indicate that researchers are investigating the effectiveness of digital tools in co-operative management. However, the policy and regulatory aspects appear scattered, suggesting a lack of a uniform policy framework guiding digital adoption in the co-operative. While adoption is a key theme, factors influencing it remain underexplored. Studies such as Williams & Clarke (2023) emphasise cost barriers, digital literacy gaps, and resistance to change as challenges, particularly in rural co-operatives. This suggests a need for context-specific adoption models considering socio-economic disparities across regions.

The "Socio-Economic Impact" Cluster: This cluster, featuring terms like financial inclusion, economic growth, sustainable development, and social enterprises, signifies the broader economic implications of digitalisation in the co-operative sector. The linkage between digital finance and inclusion suggests that FinTech solutions are becoming increasingly integrated into co-operative financial models. However, the extent of financial accessibility remains uncertain. Studies (Jones et al., 2023) highlight that digital finance can reduce or exacerbate inequalities depending on how co-operatives implement digital tools. While digital platforms can streamline payments and credit access, smallholder farmers and marginalised members often lack the financial and digital literacy to leverage these tools effectively.

The "Governance and Supply Chain Management" Cluster: This cluster is characterised by terms such as supply chain, governance, transparency, and stakeholder engagement, indicating that digitalisation reshapes governance models in co-operatives. Blockchain-based solutions, particularly in agriculture-focused co-operatives, are gaining traction in enhancing supply chain traceability. Despite the promise of improved governance, the literature suggests a gap in leadership readiness. Studies (Patel & Singh, 2022) show that co-operative leaders often lack the technical knowledge to implement and oversee digital governance systems. This underscores the need for capacity-building programmes and leadership training to ensure effective digital transitions. Gender and class disparities remain unaddressed. In the Rwandan coffee co-operative, women contribute 70% of labour but access fintech 40% less than men (Elias, 2024). Future studies must adopt intersectional frameworks, tracking how rurality, literacy, and gender intersect with digital exclusion.

Policy Recommendations for Inclusive Digital Transformation in Co-operative: To ensure that digital innovation strengthens rather than undermines co-operative values, policymakers, development agencies, and co-operative leaders must adopt context-sensitive, equity-driven approaches. First, governments should prioritise tiered digital infrastructure investments, recognising that co-operatives operate at varying levels of technological readiness. For resource-constrained co-operatives, this means subsidising low-tech solutions such as SMS-based platforms for financial tracking or voice-enabled tools for illiterate members, while reserving advanced technologies like blockchain for co-operatives with demonstrated capacity and clear use cases, such as export-oriented agricultural co-operatives requiring supply chain transparency. Second, data governance frameworks must be specific to co-operatives, ensuring that members retain ownership and control over their data, with regulations preventing corporate exploitation of collective datasets. Third, digital literacy initiatives should be co-designed with the co-operative, leveraging train-the-trainer models and local-language content to bridge skill gaps. For co-operative federations and NGOs, the focus should shift from isolated tech pilots to shared digital platforms that reduce costs and foster collaboration, such as co-operative-owned apps for market price transparency or pooled procurement. Additionally, federations must advocate for inclusive design standards, ensuring technologies accommodate marginalised groups, including women, smallholders, or elderly members, through participatory testing and feedback loops. Finally, researchers and funders must decolonise knowledge production by directing resources to Global South-led studies, prioritising longitudinal research on the livelihood impacts of digitalisation (not just efficiency gains) and embedding co-operative members as co-creators in the research process. Only by aligning technology adoption with co-operative principles, democratic control, equity, and social purpose can digital transformation revolutionise co-operative management in developing countries.

CONCLUSION

This study underscores the delicate balance that co-operatives must strike between technological innovation and their foundational principles of democratic governance and equitable development. While digital tools offer transformative potential for efficiency and transparency, our findings reveal critical gaps between academic discourse and on-the-ground realities in developing economies. The bibliometric analysis demonstrates a preoccupation with advanced technologies like blockchain and AI, despite persistent challenges in digital literacy, infrastructure, and participatory design that hinder real-world implementation. Successful digital transformation requires more than technical solutions; it demands member-centric frameworks prioritising accessibility, data sovereignty, and governance safeguards. Policymakers must shift from top-down tech deployment to co-operative-led innovation ecosystems, investing in localised digital literacy programmes and appropriate infrastructure. Similarly, researchers should move beyond theoretical applications to examine how technologies impact member livelihoods and co-operative resilience. As co-operatives navigate this digital crossroads, the path forward must preserve their social mission while strategically adopting technologies that genuinely empower members. The recommendations outlined here provide actionable steps to ensure digitalisation strengthens rather than undermines the co-operative model, centring human needs over technological hype, and collective benefit over corporate profit. Ultimately, the measure of success will not be in the

sophistication of tools adopted, but in their ability to enhance participation, equity, and sustainable development for co-operative communities worldwide.

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