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Research

Financial inclusion for economic sustainability: a systems thinking approach

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Abstract
Financial inclusion remains a global concern due to the intricate interdependencies among various influencing factors. This research adopts a systems thinking framework to analyse these interconnections and address them. A mixed-methods approach was employed, integrating both qualitative and quantitative methodologies. The qualitative analysis included a systematic literature review, database search, and the PRISMA framework to identify key variables influencing financial inclusion. The quantitative component utilised a word-to-vector methodology to measure semantic relationships among these variables. The findings reveal that while individual factors significantly impact financial inclusion within isolated themes, their influence diminishes when analysed within the broader systemic context. This aligns with the principles of systems thinking, emphasising the complexity of large-scale systems and the interconnected nature of variables. By visualising and quantifying these relationships, the study highlights the limitations of addressing financial inclusion through isolated interventions. The findings underscore the need for integrated, multi-faceted strategies considering systemic interactions. These insights provide a foundation for policymakers and stakeholders to develop more targeted, effective interventions that promote equitable economic development. By understanding how key variables interact within the more extensive system, decision-makers can design policies that address financial inclusion more holistically, ensuring sustainable and impactful solutions across diverse regions. This research contributes to the growing discourse on financial inclusion by offering a structured, data-driven approach to understanding its complexities and guiding strategic policymaking efforts.

Keywords Financial inclusion · Financial technology · Economic development · Systems thinking

1 Introduction

The financial system is a core component of the capital market and consists of rules, regulations, and standards that promote efficiency [35]. Over the years, technological advancements have significantly transformed financial services, which have enabled organisations in the financial sector to become far more innovative in their supply of products and services, which promotes investment and growth [27]. One of the most crucial components of the financial system is the banking sector, which is primarily responsible for creating liquidity for investment and stimulating economic growth [41]. For the past two decades, financial inclusion (FI) has become a key focus area for researchers to understand the global footprint of monetary institutions [2]. Furthermore, FI has become an essential phenomenon for policymakers worldwide, and they need a strong strategy for achieving sustainable growth. According to [2], FI is the ability to provide essential financial services, such as savings or credit products, to all groups in a population or society, including the poor and disadvantaged. There have been

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several initiatives by international institutions to help bridge the gap and improve FI; however, there are still many obstacles that prevent fair access to financial services. One of the biggest challenges is the limited availability and accessibility of financial services for individuals and enterprises, especially those with insufficient or no banking. In addition, significant gaps remain in account ownership; whereas wealthy nations report a high percentage of ownership of accounts, emerging nations usually fall behind, hence worsening inequality in the economy. Individuals who depend on cash transactions, especially those in remote areas, encounter challenges due to the decreasing availability of physical financial infrastructure, such as the closure of financial institutions and automated cashiers in countries like Australia. In addition, financial institutions routinely limit business accounts to vulnerable groups out of concern that doing so might damage their reputation. These difficulties highlight the necessity of particular plans and programs to deal with the various barriers to FI around the globe [65]. The significance of FI lies in its ability to increase everyone's access to finance and economic activity, which raises incomes and enables more people to live better lives [73]. As such, policymakers globally have prioritised FI as a strategy for achieving sustainable growth. Thus, recognising FI's potential in promoting capital accumulation, bank competition boosts investment and general economic growth [16]. Given the importance of FI, addressing the issues and barriers, especially related to entrepreneurs, is essential, as they often struggle to secure the capital necessary for business development, thus stalling economic potential and exacerbating unemployment and poverty [8].

The literature above highlights financial institutions' significance and contribution to economic growth. However, these institutions face challenges that require a holistic perspective. The main challenge remains that despite the wide availability of literature in the database, the ability to translate this knowledge into a robust quantitative framework systematically remains underexplored, which serves as a significant research gap. To address this gap, the study adopts a systems thinking approach that includes a qualitative to quantitative technique to identify and quantify the critical factors impacting financial inclusion across different economies and raises the following research questions: (i) What are the key factors that promote or hinder financial inclusion in other economies? and (ii) How can systems thinking be applied to assess these relationships and quantify their impact?

2 Literature review

2.1 The technological transformation of the banking sector

Significant changes have occurred in the banking industry as a result of technological advancements that have led to a move from physical branches to online platforms. Because of this expansion, the banking sector may now provide small and medium-sized enterprises (SMEs) and clients with a broader selection of goods and services. Financial technology companies (FinTechs) and financial institutions continue to compete strongly [94]. However, accessibility continues to be a major problem regardless of these technical developments, with almost two billion people still not being able to access the financial system, largely due to tight regulations and an inadequate level of financial literacy [7]. Despite significant economic growth, issues with financial inclusion become worse in developing nations due to elements like high operating costs that prevent the spread of traditional banking services.

As such, FI has been identified as a key driver in accelerating economic growth and increasing social inclusion. However, achieving complete inclusion introduces new risks. According to Kara et al. [47], although FI can promote sustainable development, poor implementation can result in low transaction volumes and inactive accounts, which can cause financial instability and lower overall efficiency. Additionally, too much financial inclusion might make people more vulnerable to criminal activity, especially in areas with lax regulations [47]. Additionally, Urooj [92] points out that strict Financial Action Task Force (FATF) regulations intended to stop illegal financial activity can occasionally create unforeseen obstacles to FI, disproportionately harming marginalised communities [92].

2.2 Financial inclusion

2.2.1 Impact of financial inclusion on the economy

Exploring financial inclusion has received much attention recently for two key reasons. The first justification is based on how a weak financial infrastructure might cause financial exclusion and negatively affect economic growth [83]. The second justification is based on what policymakers have noticed about the connection between development and a decline in poverty [83]. Early literature showed that people with access to financial services can keep their money at these organisations, which fosters economic growth [84]. Subrahmanyam and Acharya [87] analytically illustrated how

financial inclusion can accelerate growth. Mishra et al. [60] further highlight that FI contributes to broader socio-economic development by facilitating access to credit, improving household resilience, and fostering entrepreneurship, ultimately creating a ripple effect across multiple sectors [60]. Additionally, research by Yang and Zhou [96] indicates that localised FinTech development can help bridge economic disparities by providing tailored financial solutions that cater to underserved populations [96]. These findings reinforce the critical role of financial inclusion in driving sustainable and equitable economic growth.

2.2.2 Impact of financial inclusion on entrepreneurship

SMEs face significant challenges which threaten their existence, effectiveness, and expansion despite their substantial contributions. One such example is Uganda, where considerable challenges are experienced in obtaining operational and administrative funds, which are significant barriers. The impact of Islamic microfinance institutions and the role they play in improving finance in Uganda was investigated [43]. The study focused on the adoption of these institutions and identified that SMEs play a crucial role in developing and emerging economies by supporting financial sector stability, creating jobs, and facilitating capacity building through skills training and economic empowerment. The findings revealed a critical challenge in the current operations of the Microfinance Institutions that failed to achieve their objective of providing sustainable financial solutions to underserved people and small and medium enterprises. The inability leads to the current state of a large number of Ugandan small and medium enterprises in the informal financial sector continue to face financial constraints, which prematurely result in the closure of the firms in the first few years of their operation.

Mishra et al. [60] emphasise that financial inclusion can enhance entrepreneurial activity by reducing credit constraints, enabling business innovation, and improving market competitiveness [60]. However, Kara et al. [47] argue that the effectiveness of FI in supporting entrepreneurship depends on tailored financial products and policies that address the specific needs of SMEs [47]. Additionally, Urooj et al. [93] highlight the importance of gender-inclusive financial services, particularly in Asia and Africa, where women-led enterprises face higher financial exclusion rates. These insights underscore the necessity of targeted FI strategies to support entrepreneurship and drive economic resilience [93].

2.3 The financial ecosystem

Financial technology, commonly known as FinTech, is accelerating the evolution of financial services in the current era. Examples of this technology include the introduction of mobile money, robot consultation, application investment platforms, and online banking solutions. These technologies impact and influence the planning of financials as well as equality in the economy [79]. Fintech's role in promoting greater financial inclusion is evidence of its transformative influence on Sub-Saharan Africa (SSA). The connections between entrepreneurs at the base of the pyramid (BOP) and Fintech, as well as the development of social value, were explored by [12] in SSA. The study was conducted using a qualitative research design, which included in-depth interviews with four BOP entrepreneurs from various industries and members of the FinTech association. One of the key findings indicated that fintech services such as mobile money can reduce a business's unpredictability, which is growth for BOP entrepreneurs. This further emphasises the importance of FinTechs as they provide transactional security, facilitate convenience, and limit the possibility of cash robberies. In addition, FinTechs have both social and economic factors due to their ability to contribute to the development of BOP consumers and business owners.

A study by Yang and Zhou [96] highlights that FinTech advancements can help mitigate regional economic disparities by improving financial accessibility in underdeveloped areas [96]. Additionally, Urooj [92] points out that while digital financial services enhance inclusion, regulatory challenges such as compliance with Financial Action Task Force (FATF) measures can create unintended financial barriers, particularly for small businesses and marginalised communities [92].

2.4 Developed versus developing economies

There are key differences across various regions in relation to the barriers and solutions, which reflect social, technological, and economic challenges experienced. In developed economies like Japan, financial systems are highly inclusive, with 98% of people having access to bank accounts, driven by a robust banking sector and supportive policies. Despite economic progress, one in five people in these areas still do not have access to formal financial services [50]. However, despite the promise of mobile technology to promote inclusion, developing nations like Africa confront more significant obstacles, where access to financial services is restricted by poverty, inequality, and rural–urban divides [15]. According

to recent research conducted between 2022 and 2024, mobile technology could boost financial inclusion by broadening access to financial services. However, it is still insufficient for eliminating the challenges that rural communities experience, where their financial constraints are severe. As an example, Owusu and Asare (2024) highlight that despite the widespread adoption of mobile banking, challenges like poor infrastructure and insufficient financial literacy continue to plague rural areas, preventing mobile finance from reaching its full potential [13]. Additionally, Agarwala et al. [6] emphasise the effectiveness of Indian banks in promoting financial inclusion, demonstrating how banks in developing nations may significantly contribute to closing financial gaps, even though there are still issues in underserved and rural areas [6]. These results highlight the underlying difficulty in ensuring widespread affordability and accessibility for all people, even while inclusive finance policies are making progress.

2.5 Summative

The literature above provides a comprehensive overview of the financial sector and its evolution. Key developments within this sector, especially with the introduction of innovative technologies, have resulted in intense competition with traditional banking. Through the application of digital banking in some regions, financial institutions have improved the accessibility of affordable financial services to consumers through enhanced digital solutions without physical infrastructure. However, the banking sector still experiences significant challenges, mainly in non-urban areas, due to poor infrastructure, limited financial understanding and geographical isolation. Kara et al. [47] emphasise that sustainable financial inclusion requires targeted interventions that address these regional disparities [47]. Mishra et al. [60] further stress the importance of financial education programs to enhance individuals' understanding of available financial services [60]. Urooj et al. [93] also highlight that inclusive finance strategies must account for gender disparities, ensuring equitable access for all demographics [93].

The main difficulties surrounding accessibility are concentrated in the non-urban regions where the establishment of physical buildings is not sustainable, resulting in a significant portion of the population being excluded from the financial system. The gaps identified in the literature highlight the need for higher levels of accessibility for essential services in far-to-reach regions, an improved level of financial literacy, which can help individuals understand these services, and improved investments into SMEs supporting their growth and expansion. Balanced and sustainable strategies are necessary to ensure the benefit of inclusive finance in the long term. These strategies must consider the risks and complexity associated with over-inclusiveness and inactive financial engagement. A summary of the insights obtained from the literature reviewed is presented in Fig. 1.

2.6 Theoretical framework

2.6.1 Supporting theories

Financial inclusion is a complex topic due to the different perspectives proposed on the actual beneficiaries of an inclusive system. There is a belief that the underprivileged would be able to receive an adequate quantity of food, while others highlight the holistic benefit for the broader financial and economic system. There has been a proposal of the benefits women may receive from an inclusive system. In addition to these mentioned groups, additional individuals within the population are not covered and will potentially benefit from inclusion. Through the examination of the dynamics within financial inclusion, four key theories support this phenomenon. The theories surrounding financial inclusion are illustrated in Fig. 2. These theories include the theory of public good for financial inclusion [69] [57], dissatisfaction regarding financial inclusion is essential [69] [71], vulnerable groups and financial inclusion [69] [67], and systems for financial inclusion [69] [57] [72].

2.6.2 Systems thinking

When examining complexities spanning a broad spectrum of disciplines, a multidisciplinary strategy called systemic thinking (ST) becomes crucial [68]. The significance of it originates from its ability to provide a comprehensive perspective [82]. There is significant research concerning the integration of ST with novel disciplines and techniques in addressing present-day problems, particularly those related to the financial inclusion system [51]. Therefore, the concept of integration, which highlights how a system's functions cannot be fully comprehended by looking at its parts in isolation, is at the core of ST.

Evolution in banking

- The introduction of digital services has resulted in major competition between FinTechs and traditional banks (Ajide, 2019).

Accessibility to finance

- Strict and rigid rules surrounding financial services coupled with limited infrastructure have limited accessibility to basic financial services (Vives, 2019) (Yang & Zhou, 2024).

Economic impact

- Inclusive finance is beneficial to developed and developing economies; however, both these economies still experience severe challenges surrounding inclusive finance for all groups within the population (Kakembo, Abduh, & Salleh, 2021) (Urooj, Luo, & Ullah, 2025).

Financial inclusion

- Inclusive finance has advantages and disadvantages. The advantage of inclusive finance is that it enables all groups in a population to participate in the economy. The disadvantage revolves around security risks (Agwu, 2021).

SMEs

- SMEs help encourage economic development and growth due to their ability to provide employment, which, in turn, reduces poverty. However, these establishments continue to experience challenges in terms of receiving investments or suitable financial services (Sethi & Acharya, 2018).

Role of FinTechs

- Financial technology companies have made a significant attempt to bridge the gap between the unbanked population and the financial sector through the introduction of digital services such as mobile banking (Subrahmanyam & Acharya, 2017) (Mishra, Kandpal, Agarwal, & Srivastava, 2024).

Microfinance institutions

- Although these institutions have been established to assist the underserved parts of the economy, they still face challenges in supporting these communities due to their inability to fulfil financial needs (Sethi & Acharya, 2018).

Fig. 1 A summary of key insights generated from the literature review

In addition, as stated by [20], ST recognises the development phenomenon in which novel characteristics or actions develop from interactions of system components, which frequently defy assumptions based on each element alone. In addition, feedback loops, crucial for ST, illustrate how systematic actions may result in subsequent reactions that either stabilise or accelerate change. The origins of ST can be detected in early philosophical arguments on interrelationships, and Aristotle presented initial concepts on a comprehensive understanding. [59]. However, in the latter part of the twentieth century, ST became officially acknowledged [68]. A significant turning point that encouraged interdisciplinary cooperation was Ludwig von Bertalalanffy's General Systems Theory, which argued that systems have underlying principles irrespective of their specific fields of expertise. It was a significant turning point that promoted multidisciplinary cooperation [80].

In business and management, ST assists in understanding how organisational operations are interconnected and influences the development and execution of strategies, along with other practical applications [23]. ST enables the modelling of ecosystems and the analysis of intricate dynamics. The extant literature highlights several key insights on financial inclusion, providing valuable information on the associated impact factors. However, no established systems thinking approach currently exists within the literature that assists in unpacking the relationship between the key variables to obtain a deeper understanding of their impact on the holistic financial inclusion system. Therefore, this study takes a systems thinking approach by adopting the word-to-vector approach to gain a better understanding of the complexity of financial inclusion.

3 Methodology

This study adopts a mixed methods approach, comprising qualitative and quantitative techniques that align well with systems thinking, providing a foundation to understand the interconnections and interdependencies within the complex financial inclusion systems. The initial systematic review helps to provide a foundational understanding of the concept and helps to build a body of knowledge as guided by the principles adopted in [70]. The systematic review is guided by the principles of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) techniques, which

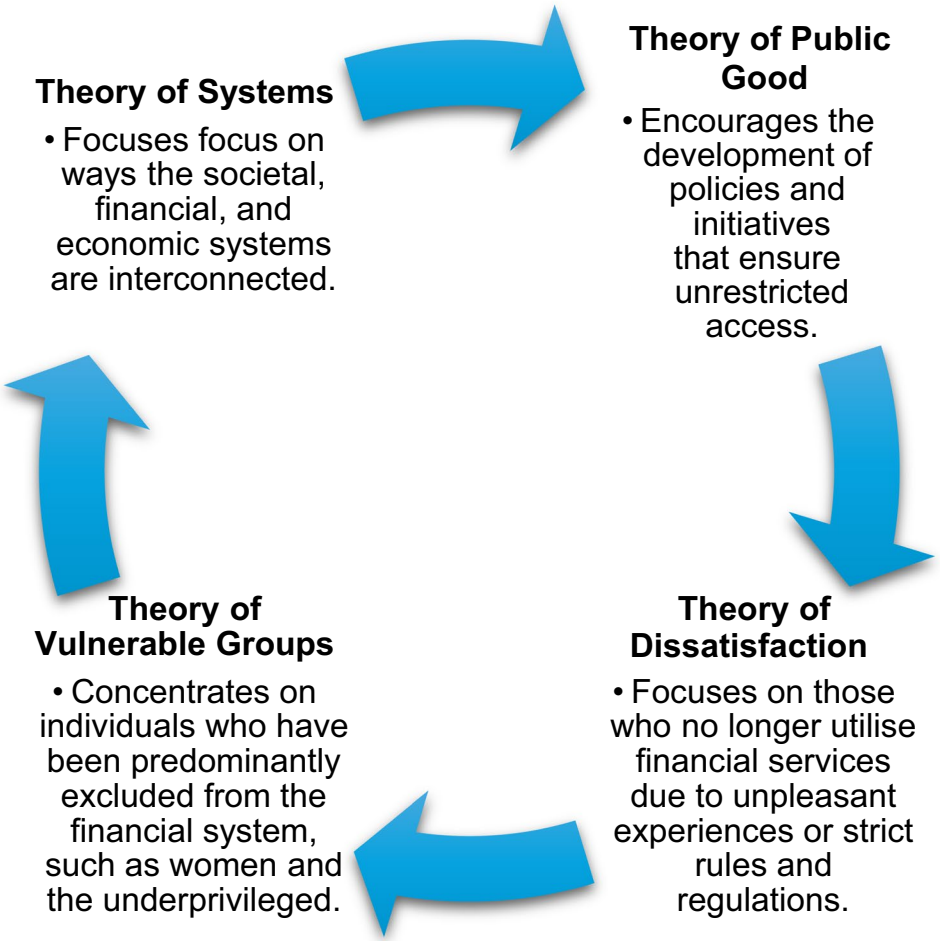

Fig. 2 Summary of key theories which support financial inclusion (Source: Author development)

ensures replicability and precise data selection. The review provides a comprehensive overview of the literature and helps to identify key variables through the analysis and identification of key impact factors [56]. This was used to construct Boolean search strings, which were implemented to refine the focus of this research. [31].

The quantitative process steps utilise the above-constructed search strings to conduct a bibliometric analysis using research information system (RIS) files obtained from the PRISMA technique. The bibliometric software was utilised to perform bibliometric analysis guided by [29] and [18] for co-word analysis to find hotspots and bibliographic coupling network analysis for data clustering. The results extracted are then processed using word-to-vector analysis. The data retrieved was processed into the word-to-vector model. Word-to-vector is a popular word embedding technique that utilises natural language processing (NLP) to convert words into numeric vectors. This method embeds words in a continuous vector space to capture semantic links between them, enabling the model to learn word associations from extensive corpora of text, making it highly effective for a variety of analytical tasks, including clustering, similarity measurement, and trend analysis [88] [58]. A summary of the steps implemented in the complete methodology outlined above is presented in Fig. 3.

3.1 Preliminary analysis

The initial step in the preliminary analysis involved a comprehensive search of existing literature on the Scopus database with financial inclusion as the central theme. Other databases, such as IEEE and EconLit, were also considered and compared for this research. Although EconLit specialises in finance and economics, the database lacks interdisciplinary views from technology, policy, and development studies. On the other hand, IEEE Xplore concentrates mostly on fintech and digital banking but overlooks economic and social factors [39]. The most extensive database for research on financial inclusion is Scopus, which includes conference proceedings, working papers, and policy documents in addition to

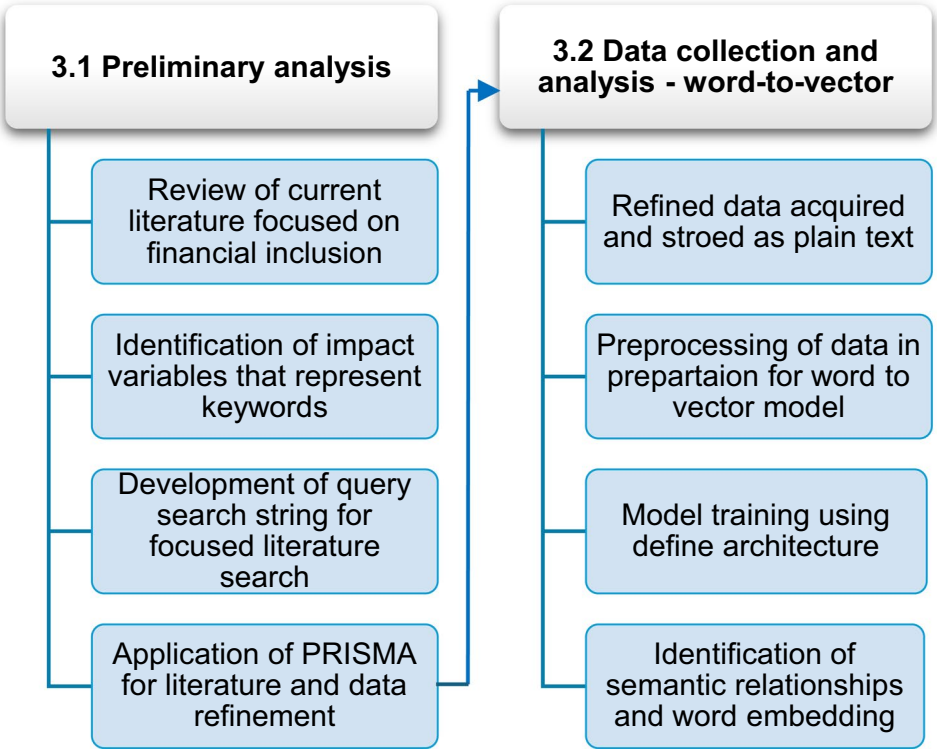

Fig. 3 Summary of methodology steps implemented in this research study (Source: Author development)

covering economics, finance, business, policy studies, and social sciences [38]. The comparison of these databases and the justification for selecting Scopus will be provided in the Results section. Due to the rapid and constant evolution of the financial industry, the literature between 2014 and 2024 was reviewed for the initial step, ensuring the body of knowledge obtained and reviewed was relevant and recent. The timeframe selected also captures the latest innovations, regulatory changes, and shifts in financial inclusion, providing a comprehensive understanding of the topic. Any data prior to 2014 may not account for significant technological advancements, regulatory changes, and the shifts will be significantly different due to the constant evolution of the financial sector. Guided by previous research [70], literature reviews assist in identifying and addressing challenges within a research topic. From the review, a series of five sub-systems were identified. The literature reviewed in the first step provided a foundation that assisted in identifying the impact variables representing keywords that play a role in the central theme of financial inclusion. A keyword dictionary was built based on the variables identified in each sub-system. This step assists in developing expertise on the research topic, guiding the research correctly [56]. The identified keywords were then grouped using Boolean statements "AND" and "OR" to develop a search string that can be used for further analysis in the research study [62]. The strings generated were processed on the Scopus database, and the established PRISMA protocol was applied to the search process. The search query involved the search of the identified keywords in the "Article title, Abstract, Keywords" of all papers in the database. The criteria steps implemented included a period restriction of 10 years and category conditions in which categories such as "Psychology" were excluded. A language restriction of English was also applied to ensure all selected literature could be understood. The protocol established is guided by the methodology adopted in Page et al.[74]. Once the protocol was adopted for each string, the files were extracted using the research information system (RIS) format for further analysis. Figure 4 provides a summary of the sub-steps implemented in the preliminary study.

3.2 Data collection and analysis—Word-to-vector

The word-to-vector methodology aligns well with ST as it enables the identification of relationships within complex data. It captures semantic links by embedding words in a continuous vector, enabling tasks like clustering, trend analysis, and similarity measurement [36] [76]. The process begins with tokenisation of abstracts into discrete units (tokens), converted to lowercase, and stripped of stop words to minimise noise. Stemming and lemmatisation techniques are employed to reduce the number of words in base forms and enable the identification of trends. The tokenised text was fed into the word-to-vector model following preprocessing. Continuous Bag of Words (CBOW) and Skip-gram were

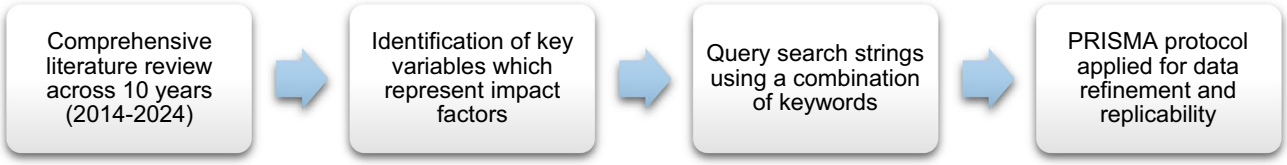

Fig. 4 Summary of the sub-steps implemented in the preliminary analysis (Source: Author development)

the main architectures considered. The CBOW model predicts a target word based on surrounding words, which helps understand commonalities in high-frequency words. The Skip-gram model uses a target word to predict surrounding words. It excels with smaller datasets and less frequent words, aligning with the specialised nature of financial inclusion language. Skip-gram's ability to capture context-dependent relationships made it ideal for this study, as it has been demonstrated to be highly effective in representing rare and domain-specific terms [36].

The word-to-vector model adopts neural networks to map each word into a continuous vector space, where the proximity of the vectors reflects the similarity in meaning. CBOW and Skip-gram leverage a shallow neural network that adjusts word vectors iteratively through backpropagation and gradient descent to maximise cosine similarity among contextually related words [36]. In this manner, the model learned to represent semantic similarities, clustering words such as "financial literacy" and "income equality" closer together based on their contextual usage. This embedding approach has been validated across multiple studies, demonstrating its efficacy in extracting latent semantic structures in domain-specific corpora [58] [76]. Following training, word vectors were saved in a 300-dimensional format within.emb files, balancing the need to capture complex relationships while maintaining manageable file sizes. These vectors enabled various analyses such as clustering, classification and similarity measurements. Figure 5 summarises the sub-steps implemented in the data collection and analysis using word-to-vector.

It is crucial to understand how financial inclusion can be achieved or accelerated and which factors function as barriers preventing different regions from achieving inclusion. This comprehensive understanding will serve as foundational knowledge, accelerating the process of financial inclusion in various economies. Therefore, the mixed-methods approach is suitable for this study as this rigorous approach can help address the research questions raised.

4 Results

This section presents the results obtained after implementing the methodology steps outlined in Sect. 3. The section begins with a detailed breakdown of the preliminary analysis. This includes an outline of the keywords identified and the search strings constructed for the study, providing an overview of the data that formed the foundation for this analysis. The latter part of this section presents the data obtained from the word-to-vector analysis. For illustration purposes, the results for one theme, financial inclusion, are presented to illustrate the process implemented for analysis and interpretation, followed by the complete system. The results obtained for the remaining themes will be presented in the Appendix.

4.1 Preliminary analysis

Five themes emerged from the results database: best practices (BP), financial technology (FT), financial ecosystem (FE), financial inclusion entrepreneurship (FIE), and financial inclusion and the economy (FITE). These topics serve as the primary motivators for the study and provide a conceptual framework for the following analyses. To create search strings inside each theme, the identified keywords were grouped based on their impact, within the subject area, and about one

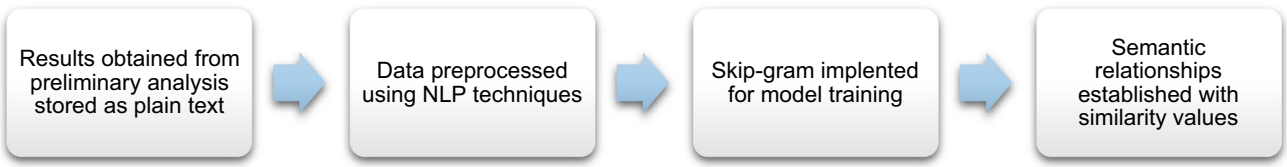

Fig. 5 Summary of the sub-steps implemented in the Data collection and analysis: Word-to-vector (Source: Author development)

another. A total of 21 search strings were generated, and each search string was directly aligned with the core theme. This strategic alignment makes a targeted and concentrated approach to data synthesis and analysis possible, making it easier to retrieve important information efficiently. Table 1 provides a summary of the search strings generated for this research:

Once constructed, the search strings were processed through the three databases, Scopus, IEEE and EconLit and compared prior to further analysis. The results from each of these databases are provided in Table 2 for the five strings within the theme of Financial Inclusion and the Economy as an example.

From the results in Table 2, it can be seen that after applying the established selection protocol, the Scopus database contained a significantly higher number of results across the three databases evaluated. Therefore, the Scopus database was selected and used for the identification of key variables in the research study.

Several essential components in the research development process have been included in the PRISMA framework. The primary objective was to thoroughly understand the current themes and how a systems dynamic model may be used to analyse them. Five essential processes were engaged in the PRISMA technique, producing an output of literature to respond to all the research questions. The research pool was initially limited to ten years to ensure that all pertinent literature and advancements could be found and examined. Categorical limits were the second criterion, ensuring only relevant literature from the designated disciplines was evaluated. The results obtained after implementing the PRISMA protocol are presented in Table 3 for the financial inclusion and economy theme. The table presents the results obtained at each stage of the protocol, illustrating how the final result was obtained. For this theme, the initial search string query resulted in 7 681 papers, which was refined to 3 717 papers after applying the conditions established within the protocol.

As depicted above, the same approach was adopted for the remaining 16 query strings listed in Table 1. The results obtained for the remaining query strings are presented in Table 4 in a consolidated format; that is, the results for each theme are listed and not for the individual strings. Collectively, for the complete system, 14 444 papers were obtained, which were further refined to 6 482 papers after implementing the protocol.

The preliminary analysis assisted in identifying relevant literature which was appropriate for this research study. The broader literature search identified a vast volume of papers, reflecting the many current studies focusing on financial inclusion. Whilst the identified keywords assisted in focusing the search query on the topic of interest, the established protocol helped further refine the data, ensuring that only relevant and appropriate literature was included. These steps served as the foundation for the word-to-vector modelling process. The results obtained through the second analysis stage are presented in Sect. 4.2.

4.2 Data collection and analysis: word-to-vector

The data visualisation in heatmaps illustrates the interdependencies between the variables in the different causal links produced after the word-to-vector processing and data analysis described in the methodology section. The narrative used to interpret the heat map created for the model is shown by the colour bar in Fig. 6. The colour bar provides a gradient with values ranging from 0 to 1. A value of 0 at the bottom end of this range indicates a "very weak relation" between usability factors, suggesting little correlation or influence. On the other hand, a score of 1.0 at the higher end denotes a "robust relation," meaning that there is a significant degree of influence or correlation between the components.

The results obtained through the N-gram analysis are presented as heatmaps, enabling an intuitive interpretation of the strength of associations between usability factors. The heatmaps enhance analytical clarity by visually distinguishing connection strengths where minor effects (light colours) are related to significant associations (dark colours). This standardisation ensures consistent interpretation across different datasets and usability features, facilitating a deeper understanding of their interrelationships. The heatmap's visual representation simplifies the comparison of usability-ranked features, enabling an easier understanding of the relative influence of each factor.

The heatmaps, coupled with the correlation matrices, strengthened the evaluation of the relationships within the different systems. These quantitative tools strengthened the analysis by illustrating semantic connections and patterns in the data, enhancing comprehension of word-to-vector embeddings. The colour gradients represent the similarity scores between terms, whereas darker shades indicate more substantial relationships. By visually highlighting these connections, the analysis contributed to a nuanced understanding of the underlying dynamics within the financial inclusion space. A colour-coded heatmap illustrating the similarity scores between a specific group of financial inclusion terms is displayed in Fig. 7. The degree of similarity between two phrases is represented by each cell in the grid; lighter colours indicate lower similarity scores, while darker colours indicate more similarity. Word clusters with significant semantic relationships can be quickly identified due to this visual differentiation.

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Table 1 Summary of search strings generated per a theme

String No	Theme	Search string	References
1	Financial inclusion & The Economy	"Financial Inclusion" AND "Financial technology" OR "FinTech" OR "Mobile Banking"	[4, 10, 33] [75, 86]
2		"Digital Financial services" AND "Financial literacy" OR "Entrepreneurship"	[10, 75] [40] [14, 46]
3		"Financial Inclusion" AND "Economic Growth" OR "Socioeconomic Progress"	[3, 19] [55]
4		"Financial Inclusion" AND "Poverty" OR "Income inequality"	[17], [20]
5		"Financial Inclusion" AND "Technology" OR "Financial stability"	[33] [26]
6	Financial Technology	"Digital Finance" AND "Financial Technology" AND "Policy" OR "Financial Regulation"	[25] [90]
7		"Financial Inclusion" AND "Gender" OR "Mobile Banking" AND "Economy"	[53] [54]
8		"Implementation" AND "Financial Literacy" AND "Technology"	[40] [54] [32]
9	Financial Ecosystem	"Ecosystem" AND "Microfinance institutions" OR "Financial Inclusion"	[44, 45, 89] [78]
10		"Financial technology" AND "Regulatory technology" AND "Digital Financial Inclusion"	[11, 22, 34]
11		"Financial literacy" OR "Generation Z" AND "Financial Inclusion"	[44, 45] [44, 45]
12	Financial Inclusion & Entrepreneurship	"Small and Medium-sized Businesses" OR "Microfinance Institutions" AND "Financial Inclusion"	[43]
13		"Financial Inclusion" AND "Entrepreneur" OR "Ecosystem"	[14] [9, 24, 64]
14		"Financial Inclusion" AND "Entrepreneur Finance" AND "Gender"	[64] [9, 24, 64]
15		"Gender" AND "Digital Finance"	[64] [95]
16		"Financial Risks" AND "Entrepreneurship"	[64] [77]
17		"Financial Inclusion" AND "Digitization" OR "Gender Equality"	[95] [49]
18	Best Practices	"Financial inclusion" OR "Financial technology" OR "Digital literacy" AND "Best Practices"	[89] [11]
19		"Digital financial services" OR "Entrepreneurship" OR "Technology road map" AND "Best practices"	[64] [61]
20		"Financial innovation" AND "Poverty" OR "Inequality" AND "Best practice"	[78] [77]
21		"Financial stability" OR "Inclusive Development" OR "Financial Ecosystem" AND "Best practice"	[89] [77] [81]

Table 2 Summary of results obtained for the financial inclusion and economy theme after applying the established PRISMA protocol on IEEE, Scopus and EconLit

String	Scopus	IEEE	EconLit
1	1 241	207	130
2	235	144	456
3	565	15	50
4	623	33	249
5	1 053	317	353
Total	**3 717**	**716**	**1 238**

Table 3 Summary of results obtained for the financial inclusion and economy theme after applying the established PRISMA protocol

String No Conditions	Number of results Unfiltered	Date Range 2014–2024	Subject Area Limited to*	Document Type Article	Source Type Journal	Language English
1	2 688	2 470	1 964	1 272	1 268	1 241
2	485	467	379	248	247	235
3	1 013	926	802	597	597	565
4	1 202	1077	896	657	654	623
5	2 293	2 057	1 621	1 086	1 082	1 053
Total	**7 681**	**6 997**	**5 662**	**3 860**	**3 848**	**3 717**

**Business, Management and Accounting, Decision Sciences, Economics, Econometrics and Finance, Engineering, Multidisciplinary, Psychology and Social Sciences*

Table 4 Results summary for all themes within financial inclusion

String No	Theme	Before PRISMA protocol	After PRISMA protocol
1–5	Financial inclusion & The Economy	7 681	3 717
6–8	Financial Technology	777	374
9–11	Financial Ecosystem	1 076	625
12–17	Financial Inclusion & Entrepreneurship	1 843	947
18–21	Best Practices	3067	819
Total system		**14 444**	**6 482**

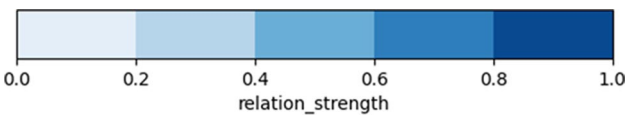

Fig. 6 Colour bar legend for heatmap interpretation (Source: Author development)

While heatmaps provide immediate visual cues of similarity, correlation matrices allow for a structured and quantitative interpretation of word relationships. Table 5 represents a correlation matrix, where each row and column correspond to a word, and the cells display cosine similarity scores, quantifying the association strength between pairs.

From the heatmap in junction with the similarity values highlighted in Table 5, a few characteristic pairs, are selected as examples and are discussed below to elaborate on the key insights that the pairs have. The characteristic pairs were chosen based on the lowest (0.39), highest (0.94) and some examples with mid or median (0.71) similarity values. Table 6 provides the details on these characteristic pairs and the key insights obtained.

The analysis method, as stipulated above, was carried out for the remaining themes identified in this research study. The heatmaps and supporting similarity matrices are presented in the Appendix. Several key variables and characteristic pairs were identified across the remaining systems, and key insights were drawn. In terms of financial technology, the pairing of adoption and accessibility places emphasis on how accessibility influences the rate of adoption. In addition to this, the relationship shared between the digital economy and digital inclusion highlights

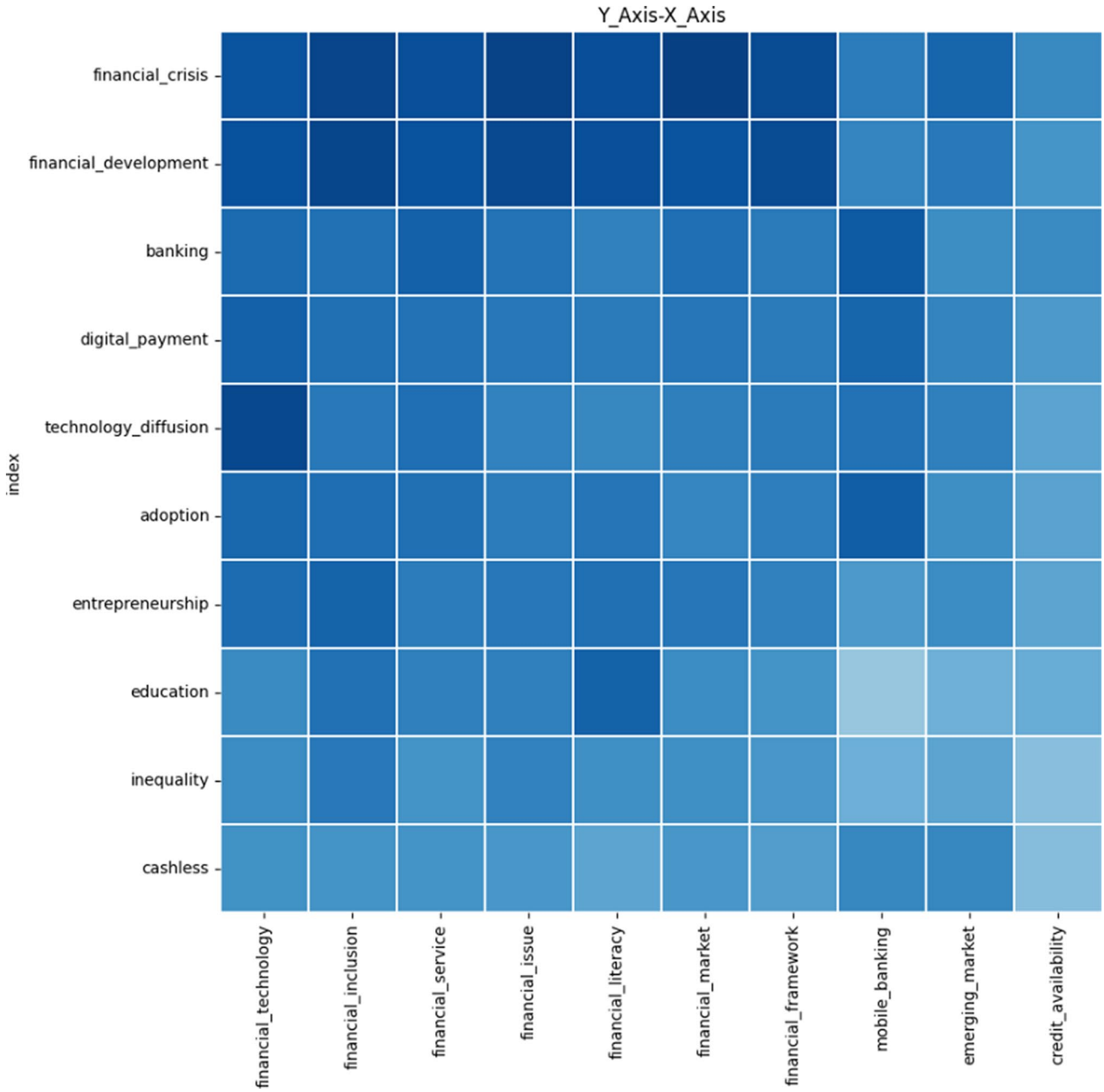

Fig. 7 - Heatmap plot for financial inclusion (Source: Author development)

the importance of incorporating unbanked or disadvantaged groups of people into digital financial systems to ensure equitable participation in the growing digital economy. Collectively, these examples emphasise how accessibility can boost the adoption of digital technology, in turn promoting sustainable and economic growth. The financial ecosystem analysis revealed a weak relationship between funding and economic development, highlighting that investments are a key driver of economic development. The characteristic pair of entrepreneurship and financial crisis in the financial inclusion and entrepreneurship system underlines the importance of SME growth as it has the potential to reduce poverty by promoting employment, thereby improving the financial status of individuals. However, although it promotes economic growth, it still has the potential to increase risk due to exposure during times of economic instability, which can be mitigated through supporting policies and governance. The best practices system revealed key characteristic pairs such as technology integration and digital literacy, which share a strong relationship, highlighting the pivotal role literacy plays in the adoption and integration of these

Table 5 A matrix representing a similarity value for a characteristic pair of terms in financial inclusion

	Index	Characteristic									
		1	2	3	4	5	6	7	8	9	10
		financial_ technology	financial_ inclusion	financial_ service	financial_issue	financial_lit- eracy	financial_ market	financial_ framework	mobile_ banking	emerging_ market	credit_ avail- ability
Characteristic											
1	financial_crisis	0.87	0.92	0.88	0.93	0.89	0.94	0.90	0.71	0.80	0.66
2	financial_development	0.87	0.92	0.87	0.90	0.88	0.86	0.90	0.67	0.72	0.61
3	banking	0.77	0.75	0.81	0.74	0.69	0.75	0.72	0.84	0.64	0.65
4	digital_payment	0.81	0.75	0.74	0.72	0.71	0.73	0.71	0.79	0.68	0.59
5	technology_diffusion	0.91	0.72	0.75	0.69	0.66	0.70	0.71	0.75	0.69	0.55
6	adoption	0.79	0.76	0.75	0.71	0.73	0.67	0.70	0.82	0.63	0.55
7	entrepreneurship	0.77	0.80	0.71	0.73	0.75	0.73	0.69	0.59	0.65	0.55
8	education	0.65	0.75	0.69	0.69	0.81	0.65	0.62	0.39	0.49	0.51
9	inequality	0.65	0.72	0.61	0.69	0.63	0.63	0.61	0.49	0.54	0.42
10	cashless	0.62	0.61	0.61	0.61	0.54	0.60	0.58	0.67	0.67	0.43

Table 6 Key insights on selected characteristic variable pairs identified in the word-to-vector analysis for financial inclusion and the economy theme

Characteristic pair	Similarity score	Key insight	Reference
financial_crisis:financial_market	0.94 *(highest similarity)*	The financial market, which comprises the banking industry, faces severe challenges in trying to improve the level of inclusiveness for economic growth	[1]
education:mobile_banking	0.39 *(lowest similarity)*	Literature has highlighted the importance of educating consumers on digital solutions through several studies, enabling a comprehensive understanding of these products. The low similarity value further concurs with this	[91]
entrepreneurship:financial_status	0.71 *(median similarity)*	Entrepreneurship promotes job creation, which, in turn, reduces the level of poverty. This can help to improve and stabilise an individual's financial status and living standard	[10]
adoption:financial_issue		One of the major challenges surrounding inclusive finance is the adoption of innovative technological solutions developed to improve inclusivity	[11] [52]

technologies. In addition to this, the relationship between emerging markets and innovation for financial inclusion reflects the potential for innovative solutions to address financial access challenges, though these markets may face structural or infrastructural limitations. A summary of additional insights generated from the remaining systems is presented in Table 7.

4.3 Consolidated system

The word-to-vector process discussed in the previous section was also implemented to generate results for the consolidated system, highlighting the key characteristic pairs. This was achieved by combining all the results obtained for the complete system, resulting in a total of 6482 papers that were compiled and saved as plain text files, forming the core dataset for the consolidated view. The heatmap representing the key characteristic pairs is illustrated in Fig. 8. From the consolidated system view, it can be seen that the semantic relationships become more diluted in comparison to when the systems are mapped individually, which indicates that the larger the system becomes, the more complex the interactions within the system become [48].

Overall, the heatmap for the consolidated system highlights many key characteristic variable pairs, shedding light on some key components that stakeholders and policymakers could focus on when trying to improve the level of inclusion or achieve inclusion as a whole.

The similarity matrix for the consolidated system is presented in Table 8. The similarity values place further emphasis on the complexity of the relationships between all variables identified. The insights from the consolidated word-to-vector system are outlined below:

The characteristics pairs identified within the holistic system provide a clear view of the several key impact factors that influence inclusion. As identified within the individual systems, factors such as the financial market, financial development, digital literacy, and entrepreneurship, among others, were identified as key impact factors. Poverty noticeably shared stronger correlations with financial inclusion and development, which further emphasises the impact that poverty has on the reduction of economic development and growth as it contributes to socioeconomic challenges [17] [28].

The characteristic pair financial_literacy and financial_inclusion results in the highest similarity score. These results align and concur with several previous works of literature. Financial literacy has been identified as a significant roadblock for many economies in terms of improving the level of financial inclusiveness. The lack of financial literacy relates to the inability of individuals to understand the role of financial services as well as the products and services that they offer. Due to this, most individuals do not adopt these services, resulting in an increase in the unbanked population [7] [37] [5].

Collectively, the results place emphasis on the several factors that play a key role in helping various economies reach financial inclusion. The similarity matrices complement the heatmaps generated for each theme as well as the holistic system, making it easier for the data to be consumed and interpreted. These results provide an in-depth knowledge of the intricate interdependencies inside the financial inclusion system, which lays the foundation for the creation of a system dynamics model. A conceptual representation of the recommended framework is shown in Fig. 9 below, which demonstrates how the various variables interact.

This mixed methodology approach has assisted research in obtaining its objectives and answering the research questions that were raised. The first research question focused on the identification of key factors that served as impact factors. This was achieved through the preliminary analysis, where the keywords were identified and combined to form a query string that was utilised to extract relevant research works for this study. The second research question focused on the application of systems thinking to assist in understanding the relationship between variables and quantifying their impact. This was achieved through the word-to-vector methodology, which converted words to represent vectors quantifying the relationships shared between the variables where a high value could be associated with a high influence and a low value with a low or minimal influence.

Table 7 Key insights on selected characteristic variable pairs identified in the word-to-vector analysis for the remaining themes within financial inclusion

System	Characteristic pair	Similarity score	Key insight	System summary	Reference
Financial technology	Payment_infrastructure:aceessibility	0.74 *Appendix*	The strong correlation between these variables highlights the importance of well-developed infrastructure in order to enhance accessibility	These characteristic pairs highlight how financial technology can help improve the journey towards more inclusive finance. Improve infrastructure enhances accessibility to various individuals which in turn improves adoption. Although these technological advancements help improve the level of inclusion, it is also important to focus on protecting data in order to minimise risks	[54] [22] [81]
	Adoption:digital_inclusion	0.80 *Appendix*	This pair places emphasis on how digital ecosystems have the ability to drive the adoption of technologies		
	Data_privacy:technological_innovation	0.48 *Appendix*	This pair highlights that despite the vast advancements in digital technologies, the ability to maintain data privacy has become a major challenge		
Financial ecosystem	Technology_integration:financial_ecosystem	0.78 *Appendix*	This pair highlights how crucial the integration of technology into the ecosystem is in order to improve the interconnectedness and efficiency of financial services	These characteristic pairs highlight the key role these variables play in advancing financial inclusion. However, it is also important to note that these factors need to be worked on collectively and not in isolation in order to obtain the best results	[78] [77] [85]
	microfinance_rural_development: economic_development	0.81 *Appendix*	This strong correlation demonstrates how microfinance institutions help contribute towards the development of the economy		
	Funding_source:financial stability	0.54 *Appendix*	This relationship highlights the critical role that investments play towards the advancement of products and services to help improve the ecosystem. However, the weak relation also suggests that there may be additional contributing factors which may be essential in driving financial inclusion, as investments alone are not strong enough		

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Table 7 (continued)

System	Characteristic pair	Similarity score	Key insight	System summary	Reference
Financial inclusion and entrepreneurship system	entrepreneurship:employment	0.73 *Appendix*	The literature surrounding entrepreneurship has provided evidence of how the establishment of SMEs has been able to create employment. The generation of employment reduced the level of unemployment, ensuring the livelihood of individuals is improved	Entrepreneurship, especially through SMEs, enhances economies and encourages inclusion while creating jobs and making a substantial contribution to economic growth. However, obstacles like limited finance and availability of resources prevent them from attaining their full potential, emphasising the necessity of focused assistance to increase their influence	[43] [42] [77]
	entrepreneurship:investment	0.68 *Appendix*	It has been identified that SMEs significantly contribute to the economy's growth. However, this entrepreneur business still encounters several challenges in terms of receiving funding or investment, which they require for their growth		
	Entrepreneurship:availability	0.44 *Appendix*	Although entrepreneurship has the ability to create employment opportunities, which plays a key role in inclusion, the weak correlation suggests that accessibility to these resources remains a challenge		

Table 7 (continued)

System	Characteristic pair	Similarity score	Key insight	System summary	Reference
Best practices system	technology_integration: financial_technology_adoption	0.90 *Appendix*	Significant technological advancements in finance have occurred over several years. Several countries have created innovative products and services that can assist consumers in receiving and utilising financial products and services more efficiently. It is important to note that whilst this has worked in some regions, other regions have remained unsuccessful	The success of technological advancements has differed across various regions. However, it has enabled the development of diverse financial products and services. Although digital banking is now starting to narrow the gap between financial institutions and the unbanked, its influence is hindered by challenges with infrastructure and digital literacy, requiring focused interventions for optimal inclusion	[44, 45] [34] [64]
	branchless_banking: financial_access	0.76 *Appendix*	Digital inclusive finance has gained attention due to its benefits on digital economic expansion. Studies have provided evidence of how digital finance has been able to start bridging the gap between the unbanked and financial institutions, as it requires digital and not physical infrastructure		
	Unbanked_population:fintech	0.50 *Appendix*	Although fintech solutions present captivating potential, their influence can often be hindered by digital literacy and infrastructure shortcomings. Focused interventions are required in order to leverage the benefits of financial technologies for inclusion		

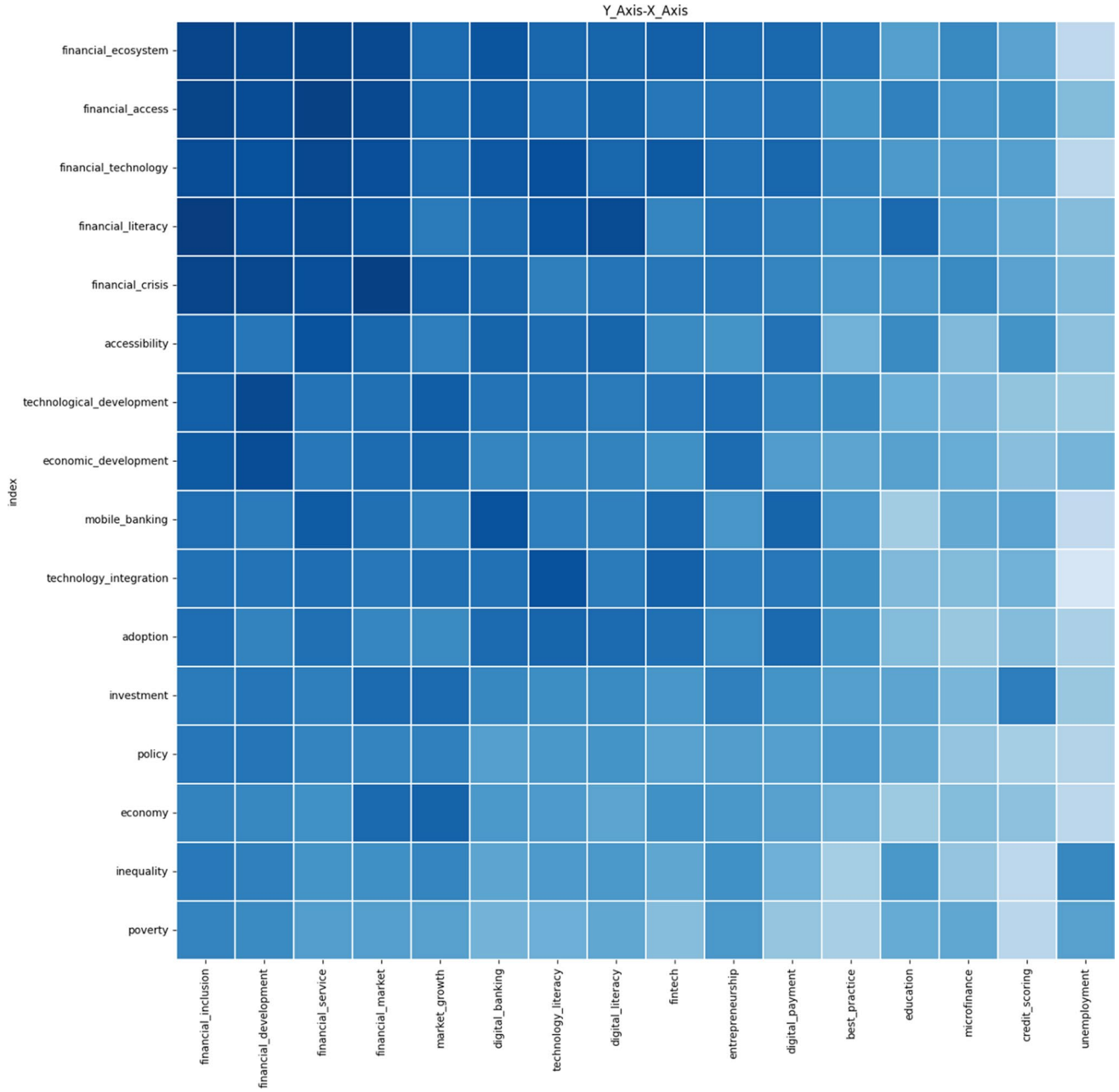

Fig. 8 Heatmap plot for the complete system (Source: Author development)

5 Discussion and conclusion

This research paper explored the complex interactions between several main impact variables that affect financial inclusion to identify critical elements and understand their interdependencies within a comprehensive system. The deep examination of these factors were achieved by the mixed-methods approach, which combines qualitative and quantitative analysis to offer insightful information on the dynamics influencing financial inclusion. Similar evidence from recent studies highlights the importance of this approach. According to Brown et al. [21], for example, incorporating systems thinking into policymaking enables decision-makers to approach complicated problems methodically, improving their capacity to successfully handle challenges related to financial inclusion [21].

The primary objective of this research paper was to investigate and examine the multifaceted and intricate relationships between a range of core impact variables that play a crucial role in the concept of financial inclusion. The main

Table 8 A matrix representing a similarity value for a characteristic pair for the complete system

		Characteristic														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		financial_inclusion	financial_development	financial_service	financial_market	market_growth	digital_banking	digital_literacy	fintech	entrepreneurship	digital_payment	best_practice	education	microfinance	credit_scoring	unemployment
Characteristic																
1	financial_ecosystem	0.92	0.91	0.92	0.91	0.78	0.86	0.80	0.82	0.78	0.78	0.72	0.57	0.66	0.55	0.27
2	financial_access	0.92	0.89	0.93	0.90	0.79	0.83	0.80	0.73	0.73	0.74	0.61	0.69	0.61	0.61	0.44
3	financial_technology	0.89	0.87	0.91	0.88	0.77	0.85	0.79	0.84	0.75	0.79	0.67	0.59	0.58	0.57	0.28
4	financial_literacy	0.95	0.88	0.90	0.86	0.72	0.77	0.90	0.67	0.74	0.69	0.64	0.78	0.59	0.52	0.43
5	financial_crisis	0.92	0.91	0.88	0.94	0.82	0.79	0.74	0.73	0.72	0.68	0.61	0.61	0.65	0.55	0.46
6	accessibility	0.82	0.73	0.87	0.79	0.71	0.80	0.80	0.65	0.61	0.74	0.49	0.65	0.45	0.62	0.41
7	technological_development	0.82	0.90	0.74	0.75	0.82	0.74	0.72	0.74	0.76	0.67	0.65	0.50	0.46	0.41	0.38
8	economic_development	0.84	0.89	0.72	0.77	0.79	0.68	0.68	0.63	0.77	0.58	0.55	0.56	0.51	0.43	0.47
9	mobile_banking	0.77	0.71	0.83	0.75	0.69	0.87	0.69	0.78	0.61	0.80	0.59	0.36	0.52	0.55	0.26
10	technology_integration	0.75	0.74	0.76	0.72	0.75	0.75	0.71	0.81	0.70	0.72	0.64	0.45	0.44	0.49	0.17
11	adoption	0.76	0.68	0.75	0.67	0.65	0.77	0.78	0.75	0.65	0.78	0.61	0.44	0.39	0.44	0.33
12	investment	0.71	0.73	0.70	0.77	0.78	0.66	0.65	0.60	0.69	0.62	0.57	0.54	0.46	0.70	0.39
13	policy	0.73	0.73	0.68	0.68	0.69	0.57	0.62	0.56	0.57	0.57	0.59	0.52	0.40	0.35	0.31
14	economy	0.68	0.67	0.63	0.78	0.80	0.60	0.55	0.63	0.60	0.56	0.49	0.38	0.44	0.42	0.28
15	inequality	0.72	0.69	0.61	0.63	0.67	0.54	0.60	0.54	0.63	0.49	0.35	0.60	0.40	0.28	0.67

Table 8 (continued)

		Characteristic														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		financial_inclusion	financial_development	financial_service	financial_market	market_growth	digital_banking	digital_literacy	fintech	entrepreneurship	digital_payment	best_practice	education	microfinance	credit_scoring	unemployment
16	poverty	0.68	0.65	0.57	0.57	0.56	0.48	0.53	0.43	0.60	0.40	0.35	0.51	0.53	0.29	0.56

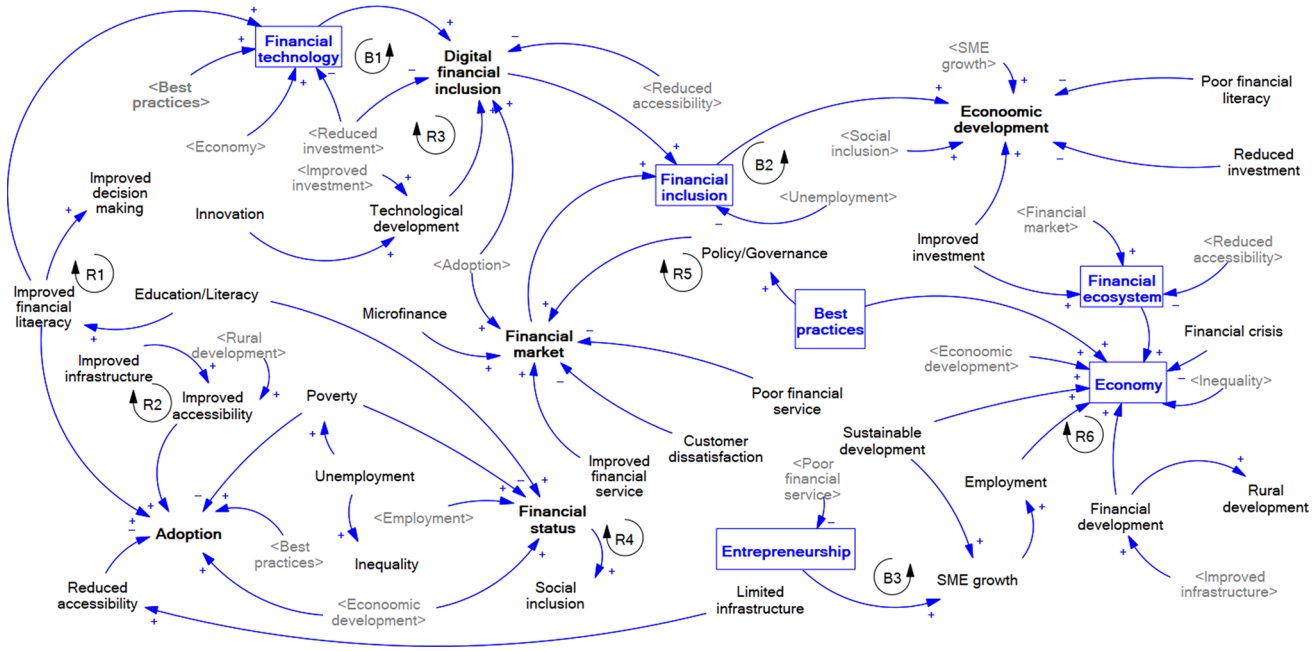

Fig. 9 A conceptual framework for the consolidated systems dynamic model for financial inclusion

focus was to identify the core impact variables and understand their impact in relation to each other and within the holistic system. The key insights obtained from the systems enable researchers to construct more predictive models that capture the dynamic interactions within financial systems, providing a robust framework for future empirical studies. The research findings of this study can help policymakers create an inclusive financial environment that promotes economic development, long-term growth, and financial inclusion. As demonstrated by Nguyen et al. [63], integrating systems thinking into public policy enhances policymakers' ability to address complex challenges systematically [63]. Similarly, Felmingham et al. [30] highlight how systems thinking facilitates intervention design and adaptation in local governance, providing a structured approach to problem-solving (Felmingham, et al., 2023). These predictive characteristics can also help policymakers and experts develop targeted measures that address fundamental barriers to financial inclusion more effectively.

In order to achieve this, a mixed-methods methodology was developed, which incorporated both qualitative and quantitative analysis. The qualitative methodology involved a literature review to identify key impact factors utilised as keywords for further analysis. The keywords were generated and used for the in-depth literature search, which assisted in focusing the study on literature relevant to the current research aims and objectives. A series of keywords were identified across the five themes within financial inclusion, which were then grouped together based on their impact guided by the literature reviewed into search strings. The search strings were then processed on the search engine database, and the results were extracted in plain text format for further analysis as part of the quantitative steps of the methodology. For the qualitative step, the word-to-vector methodology was applied to identify the key semantic relationships between the variables within the data. The analysis resulted in a series of heatmaps generated for each theme and a consolidated heatmap that visualised the semantic relationships within the completed system. These established relationships were then quantified by the similarity values obtained.

The results for the financial inclusion and economy system revealed key insights on the relationships between SMEs and financial services, highlighting the importance of financial support for the growth and sustainability of SMEs as they are key to driving economic growth. This finding is supported by Ogujiuba et al. [66], who demonstrate that financial and business support significantly impact the SME ecosystem in South Africa, emphasising that improved access to financing through grants, equity financing, and loans enhances SME growth and sustainability, ultimately contributing to economic development [66]. Inequality was identified as a high-impact variable within the holistic system as it contained the highest number of semantic relationships with the highest similarity value, emphasising the requirements for improved infrastructure for financial services, increased investments in technology and support to microfinance institutions to help bridge the gap between financial institutions and the unbanked. The findings of this study may assist policymakers in establishing an inclusive financial environment that encourages economic development, long-term growth, and financial

inclusion. The results of the research emphasise how important it is for policymakers to approach the complex problems of financial inclusion from a systems thinking perspective. Policymakers may develop more successful interventions by comprehending the interdependencies between important variables, such as the development of infrastructure and SMEs' access to financial services. To reduced the gap between the banked and unbanked populations and eventually promote long-term economic growth and inclusion, targeted actions are crucial. These include investments in technology and assistance for microfinance institutions.

6 Study limitations

The research study utilised a mixed methods approach through which five significant themes were identified within the complete system for financial inclusion. It is possible for these results to reflect a generalised view as only a single database was used for the data extraction process. In addition, the research paper only elaborates on a single theme, with the remaining four being added to the appendix due to limitations on the length of the paper.

7 Future work

The paper's mixed-methods approach presents important insights into the multifaceted interactions between the variables, establishing the foundation for the adoption of dynamic modelling. The creation of a systems dynamics model will be guided by these findings. The initial framework is demonstrated using a conceptual model; however, subsequent research will refine the interactions among the identified variables and build on the findings to produce a comprehensive systems model.

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Data availability The data will be made available upon request.

Declarations

Ethics approval This research paper has been granted ethics clearance. The clinical trial number is not applicable as the research does not involve people.

Consent to participate Not applicable.

Consent to publish This research article does not require consent to publish as no third-party tables or figures were used. All figures and tables included are developed by the author.

Competing interests The authors declare no competing interests.

Appendix

See Table 9, 10, 11, 12 and Figs. 10, 11, 12, 13

Table 9 A matrix representing a similarity value for a characteristic pair of terms in financial technology

	Index	Characteristic									
		1	2	3	4	5	6	7	8	9	10
		financial_technology_platform	Financial_technology_sector	Financial_technology	financial_technology_acceptance	financial_technology_area	financial_technology_enterprise	digital_inclusion	financial_technology_role	technological_innovation	accessibility
Characteristic											
1	digital_technology	0.92	0.88	0.90	0.90	0.89	0.88	0.89	0.86	0.82	0.71
2	digital_banking	0.86	0.85	0.85	0.84	0.86	0.84	0.87	0.83	0.71	0.78
3	fintech_growth	0.83	0.87	0.84	0.80	0.82	0.85	0.83	0.83	0.80	0.64
4	financial_crisis	0.82	0.86	0.87	0.79	0.83	0.85	0.77	0.84	0.66	0.73
5	digital_economy	0.81	0.84	0.81	0.76	0.82	0.84	0.87	0.81	0.77	0.63
6	mobile_banking	0.84	0.83	0.82	0.84	0.83	0.78	0.75	0.77	0.65	0.78
7	payment_infrastructure	0.88	0.81	0.82	0.83	0.80	0.77	0.75	0.77	0.72	0.74
8	adoption	0.83	0.79	0.79	0.84	0.79	0.77	0.80	0.79	0.72	0.72
9	data_privacy	0.70	0.69	0.67	0.67	0.66	0.68	0.61	0.60	0.48	0.52
1 0	machine_learning	0.58	0.50	0.52	0.59	0.47	0.50	0.43	0.41	0.43	0.48

Table 10 - A matrix representing a similarity value for a characteristic pair of terms in a financial ecosystem

	Index	Characteristic									
		1	2	3	4	5	6	7	8	9	10
		financial_ ecosystem	fintech_ ecosystem	Digitalization	ecosys-tem_ser-vice	financial_ stability	financial_ transaction	technology_ ecosystem	ecosystem_ economy	digital_ ecosystem	economic_ develop-ment
Characteristic											
1	technology_integration	0.78	0.85	0.83	0.82	0.68	0.74	0.96	0.79	0.81	0.71
2	microfinance_technology	0.83	0.87	0.74	0.80	0.70	0.73	0.88	0.76	0.73	0.67
3	adoption	0.78	0.80	0.80	0.78	0.67	0.78	0.78	0.69	0.81	0.58
4	microfinance_regulation	0.82	0.80	0.71	0.72	0.80	0.70	0.68	0.72	0.66	0.66
5	microfinance_rural_development	0.79	0.69	0.74	0.69	0.73	0.67	0.64	0.67	0.69	0.81
6	microfinance_market	0.77	0.74	0.65	0.68	0.76	0.69	0.63	0.77	0.61	0.67
7	growth_rate	0.70	0.61	0.73	0.60	0.79	0.75	0.54	0.66	0.64	0.78
8	microfinance_institution	0.72	0.69	0.61	0.70	0.72	0.60	0.57	0.63	0.55	0.60
9	funding_source	0.58	0.59	0.55	0.60	0.54	0.60	0.56	0.58	0.52	0.54
10	cybersecurity	0.59	0.60	0.62	0.55	0.53	0.57	0.59	0.49	0.58	0.41

Table 11 A matrix representing a similarity value for a characteristic pair of terms in financial inclusion and entrepreneurship

	Index	Characteristic									
		1	2	3	4	5	6	7	8	9	10
		Financial_crisis	Technology_integration	Education_level	Policy_implication	Investment	Credit_availability	Regulatory_framework	Employment	Availability	Financial_crisis
Characteristic											
1	financial_inclusion_sme	0.92	0.74	0.80	0.75	0.70	0.70	0.64	0.60	0.69	0.92
2	financial_inclusion_potential	0.90	0.77	0.78	0.77	0.69	0.67	0.67	0.59	0.67	0.90
3	financial_support	0.93	0.69	0.75	0.80	0.74	0.68	0.69	0.55	0.64	0.93
4	financial_service	0.88	0.74	0.72	0.72	0.67	0.77	0.60	0.53	0.78	0.88
5	financial_inclusion_impact	0.90	0.72	0.80	0.75	0.72	0.67	0.60	0.61	0.66	0.90
6	financial_ecosystem	0.92	0.77	0.68	0.73	0.68	0.64	0.70	0.48	0.63	0.92
7	digital_finance	0.76	0.76	0.69	0.65	0.74	0.67	0.52	0.53	0.59	0.76
8	economic_inclusion	0.77	0.68	0.72	0.72	0.61	0.57	0.55	0.60	0.53	0.77
9	entrepreneurship	0.74	0.70	0.69	0.64	0.68	0.55	0.44	0.73	0.44	0.74
10	technology_adoption	0.66	0.93	0.61	0.60	0.61	0.58	0.60	0.37	0.61	0.66

Table 12 - A matrix representing a similarity value for a characteristic pair of terms in best practices

	Index	Characteristic									
		1	2	3	4	5	6	7	8	9	10
		financial_inclusion_innovation	financial_technology	financial_technology_adoption	financial_access	digital_banking	financial_policy	fintech	digital_literacy	mobile_banking	digital_payment
Characteristic											
1	financial_crisis	0.89	0.87	0.83	0.91	0.79	0.90	0.73	0.74	0.71	0.68
2	technology_integration	0.83	0.91	0.90	0.67	0.75	0.70	0.81	0.71	0.70	0.72
3	branchless_banking	0.73	0.78	0.80	0.76	0.90	0.66	0.77	0.63	0.88	0.76
4	innovation_index	0.85	0.79	0.79	0.72	0.73	0.73	0.65	0.74	0.64	0.68
5	emerging_market	0.79	0.78	0.76	0.73	0.72	0.72	0.77	0.66	0.64	0.66
6	growth_rate	0.80	0.71	0.72	0.75	0.72	0.75	0.63	0.66	0.66	0.63
7	policy_implication	0.78	0.70	0.69	0.71	0.64	0.90	0.62	0.65	0.57	0.60
8	unbanked_population	0.61	0.63	0.64	0.73	0.64	0.61	0.50	0.61	0.66	0.59
9	funding_source	0.60	0.62	0.60	0.63	0.55	0.60	0.60	0.51	0.46	0.47
10	artificial_intelligence	0.50	0.57	0.57	0.39	0.53	0.37	0.59	0.46	0.44	0.53

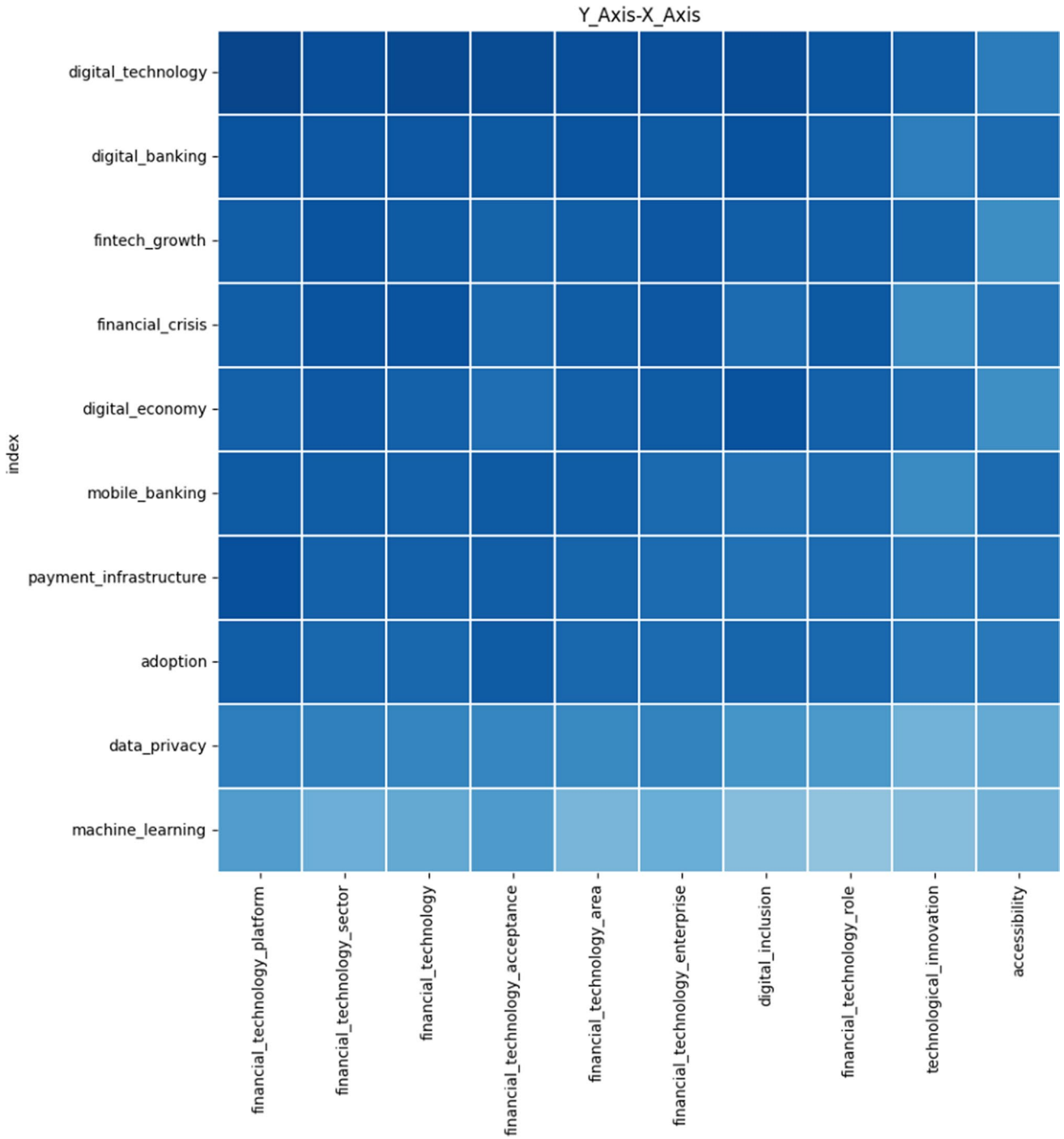

Fig. 10 Heatmap plot for financial technology

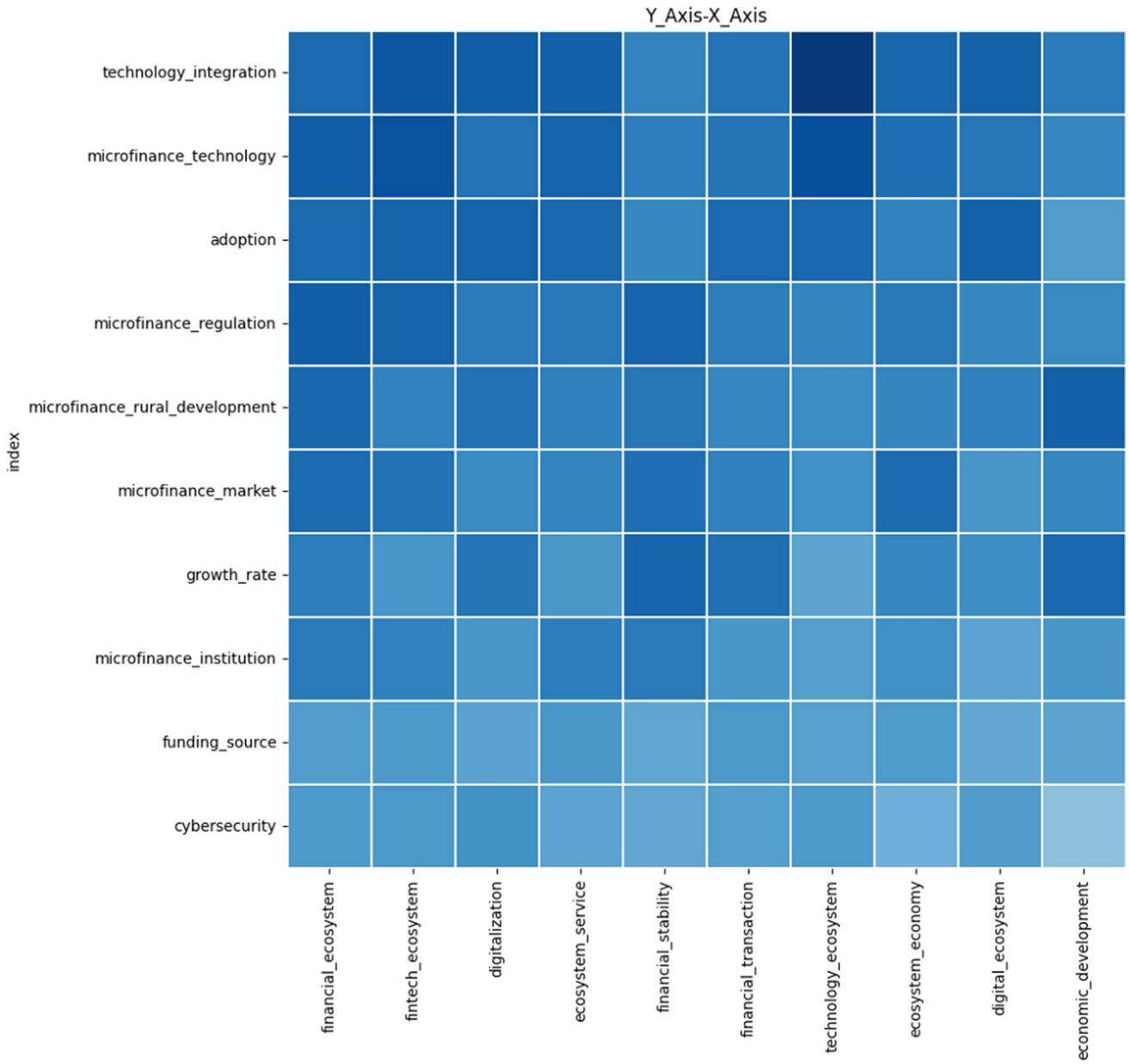

Fig. 11 Heatmap plot for the financial ecosystem

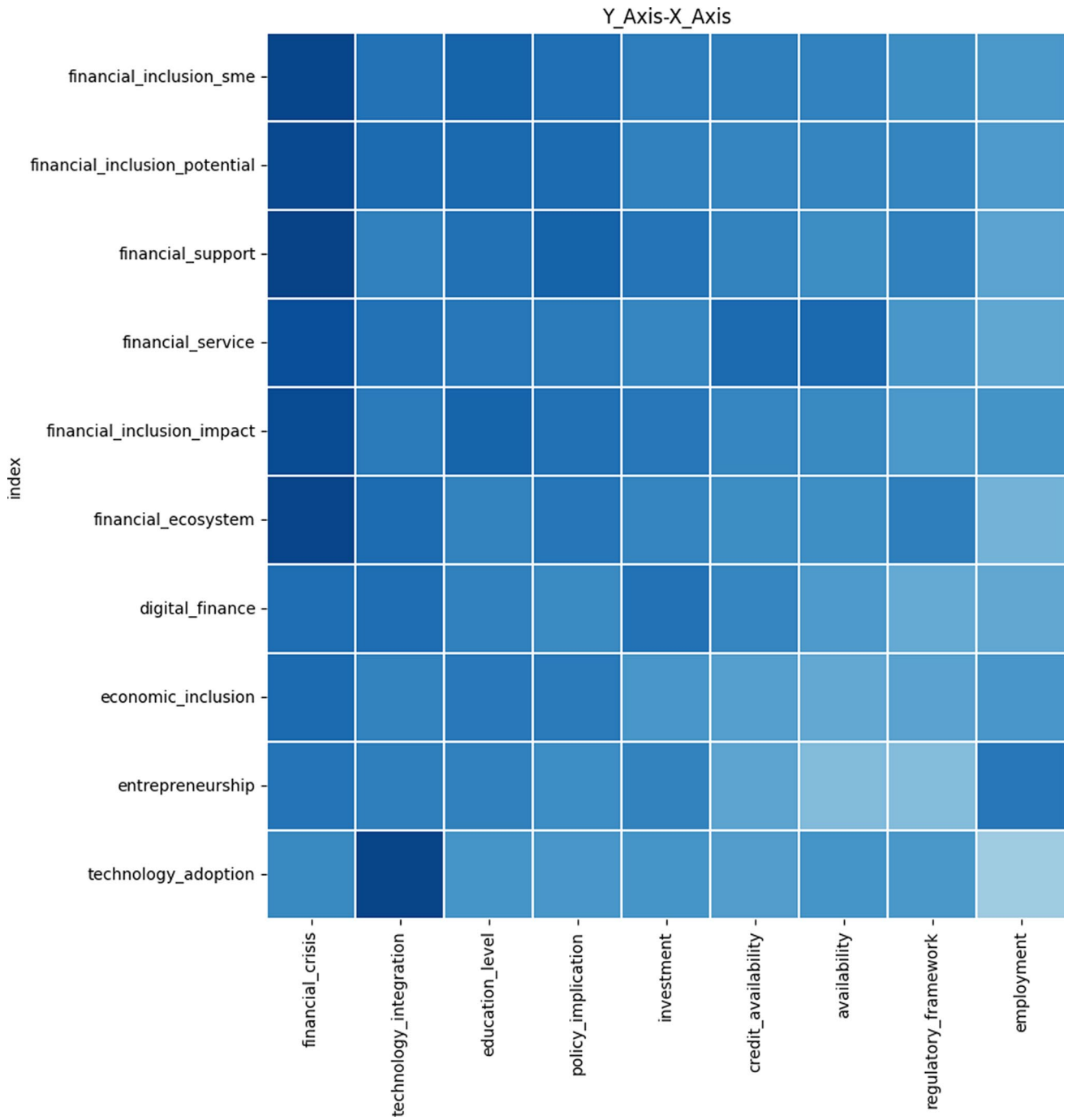

Fig. 12 Heatmap plot for financial inclusion and entrepreneurship

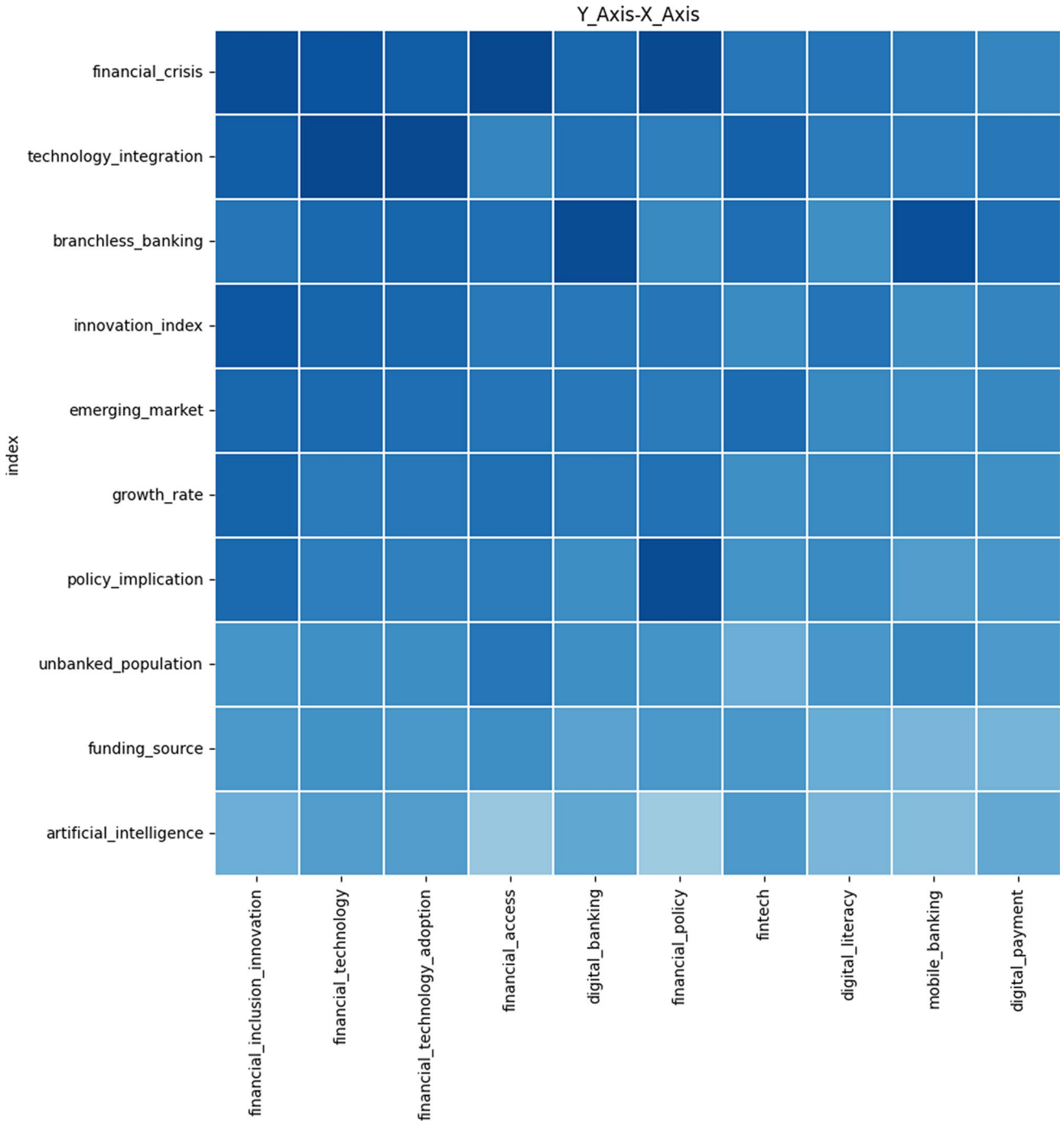

Fig. 13 Heatmap plot for best practice

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