



Review article

A scientometric review of hotspots and emerging trends in sustainable business model

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ABSTRACT

A sustainable business model (SBM) has become an inevitable trend for the traditional business model to follow the development of the times. Based on scientometrics, we explored and visually analyzed SBM's hotspots and emerging trends using the references co-citation networks, landmark references, burst references, keywords co-occurring networks, timeline map, and burst keywords indicators. Our findings consist of four aspects: hotspots and emerging trends, hotspots evolution history, landmark references, and burst references evolution history. First, the core hotspots are "sustainable innovation" and "open innovation". Second, the main hotspots have evolved from "sustainable innovation," "strategy," "performance," and "supply chain" from 1998 to 2012 into "resource-based view," "product-service system," "China," "life cycle assessment," and "conceptual framework" in 2013–2017. And "circular economy," "renewable energy," "value creation," "decarbonization" have appeared since 2019, which are emerging trends of SBM. Third, we have found ten landmark references in total. Articles written by Bocken & Short, Boons & Ludeke-Freund, and Zott & Amit are the three most landmark references that significantly impact the whole field. Last, the top 10 cited references have burst since 2011 and lasted until 2022. The article written by Teece became a long-term cited hotspot from 2011 to 2018. Moreover, the article written by Geissdoerfer & Vladimirova, which burst in 2020–2022, was the most cutting-edge. This research aims to enrich the existing research theories related to SBM and help governments and enterprises capture hotspots and emerging trends of SBM so that they can better understand and study SBM.

1. Introduction

Peter Drucker believes that the competition among enterprises in the 21st century is ultimately the competition of business models [1]. For a long time, the business model has been a key means for all walks of life to study how economic entities make profits. However, with the development of the times, some traditional business models will eventually be eliminated [2–5]. Under the influence of the wave of global low-carbon economic development and the rapid expansion of consumer demand for eco-friendly products, more and more enterprises have begun to carry out green innovation in the business model [6–10]. Their existing traditional business models are also developing and transforming into SBMs (Sustainable Business Models) [11–14]. An SBM is not only a profit model that helps enterprises achieve sustainable development [15,16], but more critically, it can also significantly improve the

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environment compared to the traditional business model [17]. SBM is generally considered a more social, environmental, and economic development approach to managing [18–21].

Figs. 1 and 2 show the reference's publications and citations in the WOS (Web of Science) Core Collection over time. The research history of SBM began in 1998. SBM was in the low research ebb from 1998 to 2005, with very low publications and citation times of close to zero. However, SBM literature has gradually been cited since 2005, and from 2005 to 2015, SBM's publications and citations increased, but the increase was insignificant. Hence, this period is the rising period of SBM research. After 2015, the number of publications and citations of SBM showed a steep growth, indicating that SBM has entered its research upsurge and become a hot topic.

Although the scope of previous references is extensive, SBM research has two noticeable gaps. First, in terms of content, there needs to be an article to discuss what scholars are most concerned about SBM now and in the future by exploring the hotspots and emerging trends in SBM. Second, methodologically, there needs to be a review article to visualize the hotspots and emerging trends in SBM with a practical methodology. Hence, these gaps affect new entrants to SBM. Because they can't find research focus and direction of SBM, they may give up their research despite their interest in SBM. Therefore, in terms of content, we explore the hotspots and emerging trends to make readers understand what scholars are most concerned about now and in the future. Methodologically, we choose scientometrics, combining mathematics and statistics to show the hotspots and emerging trends in SBM quantitatively and visually. As a result, both professional and non-professional researchers can quickly find essential information such as landmark references and research topics, see the research core and direction in the field, grasp the whole picture, and find the starting point for their future research.

Hence, to contribute to the existing literature by increasing the interest in reading, inspiring readers' thinking about SBM, and attracting readers to have deep and diversified research on SBM in the future, we aim to answer the following research questions:

Rq1. What are the knowledge landscapes of SBM?

Rq2. What are the hotspots of SBM, and how to evolve in the past 25 years?

Rq3. What are the emerging trends of SBM?

To answer our Rq1, we have generated the knowledge landscape of SBM by the reference's co-citation network, landmark references, burst references, the keywords co-occurring networks, timeline map, and burst keywords indicators. Then, based on the knowledge landscapes, we answered our Rq2 and Rq3.

To answer our Rq2, we have found 30 hotspots, namely, "sustainable innovation," "open innovation," "social entrepreneurship," "corporate social responsibility," "sharing economy," "creating integral value," "sustainable niche markets," "value acquisition," and "manufacturing companies." In addition, we noted that during the past 25 years, the main hotspots have evolved from "sustainable innovation," "strategy," "performance," and "supply chain" in 1998–2012 into "resource-based view," "product-service system," "China," "life cycle assessment" and "conceptual framework" in 2013–2017. Furthermore, since 2019, "circular economy," "renewable energy," "value creation," and "decarbonization" have been the new hotspots.

Lastly, to answer our Rq3, we have found that "circular economy," "renewable energy," "sharing economy," "value creation," "barriers," and "decarbonization" are emerging trends of SBM. These answers are also significant findings of our paper which deepen readers' understanding of SBM. Based on scientometrics, our research reduces the tedious feeling of researchers dealing with a massive amount of information about SBM, decreases the difficulty for them to digest information, attracts their interest in SBM, and promotes the research and development of SBM.

The rest of the paper proceeds as follows: Section 2 discusses the existing literature in SBM. Section 3 describes the data sources and tools used. Section 4 presents the results from visualization and analysis of the hotspots and emerging trends in SBM through reference indicator (references co-citation networks, landmark references, burst references) and keyword indicator (keywords co-occurring

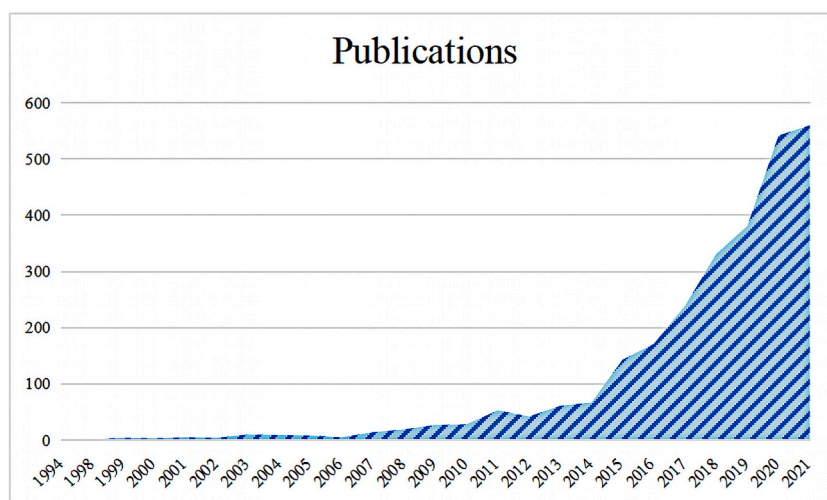


Fig. 1. The number of publications of all references retrieved on SBM (Sustainable Business Model) versus time.

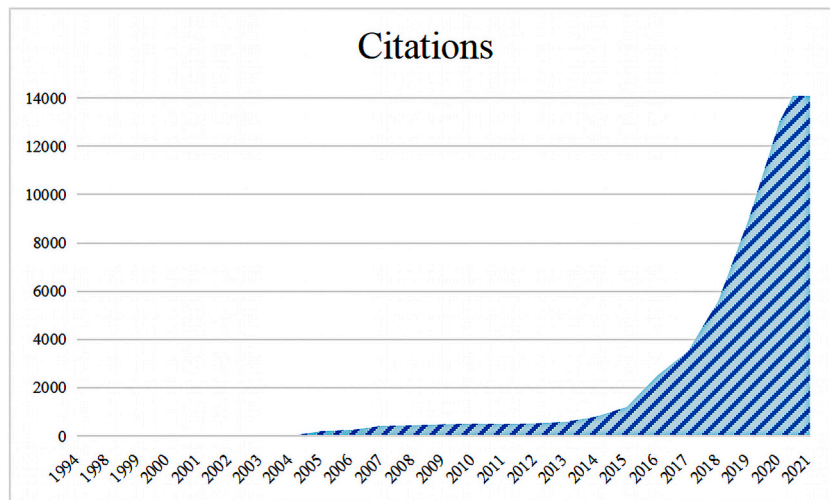


Fig. 2. The number of citations of all references retrieved on SBM (Sustainable Business Model) versus time.

networks, timeline map, and burst keywords) generated by CitespaceV and VOSviewer. Section 5 discusses new findings, the managerial and practical implications, and recommendations. Ultimately, we give the conclusions, research limitations, and prospects.

2. Literature review

In line with existing literature, we construct a knowledge structure about SBM by introducing five essential theories: business model, SBM, sustainable innovation, open innovation, and a circular economy.

2.1. Business model

The term “business model” was used in the early 1840s and still attracts much attention in academic literature. A business model is an architecture that includes products, services, and information flows, and this architecture also describes the roles, potential benefits, and revenue sources of participants [22]. It is also an interdependent system of activities run by enterprises and their partners and an essential mechanism for linking their actions to each other [23]. The business model helps enterprises capture, create, and deliver value [24] and affects various essential parts of corporate governance, such as its culture and performance [25]. Enterprises can also gain a sustainable competitive advantage by improving their business models [26]. An excellent business model can even drive green development growth [27]. A business model is also being more widely used in education [28,29], healthcare [30,31], leisure [32,33], and many other areas [34,35] in humanities. Given this, the attention to the business model is increasing.

2.2. Sustainable business model

An SBM is an inevitable type of business model developing with the times. It is a business model in which multiple stakeholders actively take management actions that can create value for the enterprise from a long-term perspective [36]. Besides enterprises, SBM also designs value for society and the environment [37]. It describes how organizations sustainably create, deliver, and capture value in the economy, community, and culture [38]. Therefore, SBM will enhance enterprises’ competitive advantages [39–41]. Besides, the implementation of SBM also contributes to creating long-term values [42], creating social value and maximizing social benefits [43], achieving sustainable goals [40], obtaining reliable income [44], and gaining corporate reputation and resilience [45]. Therefore, SBM can generate value and substantially impact the local environment [46,47], develop our current consumer society, and integrate sustainable development into our lifestyles [48].

2.3. Sustainable innovation

Enterprises increasingly develop innovations coordinating economic, environmental, and social goals (i.e., sustainable innovation) to adhere to sustainable development [49]. Sustainable innovation can be broadly defined as innovation that must consider the needs of the environment, society, and future generations [50]. Sustainable development is a new concept in business practice [51]. It plays a leading role in transforming and upgrading enterprises, and the new business model is increasingly becoming a typical form of sustainable innovation [52–55]. Sustainable innovation involves stakeholders and crosses the internal boundaries of the organization, requiring companies to adopt a proactive attitude and fundamentally modify their business models [56]. A sustainable innovation strategy is implemented in the business model to improve its economic performance and competitiveness in the market [26]. Some enterprises have incorporated a sustainable development strategy into their business model, and they can gain a sustainable

competitive advantage by improving their sustainable innovation strategy in their business model [57]. The primary purpose of enterprises in implementing sustainable innovation is to reduce the damage to the environment. However, financial constraints are significant barriers for enterprises to achieve sustainable innovation [58].

2.4. Open innovation

Open innovation is a widely used concept in academia, industry, and policymaking [59–61]. It has many benefits and tangible results for participants [62] and has been widely recognized in innovation management [63]. Open innovation is a way of organizational research and development (R&D) [64] and a collaborative model to improve business performance [65]. It is also an innovation strategy that enterprises adopt by integrating knowledge from inside and outside the enterprise, using their knowledge, and exploring the understanding of their environment [66]. Open innovation is increasingly being introduced into the business model design of international and national organizations to create value [67]. Any open innovation business model must consider the relationship between value creation and value acquisition of all participants in the value network [68]. Organizations can develop their competitive advantage by adopting open innovation to embed sustainable development in their strategies and business models [69] and improve their ability to undertake and achieve market absorption of innovation [70]. Sustainable open innovation has become a unique problem of the intersection of open innovation and sustainable development concepts. It is also a challenge to the future business model of enterprises [71].

2.5. Circular economy

The circular economy organizes an industrial system, supporting elasticity by decoupling economic growth from material consumption [72]. It attracts the interest of business leaders, policymakers, and scholars because of its potential to contribute to a more resilient, prosperous, and resource-efficient economy [73]. The circular economy is a sustainable development model that reduces the environmental impact and enables products to be recycled effectively [74]. To promote sustainable development, global organizations should transform into a circular economy [75]. However, organizations need help transitioning to a circular economy [76]. They often need clarification about the impact of the circular economy on themselves [77]. Compared with the linear economy, the circular economy can solve the contradiction between social development and resource utilization, promote material circulation [78] and ensure sustainable development [79]. The transition to a circular economy requires enterprises to actively participate in more sustainable practices [80] and challenge the linear logic of value creation, which still exists in most industries [73]. As a result, enterprises need to create new business models to achieve stronger value propositions and delivery [81].

3. Methodology

3.1. The choice of methodology

Scientometrics is a fundamental scientific theory for systematically evaluating information [82]. We choose scientometrics which combines mathematics and statistics to show the hotspots and emerging trends in SBM systematically and quantitatively. There are four main reasons to use scientometrics. Firstly, scientometrics seeks to understand, quantify, and predict research activities and results [83]. Its focus is not only on the information derived from the literature but also on the essential relationship and analytical quality of the literature explored by researchers [84]. Hence, it supports our aim to help readers understand SBM and know the focus of scholars and emerging trends in SBM by extracting information from references and exploring the essential relationship among them. Secondly, scientometrics can be applied in social science research [85], which aligns with our research nature. Thirdly, bibliometric analysis, citation analysis, keyword analysis, and cluster analysis are the most critical research methods in scientometrics [86]. They help explore hotspots and emerging trends in SBM. Finally, scientometrics provides reliable, transparent, and related results [87]. Nowadays, many research studies evaluate a field with scientometrics [88–92]. Hence, using scientometrics can ensure the correctness and reliability of results.

3.2. The choice of tools

Besides hotspots and emerging trends exploration, we also focus on visualization to make our research results vivid. Information visualization can help researchers to understand complex information more directly [93]. Moreover, Ware (2020) also states that this technology allows information to be more readily understood [94]. Meanwhile, there are many ways to visualize data. Dzemyda et al. (2013) and Shen et al. (2019) classify several common types of visualization ways as “line, plot, map, parallel coordinates, and radial coordinates” [95,96]. Nowadays, there are many information visualization tools [97,98]. Citespace, developed by Dr. Chaomei Chen and VOSviewer, created by van Eck, NJ, and Waltman, L, are the most used and reliable visualization tools. Visualization has clarity and user-friendliness with VOSviewer [99]. Its function is beneficial for displaying large bibliometric maps in a way that is easy to explain [100]. Citespace is an effective tool for analyzing reference information by visualizing models and potential trends in a field [101,102]. Because of the availability, ease of operation, and reliability recognized by most scholars of Citespace and VOSviewer, we finally chose them as our visualization analysis tools. Although the parameter settings and specific steps of different knowledge graphs generated by Citespace and VOSviewer are different, we will not give a unified explanation here. And we will explain the operation details to generate each knowledge graph in Section 4.

3.3. The research query

We choose, combine, and structure our search queries based on different interpretations of the research objects [103]. Hence, our research keywords depend on the research scope of SBM. Therefore, the definition of SBM is essential, as according to its description, SBM is to integrate sustainability into a series of value-related activities such as value proposition, value capture, and value delivery for the sustainable development of enterprise, society, and the environment. Hence, a deep understanding of “sustainability” is the key to delineating the boundary of SBM research. We find some essential aspects of sustainability in the study of Harris (2003) as follows. First, an economically sustainable model must ensure the continued production of goods and services. Hence, we extract “continuable,” “continual,” and expand “circular.” Second, an environmentally sustainable model must maintain stable resources and avoid over-exploiting renewable resources. Hence, we draw “renewable.” Third, an industry-ecologically sustainable model must realize reform and greening. So, we extract “green” [104]. Lastly, we include “business mode,” “commercial model,” and “commercial mode” to describe the business model in our research query.

3.4. Running research query & the choice of database

The Web of Science (WoS), Scopus, and the Engineering Index (EI) are all internationally famous databases. However, EI mainly contains important references in engineering and technology, which aligns differently from our research. So, we exclude EI data and focus on WoS and Scopus. The WoS Core Collection (1900-present) has a better reference quality than the other databases. We searched SBM in these two databases. In WoS Core Collection, the query is TS = (“business model” or “business mode” or “commercial model” or “commercial mode”) AND TS = (green* or sustain* or environmental* or continuable or continual or renewable or “circular economy”). In Scopus, the query is TITLE-ABS-KEY (“business model” or “business mode” or “commercial model” or “commercial mode”) AND TITLE-ABS-KEY (green* or sustain* or environmental* or continuable or continual or renewable or “circular economy”). The * at the top of some words represents a collection of words obtained by morphological changes with the word as the root. Although the data returned by Scopus was significantly more than the WoS Core Collection, the references with the highest correlation rank did not focus on SBM but only mentioned SBM in some descriptions. Hence, the Scopus sample has a weak correlation with SBM. Therefore, we choose WoS Core Collection as our database.

3.5. Collecting and cleaning data & essential explanation

We retrieved 3664 references (language is included in English only) on (26/11/2021) using the query TS = (“business model” or “business mode” or “commercial model” or “commercial mode”) AND TS = (green* or sustain* or environmental* or continuable or continual or renewable or “circular economy”), from WoS Core Collection (See Table 1). We only keep two literature types of articles and reviews to refine the later visual maps while running CitespaceV and VOSviewer. Hence, there were 2783 references, including 2537 articles and 246 reviews. More importantly, our dataset includes 3664 references from WoS Core Collection and their cited references. Although according to Citespace, the number of cited references is enormous and contains 115376 valid references. Therefore, the data sources of these cited references analyzed by the software are not limited to WoS Core Collection, which enhances the credibility of running results. To ensure the repeatability of the operation, we also present the dataset as supplementary material.

4. Results and discussion

We use CitespaceV and VOSviewer to generate visualization results of references and keywords to study SBM. Regarding reference results, we use the co-citation analysis, landmark reference analysis, and burst reference analysis of CitespaceV to explore the hotspots, emerging trends, landmark references, and the evolution of burst references in SBM. Regarding keyword results, we use the co-occurring keyword network of VOSviewer to display the cooperation between keywords. We also use the timeline map of co-occurring and burst keywords of CitespaceV to trace the evolution footprint of hotspots in SBM. Finally, we explain the terms’ meaning, visualization steps, and visualization results for clarity.

4.1. References as indicators

According to the following operations, we extract our results from the co-cited reference network. When setting CitespaceV, *time slicing* is defined from 1998 to 2022, and *node type* is cited reference. Furthermore, we use the *top N = 100* algorithm, indicating that the software will select the 100 most frequently cited documents in each time slice. Hence, the higher the N value, the more content it includes. Moreover, there is *no pruning* on our network.

Table 1
Search results about SBM.

Data source	SCIE	SSCI	CPCI-S	CPCI-SSH	ESCI
Core collection	1556	1817	711	387	475

4.1.1. The landscape of co-cited reference clusters

The co-cited reference means that they have a co-citation relationship if the same article cites two (usually mentioned references). The co-cited references are classified into clusters according to different topics. Hence, we generate the clusters according to the keyword index by using the find clusters of clusters function in the menu bar. We generate 66 clusters by running 115376 valid documents. We illustrate the ten most significant clusters in Fig. 3. According to the signature, the modularity that measures the clarity of modularization in a network [105] is 0.6955, demonstrating that the specialties of SBM could be defined clearly in the view of co-citation clusters.

Furthermore, the mean silhouette, which reflects the quality of the whole clustering configuration [106], is 0.8875, proving that the quality of the cluster is high. The caliber of a co-citation cluster depends on the values of modularity and the silhouette mean jointly. The closer they are to 1.0, the better caliber the cluster has [107]. Therefore, the aggregation quality and analyzability of this co-citation network are high.

The cluster size represents the average number of documents it contains, which can directly reflect the hot topics. The cluster nodes show different cited literature. The connection between nodes is called a co-citation line, and its color indicates the time when literature was first co-cited [108]. Corresponding to the color card on the right, the closer the color is to the red color, the more frontier the cited literature is. As Fig. 3 illustrates, the clusters are mainly blue and green, and there are no gray or white clusters, which shows that the hot topics related to SBM primarily came into existence after 2012 and centrally appeared in 2015, 2016, and 2017. Fig. 3 shows that “sustainable innovation” and “business model innovation” are hot research topics. In addition, “circular economy” may be the hotspot in the future as the color of cluster # 2 is closest to red. The co-citation lines are dense in cluster #0, cluster #1, and cluster #3, which indicates that there are plenty of co-cited references in the three clusters. The color of the three clusters’ co-citation lines shows that the first co-citation was between 2013 and 2015. Hence, sustainable innovation, business model innovation, and sustainable energy are often studied together from 2013 to 2015.

In CitespaceV, we choose the summary table of clusters function in the menu bar. Then we got Table 2. It summarizes the information on clusters obtained from two different algorithms, which provides more robust evidence for further analysis of hotspots and emerging topics of SBM. We present cluster ID (cluster identification), size (number of items contained in the cluster), silhouette (the quality and consistency within the cluster), and mean year means (average time of publication of all documents in a cluster). Furthermore, we present two clustering algorithms provided in CitespaceV: LSI (late semantic indexing) and LLR (log-likelihood ratio). However, the LLR algorithm always gives the best results. Cluster #0 contains 97 references, and the mean publication time of the literature is 2013, which is in the middle and later stages of the whole research period.

Therefore, “sustainable innovation” is the hottest research topic and has a promising frontier. Sustainable innovation is a model based on sustainable development that currently many public policies encourage [109]. Based on the existing research, sustainable innovation’s and SBM’s effects are mutual. On the one hand, sustainable innovation is an effective means for the traditional business model to gradually turn to a green business model, which plays a role in the value chain and proposition. Hence, introducing the concept of sustainable innovation into business models will generate SBM [110,111].

On the other hand, SBM is an essential means for enterprises to improve sustainable innovation ability [112], build a sustainable

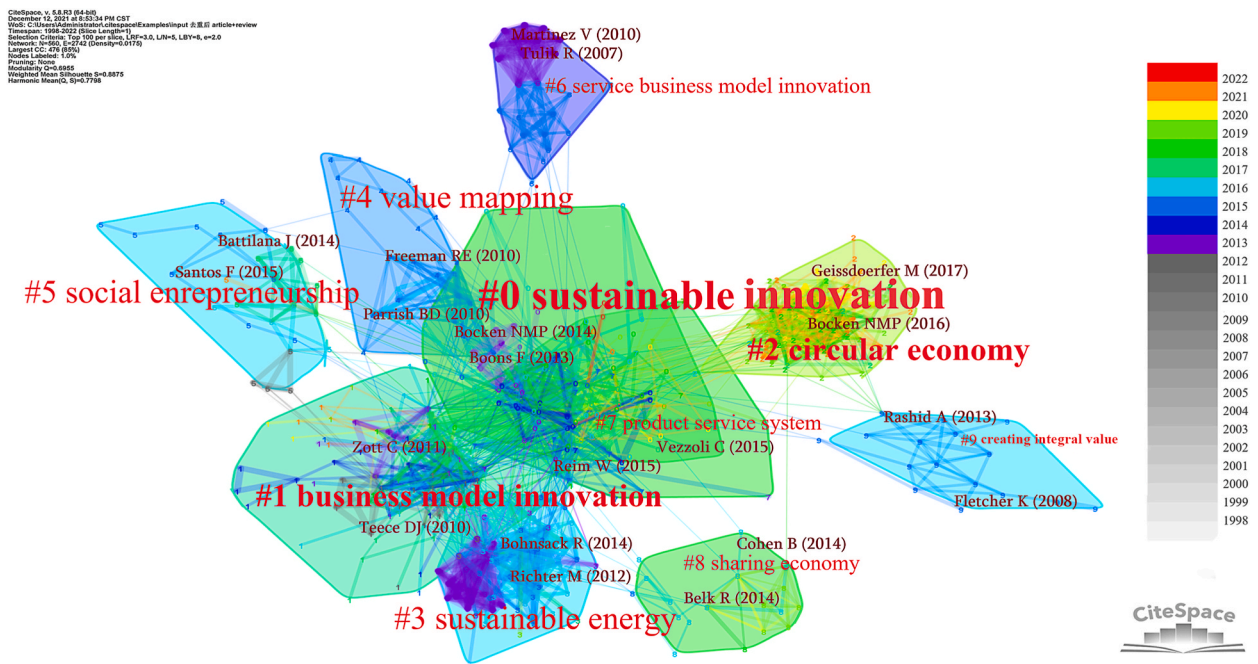


Fig. 3. A landscape of the co-cited reference clusters (1998–2022).

Table 2
Summary of top 10 Clusters.

Cluster ID	Size	Silhouette	Mean (Year)	Label (LSI)	Label (LLR)
0	97	0.809	2013	sustainable business model	sustainable innovation
1	84	0.832	2011	business model innovation	business model innovation
2	69	0.975	2017	manufacturing companies	circular economy
3	64	0.833	2011	renewable energy	sustainable energy
4	28	0.945	2009	sustainable business thinking	value mapping
5	25	0.94	2010	B Corp	social entrepreneurship
6	24	0.963	2008	service business model innovation	service business model innovation
7	22	0.888	2011	product-service system	product-service system
8	18	0.933	2012	sharing economy	sharing economy
9	16	0.951	2010	creating integral value	creating integral value

innovation system [113] and sustainable innovation practice [57,114], and play a strategic guiding role [37,115,116]. Cluster #2 comprises 69 references; the publication average year is 2017, which is relatively new. It also has the highest S (Silhouette) value concurrently. The S value can reflect the homogeneity of the content in the clustering. The clustering result is more meaningful if the S value is higher than others [117]. Hence, “circular economy” is the most cutting-edge research topic. The circular economy has gained increasing attraction in academic fields as an alternative model to minimize resource depletion, waste, and emissions [118].

Furthermore, the circular economy is an SBM to achieve business goals without environmental damage [119,120]. Additionally, the circular economy is the background of previous research on SBM [121,122] and is a tool for designing and implementing SBM [38, 123–125]. Future research on SBM can explore circular economy and investigate implementation strategies of SBM for sustainable development. Alternatively, it is necessary to further study the circular and green development of the enterprise and social economy through implementing SBM. Besides, we also notice that “social entrepreneurship,” “sharing economy,” and “creating integral value” are also hotspots in SBM. Therefore, we analyze these hotspots to generate research inspiration for readers. For example, “social entrepreneurship” shows that the design or implementation of SBM essentially encourages enterprises to apply social responsibility more than before. Hence, corporate leaders can better demonstrate their social entrepreneurship. In addition, social entrepreneurship urges enterprises to pay more attention to sustainable development and then constantly try the sustainable reform of the business model; the “sharing economy” shows that embedding such a way of creating value by sharing idle resources into an enterprise’s existing business models can help them to promote the implementation of SBM successfully. Moreover, the hotspot, “creating integral value,” reflects that compared with other enterprises, enterprises that develop or implement SBM are not only concerned about the value of individual assets but also pay more attention to the integrity of enterprise value from the perspective of continuous operation.

4.1.2. Landmark references

The landmark references are the references that have made significant contributions (the references that have high citations). Citation counts in Citespace represent the acceptance of knowledge contribution in a discipline [126]. First, we generate a co-citation network and present the references’ titles, years, authors, and citation times. Then, we extract the most frequently cited references from 1998 to 2022, discuss their landmark significance, and present them in Table 3. We note that landmark references were published after 2010 and mainly around 2016, which shows that landmark references appeared relatively late during the study period from 1998 to 2022. Nevertheless, many of the viewpoints in these documents are from the current era, which may be a significant guide for the future study of SBM. The top two cited articles, written by Bocken et al. (2014) and Boons and Ludeke-Freund (2013), are the most

Table 3
Top 10 cited references ranked by citation counts.

Rank	Research hotspots of extraction	References	Citation counts	Cluster-ID
1	Origin and development	Bocken NMP, 2014, J CLEAN PROD, V65, P42, DOI 10.1016/j.jclepro.2013.11.039	441	0
2	Value chain Value proposition	Boons F, 2013, J CLEAN PROD, V45, P9, DOI 10.1016/j.jclepro.2012.07.007	337	0
3	Information integration technology	Zott C, 2011, J MANAGE, V37, P1019, DOI 10.1177/0149206311406265	226	1
4	Conceptual framework	Bocken NMP, 2016, J IND PROD ENG, V33, P308, DOI 10.1080/21681015.2016.1172124	165	2
5	Sustainable niche markets	Schaltegger S, 2016, ORGAN ENVIRON, V29, P3, DOI 10.1177/1086026615599806	159	0
6	Value acquisition	Evans S, 2017, BUS STRATEGY ENVIRON, V26, P597, DOI 10.1002/bse.1939	157	0
7	Circular economy	Geissdoerfer M, 2017, J CLEAN PROD, V143, P757, DOI 10.1016/j.jclepro.2016.12.048	151	2
8	Framework	Joyce A, 2016, J CLEAN PROD, V135, P1474, DOI 10.1016/j.jclepro.2016.06.067	146	0
9	Circular economy	Ghisellini P, 2016, J CLEAN PROD, V114, P11, DOI 10.1016/j.jclepro.2015.09.007	136	2
10	Product-service system (PSS)	Tukker A, 2015, J CLEAN PROD, V97, P76, DOI 10.1016/j.jclepro.2013.11.049	135	2

influential, and the landmark references written by Evans et al. (2017) and Geissdoerfer et al. (2017) are the forefronts.

According to the clustering topic, the references with Rank numbers 1, 2, 5, 6, and 8 belong to cluster #0 and focus on “sustainable innovation.” Bocken and Short (2014) explore the mechanisms and solutions for business model innovation that promote sustainable development by introducing eight SBM archetypes to describe the mechanisms and solutions that may help establish SBM [127] (reference Rank 1). Boons and Ludeke-Freund (2013) study the concept of a business model combined with sustainable innovation and introduce critical factors such as value chain and value proposition [53] (reference Rank 2). Schaltegger et al. (2016) establish a theoretical framework to analyze the evolution path of the business model of a sustainable niche market and traditional mass-market aiming at sustainable development [128]. Evans and Vladimirova (2017) introduce five propositions on SBM’s value acquisition, laying the foundation for the SBM innovation concept. The article [129] studies the sustainable development of organizations by providing a framework of the triple business model canvas (reference Rank 8). Cluster #1, with the theme “business model innovation,” only contains reference Rank 3. Zott et al. (2011) emphasize that integrating information technology in the sharing economy positively impacts the innovation of business models based on the discussion of the bank business model [130]. The remaining four articles [131,132–134] are associated with cluster #2 and present the “circular economy” as their narrative. Reference 4 designs a strategic framework to guide the shift from a linear business model to circular development. Reference 7 discusses the connection and difference between the circular economy and sustainability concepts. It emphasizes that circular economy is defined as a regeneration system that reduces the waste of resources by employing remanufacturing. At the same time, sustainability is a state of balance between the economy, society, and the environment. Reference 9 proposes that the circular economy is a reliable theoretical framework for improving business models. The last reference state that a PSS (product-service system) can give users a higher value from both tangible and intangible aspects. Also, due to the low creation cost of PSS, it promotes the circular development of the enterprise to a certain extent, although the usage of PSS requires a radical change in the business model.

4.1.3. Burst references

Burst references refer to suddenly discovered references or highly cited references during a period. For instance, a reference published long ago and was not cited for a while suddenly gets a high citation record and becomes a ‘star literature’ for a period. Hence, we obtain burst reference results using the *burstness* tab in the control panel. Moreover, the intensity of the burst reveals how much people care about a particular topic [135]. Hence, we select and describe the top ten cited literature with the most vigorous burst to show the more representative results. The listed references in Table 4 show no burst reference in SBM before 2011. However, it does not mean that these studies are of no significance to the research on SBM. The lack of burst references until 2011 may be due to the United Nations Conference on Sustainable Development convening in Rio de Janeiro, Brazil, in 2012. The conference was the next large-scale and high-level meeting on international sustainable development after the 1992 United Nations Conference on Environment and Development and the 2002 World Summit on Sustainable Development in Johannesburg, South Africa. Hence, the conference in 2012 attracted a high degree of attention to sustainability again, so the references to SBM began to burst.

Table 4 shows that Teece (2010) was the earliest literature bursting after 2011 and was published in Long Range Planning. Its burst lasted from 2011 to 2018, with an intensity of 50.65, lasting for a long time and much stronger than the rest of the literature, which indicates that this literature has been cited as a hotspot and plays a leading role in the field of SBM. Furthermore, we show the citation history of the article [136] in Fig. 4, having a total of 183 citations, and its citation increased significantly from 2017 to 2018, peaking in 2018. Hence, strategic analysis is the key to SBM, and the specific implementation of SBM is also related to its position in the value chain, which means the performance of SBM will be different in different locations of the enterprise management link.

The article [137] was published in the same journal as the article [136] entitled “Business Model Evolution: In Search of Dynamic

Table 4
Top 10 references with the most vigorous citation bursts.

References	Year	Strength	Begin	End	1998–2022
Teece DJ, 2010, LONG RANGE PLAN https://doi.org/10.1016/j.lrp.2009.07.003	2010	50.65	2011	2018	
Demil B, 2010, LONG RANGE PLANN https://doi.org/10.1016/j.lrp.2010.02.004	2010	18.7	2012	2018	
Casadesus-Masanell R, 2010, LONG RANGE PLANN https://doi.org/10.1016/j.lrp.2010.01.004	2010	19.05	2013	2018	
Yunus M, 2010, LONG RANGE PLANN https://doi.org/10.1016/j.lrp.2009.12.005	2010	17.9	2013	2018	
Stubbs W, 2008, ORGAN ENVIRON https://doi.org/10.1177/1086026608318042	2008	16.92	2014	2016	
Hockerts K, 2010, J BUS VENTURING https://doi.org/10.1016/j.jbusvent.2009.07.005	2010	8.76	2015	2018	
Baumgartner, R, 2017, J CLEAN PROD https://doi.org/http://doi.org/10.1016/j.jclepro.2016.04.146	2017	7.41	2017	2019	
Klewitz J, 2014, J CLEAN PROD https://doi.org/10.1016/j.jclepro.2013.07.017	2014	5.57	2018	2020	
Manninen K, 2018, J CLEAN PROD https://doi.org/10.1016/j.jclepro.2017.10.003	2018	9.58	2019	2020	
Geissdoerfer M, 2018, J CLEAN PROD https://doi.org/10.1016/j.jclepro.2018.06.240	2018	19.85	2020	2022	

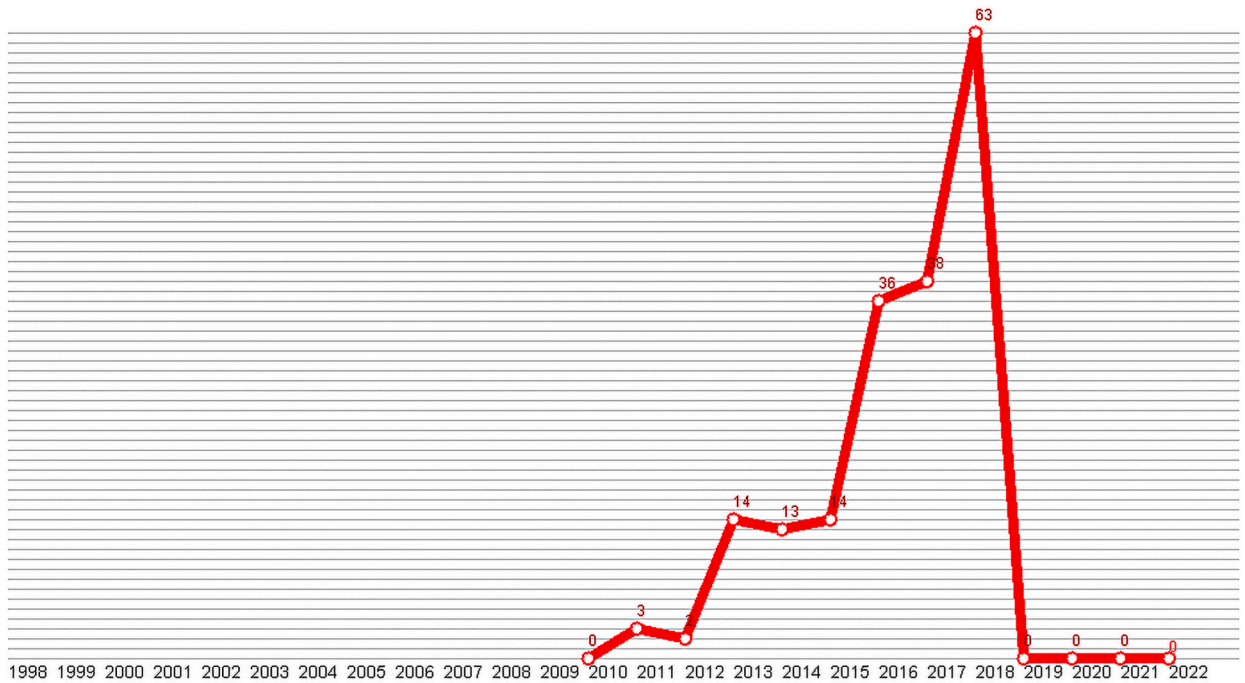


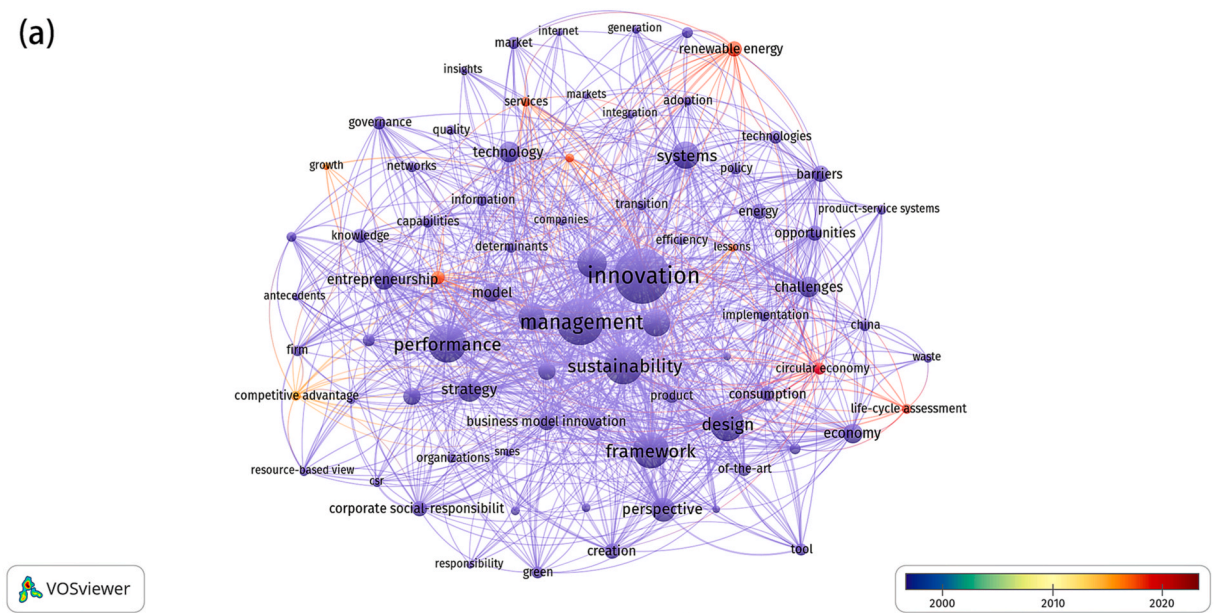
Fig. 4. Citation history of Teece (2010).

Consistency,” which began to burst from 2012 to 2018. They state that the evolution of the business model is a dynamic process, and sustainability depends on whether managers identify the impact of a single element, such as the value proposition and customer relationship of the business model on itself. In 2010, two articles written by Casadesus-Masanell et al. and Yunus et al. began to burst simultaneously. Casadesus-Masanell and Ricart (2010) argue that establishing a sustainable competitive advantage is the core issue of business model design, and enterprises should be able to constantly break the original market competition rules and standards and gradually design a business model with a sustainable competitive advantage, to create sustainable growth of value [138]. On the other hand, Yunus et al. (2010) pay much attention to the problem of CSR (corporate social responsibility) [139]. They mainly discuss establishing the business model of social enterprises and the value acquisition model. Hence, the business model of social enterprises should pay attention to the contribution to society and recover all the costs to obtain profits like ordinary enterprises to achieve sustainable development. The burst duration of these three articles was not short, and the burst value was relatively high, indicating that they also had a particular citation heat from 2012 to 2018. The Journal of Organization & Environment published a reference named Conceptualizing a “Sustainability Business Model” in 2014, and its burst began in 2016. First, Stubbs and Cocklin (2008) conceptualize SBM and mention that organizations implementing SBM must develop internal structures and focus on organizational culture to achieve real sustainability [140]. Then from 2015 to 2018, the document [141] began to burst, and the authors state that new entrants in an industry may pay more attention to sustainable development opportunities than existing ones and are often more likely to achieve sustainable development innovation.

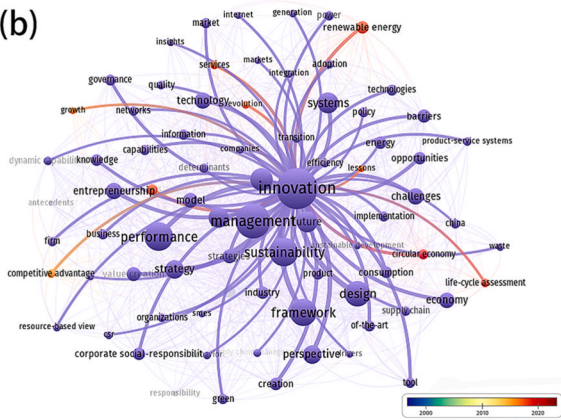
Furthermore, concerning sustainable entrepreneurship, Schaltegger and Wagner (2011) also show that a dynamic market environment and social goals can be combined with sustainable innovation through social and institutional entrepreneurship [142]. Finally, in 2017, with the change in customer demand, the article [143] began to burst. The authors explain that changing the traditional product-selling model to a product-service system will significantly increase products’ positive impact on the environment and society. Moreover, introducing product life cycle assessment could promote the sustainable development of the business model.

The article [144] published in the Journal of Cleaner Production began to burst in 2018. The authors state that sustainable or ecological strategies will likely revolutionize SMEs (Small and Medium Enterprises). In 2019, the article [145] “Do circular economy business models capture intended environmental value propositions?” began to burst. The document mentions that the CE (circular economy) principle can be embedded in the value proposition of SBMI, making CE the driving force of sustainability. They design an evaluation framework to analyze the environmental value proposition of the circular business model and conclude that the user’s choice of product or service is crucial to realizing the value proposition; if the product or service does not have the final user, it will not be able to create environmental value. The burst of these two papers was relatively new, lasting until 2020, indicating that their viewpoints have a particular frontier and are reasonably popular. The study [36] was also published in the Journal of Cleaner Production burst in 2020, lasting until 2022, ranking second in intensity at 19.85. It proves that it has the most frontier and has high citation heat. Geissdoerfer and Vladimirova (2018) construct a framework that combines the circular business model and circular supply chain management, confirming that the circular business model and circular supply chain contribute to sustainable development.

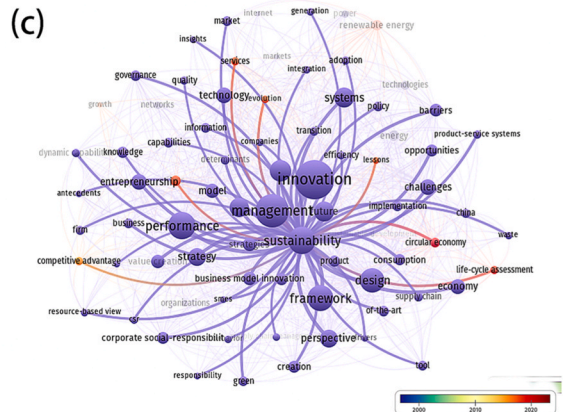
(a)



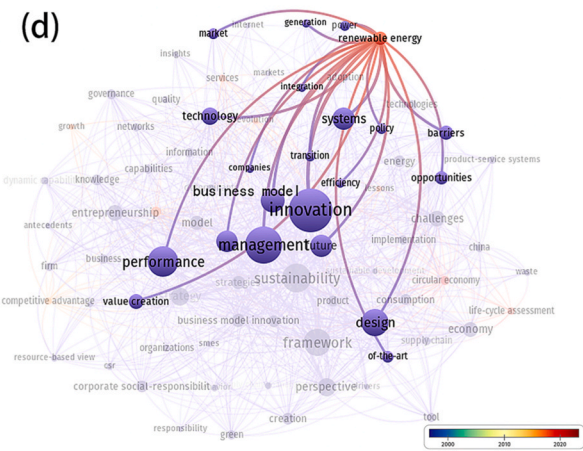
(b)



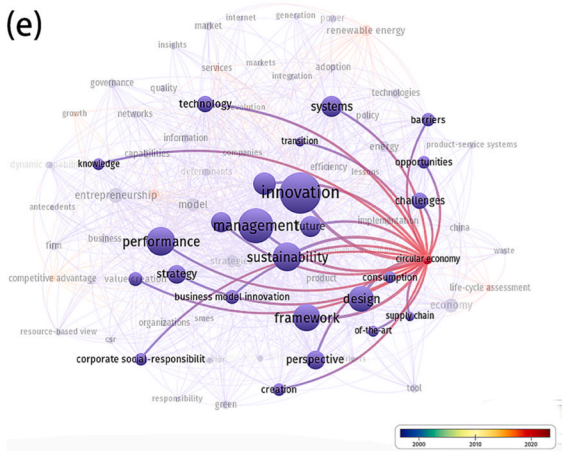
(c)



(d)



(e)



(caption on next page)

Fig. 5. The keywords co-occurring network on SBM (Sustainable Business Model)

- (a). The comprehensive landscape of keyword co-occurrence network on SBM (Sustainable Business Model)
- (b). The co-occurrence network centered on “innovation.”
- (c). The co-occurrence network centered on “sustainability.”
- (d). The co-occurrence network centered on “renewable energy.”
- (e). The co-occurrence network centered on a “circular economy.”

4.2. Keywords as indicators

4.2.1. The keywords co-occurring network

The co-occurrence occurs between two keywords if they appear simultaneously in one reference. We use VOSviewer to generate the keywords co-occurring network. After importing the data, we select type of analysis as co-occurrence, unit of analysis as keywords plus, and counting method as fractional counting. We obtain keywords co-occurring networks, as shown in Fig. 5. Fig. 5 (a) shows the overall situation of keyword co-occurrence, including 79 co-occurring keywords. Each node represents a different keyword, and the node size represents the frequency of occurrence of the corresponding keyword. The connection between the nodes shows the year the connected node first appeared together.

Moreover, we present the emerging trends in a color block at the bottom of the figure. So, we find that the time of the first co-occurrence of these keywords showed polarization distribution throughout the research period (1998–2022). About 90% of the keywords first co-occurred around 2000, and the remaining 10% co-occurred around 2020. It is evident that “innovation” and “sustainability,” with relatively large node sizes, are the hot and vital keywords in SBM. Therefore, we focus on these two keywords and show the distribution of keywords that have a co-occurrence relationship with them, as shown in Fig. 5 (b) and 5 (c). For example, as Fig. 5 (b) illustrates, the co-occurrence network centered on “innovation” contains the crucial keywords “technology,” “CSR,” “green,” and frontier keywords such as “renewable energy” and “LCA (life cycle assessment)” are also included.

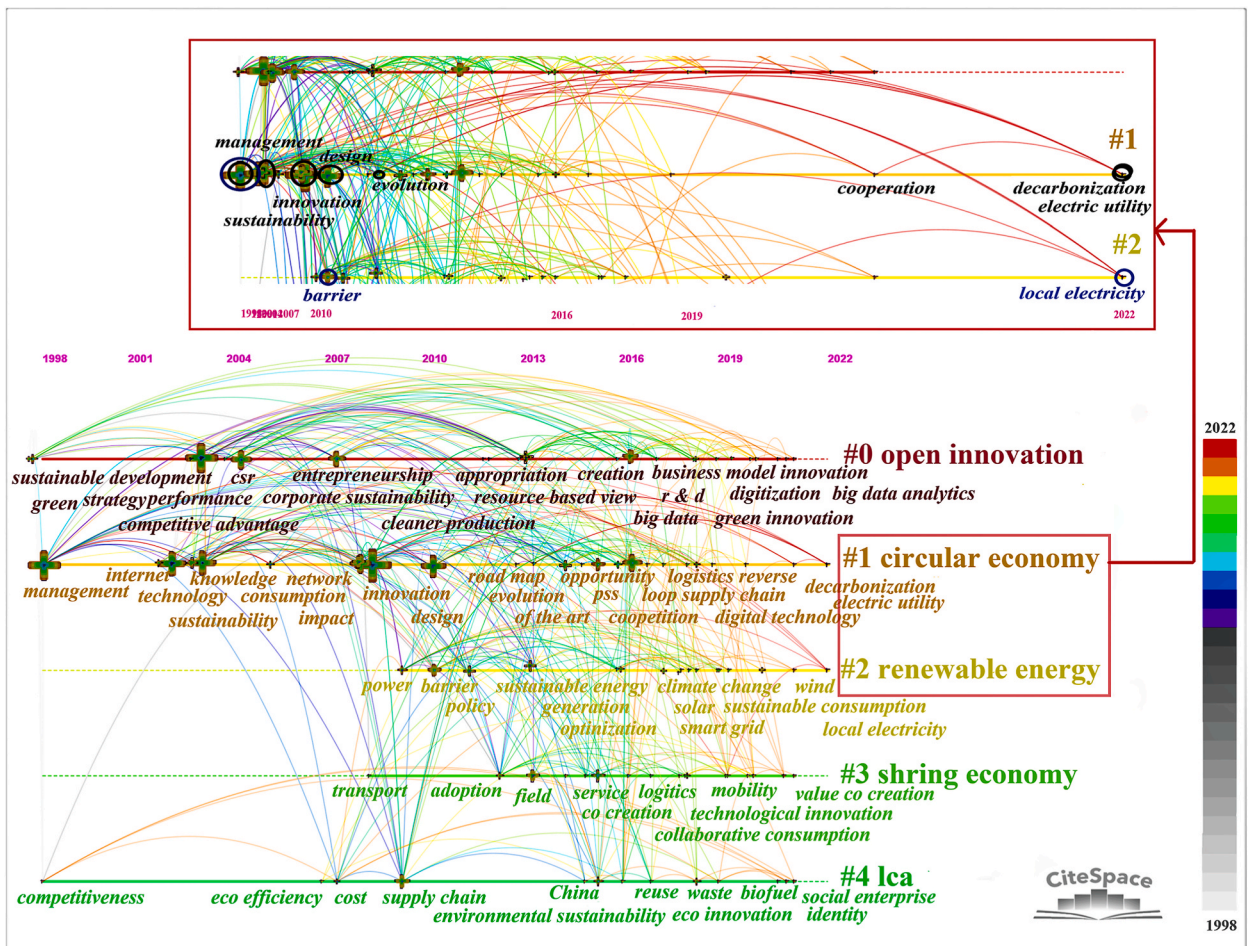


Fig. 6. The timeline map of the co-occurring keywords on SBM (Sustainable Business Model).

Furthermore, it shows that scientific and technological innovation, CSR innovation model, green innovation, renewable energy development, use innovation, and LCA innovation are hot aspects of SBM research. Fig. 5 (c) presents that the keywords related to “sustainability” mainly are “innovation,” “management,” “BMI (Business Model Innovation),” and “product.” These keywords indicate that scholars are more concerned about the sustainability of innovation, management, reformation, or creation of the business model and the sustainability of products in the stages of design and production in the sustainable development of a business model.

Moreover, we also show the keywords co-occurrence network centered on “renewable energy” and “circular economy” in Fig. 5 (d) and (e), respectively, which indicates the emerging trend and areas for recent and future development of SBM. For example, Fig. 5 (d) illustrates the co-occurrence network centered on “renewable energy,” which contains several keywords with large nodes such as “innovation” but also notes that “barriers” and “value creation” together with “renewable energy” can form a topic that is likely to be discussed frequently in the future research process of SBM. Based on this, we can speculate that although the renewable energy industry may face various obstacles such as policy, system, and technology on the road to green reform of the business model, it may have an enormously positive effect on realizing the sustainable value creation of the industry itself and the whole energy industry. So SBM may be more applied in the renewable energy industry chain in the future. In addition, “circular economy” reveals a co-occurrence relationship with “consumption,” “supply chain,” and “perspective.” Therefore, “supply chain” is the keyword that can highlight the future research trend of SBM and “circular economy.” Supply chain management pays more attention to sustainability than the business model under the circular economy principle. However, the business model can provide an analytical and instructive framework for supply chain management. Therefore, we suggest promoting the sustainable development of supply chain management and more studies integrating the concept of balancing supply and demand into SBM’s future innovation and design.

4.2.2. The timeline map of the co-occurring keywords

Although we analyzed the hotspots and emerging trends of SBM in Fig. 4, we still need to show their development chronologically. The timeline map of the co-occurring keywords can show the occurrence of keywords in different clusters and the time of the first co-occurring relationship between keywords. We use CitespaceV to generate the timeline map. When setting CitespaceV, time slicing is from 1998 to 2022, and node type is the keyword. We use the top N = 100 algorithm.

Furthermore, there is *no pruning* on our network. After generating the co-occurring keyword network, we use the timeline function of *layout* in control panel, then, we get the final map. Fig. 6 presents the timeline map containing nodes, links, and a color bar. The nodes on the map represent the keywords, and the color of the links indicates the time when the two nodes co-appear for the first time. Compared with the time bar on the right, the closer the connection is to the red color, the closer the co-occurrence time of keywords is to the present.

The clustering results show that “open innovation,” “circular economy,” “renewable energy,” “sharing economy,” and “LCA” are the top 5 hotspots. “Open innovation” is the most concerned topic, and “renewable energy” and “sharing economy” can be found to be relatively new keywords according to the start time of the whole timeline. The timeline illustrates that the research hotspot in SBM begins with “open innovation,” which is also the largest cluster, proving that “open innovation” is one of the most significant hotspots in the field of SBM. Open innovation is the ability to open enterprises’ original closed innovation model. However, we have noted that in the field of SBM, open innovation is often regarded as a tool or means that can indirectly help SBM’s establishment successfully. The concrete manifestation is that open innovation can shorten the distance between the stakeholders in the value chain, help them form cooperative relationships and create shared values to start a business ecosystem of mutually beneficial coexistence, healthy competition, and long-term cooperation and development. Finally, SBM will successfully achieve this under such a good business ecosystem. Furthermore, the hotspots transferred to “circular economy” and “LCA” quickly. In 2008, the “sharing economy” began to be widely

Table 5
Top 20 keywords with the strongest citation bursts.

Keywords	Year	Strength	Begin	End	1998–2022
strategy	1998	5.68	2003	2014	
innovation	1998	2.58	2008	2010	
supply chain	1998	2.67	2009	2010	
CSR	1998	1.42	2011	2012	
industry	1998	1.99	2011	2012	
performance	1998	3.91	2011	2013	
technology	1998	4.87	2012	2013	
evolution	1998	3.91	2013	2016	
resource-based view	1998	2.79	2013	2016	
growth	1998	3.23	2014	2015	
China	1998	6.43	2015	2018	
sustainable energy	1998	3.75	2016	2017	
product-service system	1998	7.91	2016	2018	
competitive advantage	1998	3.63	2016	2018	
conceptual framework	1998	4.14	2017	2018	
LCA	1998	3.9	2017	2019	
generation	1998	5.56	2018	2019	
circular economy	1998	4.13	2019	2022	
value creation	1998	2.12	2020	2022	
barrier	1998	3.01	2020	2022	

studied, and then “renewable energy” became a relatively new hotspot in 2009. Notably, “decarbonization” appears to be the latest in “circular economy,” indicating that this keyword is also frontier. Moreover, we predict that the future research of SBM combined with decarbonization will have two directions. First, realizing economic decarbonization will become the fundamental goal of SBM implementation by integrating economic decarbonization into the value proposition of SBM’s canvas. Second, in the future, many high-pollution industries (e.g., the steel industry) may need industrial decarbonization actively or be forced to consider sustainable innovation or reform the traditional business model to achieve long-term development. Eventually, most of them form SBMs intentionally or unintentionally. Consequently, we hold the belief that “decarbonization,” the same as “circular economy” and “renewable energy,” is also a vital emerging topic with practical significance in SBM.

4.2.3. Burst keywords

Like burst references, burst keywords refer to the keywords that are suddenly discovered by being highly cited. For instance, a keyword that existed long ago and was not cited for a while suddenly gets a high citation record and becomes a ‘star keyword’ for a period. After generating the co-occurring keyword network by CitespaceV (the same as 4.2.2), we use the *burstness* function of the control panel to find the burst keyword. We study the burst of the top 20 keywords in SBM between 1998 and 2022, as shown in Table 5. “Begin” and “End” correspond to the beginning and end times of the emergence of a subject word. “Strength” represents the intensity of the subject words. The stronger the intensity, the more the keywords will be in the leading position in the development stage of this field. The blue lines represent the entire selected research period, while the red lines constitute the duration of the emergence of the subject words. For example, the keyword “strategy” has an intensity of 5.68 and an emergence period of 11 years from 2003 to 2014. Compared with other data, it has a vigorous intensity and a long duration, indicating that this keyword has always been a hotspot while leading SBM development. We also noted that the intensity of “PSS” is 7.91, the strongest of the 21 most vital prominent keywords, with the emergence period from 2016 to 2018 indicating that this keyword has indeed set off a high research upsurge. However, the increase has also retreated very quickly. Hence, the position of “PSS” in the future research of SBM is unknown and does not lead to the current trend.

Moreover, we find that “strategy” and “performance” are the hotspots with high intensity in the early period of SBM research (2003–2013). Obviously, in the early stage of research in SBM, people focus on the organization’s management, strategic, and performance management. However, we also find that SBM is considered a development strategy with a sustainable competitive advantage in most cases. Therefore, it can improve the sustainable development performance of the organization. We also find that “innovation” and “supply chain” have great attention. In addition, the emergence of “CSR” also shows that many enterprises, especially some SMEs, are increasingly concerned about their contribution to the sustainable development of consumers, communities, and the environment. Hence, SBM can help them achieve their willingness to meet their social responsibility. In the middle period (2013–2016), the burst intensity of “PSS” is the highest, which reflects that during this period, PSS has attracted much attention and has been widely used because people pay more attention to the quality of products as well as the pursuit of additional service quality. It also means that PSS, which can meet the higher needs of consumers, is a business model that meets sustainable development.

Therefore, we can also interpret it as a concrete form of SBM. The keyword “China,” which has burst since 2015, has become one of the new hotspots. China highlighted the importance of sustainable development in the “Central Document No. 1” issued in 2015, so the emergence of “China” shows that more Chinese enterprises have begun to care about the sustainable development of business models, and more Chinese scholars have begun to devote themselves to the research related to SBM. “Resource-based view” and “sustainable energy” also appeared simultaneously. During the period 2017 to 2019, the emergence of the “conceptual framework” showed that this period, scholars were willing to use the conceptual framework to study SBM. The “LCA” burst in the same period proves that more studies apply LCA, an effective management tool, to the field of SBM. Ultimately, from 2020 to 2022, “circular economy,” “value creation,” and “barriers” become emerging trends in the whole SBM field.

5. Discussions

The first part of this section is some new findings. Based on the previous research, we discuss the hotspots and emerging trends of SBM, the informative landmark references, the evolution process of key literature and the history of hotspots, so that readers can systematically understand and benefit from the new findings of our research. In the second part, we give theoretical and management implications, causing readers to think further. In the last part, we present some unsolved questions for each part of the new findings, hoping to provide readers with some exciting inspiration for exploring future avenues on SBM.

5.1. New findings

Our results are fivefold. First, “sustainable innovation” is one of SBM’s most critical hot topics. There may be many reasons for this phenomenon, the most important of which is that sustainable innovation has become a necessary means for the sustainable development of business models. Moreover, “business model innovation,” “circular economy,” “sustainable energy,” “value mapping,” “social entrepreneurship,” “service business model innovation,” “product-service system (PSS),” “sharing economy,” and “creating integral value” are also the hotspots of SBM. It reflects that the research topics about SBM are gradually becoming diversified. Among them, “circular economy” and “sharing economy” are still the most emerging topics. In the future research of SBM, the circular economy and the sharing economy will become two significant research in promoting the development of SBM. Second, three references written by Bocken and Short (2014), Boons and Ludeke-Freund (2013), Zott and Amit (2011), and the other seven articles have the most landmark significance. The papers written by Bocken and Short (2014) and Boons and Ludeke-Freund (2013) have the highest

citations and are the most essential. The landmark references written by Evans and Vladimirova (2017) and Geissdoerfer and Savaget (2017) are at the forefront. Moreover, we also find that “value proposition,” “value chain,” “sustainable niche markets,” “value acquisition,” “conceptual framework,” “sharing economy,” “information integration technology,” and “PSS” are the hotspots. We further find that these ten landmarks’ milestones focus on three aspects: (a) Develop the conceptual framework for sustainable business model development. (b) Prove that information technology plays a positive role in promoting business model innovation. (c) Distinguish the circular economy concept from the sustainable model and show that circular economy and PSS can improve the business model to a sustainable direction from the manufacturing process. Third, we find that the literature about SBM appeared after 2011. We cannot deny that the references that burst before 2011 contribute to SBM research. SBM began to burst after 2011 due to convening the United Nations Conference on Sustainable Development in Rio de Janeiro, Brazil, in 2012, as the conference attracted a high degree of attention to sustainability again. After 2011, the literature written by Teece (2010) became a long-term cited hotspot, and the article by Geissdoerfer and Vladimirova (2018) was the most cutting-edge. Other burst literature also promotes SBM development to varying degrees during this period. We find the SBM research also focused on “strategy,” “value chain,” “dynamic consistency,” “competitive advantage,” “Corporate social responsibility (CSR),” “sustainable entrepreneurship,” and “circular supply chain”. Fourthly, the keywords co-occurring network shows the keywords that are closely related to “innovation,” “sustainability,” “renewable energy,” and “circular economy” and gives different keyword combination. For example, with “innovation” as the main keyword, we find that “technology,” “CSR,” and “green” are words discussed by people at the same time. In addition, as scholars pay more and more attention to sustainability, we insist that “sustainability” is one of the core words in SBM research. Readers should focus on the combination of keywords with it as the core. In the meantime, “renewable energy” is the most cutting-edge keyword, and “barriers” and “value creation” are also likely to become the future research direction of SBM together with “renewable energy”. Last, the timeline and burst of keywords clearly show the evolution footprint of research focus over time in SBM. We believe that before 2012, the research hotspots in SBM began with “open innovation,” “strategy,” “performance,” and “supply chain.” Then from 2013 to 2016, the hotspots gradually shifted to “resource-based view,” “PSS,” and “China.” Next, from 2017 to 2019, “conceptual framework” and “life cycle assessment (LCA)” started to receive widespread attention. Moreover, as the world has shown increasing care about the effective exploitation, utilization, and discharge of resources since 2019, consistent with the current development, the “circular economy” and “renewable energy” have become new research hotspots. Besides, “value creation,” “barriers,” and “decarbonization” represent emerging trends of SBM to a great degree.

In summary, we show the hotspots and emerging trends in SBM and their evolution in Fig. 7. We present the ranking of the importance of hotspots on the left, which increases from 1 to 10. Colors represent the source of the hotspots we found.

5.2. Theoretical and managerial implications

Our theoretical contributions to the existing research theories related to SBM are threefold. First, “sustainable innovation” and “open innovation” are the most prominent research hotspots. Exploring the critical role of sustainable and open innovation in SBM and the other SBM hotspots will help researchers understand the origin of SBM. Second, “circular economy,” “sharing economy,” “renewable energy,” “barriers,” and “decarbonization” have become the emerging trends of SBM. Hence, the future research direction of SBM will likely focus on these directions. Third, we present 15 recommendations listed in Table 6 that could provide valuable

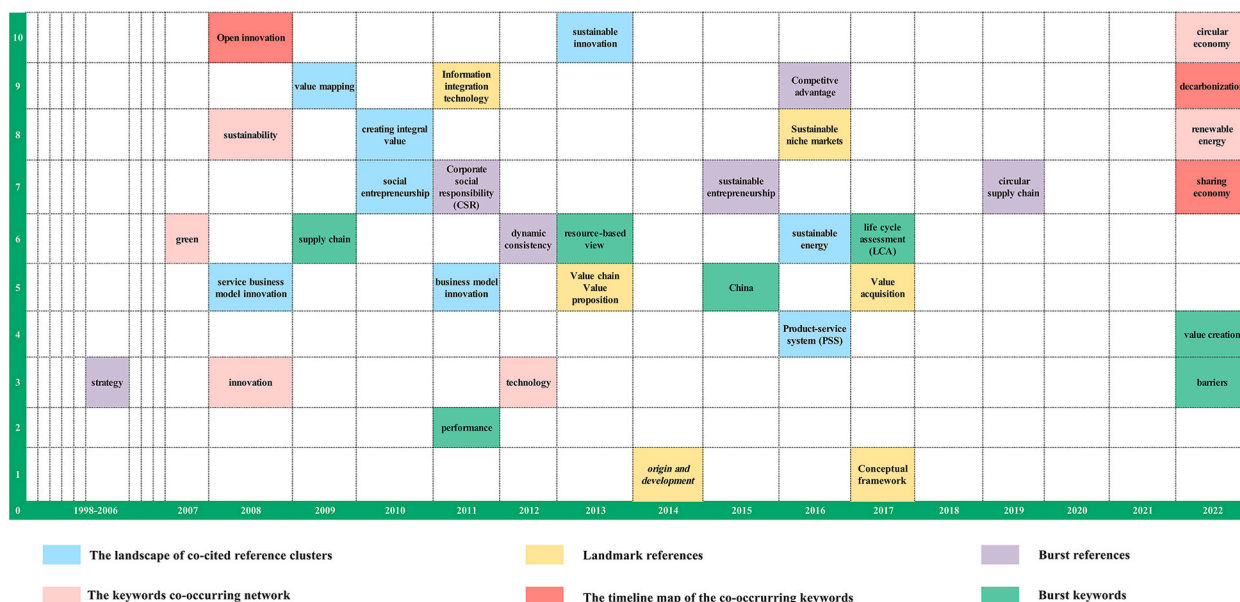


Fig. 7. The evolution of hotspots in SBM (Sustainable Business Model).

Table 6
Results and recommendations for future research on SBM.

Visualization	Results	Recommendations for future research on SBM
Overall future research avenues:		
	<ul style="list-style-type: none"> ● Collecting data from more databases and generating more comprehensive results through careful screening and abundant parameter settings and operation modes ● Using different methods and tools to continue research on SBM. 	
The landscape of co-cited reference clusters	<ul style="list-style-type: none"> ✓ “Sustainable innovation” is the biggest hotspot. ✓ Other hotspots: “business model innovation,” “sustainable energy,” “value mapping,” “social entrepreneurship,” “service business model innovation,” “product-service system (PSS),” “sharing economy,” “creating integral value”; Emerging trends: “circular economy.” ✓ Collaboration: from 2013 to 2015, sustainable innovation, business model innovation, and sustainable energy are often studied together. 	<ul style="list-style-type: none"> ● Exploring “social entrepreneurship,” “sharing economy,” and “creating integral value” of SBM. ● Jointly discussing “sustainable innovation,” “business model innovation,” and “sustainable energy” of SBM. ● Trying to discuss other hotspots based on other possible cooperation in SBM.
Landmark references	<ul style="list-style-type: none"> ✓ The two articles with the highest number of citations, written by Bocken et al. (2014) and Boons and Ludeke-Freund (2013), are the most essential, and the landmark references [146,131] are at the forefront. ✓ Landmark references belong to the themes of sustainable innovation, business model innovation, and circular economy. ✓ Hotspots: “origin and development,” “value chain,” “value proposition,” “sharing economy,” “conceptual framework,” “sustainable niche markets,” “value acquisition,” “circular economy,” and “PSS.” 	<ul style="list-style-type: none"> ● Combining “origin and development,” “value chain,” “value proposition,” “sustainable niche markets,” “value acquisition,” and “framework” with sustainable innovation to form a new research topic in SBM. ● Combining “information integration technology” with business model innovation to create a new research topic in SBM. ● Combining “conceptual framework” and “PSS” with circular economy to create a new research topic in SBM.
Burst references	<ul style="list-style-type: none"> ✓ The literature written by Teece (2010) has the most burst strength. ✓ We have shown the evolution of ten burst references in 2011–2022. ✓ Before 2011, there were no studies in SBM that attracted people’s great attention. It is probably because the United Nations Conference on Sustainable Development in Rio de Janeiro, Brazil, in 2012 attracted a high degree of attention to sustainability once again. 	<ul style="list-style-type: none"> ● Exploring why before 2011, no studies in SBM attracted attention from the perspectives of environment, economy, society, and business model development.
The keywords co-occurring network	<ul style="list-style-type: none"> ✓ “Innovation” and “sustainability” are SBM’s vital keywords. ✓ Scientific and technological innovation, Corporate Social Responsibility (CSR) innovation model, green innovation, renewable energy development, use innovation, and life cycle assessment (LCA) innovation may be the potential direction. ✓ Hotspots: “sustainable innovation,” “CSR,” “LCA.” ✓ Emerging trends: “renewable energy” and “circular economy.” ✓ “Barriers” and “value creation” together with “renewable energy” may form a topic that is likely to be discussed frequently in the future. <p>“Supply chain” is the keyword that can highlight the future research trend of SBM’s “circular economy.”</p>	<ul style="list-style-type: none"> ● Exploring more keyword combinations as a possible research direction of SBM, such as scientific and technological innovation, CSR innovation model, green innovation, renewable energy development, use innovation, and LCA innovation. ● Focusing on “barriers” and “value creation” with “renewable energy” and “supply chain” with “circular economy.”
The timeline map of the co-occurring keywords	<ul style="list-style-type: none"> ✓ “Open innovation” is the biggest hotspot. ✓ SBM begins with “open innovation,” and the hotspots transferred to “circular economy” and “LCA” quickly. Until 2008, the “sharing economy” began to be widely concerned, and then “renewable energy” became a relatively new hotspot after 2009. ✓ “Management,” “sustainability,” “innovation,” and “design” have always been the basic keywords of SBM. ✓ Emerging trends: “renewable energy,” “sharing economy,” “decarbonization,” “electric utility,” and “local electricity.” 	<ul style="list-style-type: none"> ● A deep study of management, sustainability, innovation, and design related to decarbonization, electric utility, and local electricity. ● Looking for other emerging topics of management, sustainability, innovation, and design in the timeline map as potential research directions.
Burst keywords	<ul style="list-style-type: none"> ✓ Burst keywords in the early period (2003–2012): “strategy,” “innovation,” “supply chain,” “CSR,” “industry,” and “performance.” ✓ Burst keywords in the middle period (2013–2016): “technology,” “evolution,” “resource-based view,” “growth,” “China,” “sustainable energy,” “PSS,” “Competitive advantage.” ✓ Burst keywords in the later period (2017–2019): “conceptual framework,” “LCA,” and “Generation.” ✓ Burst keywords in emerging period (2020–2022): “circular economy,” “value creation,” and “barrier.” 	<ul style="list-style-type: none"> ● Explaining the reasons for the burst of these keywords in different periods. ● Combining the keywords that have burst in the same period into various reasonable topics may lead to new hotspots and trends in SBM.

inspiration for future research on SBM.

It promotes the excellent development of SBM research. More crucially, this research is the first review article using information visualization techniques to analyze the research hotspots and emerging trends of SBM based on scientometrics. Hence, our findings and the 15 recommendations suggest that examining the relevant literature about SBM is necessary. Regarding our managerial implications, the existing research state that SBM is a business model that can help economic entities achieve sustainable development by obtaining longer-term profits. We also identify the hotspots and emerging trends such as the “sharing economy,” “renewable energy,” and “decarbonization” that can help governments accurately capture the conducive ways to their sustainable development to promote global sustainable development. Furthermore, our results help enterprises more intuitively understand SBM and its hot and emerging topics, such as “corporate social responsibility,” “social entrepreneurship,” and “sustainable niche market.” Therefore, it is also beneficial for enterprises to rethink their development orientation and quickly adjust their business model accordingly.

5.3. Future avenues on SBM

Future research can collect data from more databases and generate more comprehensive results through careful screening and abundant parameter settings and operation modes in future research. Additionally, future research could use another methodology and more tools to continue researching SBM.

5.3.1. The landscape of co-cited reference clusters

Our results reveal that “social entrepreneurship,” “sharing economy,” and “creating integral value” have not been studied deeply yet. So, exploring “social entrepreneurship,” “sharing economy,” and “creating integral value” of SBM will be helpful guides for future research. Nevertheless, the co-citation lines are dense in clusters #0, #1, and #3, indicating plenty of co-cited references in the three clusters. So, readers can jointly discuss “sustainable innovation,” “business model innovation,” and “sustainable energy” of SBM as before. Besides, future research could discuss other hotspots jointly based on different possible cooperation in SBM.

5.3.2. Landmark references

We have extracted some hotspots from the landmark references belonging to cluster #0 (sustainable innovation). These hotspots are “origin and development,” “value chain,” “value proposition,” “sustainable niche markets,” “value acquisition,” and “framework.” So, future research can combine them with sustainable innovation to form a new research topic in SBM. In addition, we have extracted a hotspot from the landmark references belonging to cluster #1 (business model innovation). It is “information integration technology.” So, future research can combine it with business model innovation to form a new research topic in SBM. Finally, we have extracted two hotspots from the landmark references belonging to cluster #2 (circular economy). They are “the conceptual framework” and “product-service system (PSS). So, future research can combine them with the circular economy to form a new research topic in SBM.

5.3.3. Burst references

We found that, until 2011, only a few studies focused on SBM due to convening the United Nations Conference on Sustainable Development in Rio de Janeiro, Brazil, in 2012. The conference attracted significant attention to sustainability, so the references to SBM began to burst. However, future research could investigate if there are any other reasons for this to happen and explore the basis from the perspectives of the environment, economy, society, and business model development.

5.3.4. The keywords co-occurring network

We have found the networks with “innovation,” “sustainability,” “renewable energy,” and “circular economy” as the primary keywords. However, future research could explore more keyword combinations as a possible research direction of SBM, such as scientific and technological innovation, CSR innovation model, green innovation, renewable energy development, use innovation, and LCA innovation. We also have found that “barriers” and “value creation” together with “renewable energy” can form a topic that is likely to be discussed frequently in the future research process of SBM, and “supply chain” is the keyword that can highlight the future research trend of SBM together with “circular economy.” So, future research needs to focus on those directions to research SBM.

5.3.5. The timeline map of the co-occurring keywords

Our results show that the management, sustainability, innovation, and design related to decarbonization, electric utility, and local electricity may be potential future research topics in SBM. In addition, we have found that management, sustainability, innovation, and design have always been the fundamental research topics of SBM. Therefore, we encourage future research to look for other emerging topics of these keywords in the timeline map as potential research directions.

5.3.6. Burst keywords

We have sorted out the 20 keywords with intensive bursts according to their burst, but we need to explain the reasons for the burst of these keywords in different periods. Hence, future research could explore explanations from many angles. Furthermore, in our findings, more than one keyword has burst almost every period. Therefore, we call for future research to combine the keywords that have burst in the same period into various reasonable topics, which may lead to new hotspots and trends in SBM. Finally, we show the results and recommendations for future research on SBM in [Table 6](#).

6. Conclusions

We comprehensively reviewed the literature in the field of SBM with scientometrics. We used CitespaceV and VOSviewer to generate a variety of SBM's visual landscapes, including the landscape of co-cited reference clusters, landmark references, burst references, the keywords' co-occurring network, the timeline map of the co-occurring keywords and burst keywords. Based on those visualization results, we found that "sustainable innovation", and "open innovation" are SBM's important hotspots and "circular economy", and "sharing economy" are emerging trends. We also showed the evolution of SBM's hotspots comprehensively. At the same time, we found that the articles written by Bocken and Short (2014), and Boons and Ludeke-Freund (2013) are landmark references and we also showed the evolution of SBM's important literature. In addition, for each visualization result, we gave the corresponding recommendations for future research on SBM so that readers can generate research inspiration and promote the future research development of SBM.

Although this paper obtained some new results on SBM, a few limitations remain. First, we got our data sample mainly from WoS Core Collection. The literary language in the database is predominantly English, which will lead to the omission of SBM research in other languages. Second, the generated visualization maps have some limitations. When using Citespace to analyze the collected data, users choose different parameter settings, such as g-index, top N, and thresholds, or operation modes (e.g., pruning, pathfinder, and minimum spanning tree) to generate different visualization results, and this also happens when using VOSviewer. Although we used the graph with a better rendering effect after running it many times, we cannot wholly guarantee their optimality.

To sum up, about research topics, scholars should explore the field of SBM deeply according to the hotspots and emerging trends we have found. Regarding data collection, scholars should choose more databases and language types to ensure the reliability and comprehensiveness of the data. Regarding the selection of tools, with the continuous increase of visualization tools, we suggest that scholars can ensure diversification in the selected piece of software, set different parameters, select the best view, and pay attention to the repeatable operation of the experiment.

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

Data availability statement

Data included in article/supp. material/referenced in article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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