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Research Article

What Will Happen In The Future Of Sustainable Banking? A Link Prediction Bibliometric Analysis Approach

Hajar Moayery Fard[1*], Hesameddin Nezamzadeh[2]

[1*]George Herbert Walker School of Business and Technology, Webster University Georgia. hajarmoayeryfard@webster.edu
[2]Department of Industrial Management, Alborz campus, University of Tehran
[3]Deputy Director of Organization and Methods Department, Central Bank of Islamic Republic of Iran.

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ARTICLE INFO ABSTRACT

The transition from traditional banking to sustainable banking is a hot topic in banking industries that, besides the financial aspect, concentrates on three other aspects: ethical, environmental, and social banking. However, there has yet to be a study to predict the future of this field. This paper is one of the first studies utilizing link prediction for bibliometric analysis and is the first study focused on predicting the future of sustainable banking. We analyze the future of stainable banking by introducing and implementing the new concepts of future co-word analysis and future strategic diagrams. We found that the concentration on social and financial aspects will decrease, while the concentration on ethical and environmental aspects alongside the customer analysis approaches will increase. Indeed, ethical and environmental considerations and customer analysis will be changed into the motor themes of sustainable banking.

Keywords: Link prediction; Future co-word analysis; Future strategic diagram; Text mining; Sustainable banking; Science mapping.

1. Introduction

Corporate sustainability has become one of the most important tools of corporate strategies that enable companies to reach a high performance economy and also improve social and environmental performance [1]. As a core component of sustainable economic growth, banks are one of the most crucial aspects of a country [2], [3].

Sustainability has now become one of the most challenging aspects of banks today [4]. By integrating environmental, social, and governance components into their main strategies, banks are transitioning from traditional banking to sustainable banking [5].

1.1. Sustainable Banking

Banks are a cornerstone of the financial market, playing a crucial role in the economic stability and growth of nations [6]. Sustainable banking refers to delivering financial products and services to employees, shareholders and customers while minimizing the negative effects of social and environmental aspects [7].

In sustainable banking, profit maximization is achieved under the consideration of social and environmental factors [8].

From a banking perspective, sustainability has evolved under four main headings: *a) social banking:* encompassing humanitarianism and community development initiatives for social development; *b) ethical banking:* incorporating business ethics and values into banking operations; *c) green banking:* Considering environmental management systems to avoid funding environmentally risky industries; *d) sustainable banking:* integrating ESG issues (environment, social, and government) for managing the environmental and social effects of banking tasks for developing sustainability in banking [9].

Besides financial actions, sustainable banking includes three other principles of environmental, social, and ethical dimensions in carrying out business activities [10]. Sustainable banking considerations can be found in Fig. 1.

Fig. 1 Sustainable banking considerations

1.2. Bibliometric and Survey Analysis in the Context of Sustainable Banking

The concept of sustainable banking cannot be universally defined in the first place [11]. As sustainable banking is now present in many niches, researchers have not been able to get a comprehensive picture of sustainable banking [12].

Some researchers have used survey analysis to analyze sustainable banks from different perspectives, such as European business models [4], multilateral development banks [13], sustainable business models [14], sustainability banking performance [10], green banking practices [15], and the role of business schools and management in sustainable development [8]. However, a lack of a comprehensive picture for covering the complete field of sustainable banking was evident. The general concept of sustainable banking has therefore been reviewed by a few researchers [11]. There are, however, some challenges associated with survey analysis methods.

Survey analysis methods are limited when it comes to analyzing large amounts of publications over a long period of time. It is impossible for researchers to analyze a wide range of publications in a short period of time [16]. In a conventional analysis, such as review analysis, it is impossible to find hidden knowledge within a text [17]. To overcome such limitations of review analysis approaches, bibliometric methods can be employed for analysis of a special field [16]–[18].

Bibliometric analyses help researchers reveal the internal structure of a field and uncover its development trends [19]. As the field of sustainable banking continues to grow in importance and publications, it is helpful to employ bibliometric analysis to provide an intellectual structure of this domain [20]. Nájera-Sánchez [20], used bibliometric analysis to analyze the sustainable banking field. Through an analysis of the indexed publications in Web of Science (WOS) database between 2009 and 2019, they were able to identify the main themes of sustainable banking. By employing a strategic diagram method, researchers were able to determine the status of disclosed themes from the perspectives of development and applicability. Even though they presented a valuable perspective on sustainable banking, they ignored the future status of this field. Based on our knowledge, prediction of the sustainable banking sector has not been applied by other researchers. In this paper, we use a link prediction method to analyze sustainable banking from the perspective of academic publications.

2. Data and Methodology

2.1. Data

WOS (Web of Science) is one of the world's largest and most widely used academic databases, listing publications related to science and technology [18], [21], [22]. At first, 1754 related article publications to sustainable banking in English were collected from WoS between 2017 and May 9, 2022. The query is searchers between titles, abstracts, and keywords of publications. After removing duplicate records, 1420 publications remain. The related search query and the statistics of extracted publications can be seen in Table 1.

Table 1 Search query information

Document Type	Database	Fields	No. publications	Search Query
Article	WOS	Title Author Keywords	1754	((TS=(sustain*)) AND (TS=(bank*)))

2.2. Methodology

2.2.1. The Construction of Complex Network

Keyword selection is a critical phase in co-word analysis affecting the result's quality directly. Indeed, utilizing the most relevant keywords for designing the co-word network extracts better quality and more profound knowledge from the co-occurrence network. One of the main criteria for keyword selection is frequency, trying to find the most frequent keywords to participate in the co-word graph [18].

After extracting the primary list of keywords, a filtering process is needed to integrate and clean the collected data. Keyword filtering comprises three main phases, i.e., a) standardizing the similar keywords (e.g., *legislation* and *legitimacy*); b) integrating acrimonies (e.g., *nongovernmental organization* and *NGOs*); c) removing general keywords (e.g., *boards*).

Link prediction begins by constructing the related keyword co-occurrence network in which two keywords appearing in the same paper are treated as connected nodes in the network of co-occurrences. In a keyword co-occurrence network, keywords play the role of involved nodes shown by the set $V = \{v_1, v_2, \dots, v_i\}$. The nodes related to a pair of keywords in the same paper are connected by an undirected edge containing a weight factor indicating how frequently the keywords occur simultaneously in all papers [21], [23]. The matrix K shows the co-occurrence relationships between the keywords among N papers.

$$K = \begin{bmatrix} k_{11} & \dots & k_{1i} \\ \vdots & \ddots & \vdots \\ k_{1i} & \dots & k_{ii} \end{bmatrix} \quad (1)$$

and

$$k_{ij} = \begin{cases} 0 & if\ keyword\ i\ and\ keyword\ j\ do\ not\ occure\ in\ the\ same\ paper \\ m & if\ keyword\ i\ and\ keyword\ j\ occure\ in\ m\ paper\ simultaneously \end{cases}$$

2.2.2. Link Prediction Model

A link prediction algorithm predicts the probability of establishing a link between two arbitrary nodes in a graph in the near future [24], [25]. This paper uses link prediction to predict relationships between potential keywords in a network of co-occurrence keywords.

The undirected graph $G\ (V, E)$ consists of a set of nodes (V) and edges (E). The number of nodes and edges are denoted by $N(N = |V|)$ and $M(M = |E|)$. The universal set of nodes in the network is shown by U, where U = $N(N-1)/2$. A score s_{xy} is calculated for each pair of nodes (v_x, v_y) that have not been connected to each other. The undirected nature of G leads to s_{xy} equaling s_{yx}. The nodes of unconnected pairs are sorted by their calculated scores, and nodes of a pair with the most scores are more likely to connect in the future.

In order to evaluate the link prediction algorithm, the edge set E is divided into two sets of training examples (E^T: is employed for calculating the scores of pair of nodes that their edges are known) and test examples (E^P: is employed for calculation of the algorithm's accuracy). Clearly, $E = E^T \cup E^P$ and $E^T \cap E^P = \phi$. In this paper, 10% of the known edges are considered the test set. The probability of creating a link between a pair's nodes in the future is calculated based on the nodes' similarity with each other. The similarity index used in the link prediction approach is explained in Section 2.2.3.

2.2.3. Similarity indices

For link prediction approaches in networks, a variety of methods have been introduced that derive their results from maximum likelihood estimation, similarity, and probability methods [26]. However, some researchers have found that simple similarity indices are suitable for large and complex networks. Because they utilize a lower amount of information when predicting links in a network, while the other two types rely on a greater quantity of information as well as having a higher algorithm complexity [21], [27]. Four similarity indicators are examined in this paper: the common neighbor index (CN), the Jaccard index (JACCARD), the preferential attachment index (PA), and the resource allocation index (RA).

Based on the CN indicator, in the future, two unconnected nodes that have more common neighbors are more likely to be connected. CN is calculated by the Eq.3:

$$s_{xy}^{CN} = |\Gamma(x) \cap \Gamma(y)| \quad (2)$$

Based on Eq.3, $\Gamma(x)$ and $\Gamma(y)$ indicate the neighbor sets of nodes v_x and v_y, respectively.

JACCARD index [28] is calculated by Eq.4:

$$s_{xy}^{JACCARD} = \frac{|\Gamma(x) \cap \Gamma(y)|}{|\Gamma(x) \cup \Gamma(y)|} \quad (3)$$

PA [29] works just based on number of node's neighbors and can be calculated based on Eq.5:

$$s_{xy}^{PA} = k_x k_y \quad (4)$$

Where k_x and k_y indicate the degree of node x and node y, respectively.

RA [27] calculates similarity based on knowledge transfer to common neighbors:

$$s_{xy}^{RA} = \sum_{z=|\Gamma(x)\cap\Gamma(y)|} \frac{1}{k_z} \quad (5)$$

AUC is one of the accuracy measures of link prediction, referring to the chance of the randomly chosen edge in the test set to have a higher score value than the randomly chosen edge that does not exist. When the related score value of a randomly selected edge from the test set exceeds that of a randomly selected nonexistent edge,

add 1 point; If the two sides are equal, add 0.5 point. With Eq.7, AUC can be calculated after n times of comparison.

$$AUC = \frac{n' + 0.5n''}{n} \tag{6}$$

n' refers to the number of times that the edge's score value in the test set is greater than that of the nonexistent edge in the related equation of the AUC index. The n'' parameter also refers to the number of times the mentioned scores are equal.

In this paper, AUC is utilized for evaluating the link prediction approach. The AUC criterion is calculated for eleven similarity indexes of publications' co-word networks by years from 2018 to 2022. A brief overview of the calculations is presented in Fig. 2. The AUC for the PA similarity index in all years is greater than other similarities. Also, the PA's AUC is more than 0.70 for all years, representing its high accuracy for predicting words' co-occupancies. Therefore, this paper uses the PA index to predict the sustainable banking environment.

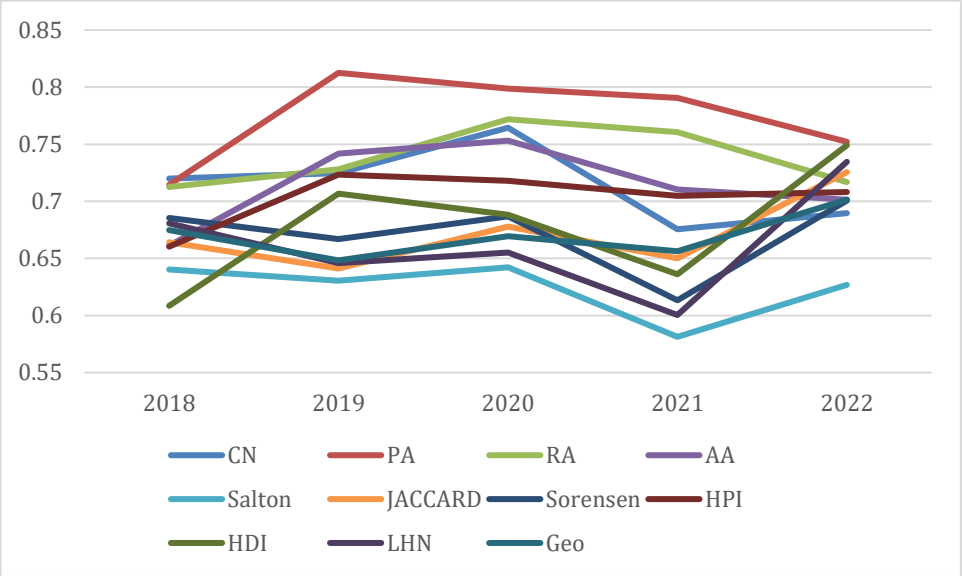

Fig. 2 AUC for eleven similarity indexes

2.2.4. Constructing future co-word network

The current co-word analysis publications focused on descriptive analysis of the past and current state of a field. However, analyzing the future state of a field provides other useful information that help managers for drawing their research road map. Therefore, we introduce a novel concept called future co-word network including the predicted relationships between keywords. For constructing the future co-word network, edges with the highest PA values are selected and others are removed. The future network is evaluated under three scenarios: 1%, 5%, and 10% of nodes with the highest PA values.

2.2.5. Community detection

Community detection is a form of clustering, trying to divide a graph's nodes into some clusters in which the involved nodes of a cluster are similar to each other's and are different from other clusters' nodes [17], [30]. Here, after executing the community detection on the future co-word network, disclosed clusters represent different involved topics in the future of the investigated science field. like co-word publications [18], [31], in order to find different involved topics of the future state of the sustainable banking, the Louvain community detection algorithm is used. The modularity measure is used for evaluation of community detection algorithms. Modularity is a criterion for measuring the quality of community detection algorithms. The higher the modularity measure, the stronger constructed communities. The modularity is calculated by the following formula:

$$Q = \frac{1}{4}\sum_{ij}\left(A_{ij} - \frac{k_i k_j}{2m}\right)S_i S_j, \quad m = \frac{1}{2}\sum_i k_i \tag{8}$$

where k_i and k_j are the degrees of nodes and m is total number of edges. Also, A_{ij} or adjancy matrix is the number of edges between vertex i and j. The expected number of edges between nodes i and j if edges are placed at random is $\frac{k_i k_j}{2m}$ [32]. Four normalization methods were applied to normalize the co-word network to avoid biased outputs. Different papers have utilized various normalizations, such as the Jaccard Index, Association Strength, Cosin, and Inclusion Index [33] presented in Table 2 in terms of Eqs. (9-12). The future network is evaluated under two scenarios: 5% and 10% of nodes with the highest PA values.

Table 2 Co-word normalization outputs

Normalization	Formula	Eq.	Modularity of network including the percentage of nodes with the highest PA values	
			5%	10%
Association Strength	$Association\ Strength\ (i,j) = \frac{C_{ij}}{C_i \times C_j}$	9	0.068	0.098
Cosine	$Cosin(i,j) = \frac{C_{ij}}{\sqrt{C_i \times C_j}}$	10	0.167	**0.215**
Inclusion index	$Inclusion\ Index(i,j) = \frac{C_{ij}}{\min(C_i, C_j)}$	11	0.104	0.153
JACCARD	$Jaccard(i,j) = \frac{C_{ij}}{C_i + C_j - C_{ij}}$	12	0.148	0.157

Where C_{ij} represents the number of co-occurrences of keywords i and j. Besides, C_i and C_j indicate the number of keywords i and j, respectively.

According to the normalized co-occurrence matrix, the co-word network can be visualized in which each node is a keyword, and edges are the normalized co-occurrences. According to Table 2, the second scenario under Cosine normalization has the highest modularity measure (with modularity 0.215) and, consequently, the highest quality of community detection. Therefore, we select it as this research's future co-word network of sustainable banking.

3. Results

After constructing the future co-word network, a graph with 56 nodes and 1422 edges was constructed. The community detection resulted in three different communities. The future co-word network has been indicated in Fig. 3. Only nodes with a higher weighted degree were shown for easier recognition of the graph components.

The green sub-graph indicates the financial aspect of sustainable banking, the yellow sub-community shows the ethical banking, and the blue sub-community explains the customer related issues. Identified sub-graphs are explained in Sections 3.1.1 to 3.1.3.

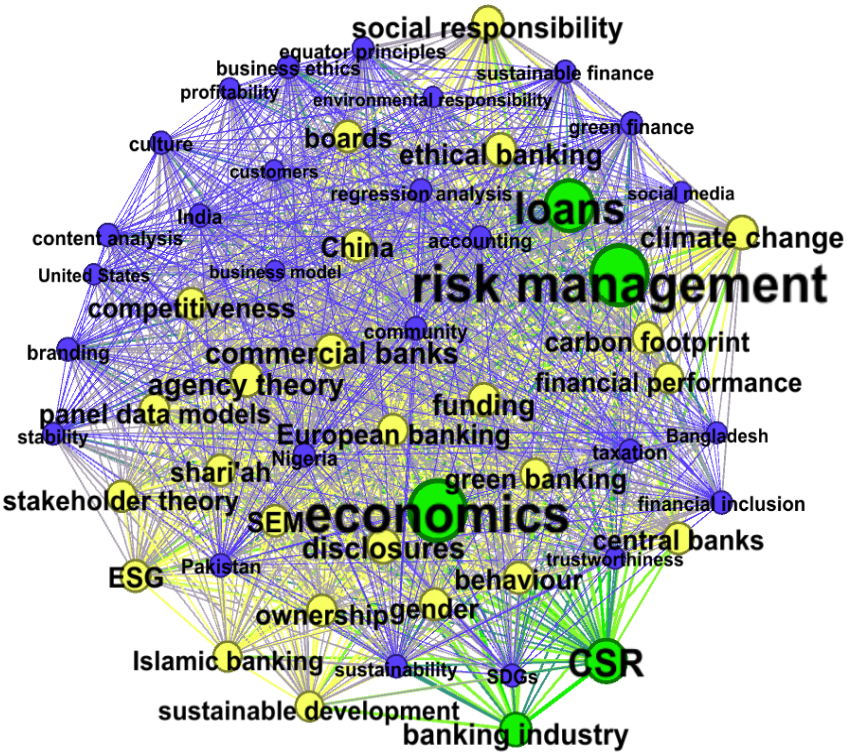

Fig. 3 Future co-word network of sustaiable banking

3.1. Theme analysis

3.1.1. C1: Confluence of financial and social aspects

The disciplines of economics, the banking sector, and the provision of loans represent the financial dimensions of sustainability, while Corporate Social Responsibility (CSR) embodies its social facets. The interconnectivity between these elements and the concept of risk management underscores the significance of risk considerations within both the social and financial realms of sustainable banking. The intricate web of relationships depicted in this sub-graph elucidates the pivotal role that risk management occupies in steering the future trajectory of sustainable banking's social and financial components.

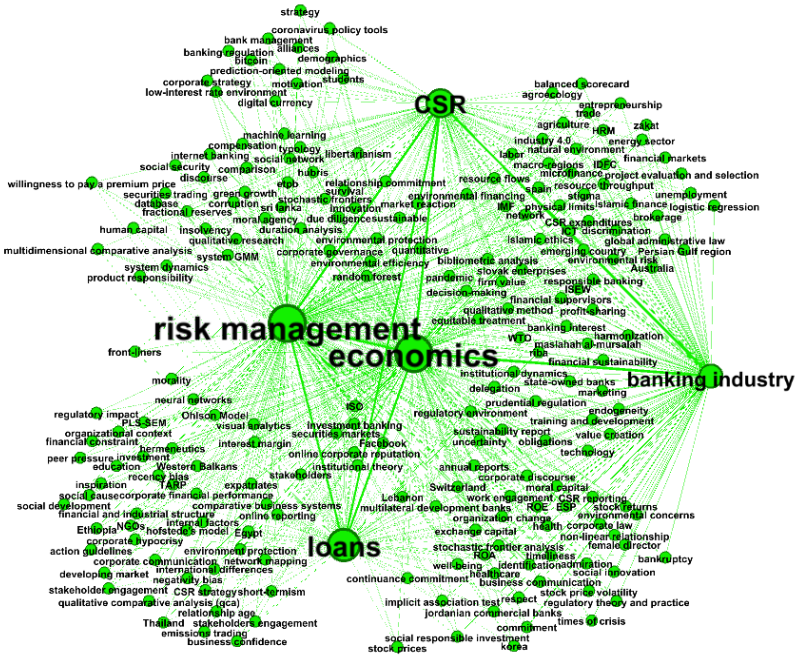

Fig. 4 Confluence of financial and social aspects

To elaborate further, the financial sustainability of banking hinges on sound economic principles, prudent lending practices, and robust financial frameworks. These ensure that banks can withstand economic fluctuations and maintain stability over the long term. Concurrently, CSR initiatives reflect the banking industry's commitment to social sustainability, addressing societal needs and challenges through responsible business practices. The nexus between these financial and social aspects is risk management. Effective risk management strategies are integral to sustainable banking as they provide a safeguard against potential financial crises and social repercussions.

Keywords with the most degree and weighted degree centralities are listed in Table 3. The degree centrality of keyword A refers to the number of links that enter or leave A. Also, the weighted degree centrality of keyword A refers to the summation of edges' weights that enter or leave A.

Table 3 Top keywords of C1

Keyword	Degree centrality	Weighted degree centrality
Economics	407	0.821127
Risk management	402	0.814634
Loans	354	0.576110
CSR	270	0.497902
Banking industry	185	0.424430
Bankruptcy	6	0.011568
Endogeneity	5	0.018375
Uncertainty	5	0.018375
state-owned banks	5	0.018368
pandemic	5	0.018368

The most likely edges of C1 has been shown in Table 4. It seems banking industry

Table 4 The most likely future coincidences in C1

Row	Predicted edge		Weight
1	Economics	Banking industry	0.009645
2	CSR	Banking industry	0.009283
3	Economics	Risk management	0.009150
4	CSR	Risk management	0.008807
5	CSR	Economics	0.008730
6	Loans	Risk management	0.008401
7	Loans	Economics	0.008327
8	Loans	CSR	0.008015
9	Bankruptcy	Banking industry	0.004126
10	Multilateral development banks	Banking industry	0.003948

3.1.2. C2: Confluence of ethical and environmental considerations

The second community (C2) encapsulates the core values and principles that underpin sustainable banking, with a focus on ethical conduct and environmental stewardship. The terminology associated with C2, such as climate change, green banking, and carbon footprint, underscores the sector's commitment to environmental conservation and the mitigation of climate-related risks. These keywords reflect a growing recognition within the financial industry of the imperative to support ecological sustainability through responsible investment and lending practices.

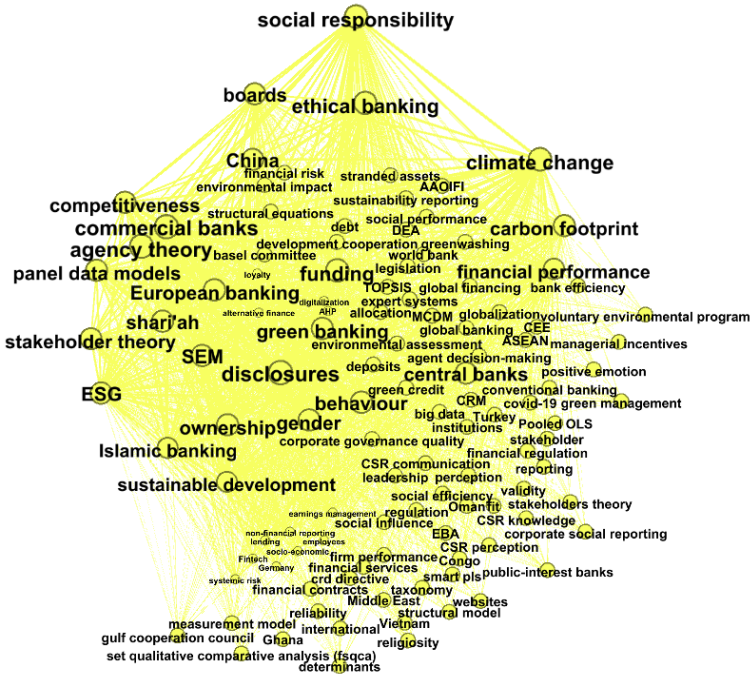

Fig. 5 Confluence of ethical and environmental considerations

Simultaneously, terms like disclosures, social responsibility, ethical banking, Islamic banking, and Shari'ah compliance highlight the ethical dimensions of C2. They emphasize the importance of transparency, accountability, and moral integrity in banking operations. This cluster illustrates how sustainable banking is not only about reducing environmental impact but also about fostering ethical financial practices that align with societal values and religious tenets, particularly within the context of Islamic finance. Keywords with the most degree and weighted degree centralities are listed in Table 4.

Table 5 Top keywords of C2

Keyword	Degree centrality	Weighted degree centrality
Disclosures	113	0.507955
Agency theory	112	0.505581
Commercial banks	112	0.504817
Climate change	107	0.499173
Social responsibility	106	0.483738
Funding	113	0.479807
Ethical banking	112	0.475274
Boards	113	0.4513803
Green banking	113	0.4496874
Islamic banking	108	0.4495134

Table 6 The most likely future coincidences in C2

Row	Predicted edge		Weight
1	Climate change	Social responsibility	0.007285
2	Climate change	Financial performance	0.007163
3	Climate change	Agency theory	0.007103
4	Climate change	Commercial banks	0.007092
5	Agency theory	Social responsibility	0.007089
6	Commercial banks	Social responsibility	0.007078
7	Climate change	Disclosures	0.007039
8	Disclosures	Social responsibility	0.007024
9	Disclosures	Financial performance	0.006908
10	Commercial banks	Agency theory	0.006902

3.1.3. C3: Customer analysis (Blue)

The third pillar within the ecosystem pertains to the customer domain. Key terms like 'customers' and 'consumers' are central to this concept, highlighting the importance of understanding customer behavior and cultural dynamics. Financial institutions aiming for sustainable development goals (SDGs) adopt the customer's perspective as a foundational element of their strategy. To this end, selecting a robust analytical methodology is crucial in the initial phase. Regression analysis and content analysis stand out as two pivotal techniques. These methods enable a deep dive into the customers' viewpoints regarding factors such as trustworthiness, reputation, corporate image, poverty alleviation, and cost efficiency. Insights gleaned from these analyses are instrumental in shaping SDGs that resonate with customer expectations and contribute to a more sustainable and equitable economic landscape.

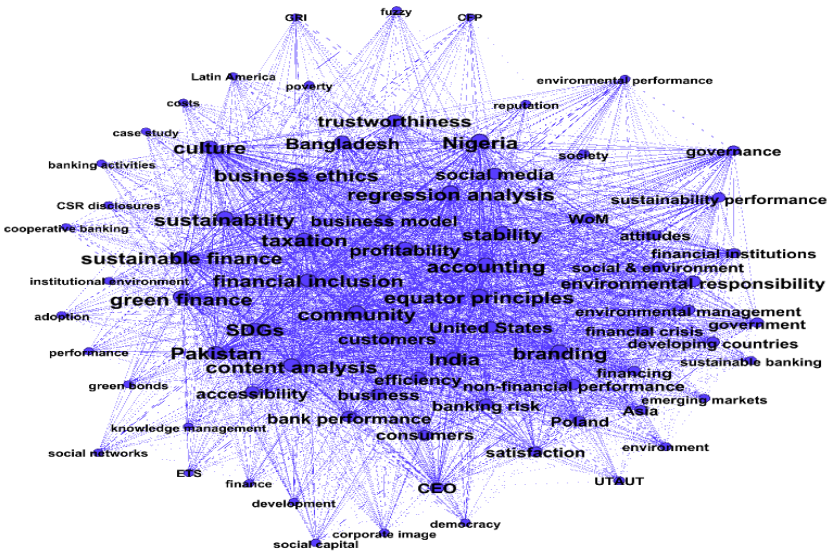

Fig. 6 Customer analysis

By integrating customer-centric data into their strategic planning, financial corporations can tailor their services and communication to align with the values and needs of their clientele. This alignment not only fosters a sense of trust and loyalty but also propels the institution towards achieving its SDGs with greater efficacy and relevance. Ultimately, the goal is to create a symbiotic relationship where both the financial entities and their customers thrive, paving the way for a future that is economically viable, socially responsible, and environmentally sustainable. Keywords with the most degree and weighted degree centralities are listed in Table 5.

Table 7 Top keywords of C2

Keyword	Degree centrality	Weighted degree centrality
Taxation	118	0.514598
Nigeria	117	0.510489
Pakistan	116	0.507344
Regression analysis	116	0.505330
Accounting	116	0.504949
Community	116	0.504884
Branding	115	0.502248

India	114	0.497952
Business ethics	114	0.497298
Green finance	114	0.496902

Table 8 The most likely future coincidences in C3

Row	Predicted edge		Weight
1	Stability	Sustainability	0.004762
2	SDGs	Sustainability	0.004724
3	Stability	Green finance	0.004709
4	Stability	Business ethics	0.004707
5	Stability	India	0.004705
6	Stability	Culture	0.004705
7	Stability	Content analysis	0.004703
8	Stability	Equator principles	0.004703
9	Sustainable finance	Sustainability	0.004691
10	SDGs	Sustainable finance	0.004691

3.2. Future strategic diagram

Although co-word analysis enables researchers to cluster publications' contents, it does not support determining clusters' status in terms of development and applications. Therefore, a strategic diagram as a complementary tool is used. In this paper, we define the concept of a future strategic diagram for the first time, describing the future status of disclosed clusters from the viewpoint of development and applicability. The strategic diagram explains the clusters' status based on two factors: centrality and density.

Here, density determines the internal cohesion of a particular cluster, and the centrality of a cluster explains how well the cluster communicates with other clusters [17]. A strategic diagram is divided into four quadrants based on the mentioned factors. All themes begin in the Chaos/Unstructured quadrant; they are low in centrality and density. By increasing its centrality, the themes move into the Bandwagon quadrant. When the cluster's internal cohesion becomes mature, the cluster moves into the Mainstream quadrant. Finally, the cluster moves to the Ivory Tower quadrant when it loses its centrality [34]. A schematic of the strategic diagram is depicted in Fig. 7. The related formulas for density and centrality are provided in Equations 13 and 14, respectively.

$$C_L = \sum_{i \in L} \sum_{j \in M} w_{ij} e_{ij} \qquad (13)$$

where C_L is the centrality of community L, i shows nodes in community L. The other communities indicate by M; thus, j refers to the other communities' nodes. e_{ij} is a binary variable that when an edge between nodes i and j exists, it equals one; otherwise, it equals zero. Finally, w_{ij} represents the weight of the possible edge between the nodes i and j.

$$D_L = \frac{2E}{N(N-1)} \qquad (14)$$

where D_L indicates the density of community L, E and N show the number of edges and nodes in community L, respectively.

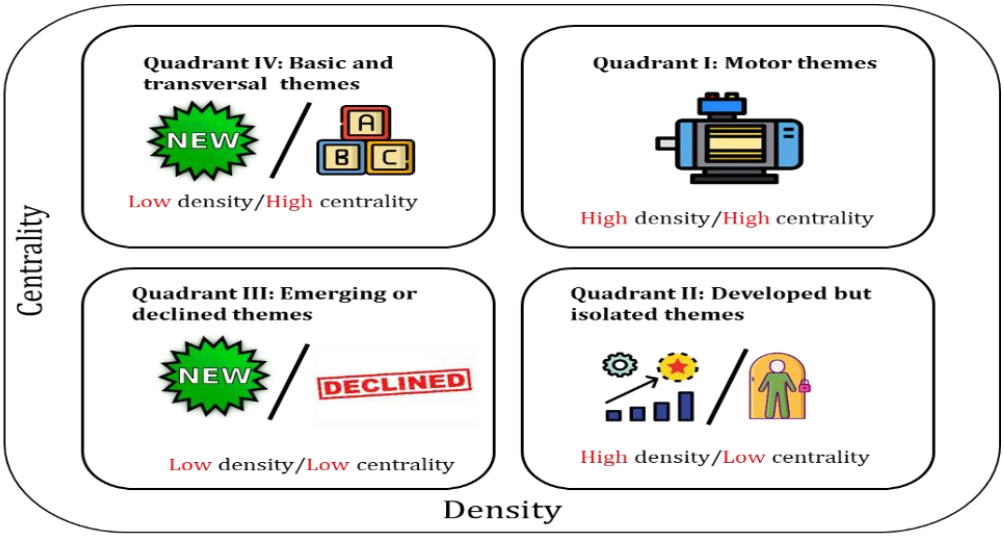

Fig. 7 Strategic diagram of density and centrality

According to Fig. 7, QI is known as the motor theme because it has developed well (due to high density) and communicates with other communities at a high level (due to the high centrality). Indeed, motor themes are considered driving themes, so not only have they grown enough, but they will have a significant impact on other areas and drive them like a driving engine. Themes in QII developed well (because of high density); however, they could not be applied by other existing themes (because of low centrality). Indeed, despite the efforts of researchers to develop such themes, these themes need more use in other fields. Themes in QIII have the lowest amount of density. As a result, they have yet to develop significantly, and it is understood that they are either emerging or disappearing. Also, these themes, like QII's, are isolated and cannot be applied to other themes. Finally, QII's themes refer to peripheral themes that provide fundamental theories and sciences for other themes.

Previously, strategic diagrams were depicted for traditional co-word networks to describe the status of involved themes. However, they needed help to analyze the future status of themes. We applied the strategic diagram for a future co-work network for the first time. Therefore, it can describe the future status of involved themes in the future network. We called it the future strategic diagram (FSD). The FSD for sustainable banking is depicted in Fig. 8.

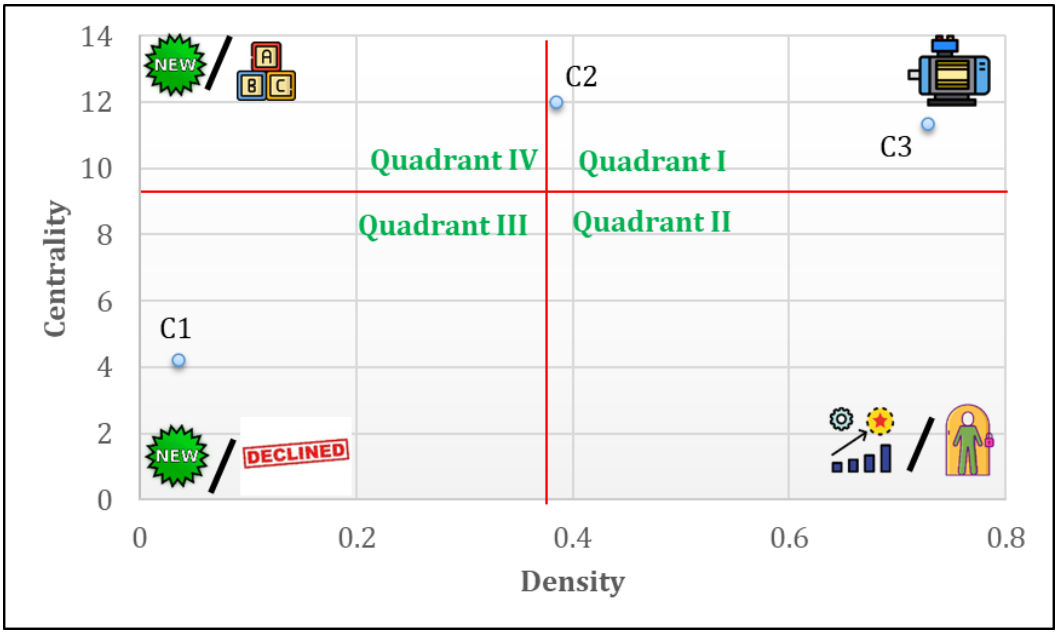

Fig. 8 The FSD for sustainable banking

According to Fig. 8, C1 lies in QIII. The confluence of social and financial aspects will only be developed a little. Also, the intention to use this theme in other disclosed themes (i.e., the confluence of ethical and environmental considerations and customer analysis) will decrease. The other two themes lie in QI. C2 and C3 are the motor themes that may revolutionize sustainable banking. Indeed, we predict that researchers will concentrate on customer analysis and ethical and environmental aspects of sustainable banking. Based on the designed future

diagram, the existing gap is in C2 and C3, and researchers in the future want to fill these gaps by not only trying to study these fields solely but also attempting to integrate them with other disclosed themes. It is predicted that the concentrations of C1 will be decreased in the future.

4. Empirical validation

To effectively evaluate the anticipated co-word network, we will delve into a selection of recently published papers that make significant contributions to each identified theme. This exploration will not only validate our predicted results but also provide a comprehensive understanding of the current research landscape and its alignment with future trends. In order to evaluate the future co-word network, we explain some newly published papers contributed to each of the disclosed themes.

Confluence of financial and social aspects (C1): Cornée et al. [35] have contributed to the discourse on sustainable banking by dissecting the operational, governance, and technological aspects of social banks and by theorizing their role in the broader banking industry. Their work helps to elucidate how these institutions merge financial objectives with social imperatives, potentially shaping the future of the banking sector. Li et al. [36] have contributed to the discourse on sustainable banking by highlighting the financial benefits of integrating social and environmental considerations into banking practices, especially in the face of global challenges like the COVID-19 pandemic. Their work underscores the importance of social and environmental activities in building resilient banking institutions that can withstand economic turbulence. Riegler (2023) [37] has contributed to the discourse on sustainable banking by addressing the complexity and evolving nature of its definition within the academic sphere. Their analysis reveals that most definitions converge on the integration of social and environmental considerations into business strategies and the development of sustainably labeled products. Thongsri and Tripak [38] have contributed to the understanding of sustainable banking by combining financial technology acceptance with social factors like trust and consumer behavior, particularly in the unique setting of a global health crisis. Their work offers valuable guidelines for the development of banking technologies that align with users' needs and preferences in a socially responsible manner.

Confluence of ethical and environmental considerations (C2): Fiordelisi et al. [39] have contributed to the confluence of ethical and environmental aspects in sustainable banking by providing empirical evidence that supports the notion that environmental responsibility is not only ethically sound but also financially prudent. Their work underscores the importance of sustainable practices in the banking industry's risk management strategies. Hassan et al. [40] have contributed to the confluence of ethical and environmental aspects in sustainable banking by mapping out the historical and current landscape of CSR research, identifying key trends, and setting the stage for future investigations in this field. Their work serves as a resource for stakeholders looking to deepen their understanding of CSR's role in the evolution of sustainable banking practices. Kiruthika et al. [41] have contributed to the ethical and environmental aspects of sustainable banking by providing a comprehensive examination of how banks can address global challenges through responsible practices, ultimately fostering a sustainable and equitable economic environment. Their work serves as a guide for the banking industry to navigate the path towards sustainability.

Customer analysis (C3): Ellahi et al. [42] contributed to the understanding of customer dynamics in sustainable banking by identifying key factors that influence green banking awareness and adoption among Pakistani bank customers. Their work provides valuable insights for banks looking to enhance their sustainable banking initiatives and for policymakers aiming to promote green banking practices. Khan et al. [43] contributed to the sustainable banking literature by providing empirical evidence on the attributes that lead to customer satisfaction in e-banking[44], offering a strategic framework for banks to align their services with customer expectations and achieve sustainable growth. Stauropoulou et al. [45] have made a significant contribution to customer analysis in sustainable banking by examining how the adoption of Sustainable Development Goals by banking institutions affects their customers. Indeed, the authors contributed to the understanding of how sustainable banking practices, aligned with global goals, can enhance customer trust and loyalty, providing a valuable framework for banks to measure the impact of their sustainability efforts on customer perceptions and behavior. Mehta and Handriana [46] have contributed to the customer analysis in sustainable banking by examining the dynamics between corporate social responsibility (CSR) and green consumer loyalty, particularly within the Pakistani banking sector. They examined the mediating role of perceived environmental value and the moderating effect of customer eco-consciousness in the relationship between CSR and green consumer loyalty.

5. Conclusion

This paper aims to investigate the future status of sustainable banking from the viewpoint of published articles in the WoS. Most of the current bibliometric analyses focus on analyzing the current status of academic fields, and they cannot be used for future analysis.

Thus, this paper used a link prediction approach to enable the co-word analysis to predict the involved themes of the future. Among the few published link prediction approaches for bibliometric analysis, this is the first attempt to disclose the involved themes of future publications.

This paper depicted the future co-word network of sustainable banking using link prediction algorithms. By applying community detection, involved themes of future sustainable banking were found. As another contribution, this paper determined the future status of disclosed themes by introducing the concept of the future strategic diagram. Indeed, the provided FSD enables researchers to find what happens in the future of sustainable banking from academic publications.

The results show that the future of sustainable banking rotates around two main topics: the confluence of ethical and environmental considerations (C2) and customer analysis (C3). It is expected that researchers not only try to develop these themes solely but also integrate each other's to introduce their capabilities in other domains. Conversely, concentrations on the confluence of social and financial aspects of sustainable banking (C1) will decrease.
Therefore, we do not expect researchers to try to integrate C2 and C3 with C1. In total, we predict that studying the ethical and environmental aspects of sustainable banking from the view of customers may be an exciting idea for the future.

Declarations:

Conflict of Interest: The authors declare that they have no conflict of interest.
Data availability: Data will be available on reasonable request.

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