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Corresponding author:
Anjun Nikmah Wakhidatul Muarifah
Email : anjunnikmah24@gmail.com

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FINTECH START-UP INNOVATION: THEMATIC AND BIBLIOMETRIC ANALYSIS OF EMBEDDED FINANCE AND AI TRENDS USING VOSVIEWER

Anjun Nikmah Wakhidatul Muarifah[1], Nur Novianti[2]

[1,2] *Universitas Alma Ata Yogyakarta, Indonesia*

ABSTRACT

Objective: This study aims to identify and map the main trends in FinTech literature from 2015 to 2025, particularly those related to embedded finance and artificial intelligence (AI).

Research Design & Methods: Adopting an exploratory qualitative approach, this study focuses on literature and bibliometric analysis. Data was collected from the Scopus database, with additional literature from Google Scholar as a supplementary source, covering publications from 2015 to 2025 using the keywords fintech, AI, embedded finance, and trust.

Findings: VOSviewer analysis places fintech as a central node with major clusters covering AI & risk management, embedded finance, user trust, regulation, financial inclusion, and blockchain. Since 2019, publications on "Fintech AI" have surged significantly, while "Embedded Finance AI" shows a declining trend due to its integration into general FinTech. AI drives efficiency and risk mitigation, embedded finance simplifies financial services, and trust and adaptive regulation issues remain key focuses.

Implications & Recommendations: These findings highlight the importance of redefining digital trust, responsible AI governance, and collaboration between startups and banks. Regulators need to adopt a principle-based adaptive approach.

Contribution & Value Added: This research offers data-driven strategic references for academics, startups, and regulators, and serves as a foundation for further empirical studies using innovative combined methodological approaches.

Keywords: FinTech, Artificial Intelligence (AI), Embedded Finance, Trust, Bibliometric Analysis.

JEL codes: G21, O33, L26
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INTRODUCTION

The financial technology (FinTech) industry has experienced rapid and intensive growth. This growth has been driven by various factors, including substantial expansion in the banking sector, accelerated digitalization, changing consumer preferences, and increased support from investors and regulators (Singh and Johri, 2024). This phenomenon is reflected in the significant increase in venture capital (VC) funding, which jumped from $19.4 billion in 2015 to $33.3 billion in 2020. Furthermore, there was a 177% year-on-year surge in funding, reaching $92.3 billion (Johan, 2024). Despite a 40% decline in funding to $55 billion in 2022, FinTech's share of total VC funding

remained stable at 12%, demonstrating its continued resilience and strategic relevance (MCKinsey and Company, 2023). Projections show that revenue in the FinTech industry is expected to grow nearly three times faster than the traditional banking sector between 2022 and 2028, with an annual growth rate of 15% compared to 6% (Johan, 2024). Additionally, FinTech accounts for 20.8% of global unicorns, solidifying its position as the leading industry for high-growth startups (Vaklinski, 2025).

In this dynamic landscape, the emergence of embedded finance and the critical role of artificial intelligence (AI) are fundamentally transforming traditional financial services. Embedded finance seamlessly integrates financial offerings, such as payments, loans, and insurance, into non-financial platforms and everyday activities, making financial interactions more accessible and intuitive (Al-Gasaymeh et al., 2023). This trend is driven by advances in Application Programming Interface (API) technology, strategic partnerships between financial and non-financial entities, and growing consumer demand for convenience (Hensen and Kötting, 2022). The global embedded finance market is projected to reach $7.2 trillion by 2030, underscoring its transformative potential (Hendi, 2025). At the same time, AI and machine learning (ML) are increasingly being adopted in the financial industry to address specific challenges, including maximizing profits, minimizing risk, supporting customer service functions, identifying investment opportunities, improving lending models, and preventing fraud. AI is expected to accelerate embedded finance by enabling real-time processing, improving security, and facilitating highly personalized financial services (Anugu, 2025).

Understanding the direction of current research in these rapidly evolving fields is critical to guiding innovation and policy. For example, regulators face complex challenges related to the implications of AI for data privacy, potential bias, consumer outcomes, and systemic risk (PwC, 2023). Similarly, the expansion of embedded finance requires the development of a new regulatory framework to ensure strong consumer protection and data security within this integrated ecosystem. Systematic mapping of academic literature provides a vital basis for strategic decision-making by academics, innovators, and policymakers.

Despite the significant growth and impact of FinTech, embedded finance, and AI, a comprehensive and systematic mapping of the academic literature from Scopus, explicitly focusing on the intersection of the three and incorporating the critical aspect of user trust, remains a prominent research gap. While existing bibliometric studies have explored FinTech in general, embedded finance, or AI in finance separately or over different periods, integrated thematic and bibliometric analysis using VOSviewer to uncover emerging trends and conceptual relationships within this dynamic intersection is currently lacking.

The development of FinTech shows resilience and maturity amid funding fluctuations, indicating a shift towards value-based growth. Initial data shows a surge in venture capital funding for FinTech in the second half of the 2010s but indicates increased diversification and signs of long-term stability despite an absolute decline in subsequent years, demonstrating the structural maturity of the industry (Cornelli et al., 2021). However, most importantly, the proportion of FinTech in total VC funding has remained stable. This is not merely a cyclical decline but a more profound structural change. The stability of FinTech's share in overall venture capital, despite a broader economic shift toward higher interest rates and inflation, shows that investors are not abandoning the sector (Cornelli et al., 2021). Instead, this is leading to the maturing of the industry. The focus will likely shift from speculative hyper-growth models to more sustainable, value-based propositions (Brown, 2017). This implies a phase of consolidation and strategic emphasis on profitability and proven business models, rather than solely on user acquisition or market share. This maturation also supports a growing model of cooperation, in which FinTech and traditional banks strategically collaborate, leveraging each other's strengths for mutual benefit and market expansion (Mohan, 2016).

Embedded finance catalyzes deepening financial inclusion, especially in underserved markets (Sam-Bulya et al., 2021). Embedded finance integrates financial services into non-financial platforms, driven by consumer convenience (Ochuba et al., 2024). At the same time, the growth potential of FinTech is highlighted in emerging markets due to the high proportion of underserved

populations. AI is noted for accelerating embedded finance by enabling customized financial solutions and loans for freelancers and SMEs who do not have a traditional credit history (Aishwaryalaxmi et al., 2024). The convergence of embedded finance and AI goes beyond mere transactional convenience for existing financial consumers. It represents a profound shift in how financial services can reach historically underserved populations globally. By integrating financial tools into everyday digital ecosystems, this innovation can bypass traditional banking infrastructure that is often inaccessible, thereby democratizing access to credit, payments, and other financial services (Omokhoa et al., 2021). This suggests that the next wave of financial inclusion will be driven by innovative, contextual platforms that anticipate and meet users' needs directly in their everyday digital lives, rather than through conventional branch-based models.

However, AI in finance is a double-edged sword, unlocking value while introducing systemic risk. AI is praised for its transformative potential, offering efficiency, cost savings, and improved accessibility and accuracy (Tierno, 2024). However, the same source also warns about heightened risks related to data privacy, quality, security, and the potential for AI to introduce or exacerbate bias (PwC, 2023). Regulators are deeply concerned about systemic and long-term risks related to market resilience, large-scale misinformation, and the loss of control over robust AI systems, as well as AI's ability to complement scammers with new capabilities (Uuk et al., 2024). The widespread integration of AI into financial services presents complex trade-offs (Alonso and Chatzianastasiou, 2024). Although AI promises unprecedented value creation through automation, personalization, and risk management, its rapid and widespread adoption, especially with self-learning models and large language models (LLMs), introduces new systemic vulnerabilities (Goodman, 2024). Reliance on shared data and concentrated technological capacity can encourage monoculture or herd behavior, which has the potential to cause widespread financial instability during market shocks (Paul, 2022). This requires a proactive and adaptive regulatory approach that not only regulates the application of AI but also anticipates and mitigates its broader systemic consequences, ensuring that innovation is balanced with strong oversight and ethical considerations.

This study aims to examine the development of major trends in FinTech research, particularly those related to embedded finance and artificial intelligence (AI) during the period 2015–2025. The primary focus is to understand how concepts such as trust, regulation, and technology are interrelated in scientific literature, as well as to formulate key themes and conceptual models from the findings. To this end, this study employs a bibliometric approach using VOSviewer to visually map keywords, authors, and relationships between concepts. Additionally, a thematic analysis of key articles is conducted to develop a conceptual framework that reflects the current direction of FinTech research. The findings of this study are expected to serve as a strategic reference for academics, startup practitioners, and regulators, as well as a foundation for further empirical research. Additionally, this study introduces a combined methodological approach between bibliometrics and thematic analysis that can provide a more comprehensive understanding of the dynamics of research in the FinTech field.

LITERATURE REVIEW

Basic Concepts of Fintech and Financial Startups

FinTech is a financial innovation that utilizes advanced technology to improve financial services (Moro-Visconti, 2021). The main characteristic is agile and often unexpected innovation in expanding, automating, and scaling financial products (Michigan Tech, 2025). The definition of FinTech is dynamic, with mature technologies moving from cutting edge to status quo (Scardovi, 2016).

FinTech provides services to various types of clients (B2C, B2B, hybrid) with solutions that complement each other, often improving existing products or processes to make them better, faster, and cheaper (Kholia, 2021). Innovation is the core, not always disruption. The creation of FinTech is driven by opportunities, the need for advanced technology, regulatory compliance, increased

productivity/profitability, and accessibility to financial services anywhere and anytime (Kapoor et al., 2024). The evolution of FinTech shows a shift from pure disruption to strategic integration and cooperation with traditional banks, creating a more symbiotic financial ecosystem (Çalışkan, 2025; Hendi, 2025).

Embedded Finance: Definition and Implementation in the Digital Ecosystem

Embedded finance is the seamless integration of financial services (payments, loans, insurance, investments) into non-financial platforms, bringing services to the moment they are needed (Çalışkan, 2025; Sambakiu, 2025). The evolution is driven by API advancements, FinTech partnerships, regulatory shifts, and consumer demand for convenience (Çalışkan, 2025; Fu et al., 2022; Kadam et al., 2024). The implementation of embedded finance shows a wide variety of practices. Real-world examples include embedded banking, such as providing bank accounts directly within transportation service apps like Lyft; embedded payments, such as the one-click payment feature in the Starbucks app; embedded lending, such as Buy Now, Pay Later (BNPL) schemes available at the point of sale; embedded insurance, in the form of protection coverage offered directly in the context of a purchase; embedded investments, which are investment options available within non-investment apps; and super apps, which are integrated platforms like Revolut that combine various financial services into a single ecosystem (Clement, 2025; Sullivan, 2024). Impacts of this model include increased financial inclusion, reduced transaction friction, a more personalized user experience, and the opening of new revenue streams for non-financial companies (Çalışkan, 2025). This phenomenon illustrates the emergence of invisible financialization, where financial services become an integral and hidden part of everyday digital activities (Milian et al., 2019). For non-financial companies, financial services integration is no longer optional, but has become a strategic step to transform into a broader digital ecosystem orchestrator (Çalışkan, 2025).

The Role of Artificial Intelligence in Digital Financial Services

Artificial intelligence (AI) in the financial sector refers to the application of advanced computing systems capable of learning, reasoning, and making autonomous decisions to generate insights in data analysis, predictions, and customer service improvements (Giudici and Raffinetti, 2023). This technology significantly improves automation in the delivery of financial services. The main applications of AI in this industry include service personalization, risk management and fraud detection, operational automation such as Know Your Customer (KYC) and the use of chatbots, identification of investment opportunities, and expansion of financial inclusion through alternative data-based credit assessment (Gafsi, 2025; Mhlanga, 2020; Okat et al., 2025; Pazouki et al., 2025; Tomaszewski, 2023). Additionally, generative AI is beginning to be used in product development and customer interactions (Shabsigh, 2023). AI adoption is being driven by rapid advances in hardware technology and big data analytics capabilities (Maple et al., 2023). However, various challenges have emerged, such as algorithmic bias due to unrepresentative training data, privacy and data quality issues, potential systemic risks arising from algorithmic homogeneity (monoculture) and herding behavior, and the emergence of new forms of fraud enabled by AI (Çalışkan, 2025; Gehrmann et al., 2025). On the regulatory side, existing legal frameworks are often unable to keep pace with the rapid pace of AI innovation, creating regulatory gaps and increasing compliance complexity (Maple et al., 2023). Overall, AI is transforming financial services from a reactive to a proactive and anticipatory approach, and driving the formation of an increasingly autonomous financial ecosystem.

Customer Trust in Financial Technology

Digital trust is essential for successful interactions in the digital environment, as it reduces perceived risk (Saveljeva and Volkova, 2025). Trust in FinTech ecosystems can be conceptualized as a combination of trust in individuals, processes, and technology, where data protection, privacy, and information transparency are crucial factors that influence user perceptions (Saveljeva and Volkova, 2025). Although there is a general view that distrust of traditional financial institutions is the primary driver of FinTech adoption, empirical findings show that this assumption is not always

consistent (Okat et al., 2025). Factors such as convenience, speed of service, and cost efficiency are often more significant determinants in the decision to use FinTech services. Trust in FinTech is complex and multidimensional, influenced by a seamless user experience, transparency in cost structures, clear communication, and reliable cybersecurity systems (Tan, 2025). In context of artificial intelligence adoption, the need for a robust and accountable governance framework is becoming increasingly important to ensure that AI integration is carried out responsibly in order to maintain and strengthen public trust.

Bibliometric Analysis and Visualization Approach with VOSviewer

Bibliometrics is a quantitative approach used to analyze scientific literature, identify research trends, and determine the contribution and influence of previous studies, thereby providing a strong theoretical foundation for further research (Wijayanti et al., 2024). This method is effective in identifying key words and mapping the direction of future research. Common types of bibliometric analysis include citation networks (including direct citations, co-citations, and bibliographic couplings), keyword co-occurrence networks (keywords that frequently appear together in the literature), and co-authorship networks (collaborative relationships between authors, institutions, or countries) (Patty et al., 2024). VOSviewer, as software widely used in bibliometric analysis, enables network visualization based on a distance-based approach (Van Eck and Waltman, 2014). The use of this tool significantly improves efficiency, accuracy, and validity in the analysis process. Its main functionalities include processing data from various databases such as Scopus and Web of Science, as well as from Google Scholar via the Publish or Perish application, constructing bibliometric networks, thematic mapping and clustering, overlay visualization to show temporal trends, and density visualization to illustrate the concentration of research topics, as well as text mining features for in-depth exploration of scientific content (Jafri et al., 2025; Van Eck and Waltman, 2014). Integration between bibliometric and thematic analysis is essential to gain a more comprehensive understanding of the dynamics and evolution of a field of study.

METHODS

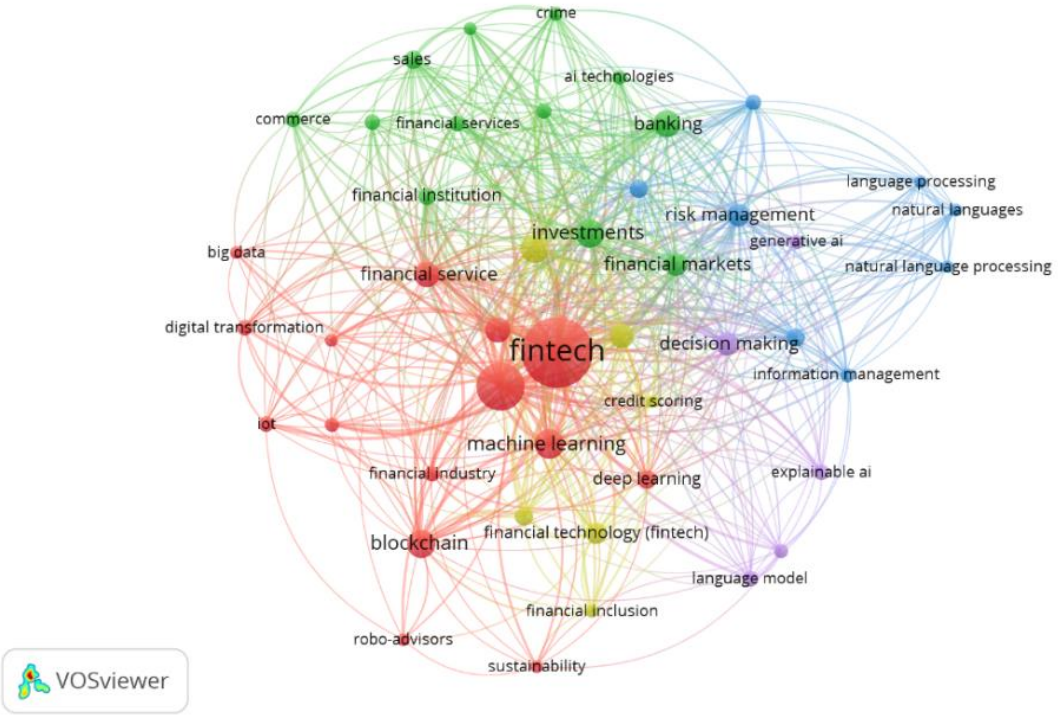
This study adopts an exploratory qualitative approach, centered on literature and bibliometric analysis, to identify and map trends, conceptual relationships, and intellectual structures in FinTech academic literature, particularly those related to embedded finance and AI, with a focus on publications from 2015 to 2025. Data will be collected from reputable bibliographic databases, namely Scopus, with Google Scholar as an additional source to broaden the scope of the literature. Inclusion criteria include articles using a combination of relevant keywords such as fintech, AI (Artificial Intelligence), embedded finance, and trust in the title, abstract, and author keywords. The extracted data will be stored in CSV format, which is compatible for import into VOSviewer, and may require initial cleaning such as author name format correction. Once the data has been collected and cleaned, VOSviewer will be used for bibliometric analysis, including keyword visualization (keyword co-occurrence) to show the relationships between terms, clustering to identify dominant research clusters, and trend mapping (overlay/density visualization) to show temporal evolution and areas of research concentration. Thematic analysis will complement this with open coding of article content within dominant clusters, identification of subthemes and main narratives, and the development of a conceptual framework that describes the knowledge structure in this field. The validity of the findings will be ensured through triangulation between articles and between clusters.

RESULT

VOSviewer Visualization Results

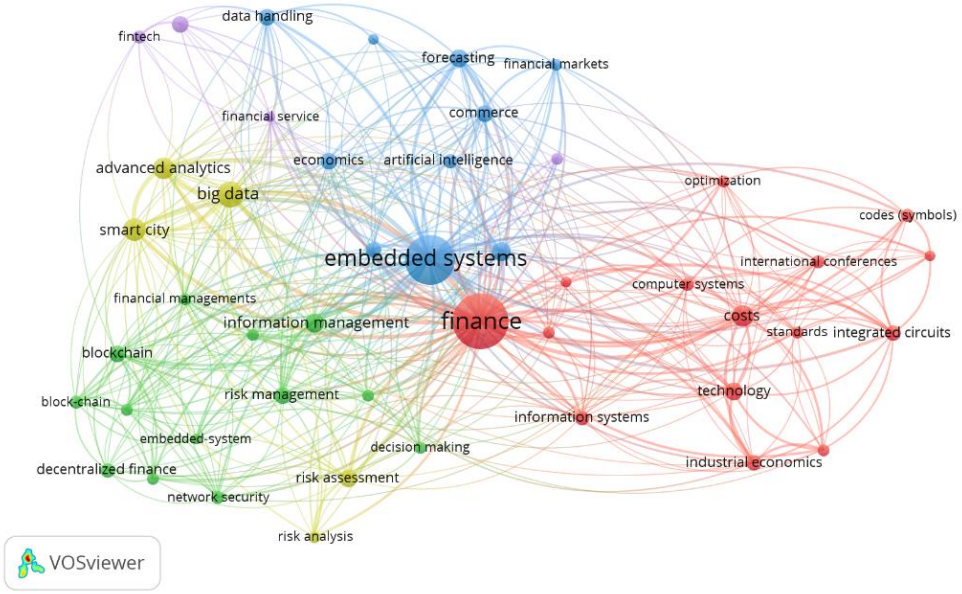
Based on the results of bibliometric analysis using VOSviewer software, a visualization of keyword networks was obtained that describes the intellectual structure and dominant trends in the field of FinTech research. This visualization shows a map of keyword co-occurrence, where the

term fintech appears as the central node with the largest size, indicating that this theme is the central point and most frequently discussed in the analyzed literature. From this visualization, several clusters have formed, representing concentrations of specific topics that are closely related thematically and conceptually.



The first cluster, marked in red, focuses on the themes of digital transformation and blockchain technology. Key terms in this cluster include "digital transformation," "big data," "IoT," "financial industry," "financial service," and "blockchain." The presence of the term "robo-advisors" indicates a focus on innovations in artificial intelligence-based financial services, particularly in automated investing. This cluster reflects the literature's attention to the role of digital technology in driving systemic change in the financial sector. The second cluster, colored yellow, is closely related to the application of AI and risk management in FinTech. Keywords such as "machine learning," "deep learning," "credit scoring," "decision making," "explainable AI," and "generative AI" indicate that research in this cluster places a strong emphasis on the development and application of artificial intelligence to support faster, more accurate, and more transparent decision-making processes. The integration of technologies such as natural language processing and language models also shows a push toward more advanced and interpretive AI. The third cluster, colored green, focuses on financial services and the banking sector, with keywords such as "financial services," "commerce," "sales," "financial institution," "investments," and "banking." The terms "crime" and "AI technologies" that appear in this cluster underscore the focus on the use of AI for risk mitigation, including in the prevention of fraud and financial crime. This cluster highlights the close relationship between FinTech, AI, and the operations of conventional financial institutions. Finally, the fourth cluster, marked in blue, shows a focus on risk management and natural language processing. Keywords such as "risk management", "language processing", "natural languages" and "information management" indicate that research in this cluster focuses on how technology, particularly language-based AI, is used to manage and analyze risks based on textual data. This reflects a trend in the literature that utilizes NLP (Natural Language Processing) to improve the efficiency of information management in the financial sector.

Overall, the results of this visualization show that FinTech research in the last decade has developed in a multidisciplinary manner, with strong links between digital technology, AI, financial institution transformation, and attention to transparency and risk management. This mapping provides a solid basis for identifying future research directions and developing a conceptual framework that reflects the development and integration of technology in future financial services.



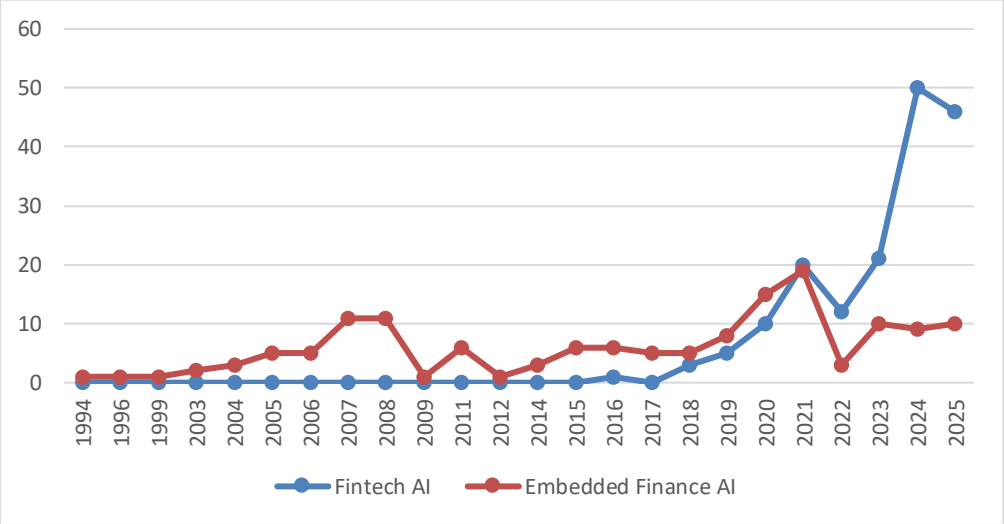
The results of bibliometric analysis using VOSviewer show that the topic of embedded finance has a strong multidisciplinary interconnection structure, as visualized in the keyword co-occurrence map. The terms embedded systems and finance appear as two dominant nodes that are closely connected, indicating that these two concepts form the core of the embedded finance discourse in scientific literature. This visualization forms several main thematic clusters that reflect the direction and complexity of research in this field. The blue cluster, which is the central cluster, centers on the keywords "embedded systems" and "finance," and is connected to terms such as "artificial intelligence," "data handling," "economics," "financial services," "commerce," "financial market forecasting," and "fintech." These findings indicate that embedded finance involves not only the integration of embedded systems into financial services, but also its connection to AI in supporting market forecasting, service efficiency, and the automation of financial transactions within the digital commercial ecosystem.

Meanwhile, the green cluster represents the realm of decentralized information and financial management. This cluster includes terms such as "information management," "financial management," "risk management," "blockchain," "decentralized finance," "network security," "embedded system," and "risk assessment". This shows that embedded finance is developing within a digital ecosystem that requires complex information management and secure technological infrastructure. The presence of terms such as "blockchain" and "decentralized finance" underscores the shift toward a more open, safe, and decentralized financial model, with risks that need to be managed systematically. The red cluster describes the technological foundations and industrial context of embedded finance. Key terms include "technology," "computer systems," "information systems," "costs," "standards," "integrated circuits," and "industrial economics." This cluster reflects that the development of embedded finance is inseparable from considerations of costs, technological standardization, and industrial economic dynamics. Additionally, its connection to "international conferences" indicates that the discourse on embedded finance is also receiving widespread attention in global academic and professional forums.

Overall, the results of this visualization show that embedded finance research is developing in three main areas: the integration of technology and AI in financial systems, risk and data management in decentralized ecosystems, and the technological and industrial foundations that enable the widespread adoption of these innovations. These findings reinforce the importance of a cross-disciplinary approach to understanding and developing embedded finance holistically.

Analysis of Publication Trends by Year

Based on a Scopus search, research on Embedded Finance AI has existed since 1994. In the early period before 2015, research that explicitly combined "Fintech" and 'AI' (the "Fintech AI" column) was almost non-existent, with zero publications in most years. In contrast, the field of "Embedded Finance AI" (which may include research on embedded systems with financial implications, even before the term "Fintech" became popular) showed a small but consistent number of publications, peaking in 2007 and 2008 with 11 publications. This indicates that the concept of technology integration in finance, although not yet referred to as "Fintech AI," has begun to be explored. Entering the 2015-2019 period, there was an interesting change. Research on "Fintech AI" began to emerge in 2016 with one publication, showing a gradual increase to three in 2018 and five in 2019. Meanwhile, "Embedded Finance AI" remained relatively stable or saw a slight increase, ranging from 5 to 8 publications. This period marked the initial emergence of AI specifically within the FinTech context as a distinct field of research.



Over the past decade, Fintech AI research has shown exponential growth, particularly post-2018, with a significant surge beginning in 2020 and peaking in 2024 before leveling off slightly in 2025. In contrast, Embedded Finance AI experienced a brief momentum in 2020–2021, but its publication trend has declined and stabilized at a low level since 2022. This difference in patterns indicates that global research focus is more inclined toward the development of Fintech AI, while interest in Embedded Finance AI has remained relatively stagnant following its initial adoption phase.

Thematic Categorization of Literature

Based on the clusters identified from VOSviewer visualization and in-depth thematic analysis, the main themes in FinTech literature can be categorized as follows. The results of thematic analysis of FinTech literature produced five main clusters that represent the direction of contemporary financial technology research and development.

Dominant Clusters	List of Key Themes	Summary of Findings by Theme and Source	Examples of Dominant Article Focuses
1. Artificial Intelligence	– Machine learning and deep learning in finance	AI accelerates operational efficiency and financial	(Benkerroum et al., 2020; Deng, 2020; Liu et al.,

Dominant Clusters	List of Key Themes	Summary of Findings by Theme and Source	Examples of Dominant Article Focuses
(AI) and Risk Management	– Fraud detection – Adaptive credit scoring – Market prediction – Explainable AI (XAI)	decision accuracy. Research examines the application of ML/DL in risk scoring, market prediction, and fraud detection. XAI provides a solution to the challenges of transparency and algorithmic bias. The importance of data analytics integration in time series forecasting is also emphasized.	2024; Pagolu et al., 2016; Paliwal et al., 2025; Xie, 2021)
2. Embedded Finance and Innovative Business Models	– Financial integration in digital platforms – Embedded banking in e-commerce/logistics – Prepaid account model + IoT – FinTech strategic partnerships	Embedded finance forms a hidden but effective ecosystem of financial services within digital platforms. This model creates a contextual user experience, increases loyalty, and encourages collaboration between the financial and non-financial sectors.	(Al-Gasaymeh et al., 2023; Mallekoote and Balraadjsing, 2025; Mancas and Enescu, 2012; Sang and Dac, 2025; Zhang and Wang, 2021)
3. User Trust, Regulation, and AI Ethics	– Data privacy and cybersecurity – Technology regulatory gap – Adaptive regulatory framework – Digital trust and AI ethics	The gap between AI innovation and regulatory readiness is a major challenge. Research emphasizes the need for technology-agnostic policies that strike a balance between innovation and consumer protection. Digital trust is determined by system security, data openness, and ethical governance. Blockchain is considered to have the potential to assist in technology-based financial supervision.	(Aldboush and Ferdous, 2023; Chatterjee et al., 2023; Devlin et al., 2025; Lange, 1997; Li, 2021; Preece, 2024; Troiano et al., 2019; Zhu, 2024)
4. The Evolution of FinTech and Financial Inclusion	– Access to financial services in remote areas – MSME financing – Post-COVID digitalization – Green FinTech & ESG	FinTech terbukti memperluas inklusi keuangan dengan menyediakan layanan berbasis digital untuk populasi underserved. Literasi digital dan infrastruktur menjadi faktor penting. Pandemi COVID-19 mempercepat adopsi FinTech dan memicu inovasi produk berbasis ESG.	(Weng, 2021; Wu, 2021)
5. Blockchain and Decentralized Finance (DeFi)	– Decentralization of the financial system – Cross-border remittances – Smart contracts and P2P	Blockchain and DeFi offer transparency, efficiency, and reduced intermediaries in financial transactions.	(Alkhodair et al., 2023; Harris et al., 2025; Huang, 2020)

Dominant Clusters	List of Key Themes	Summary of Findings by Theme and Source	Examples of Dominant Article Focuses
	lending – Decentralized data storage	Smart contracts enable the automation of services without the need for institutional trust. This technology promotes the democratization and interoperability of global financial systems.	

DISCUSSION

Interpretation of Findings

VOSviewer visualization strongly supports and enriches the understanding of thematic clusters outlined in the research framework. This analysis confirms that FinTech research is a highly interdisciplinary field, with AI and embedded finance being the main drivers of innovation. Focus on FinTech development is not just about technological advances, but also includes practical, ethical, and social considerations that significantly influence the future direction of financial services. Bibliometric analysis shows that artificial intelligence (AI), including machine learning, deep learning, and generative AI, plays a key role in risk management, creditworthiness assessment, and fraud detection. The use of alternative data enables more personalized and inclusive credit assessment systems. Additionally, the emergence of the term "explainable AI" indicates a growing focus on transparency and accountability in AI-based systems, which are essential elements in building user trust and addressing potential algorithmic bias. This development reflects a shift from reactive financial models toward more proactive and anticipatory models, where AI can predict user needs and manage risks in real time.

This shows that research is consistently moving towards automation and augmentation of decision-making processes, while encouraging the emergence of more adaptive predictive models. The shift from reactive to proactive financial models is evident through the application of AI in mapping user needs in real time and managing risk dynamically. Examples include the use of graph neural networks (GNN) to assess SME credit risk and the use of machine learning to analyze P2P lending platforms, which are concrete evidence of this evolution (Liu et al., 2024; Xie, 2021). However, increased algorithmic complexity also raises new challenges related to transparency and accountability, which are now a major concern through the development of explainable AI (XAI) (Paliwal et al., 2025). XAI not only serves as a means of mitigating bias risk, but also as a tool for strengthening the ethical legitimacy and public trust in increasingly autonomous AI systems.

Furthermore, bibliometric visualization reveals the significant role of embedded finance, as illustrated by the emergence of the nodes "embedded systems" and "finance" that are closely connected to "commerce" and "financial services." This reflects the trend of integrating financial services into non-financial platforms, which drives the emergence of innovative business models, enhances user experience, and opens up new revenue streams for non-financial entities. Embedded finance provides more contextual, seamless, and implicit financial services within users' daily activities, now available as a built-in feature in non-financial platforms. This development is driven by advancements in Application Programming Interfaces (APIs), strategic collaborations between FinTech and non-financial entities, and increasing consumer expectations for convenience and contextual services. Embedded banking in e-commerce and IoT-based prepaid account financing (Sang and Dac, 2025; Zhang and Wang, 2021). However, the convenience offered brings significant socio-technical implications. The phenomenon of invisible financialization, in which financial processes become so integrated that they are invisible, has the potential to reduce users' awareness of the financial implications of their digital actions. This poses new risks in the form of impulsive financial decisions and a shift in trust from formal financial institutions to non-financial technology entities, which are not necessarily subject to strict regulation.

The gap between technological innovation and regulatory response is a common thread in many of the studies reviewed. The acceleration of innovation, particularly in AI and FinTech, clearly exceeds the adaptive capacity of existing regulatory frameworks. The concept of the regulatory gap, as highlighted in the literature, underscores the challenges regulators face in formulating policies that are relevant, adaptive, and technology-agnostic. In this context, data privacy protection, algorithmic fairness, and systemic risk mitigation emerge as priority issues (Chatterjee et al., 2023; Troiano et al., 2019). Furthermore, the dominant narrative that assumes that the adoption of FinTech is triggered by distrust of the conventional financial sector does not seem to be entirely accurate. A number of studies show that convenience, efficiency, and low costs are the main factors driving the use of FinTech, while the aspect of trust is multidimensional. In this context, digital trust does not solely depend on the reputation of service providers but also on technological integrity, data protection, and corporate ethical practices. The factor of information openness emerges as a crucial element in shaping consumer trust perceptions, as discussed in the related article on digital ethics and privacy (Devlin et al., 2025).

In addition to technological and regulatory aspects, FinTech also plays a strategic role in expanding financial inclusion, particularly in developing countries. Findings show that since 2019, accelerated by the COVID-19 pandemic, there has been a significant acceleration in the adoption of digital banking services. FinTech has provided more affordable and widespread access to financial services for previously underserved communities, ultimately contributing to economic development and reducing social inequality. Geographical variations are also evident, with developing countries tending to emphasize access and financial inclusion, while developed countries focus more on improving the quality of the user experience. In the context of sustainability, there is also a trend toward Green FinTech and ESG-based investments supported by AI technology.

Blockchain technology and decentralized finance (DeFi) also occupy an important position in the modern FinTech landscape. The consistent emergence of blockchain nodes and decentralized finance on the bibliometric map demonstrates the transformational potential of this technology in the global financial system. Nodes related to this technology appear consistently in both visualization maps, reflecting its strategic position in the future architecture of FinTech. Distributed ledger technology (DLT) enables transparency, auditability, and reduced reliance on financial intermediaries, which can significantly reduce transaction costs and expand access, particularly in a cross-border context (Zhu, 2024). Further research shows the application of DLT in digital asset exchange and decentralized data storage, reinforcing the narrative of financial democratization (Alkhodair et al., 2023; Harris et al., 2025). However, the exponential growth of the DeFi ecosystem also poses serious challenges for regulatory authorities, including the need for mandatory code audit mechanisms and interoperability standards that ensure security and legal compliance (Cao et al., 2025). Utilizing smart contracts and trustless peer-to-peer networks, DeFi enables the reduction of intermediaries, lowers transaction costs, and increases transparency and efficiency, especially in cross-border transactions. As such, DeFi is seen as a form of financial democratization that opens up wider and fairer access for all levels of society.

Comparison with Previous Research

A comparison with previous research shows a significant shift in focus in FinTech literature from the early period to the present. Older literature, particularly from 2000 to 2010, tended to concentrate on traditional core financial topics such as option pricing, volatility, corporate governance, and credit risk management, with an emphasis on theoretical and practical analysis of uncertainty in financial markets. The transitional period between 2010 and 2020 saw an increase in the use of terms such as markets and risk management, largely influenced by the financial crisis, as well as a shift toward more specialized application domains such as embedded options and credit default swaps.

However, research from 2015 to 2025, as revealed by VOSviewer analysis and literature reviews, shows a strong and integrated shift toward areas such as artificial intelligence (AI) and

embedded finance. Scientific output on AI in finance has experienced exponential growth since 2018, with an average of 121.6 publications per year from 2018 to 2023, indicating a rapidly increasing interest in this field. Similarly, the term "FinTech" itself only emerged significantly around 2015, with the proliferation of annual publications beginning in 2019 and experiencing exponential growth until 2021, partly driven by the COVID-19 pandemic, which accelerated the adoption of technology-based banking products. The integration of themes such as AI, deep learning, and sustainability has become more prominent in contemporary studies, reflecting the field's adaptation to international social and technological developments.

The comparison also reveals differences in narratives about consumer trust. While the general narrative often links increased use of FinTech with a decline in trust in traditional financial systems after the 2008 crisis, recent empirical research does not consistently support this direct relationship. Instead, the drivers of FinTech adoption may be more related to the convenience, speed, and lower operating costs offered by these new solutions. This suggests that consumers may view FinTech products as something different or unrelated to traditional financial products.

Additionally, there are clear geographical variations in research focus. Studies in more developed markets, such as the US and the UK, tend to focus on improving user experience and technological innovation. Conversely, research in emerging markets, such as India, places greater emphasis on access to financial services and inclusion for underserved populations. This demonstrates that while technological trends are global, research priorities and FinTech applications are tailored to local contexts and needs. Overall, this comparison underscores that the FinTech field has undergone a rapid evolution from a traditional financial focus to a more interdisciplinary, technology-driven, and socially impact-oriented ecosystem.

CONCLUSION

A comprehensive literature analysis reveals a highly dynamic FinTech landscape, dominated by the convergence of artificial intelligence (AI) and embedded finance, with significant attention to trust and regulation. Research consistently highlights the central role of AI in improving operational efficiency and risk mitigation in the financial sector, including the use of machine learning for fraud detection, more accurate credit assessment, and market prediction. Embedded finance has emerged as a transformative framework that seamlessly integrates financial services into non-financial platforms and everyday activities, driving innovative business models and enhancing customer experience. Trust and regulatory aspects are key concerns, with literature emphasizing that digital trust is a multidimensional construct influenced by data transparency and security, as well as the need for explainable AI (XAI) to address black box issues. Additionally, the study highlights the broader evolution of FinTech and its impact on financial inclusion, particularly in emerging markets, as well as the critical role of blockchain and decentralized finance (DeFi) in FinTech innovation. The implications of these findings are far-reaching: for the development of FinTech theory, a reconceptualization of trust in the digital context and the development of a responsible AI governance framework are necessary; for startups and technology incubators, the focus should be on high personalization, seamless integration, and proactive regulatory navigation; and for regulators, a principle-based adaptive approach is essential to manage systemic risks and ensure consumer protection in an integrated ecosystem. While this analysis provides a comprehensive overview, there are limitations as it only uses secondary data from academic publications and does not include grey literature such as industry reports or white papers. Therefore, recommendations for further research include field studies (interviews with users and startup founders) for richer empirical insights, research by geographic region to uncover unique local dynamics, and systematic comparisons between academic and industry trends to identify gaps and areas of greater impact.

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