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Sustainable business model innovation literature: a bibliometrics analysis

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Abstract

Sustainable business model innovation (SBMI) has received growing attention since it can provide sustainable competitive advantages for corporations under a dynamic external environment. This paper aims to understand the current situations and progress of SBMI research by conducting a bibliometric study of the existing literature. By collecting data from Web of Science and using bibliometric tools, the basic characteristics of SBMI research are first presented to show the productivity and citations of publications utilizing recognized bibliometric indicators. Then, the cooperation networks among countries/regions, institutions, and authors are drawn to determine their collaborative relationships. Furthermore, keyword analysis is presented to explore the evolution of the hotspots and themes of SBMI research through co-occurrence analysis, burst detection analysis, and thematic evolution analysis. Finally, we integrate the antecedents-decisions-outcomes framework for SBMI research. The findings in this study indicate that the development of SBMI research is positive and that greater collaboration among institutions and authors is required to explore the internal drivers and design SBMI as well as other topics to be developed.

Keywords Sustainable business model innovation · Bibliometric analysis · Sustainability · Innovation

Mathematics Subject Classification 58-02

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1 Introduction

In the past decade, research on the business model (BM) has developed rapidly, as the BM provides a way for corporations to monetize products or services. As the conception and implementation of new BMs, business model innovation (BMI) can help corporations maintain their competitive edge in rapidly changing economic situation by enhancing their ability to create value (Foss and Saebi 2017). While the traditional BM and BMI bring huge economic value to corporations, they overexploit natural resources. For example, the rapid updating of electronic products wastes a massive amount of rare metal resources (Cenci et al. 2020). Hence, most traditional BMs face huge challenges to their sustainability because of damage to the public interest. To solve this issue, sustainable business model innovation (SBMI) was proposed by incorporating sustainable development goals and a responsible innovation orientation into BMI (Geissdoerfer et al. 2018). SBMI can ensure the interests of multiple stakeholders, including customers, shareholders, suppliers, and partners, as well as the environment and society (Velter et al. 2020). That is, SBMI can benefit society and the environment by generating both monetary value and nonmonetary value.

Research on SBMI has been relatively unexplored since it started late compared to research on BMI. Most research on SBMI has interpreted its conception (Barth et al. 2017), value proposition (Dyck and Silvestre 2018), design (Bocken and Geradts 2020), drivers (Arcese et al. 2020), and implementation (Mendoza et al. 2019) from a single perspective. Little work has been developed to systematically analyze and summarize the status of research on SBMI. Previous reviews have been dominated by expert-based methodologies. Hence, it is valuable to quantitatively develop an overview of existing SBMI articles to assist scholars in comprehending the research profile thus far.

To gradually promote and improve the research content of this field, we discuss the current state of SBMI research and its development, as well as research directions for the future. Hence, this paper presents a bibliometric analysis to investigate the available research publications related to SBMI. Bibliometric analysis is an effective method of reviewing and analyzing publications in SBMI research from the quantitative point of view since it can visualize the overview and development of the SBMI field using science mapping (Donthu et al. 2021a, b). Due to the effectiveness and universality of bibliometric analysis, it has been utilized to analyze various topics (such as COVID-19 research activity (Chahrour et al. 2020), group decision-making (Wang et al. 2021a, b, c), investment and economic growth (Wang et al. 2021a, b, c) and financial innovation (Li and Xu 2021)) and journals (such as the *Journal of Business Research* (Donthu et al. 2020), *Information Sciences* (Yu et al. 2017), and the *Review of Managerial Science* (Mas-Tur et al. 2020)).

It is easy to find that scholars have not undertaken any bibliometric analysis in the SBMI field. From a quantitative standpoint, bibliometric analysis is an effective technique for avoiding subjective and probable biases existing in expert-based reviews. Hence, the purpose of this paper is to conduct a systematic review

of the literature on SBMI by answering the following research questions: (1) what is the current status of publications in the field of SBMI? (2) What are the collaborative relationships existing in SBMI research? (3) What are the main themes in current SBMI research? (4) What are the conceptual framework and future research directions of SBMI?

The main contributions of this paper include the following aspects: (1) it provides a bibliometric analysis to depict the development of SBMI research as a supplement to the structural reviews in Table 1; (2) it derives an integrative framework by reviewing current knowledge related to SBMI and referring to the results of bibliometric analysis; and (3) it offers clear directions for future research following the proposed framework and provides some new ideas to compensate for the gap between the theoretical framework and practical implementation.

The structure of this paper is as follows: we first describe the conceptualization of SBMI and previous reviews. Second, the data collection and the procedures involved in bibliometric analysis are explained. Subsequently, the results of bibliometric analysis related to SBMI research are presented from three perspectives. Then, the findings based on the literature review and bibliometric analysis are discussed. Finally, the conclusions of this paper are presented.

2 Conceptualization of SBMI and previous reviews

Considering that SBMI is an extraordinarily tangled and complicated concept, it is necessary to elaborate how it is conceptualized. The notion of SBMI originated in the BM and BMI. As a hot topic in management research, the BM is the foundation of a corporation, and it involves value proposition, value creation and delivery, value acquisition, and their interaction (Richardson 2008; Filser et al. 2021). Considering that innovation is the dominant theme in BM research and an important source for corporations to maintain competitive advantages, BMI is defined as the changes in the overall BM or the individual configuration elements (Foss and Saebi 2017). However, increasingly severe ecological problems and changing external environments make it difficult for corporations to gain sustainable competitive advantages through traditional BMI. Thus, SBMI was proposed by incorporating sustainable development goals and a responsible innovation orientation into BMI (Geissdoerfer et al. 2018). Since then, SBMI has been utilized in different fields, such as agriculture (Björklund 2018), customer relationship management (Gil-Gomez et al. 2020), and the banking industry (Yip and Bocken 2018).

There have been only a few systematic literature reviews related to SBMI research (Kraus et al. 2020a, b). We summarize these articles in Table 1 by referring to Vlacic et al. (2021). Specifically, Geissdoerfer et al. (2018) reviewed the conception of SBMI research based on qualitative analysis and determined a research gap. Shakeel et al. (2020) discussed the conceptual and theoretical rationality of the components of the SBMI framework from the qualitative perspective. Moreover, an overview following the antecedents-phenomenon-consequences framework and the numerous expressions of SBMI were derived (Sinkovics et al. 2021). The evolution of concepts and the theoretical and empirical implications of the findings were

Table 1 The published references for reviewing the literature related to SBMI

References	Title	Type of Review	Methodology	Sample	Time Span	Database	Findings
Barth et al. (2017)	Towards a conceptual framework of sustainable business model innovation in the agri-food sector: systematic literature review	structured review	Qualitative-Expert-based survey	21	1990–2014	Web of Science/Scopus, ABI/Emerald/Science Direct/Academic/Search, Springer-Link/JSTOR/Sage/Agricola	The conceptual framework for SBMI and theoretical guidelines for sustainable innovations in the agri-food area are derived
Geissdoerfer et al. (2018)	Sustainable business model innovation: A review	structured review	Qualitative-Expert-based survey	199	1990–2018	Web of Science/Scopus	Definitions for the major underlying concepts and the research gap and questions for implementation are identified
Shakeel et al. (2020)	Anatomy of sustainable business model innovation	structured review	Qualitative-Expert-based survey	61	1960–2020	Web of Science/Scopus	The analogy of SBMI and the components the compose sustainable value proposition innovation are proposed
Sinkovics et al. (2021)	Sustainable Business Model Innovation: An Umbrella Review	structured review	Qualitative-Expert-based survey	57	1990–2021	Web of Science	The numerous expressions of SBMI are identified, and an overview following the antecedents-phenomenon-consequences framework is proposed
Molina-Castillo et al. (2021)	Sustainable business model innovation: review, analysis, and impact on society	Structured review	Expert-based survey	n.a	n.a	n.a	The main contributions and the corresponding theoretical and empirical implications are described

explored (Molina-Castillo et al. 2021). The articles mentioned above have significantly contributed to fresh thinking in the SBMI field by summarizing all the literature into a conceptual framework. The only flaw is that all the articles are based on subjective and qualitative analysis. A comprehensive understanding of the structure and evolution of the SBMI field is lacking.

3 Methodology

This paper aims to review publications in SBMI research and further reveal the internal structure and development trends of SBMI research. To do so, a reliable way to collect data and appropriate bibliometric methods are identified in this section. Moreover, the research procedures of the methodology are developed. The methodological framework of this study is shown in Fig. 1.

3.1 Data collection

In terms of data sources, the main databases include Web of Science (WoS), Scopus, and Google Scholar. Compared to the other databases, WoS is one of the most authoritative and widely used sources. It has high-quality journals and can provide a more complete data structure for bibliometric analysis (Singh et al. 2021). Scopus has one of the most thorough coverages of academic publications and pays more attention to the comprehensiveness of academic content. (Caputo and Kargina

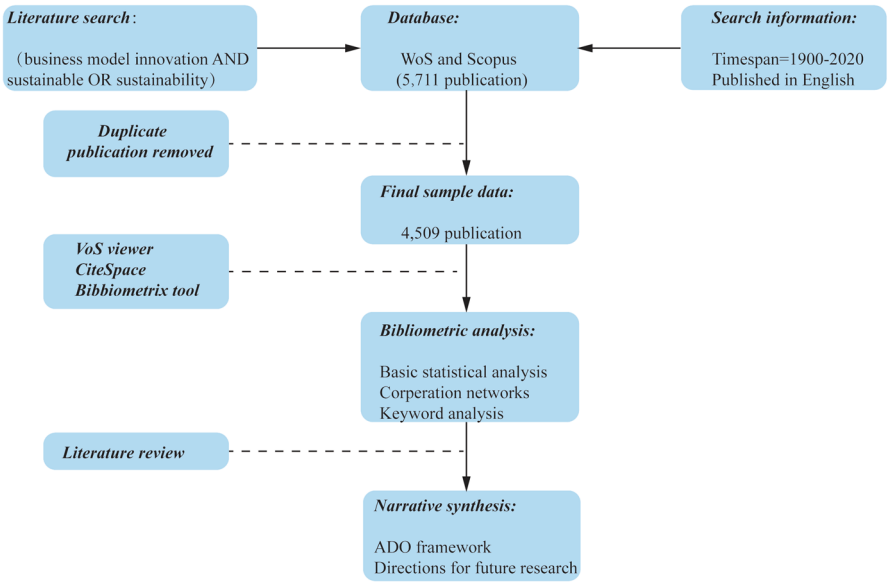


Fig. 1 The methodological framework of this study

2021). Hence, we extract the literature data from WoS and Scopus to ensure a broader range of cutting-edge journals. The collection strategy is as follows: topic search = "business model innovation" AND "sustainable OR sustainability"; timespan = 1900–2020; and database = WoS and Scopus. The literature materials were obtained on December 31, 2020, and 5711 publications were extracted. To ensure the accuracy and validity of the results, we utilized Bibliometrix tool and Excel to merge data and remove duplicated data (Caputo and Kargina 2021). Then, 4509 publications were retained for bibliometric analysis.

3.2 Bibliometric analysis

As a branch of scientometrics, bibliometrics is a mature and effective subject for revealing the development process and knowledge structure of publications (Cooper 2015). Based on the collected data and bibliometric theory, this study analyzes the characteristics of SBMI publications using two procedures: (1) it explores the basic statistical characteristics of publications, including the annual productivity and citations based on recognized bibliometric indicators [such as the number of publications (NP), number of citations (NC), average number of citations (AC)], types and research direction, and highly influential publications, sources and authors; and (2) it conducts science mapping analysis to reveal the conceptual structure and development trend of publications by adopting three powerful visualization tools, namely, CiteSpace (Chen 2004), VOSviewer (Van Eck and Waltman 2013) and Bibliometrix (Aria and Cuccurullo 2017) software. This study selects six bibliometric methods to present the keyword analysis and the visualization networks of publications, sources, and authors. (1) Citation analysis can evaluate the influence and quality of countries/regions, institutions, sources, and authors by analyzing the citation frequency (Lim and Suh 2021). (2) Co-authorship analysis shows the collaborative relationships among different countries/regions, institutions, and authors by calculating the number of publications co-authored (Higaki et al. 2020). (3) Co-occurrence analysis measures the correlation between two keywords by counting the number of occurrences of the two keywords in the same publications (Al-Zaman 2021). (4) Burst detection analysis reflects the merging trends of keywords, authors, and references by detecting the citation frequency in each time interval (Zhou et al. 2019). (5) Thematic evolution analysis illustrates the development of the field, the shift in research directions, and trends in the field by analyzing the evolutionary paths of themes based on the measurements of centrality and density (López-Robles et al. 2021).

4 Results

Based on the data and methods described in Sect. 3, the results of bibliometric analysis of publications related to SBMI are presented, including their basic statistical characteristics, the cooperation networks among countries/regions, institutions and authors, and keyword analysis.

4.1 Basic statistical analysis

The basic statistical characteristics of publications on SBMI are explored in detail in the following three ways: annual indicators of publications, the types and research directions of publications, and citation analysis of publications.

4.1.1 Annual indicators of SBMI publications

Based on the data in WoS and Scopus, the numbers of SBMI publications and citations from 1994 to 2020 are shown in Fig. 2. From Fig. 2, it is easy to find that the total NP and NC trends increase over time. This result indicates that SBMI research has received much attention in recent years. Specifically, the NP before 2008 is slight. In 2009, the development of SBMI research began to improve. Moreover, the increase in the NP fluctuated between 2009 and 2014. The possible reason is that theories of SBMI have been developed in research since 2009, but they are not mature. For example, Nidumolu et al. (2009) first linked sustainability and innovation in this field. Then, the NP increased rapidly in 2014, which means that SBMI research entered a period of rising prosperity. This may be due to the rapid development of related theories in SBMI research since 2014. For example, a literature review related to sustainable business model archetypes was proposed in 2014 (Bocken et al. 2014). The overall growth trend of the NC is roughly consistent with the trend of the NP. It is worth noting that the growth trend of the NC has been better than that of the NP since 2017. The possible reasons may be that the publications produced in recent years have made more contributions and attracted more attention than before. By analyzing the growth trends of the NP and NC, we can initially

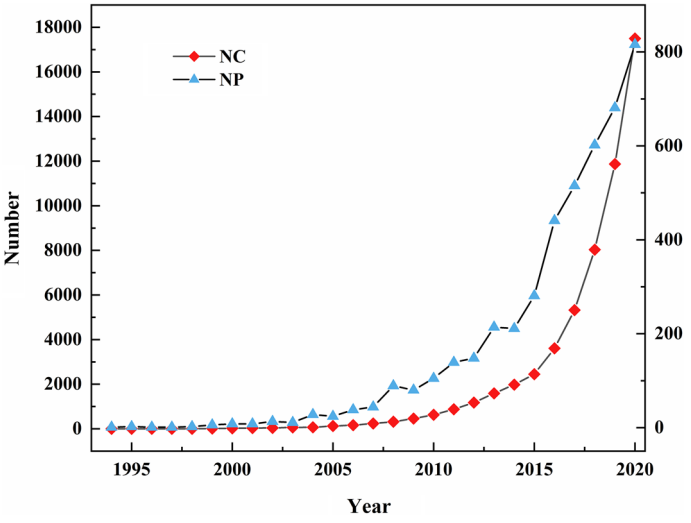


Fig. 2 The number of publications and citations related to SBMI research from 1994 to 2020

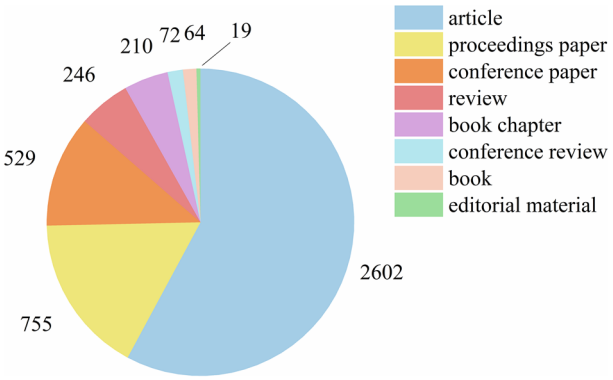


Fig. 3 The distribution of types of publications related to SBMI research

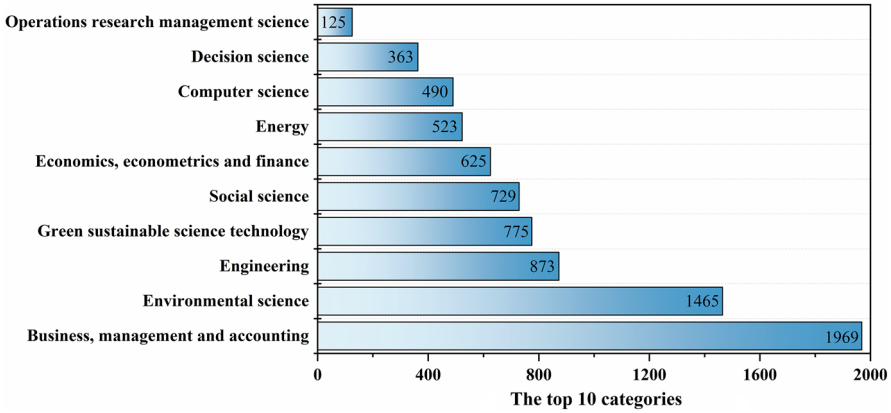


Fig. 4 The top 10 research categories of publications related to SBMI research

conclude that the theoretical system of SBMI research is in a period of rapid development and has not yet entered a mature stage.

4.1.2 Types and research directions of SBMI publications

There are 4509 publications related to SBMI research in WoS and Scopus, and the distribution of the types of publications is shown in Fig. 3. From Fig. 3, it is easy to see that there are 8 types of SBMI research, including articles (2602), proceeding papers (755), conference papers (529), reviews (246), book chapters (210), conference reviews (72), books (64), and editorial material (19). This finding indicates that the first three types are the main types of SBMI research. The lack of book chapters and books indicates that the SBMI field has not yet formed a systematic and mature methodology.

Figure 4 portrays the top 10 research categories of the 4509 publications in SBMI research. Based on Fig. 4, we find that the distribution of research categories is

cross-field, including the social sciences and natural sciences. This result indicates the great development potential of this field and wide future applications in diversified fields, such as business, management and accounting.

4.1.3 Citation analysis of SBMI publications

The NC can effectively reflect the impact of countries/regions, institutions, authors, and publications. Therefore, Table 2 lists the top 10 most highly cited journals of publications related to SBMI, and it contains detailed indicators, including the NC, NP, AC, and H-index. The most highly cited journals are ranked as follows: the *Journal of Cleaner Production* (11,231), *Sustainability* (2257), *Business Strategy and the Environment* (1236), the *Harvard Business Review* (1104), the *Journal of Business Ethics* (1015), *Organization & Environment* (1007), *Long Range Planning* (1001), *Technological Forecasting and Social Change* (974), *Energy Policy* (846), and *Research Policy* (690). It is shown that the most influential journal is the *Journal of Cleaner Production,* whose NC (11,231) and H-index (54) are much higher than those of the other journals. It is worth noting that the *Harvard Business Review* has the highest AC (184) and that *Long Range Planning* has the second highest AC (111.22). In contrast, the NP of the two journals is lower than that of most journals, only 6 and 9 publications, respectively. This result indicates that the two journals have great potential in the field of SBMI. In addition, the journal with the highest number of publications is *Sustainability*, which has the second highest NC (2257) and the lowest AC (8.24). It is possible to assume that the quality of publications in *Sustainability* is lower than that in other journals whose AC is higher.

Table 3 lists the top 10 most highly cited countries/regions, institutions, and authors of publications with their numbers. Regarding countries/regions, the USA has the highest NC of publications (10,861) related to SBMI, followed by England (9126), the Netherlands (7175), Germany (7180), and China (3642). The remaining five countries/regions are Canada (3631), Sweden (3239), France (3136), Italy (3125), and Finland (2546). Regarding highly cited institutions, the University of Cambridge in England is ranked first, with 3267 citations, followed by Delft

Table 2 The top 10 most highly cited journals of publications related to SBMI

Rank	Journals	NC	NP	AC	H-index
1	Journal of Cleaner Production	11,231	267	42.06	54
2	Sustainability	2257	274	8.24	19
3	Business Strategy and the Environment	1236	49	25.22	18
4	Harvard Business Review	1104	6	184.00	6
5	Journal of Business Ethics	1015	28	36.25	17
6	Organization & Environment	1007	15	67.13	13
7	Long Range Planning	1001	9	111.22	8
8	Technological Forecasting and Social Change	974	27	36.07	17
9	Energy Policy	846	21	40.29	13
10	Research Policy	690	8	86.25	7

Table 3 The top 10 most highly cited countries/regions/institutions/authors of publications related to SBMI

Rank	Country/Region	NC	Institution	NC	Author	NC
1	USA	10,861	University of Cambridge	3267	Nancy, Bocken	2628
2	England	9126	Delft University of Technology	1910	Steve, Evans	2020
3	Netherlands	7175	Stanford University	1223	Florian, Lüdeke-Freund	1519
4	Germany	7180	Erasmus University	1221	Padmakshi, Rana	1421
5	China	3642	Saint Mary's University	1203	Sanjay, Sharma	1238
6	Canada	3631	University of Southern California	1170	Samuel, W. Short	1213
7	Sweden	3239	Leuphana University of Luneburg	1088	Harrie, Vredenburg	1195
8	France	3136	Rady Children's Hospital	1083	Stefan, Schaltegger	1151
9	Italy	3125	University of California San Diego	1083	Frank, Boons	1127
10	Finland	2546	Cranfield University	954	Gregory, Aarons	1083

University of Technology in the Netherlands (1910), Stanford University in the USA (1223), Erasmus University in the Netherlands (1221), Saint Mary's University in Canada (1203), and the University of Southern California in the USA (1170). The USA has five institutions, and England and the Netherlands have two institutions. Germany and Canada each have one institution. In terms of authors, Nancy Bocken from the Netherlands is the most influential author related to SBMI, with 2628 citations, followed by Steve Evans from the USA (2020), Padmakshi Rana from Nepal (1421) and Samuel W. Short from the USA (1213), who cooperated to produce a highly cited publication. Moreover, Florian Lüdeke-Freund from Germany (1519), who has the second highest citations, produced a highly cited publication with Frank Boons from England (1127). Remarkably, Sanjay Sharma from the USA (1238) and Harrie Vredenburg from Canada (1195) completed the most cited publication together.

Table 4 shows the top 10 highly cited publications in the field of SBMI. It contains information including the type, year, NC, AC, number of authors (AN), number of institutions (IN), and number of countries/regions (CN). It is easy to see that the most influential publication is Sharma and Vredenburg (1998), with 1195 citations, followed by Aarons et al. (2011), with 1083 citations, Bocken et al. (2014), with 926 citations, and Nidumolu et al. (2009), with 728 citations. All top 10 highly cited publications were completed by multiple authors, and most publications were from multiple institutions in the same country. Only Boons and Lüdeke-Freund (2013) and Meier et al. (2010) cooperated across borders. The results indicate that cooperation among authors, institutions, and countries is conducive to enhancing the quality of publications. The contents in terms of SBMI are mainly focused on innovations, strategy, conceptual models, driving factors, and implementation. In addition, the implementation of the SBMI model includes public services, industrial products, the supply chain, and manufacturing.

Table 4 The top 10 most highly cited publications related to SBMI

Rank	Title	Source	Type	Year	NC	AC	AN	IN	CN
1	Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. (Sharma and Vredenburg 1998)	Strategic Management Journal	Article	1998	1195	49.79	2	2	1
2	Advancing a conceptual model of evidence-based practice implementation in public service sectors. (Aarons et al. 2011)	Administration and Policy in Mental Health	Article	2011	1083	98.45	3	3	1
3	A literature and practice review to develop sustainable business model archetypes. (Bocken et al. 2014)	Journal of Cleaner Production	Article	2014	926	115.75	4	1	1
4	Why sustainability is now the key driver of innovation. (Nidumolu et al. 2009)	IEEE Engineering Management Review	Article	2009	728	56.00	3	2	1
5	Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. (Boons and Lüdeke-Freund 2013)	Journal of Cleaner Production	Review	2013	712	79.11	2	2	2
6	Business model evolution: in search of dynamic consistency. (Demil and Lecocq 2010)	Long Range Planning	Article	2010	552	46.00	2	1	1
7	Industrial product-service systems—IPS2. (Meier et al. 2010)	CIRP Annals—Manufacturing Technology	Article	2010	501	41.75	3	3	2
8	Business cases for sustainability: the role of business model innovation for corporate sustainability. (Schaltegger et al. 2012)	International Journal of Innovation and Sustainable Development	Article	2012	491	44.64	3	1	1
9	Sustainable innovation, business models and economic performance: an overview. (Boons et al. 2013)	Journal of Cleaner Production	Review	2013	382	42.44	4	4	2
10	Additive manufacturing and sustainability: an exploratory study of the advantages and challenges. (Ford and Despeisse 2016)	Entrepreneurship Theory and Practice	Article	2016	373	62.17	2	1	1

4.2 Cooperation networks

Considering that the 4509 publications related to SBMI involve 297 countries/regions, 3855 institutions, and 12,730 authors, it is necessary to analyze the collaborative relationships among these actors. In this section, cooperation networks are obtained by using CiteSpace, VOSviewer, and Bibliometrix software from three aspects: the co-country/region network, co-institution network, and co-author network.

4.2.1 The co-country/region networks

To detect the output and cooperative relationships related to SBMI research from a macroscopic perspective, we analyze the distribution and interaction of countries/regions based on two software tools, CiteSpace and Bibliometrix. First, the global geographical distribution of publications related to SBMI research is presented in Fig. 5, in which the shade of the color represents a country's output. The darker the color is, the higher the output. Clearly, among 19 countries/regions, China, the USA, and England dominate, with 580, 492, and 429 publications, respectively. Moreover, we can conclude that the output of publications related to SBMI is mainly distributed in North America, Asia, and Europe. That is, the output of publications has a central tendency in terms of geographical distribution. Based on the global geographical distribution of publications, the path of cooperation among these countries/regions is further presented in Fig. 6, where the red lines indicate that the countries/regions have collaborative relationships. It is easy to see that the international cooperation among countries/regions is intimate. Furthermore, the three highly productive countries have strong collaborative relationships with other countries/regions since their lines are thicker. This finding indicates that international cooperation can inspire a better outcome in terms of quantity and quality.

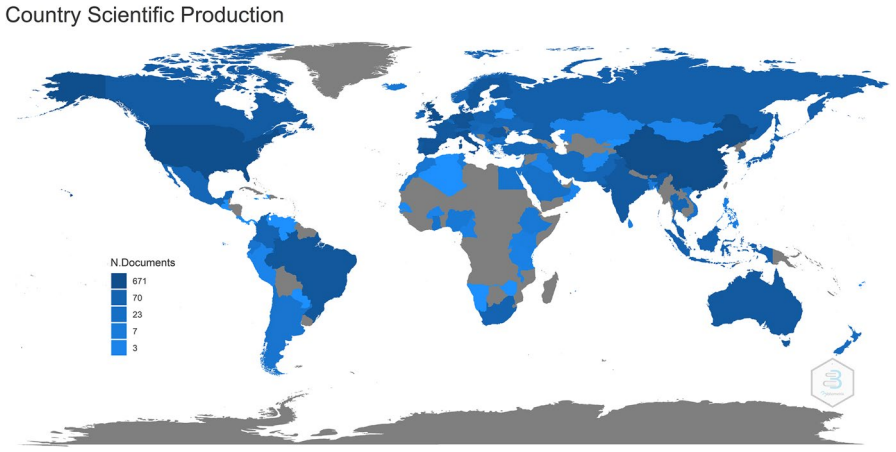


Fig. 5 Global geographic distribution of publications related to SBMI research

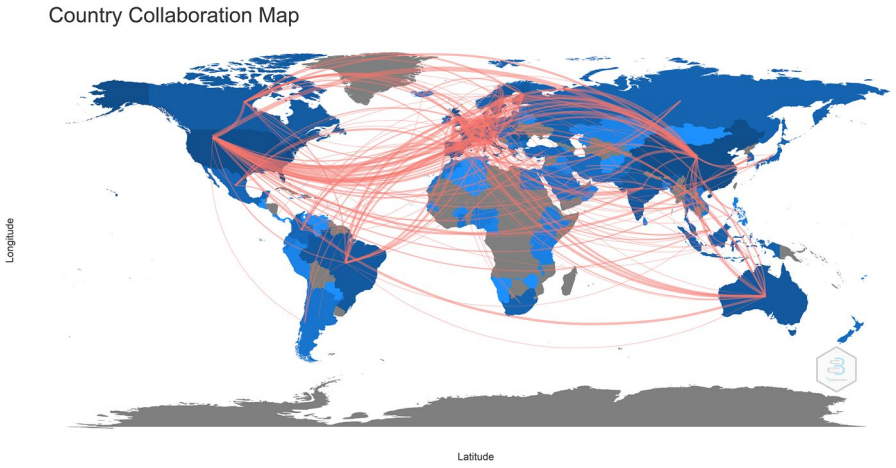


Fig. 6 Country collaboration map related to SBMI research

To further discuss the collaborative relationships among these countries/regions, we utilize the clustering algorithm in VOSviewer to obtain the co-country/region network. Based on the co-authorship of countries in VOSviewer, in Fig. 7, we visualize the 38 countries/regions that meet the threshold, i.e., the minimum number of publications of a country/region is 25. It is worth noting that the nodes represent countries/regions, and the size of the node denotes the number of publications. The

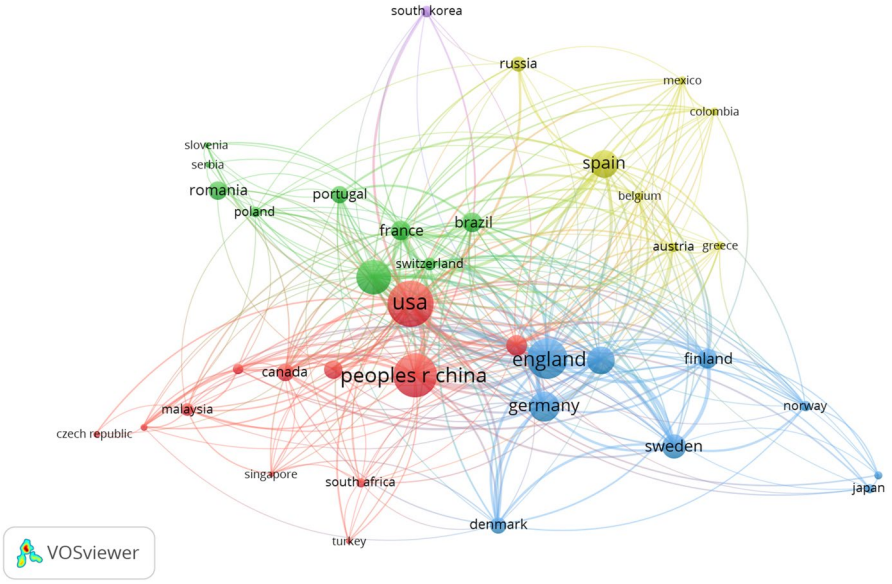


Fig. 7 The cooperation network of countries/regions related to SBMI research

links between any two countries/regions indicate cooperative relationships, and the thickness of links represents the strength of the relationship. In addition, the top 10 countries/regions based on the NP and total link strength (NL) are listed in Table 5. Figure 7 and Table 5 show that the NL of China, the USA, and England is 183, 233, and 272, respectively. It is easy to find that the rankings based on the NL are inconsistent with the results based on the NP and NC. The lack of cooperation with Finland, Colombia, Greece, and Russia may be the reason for the lower link strength of China.

In addition, the 38 countries/regions are divided into 5 clusters, which are represented by different colors in Fig. 7. Cluster 1 (in red) contains China, the USA, Australia, Canada, Singapore, India, Indonesia, the Czech Republic, Malaysia, Pakistan, South Africa, and Turkey. Cluster 2 (in green) contains Brazil, France, Italy, Poland, Portugal, Romania, Serbia, Slovenia, and Switzerland. Cluster 3 (in blue) contains England, Japan, the Netherlands, Norway, Sweden, and Thailand. Cluster 4 (in yellow) contains Austria, Belgium, Colombia, Greece, Mexico, Russia, and Spain. Cluster 5 (in purple) contains South Africa.

4.2.2 The co-institution network

A total of 3855 institutions are affiliated with publications on SBMI research. It is necessary to discuss the co-institution network through VOSviewer software. In this process, we set the minimum number of publications of an institution to 7, and 103 institutions meet the threshold. The visualization results are shown in Fig. 8. In Fig. 8, only 88 institutions are shown since some of the 103 institutions are not connected to other institutions. The nodes represent institutions, and the color of the nodes denotes the 13 clusters of institutions. The thickness of links represents the intensity of the cooperative relationship between any two institutions. Moreover, the most active and productive institutions are listed in Table 6 based on the NP and NL. The table shows that the most active and productive institution is Delft University of Technology. The rankings of the following active and productive institutions are not consistent.

Table 5 The top 10 countries/regions based on the NP and NL

Rank	Country/Region	NP	Country/Region	NL
1	China	681	England	272
2	USA	622	USA	233
3	England	581	China	183
4	Italy	448	Netherlands	163
5	Germany	384	Germany	152
6	Spain	334	France	128
7	Netherlands	310	Italy	123
8	Brazil	252	Sweden	119
9	Sweden	223	Spain	118
10	Romania	214	Finland	128

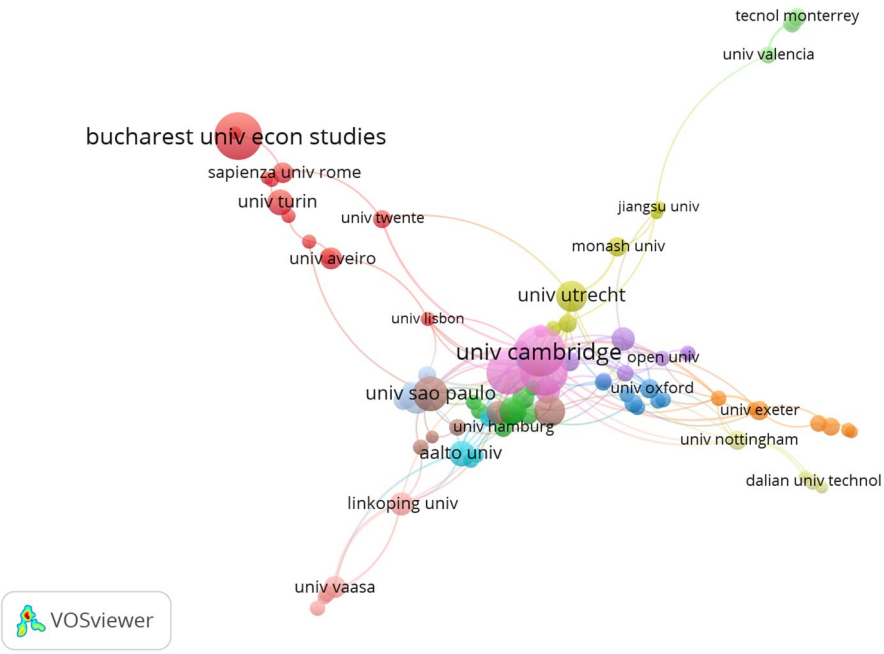


Fig. 8 The co-institution network related to SBMI research

Table 6 The top active and productive institutions in SBMI research

Rank	Institutions	NL	NC	Institutions	NP	NC
1	Delft University of Technology	53	1910	University of Cambridge	47	3267
2	Lund University	37	903	Delft University of Technology	43	1910
3	University of Cambridge	36	3267	Bucharest University of Economic Studies	43	56
4	University of Vaasa	17	297	Lund University	39	903
5	University of São Paulo	15	508	University of São Paulo	28	508
6	University of Oxford	14	302	Politecnico di Milano	23	629
7	Aalto University	12	573	University of Manchester	23	419
8	Imperial College London	12	117	University of Utrecht	23	738
9	Lappeenranta University of Technology	12	325	Aarhus University	19	215
10	Linköping University	12	218	Aalto University	18	573

From Fig. 8 and Table 6, there is strong cooperation between 88 institutions, and the central hubs for connecting the other institutions are Delft University of Technology, Lund University, and the University of Cambridge, which have the highest link strength and highest number of publications. However, the 3855 institutions related to SBMI research lack cooperation and collaboration. Some institutions with

a higher number of publications need to strengthen their cooperation with other institutions to improve the quality of their publications, such as Bucharest University of Economic Studies, Tecnológico de Monterrey, Dalian University of Technology, and Wuhan University.

4.2.3 The co-author network

Relying on the algorithm in VOSviewer, we find that there are 12,730 authors who contributed to the 4509 publications in SMBI research. To further analyze the cooperative relationships of SBMI research at the author level, this subsection derives the co-author network through VOSviewer. A total of 291 authors who met the criterion of completing at least 3 publications were selected, and only 87 authors were connected. The visualization results of 87 authors are shown in Fig. 9, where the nodes denote authors, and the color of nodes identifies the 12 clusters of authors. To better comprehend the cooperative relationships between authors, we list the top 10 authors by their NP and NL in Table 7.

Based on Fig. 9 and Table 7, we can conclude that most authors completed their publications alone. Moreover, there is no doubt that Nancy Bocken from the Netherlands and Steve Evans from the USA are the most influential authors, having the highest and second highest NP, NC, and NL. In the cooperative network, Steve Evans is the core node connecting other authors. Except for Nancy Bocken and Steve Evans, other authors with the highest NP do not have the strongest NL. In the following top active authors, Yuge Ma, Diana Mangalagiu, and Thomas F. Thornton have the same NC (127). By reviewing their publications in detail, we find that Yuge Ma wrote all publications in collaboration with Diana Mangalagiu and Thomas F. Thornton, and they are all from the University of Oxford in England. Similarly, Romana Rauter completed most of her publications through cooperation with Jan Jonker. In addition, Baldassarre Brian and Erik J. Hultink, who are both

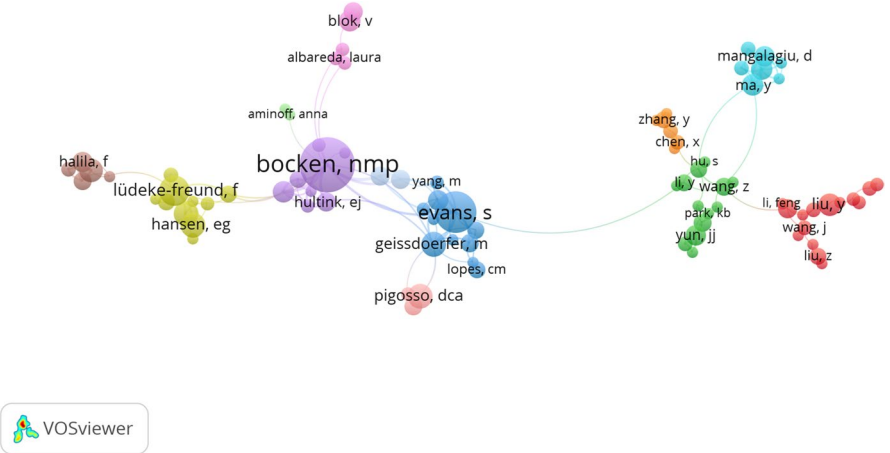


Fig. 9 The co-author network related to SBMI research

Table 7 The top active and productive authors in SBMI research

Rank	Authors	NL	NC	Authors	NP	NC
1	Nancy, Bocken	60	2628	Nancy, Bocken	66	2628
2	Steve, Evans	55	2020	Steve, Evans	37	2020
3	Yuge, Ma	29	127	Florian, Lüdeke-Freund	20	1519
4	Thomas, F. Thornton	28	127	Stefan, Schaltegger	14	1151
5	Diana, Mangalagiu	27	127	Erik, G. Hansen	14	539
6	Baldassarre, Brian	44	167	Daniela, C.A. Pigosso	13	164
7	Martin, Geissdoerfer	26	89	Martin, Geissdoerfer	13	394
8	Florian, Lüdeke-Freund	24	121	Min-Ren, Yan	12	32
9	Erik J. Hultink	22	162	Maya, Hoveskog	12	60
10	Vladimirova, Doroteya	41	1519	Ming-Lang, Tseng,	11	299

from Delft University of Technology in the Netherlands, have good cooperative relationships with Nancy Bocken. In summary, team cooperation can be conducive to improving the influence of authors. Hence, authors who lack collaboration need to strengthen their communication and cooperation with other authors, especially those with the highest NP. Doing so will contribute to the development of SBMI research.

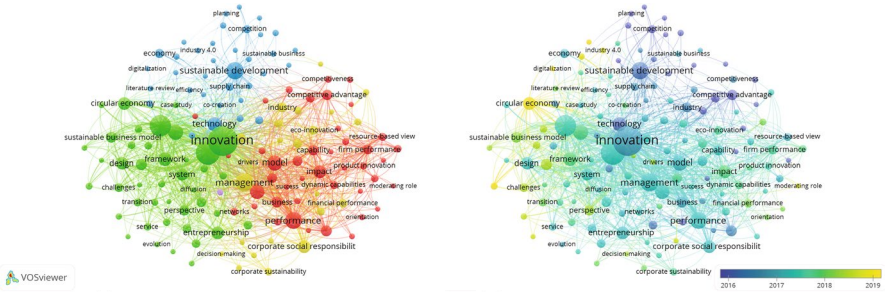
4.3 Keyword analysis

In this section, the characteristics and hotspots of publications related to SBMI research are explored through keyword analysis. In practice, co-occurrence analysis, burst detection analysis, and thematic evolution analysis are performed to complete keyword analysis using three software tools, i.e., VOSviewer, CiteSpace, and Bibliometrix.

4.3.1 Co-occurrence analysis

Co-occurrence analysis can reveal the content associations and characteristics implicit in SBMI research based on a quantitative study of the number of times of co-occurrence of keywords (Kraus et al. 2020a, b). Hence, we obtain the co-occurrence network of all keywords (author keywords and keywords plus) related to SBMI research by utilizing VOSviewer software. The results are shown in Fig. 10, in which the occurrence threshold of each keyword is set to 30 and 143 out of 13,137 words meet the threshold.

Based on Fig. 10a, we can obtain the following observations: (1) The top five words are “innovation” in green (occurrences 1469), “sustainability” in green (883), “business model” in green (197), “management” in yellow (374), and “performance” in red (332). (2) A total of 155 words are divided into 5 clusters: Cluster 1 (in red) includes 42 words, Cluster 2 (in green) includes 42 words, Cluster 3 (in blue) includes 35 words, Cluster 4 (in yellow) includes 23 words, and Cluster 5 (in purple) includes 1 word. This result indicates that the product topic related to SBMI research is underdeveloped.



(a) Co-occurrence network of all keywords. **(b)** Overlay co-occurrence network of all keywords.

Fig. 10 Visualization map of the keyword co-occurrence network related to SBMI research

To observe the evolution of keyword occurrences over time, the overlay co-occurrence network of all keywords is obtained in Fig. 10b, in which the color represents the average year in which the keyword appears. Specifically, the lighter the color is, the later the keyword appears. It is easy to find that "circular economy", "sharing economy", "big data", "digitalization" and "industry 4.0" are major topics of concern to scholars in the field of SBMI. That is, the focus of SBMI research has shifted from its theoretical basis to its application and realization.

4.3.2 Burst detection analysis

To further explore the active area and emerging trend of SBMI research, burst detection analysis is performed by collecting keywords that are cited suddenly in a short period of time (Zhou et al. 2018). Based on the burst term detection function in CiteSpace, the top 15 keywords for citation bursts from 1994 to 2020 are obtained in Table 8 by setting the minimum duration to one year. The blue line indicates the time interval, and it turns into a red line when the keyword bursts.

As a result, the keyword with the maximum burst strength is "human" (strength: 14.00). The keywords with higher strength are "competition" (13.77), "strategic planning" (12.20), "manufacture" (11.95), "information technology" (11.89), and "industry" (11.20). In terms of the length of the burst duration, "information technology" is the earliest bursting keyword with the longest burst duration, which lasted 15 years (1999–2014). Furthermore, the following keywords had longer burst durations: "environmental policy" lasted 13 years (2003–2015) and "competition" lasted 11 years (2004–2014). In recent years, the topics related to "market" and "circular economy" have been the emerging trends of SBMI research. Significantly, there were fewer bursting keywords in the last two years. This finding shows that the development of SBMI research is less than ideal.

4.3.3 Thematic evolution analysis

To clarify the rise, boom, and decline of research directions, thematic evolution analysis of SBMI research from 1994 to 2020 was conducted based on the time slice

Table 8 The top 15 keywords by citation bursts from 1994 to 2020

Rank	Keywords	Strength	Begin	End	1994-2020
1	Information technology	11.89	**1999**	2014	
2	Mathematical model	9.40	**1999**	2007	
3	Environmental policy	6.92	**2003**	2015	
4	Competition	13.77	**2004**	2014	
5	Strategic planning	12.20	**2005**	2009	
6	Knowledge management	7.93	**2005**	2012	
7	Industrial economics	7.26	**2005**	2008	
8	Technology	8.81	**2006**	2014	
9	Human	14.00	**2007**	2014	
10	Economics	10.81	**2008**	2016	
11	Organizational innovation	7.14	**2008**	2014	
12	Industry	11.20	**2010**	2013	
13	Manufacture	11.95	**2012**	2017	
14	Market	7.08	**2015**	2016	
15	Circular economy	6.57	**2019**	2020	

function in the Bibliometrix tool (Aparicio et al. 2019). Based on the number of publications per year, we set the number of cutting points to 4 and the cutting years to 2005, 2008, 2012, and 2016. As a result, the strategic maps for the five time slices are obtained in Fig. 11, in which the abscissa indicates centrality, the ordinate indicates density, and the size of the circle indicates the frequency of keywords.

The strategic maps contain four quadrants that are utilized to measure the development and mutual influence of research themes. Therefore, the themes in the first quadrant (upper right) are regarded as motor themes that are usually important for SBMI research and have a sound momentum of growth; niche themes are located in the second quadrant (upper-left); the third quadrant (bottom-left) mainly contains emerging or declining themes that are currently underdeveloped; and the fourth quadrant (bottom-right) includes basic themes that are vital for the future direction of SBMI research and have to be urgently developed.

From Fig. 11, SBMI research related to mathematical models was well developed from 1994 to 2005. Then, SBMI research fell silent from 2006 to 2008. It gradually developed until 2009 with the rise of information technology. In general, the development of themes related to SBMI research changes dynamically over time. In this process, the theme related to innovation has shifted from a basic theme to a motor theme, except for a period of silence from 2009 to 2012. The theme of sustainable development developed rapidly during the 2017–2020 period after a long period of silence. The theme of management related to SBMI research emerged during the 2013–2016 period and has yet to be developed. In addition, research on the theme of performance needs to strengthen its cooperation and be combined with research on other themes. In summary, the themes of competition, industry, management, and performance require more attention from scholars.

To monitor the dynamic changes in themes over the five time slices, the integral thematic evolution of SBMI research from 1994 to 2020 was obtained by the Sankey diagram in the Bibliometrix tool. The result is shown in Fig. 12, in which the length

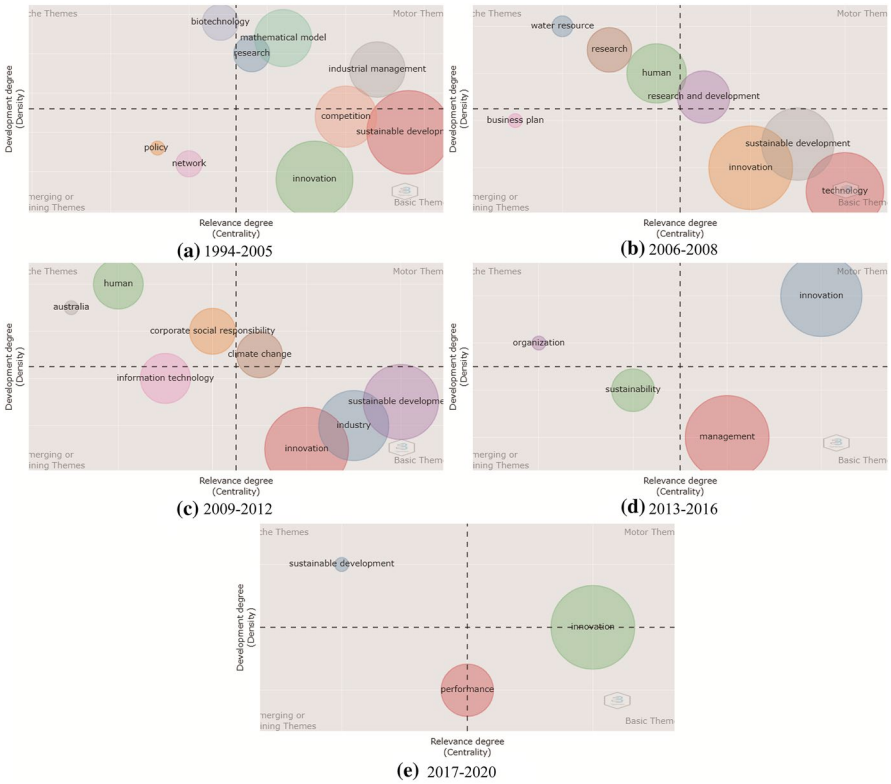


Fig. 11 Strategic maps of SBMI research for the five time slices

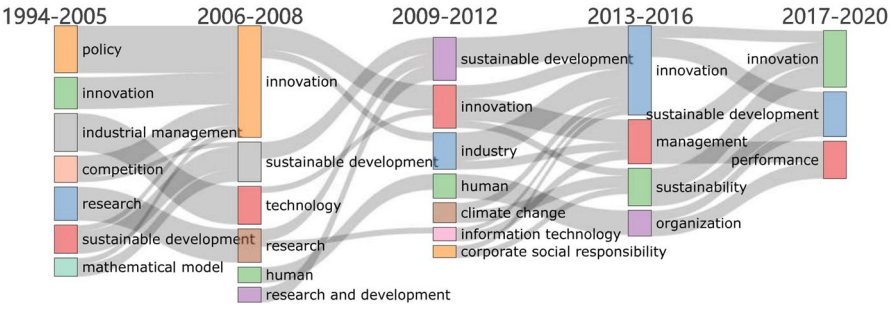


Fig. 12 Thematic evolution of SBMI research from 1994 to 2020

of the block denotes the frequency of keywords. From Fig. 12, we can conclude that most themes were derived from the themes during the 1994–2005 period, except for the themes of human, research and development, and corporate social responsibility, which emerged in 2006 and 2009. Most themes were developed coherently during the 1994–2020 period. Moreover, cooperation in research on and the combination of

most themes are good. The current mainstream research topics are still the themes of innovation and sustainable development. It is worth noting that the themes of climate change, information technology, corporate social responsibility, policy, and competition all feed into the theme of innovation.

5 Narrative synthesis

Objective results are obtained by analyzing publications related to SBMI research from different aspects through bibliometric tools such as CiteSpace, VOSviewer, and Bibliometrix. Based on the abovementioned results, this section attempts to synthesize SBMI research following the antecedents-decisions-outcomes (ADO) framework (Paul and Benito 2018), as shown in Fig. 13. Then, we further address the directions for future research and the limitations of this study.

5.1 Antecedents of SBMI

Considering that SBMI is an important source of competitive advantage for corporations under a dynamic external environment, in this subsection, we discuss the drivers that corporations transform the traditional BMI to SBMI, and we identify them as antecedents in the SBMI framework. We reduce the antecedents to three aspects: macroenvironmental drivers, strategic drivers, and human drivers.

5.1.1 Macroenvironmental drivers

The macroenvironmental drivers include ecological drivers, institutional drivers, and technological drivers. Air pollution, extreme weather, resource shortages, and other ecological problems will force corporations to be more concerned about renewable energies (Engelken et al. 2016), waste recycling (Xin et al. 2017), and other sustainable development goals. From the institutional perspective, stressful ecological problems will facilitate the government in formulating corresponding policies and regulations. The pressures from these policies and regulations will make corporations need to seek organizational legitimacy in the system in which they are located. In addition, incentive policies are essential factors in encouraging corporations to carry out SBMI activities (Sinkovics et al. 2021). Meanwhile, the development of disruptive technologies is another powerful driver of SBMI (Yovanof and Hazapis

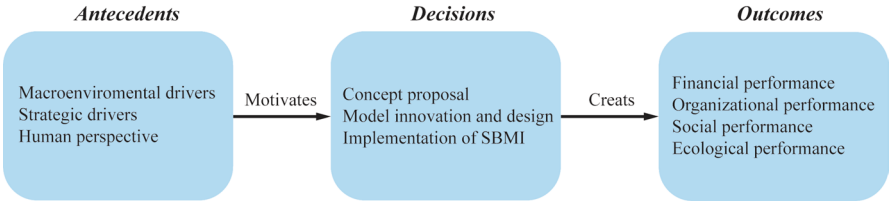


Fig. 13 The antecedents-decisions-outcomes framework of SBMI research

2008). Examples include new digital technologies (Gilberto et al. 2018), photovoltaic power generation (Horvath and Szabo 2018), renewable energy technologies (Batel 2020), and graphene annealing (Lin et al. 2012). Combining the quantitative results in Sect. 4.3, we can conclude that the environmental and innovation themes related to ecological drivers and technological drivers have received attention from scholars. Moreover, the "policy" themes related to institutional drivers have received attention since 1994.

5.1.2 Strategic drivers

The strategic orientation and competition of corporations are significant sources of drivers. Strategic orientations based on creating shared value (Chaurasia et al. 2020), collaborative innovation (Wang et al. 2021a, b, c), or sustainable development (Hoang et al. 2021) will profoundly affect the value proposition, value creation and delivery, and value acquisition of corporations and thus become powerful driving forces for adopting SBMI activities. In particular, long-term goals with sustainable development can improve or maintain corporate image and organizational legitimacy. Based on the above quantitative results, the "competition" topic related to SBMI research has yet to be developed.

5.1.3 Human perspective

The drivers from the human perspective mainly consist of sustainability-oriented leadership and stakeholder involvement. The former emphasizes sustainable value creation in business development and considers the wider interests of society in the decision-making process. Specific paths include refining productivity (Yuan et al. 2017), improving the factors of organizational structure (Carayannis et al. 2015), performance incentives (Florian et al. 2018), and sustainable culture construction (Boyd et al. 2020). The latter can be regarded as external pressures from the expectations of stakeholders that corporations will fulfill their social responsibilities. Stakeholders can drive corporations to carry out SBMI activities by claiming the positive social value of products or services (Sana 2021), focusing on environmental performance (Sun et al. 2018), and preferring to invest in sustainable projects (Kalkbrenner and Roosen 2015). Based on the above quantitative results, we find that the "corporate social responsibility" and "management" topics related to human drivers have received more attention from scholars in recent years.

5.2 Decisions of SBMI

The decisions of SBMI research refer to the concept proposal, model and framework design, and implementation of the SBMI model. Based on bibliometric analysis and the literature review, we can conclude that the current status of SBMI research is mainly focused on innovation, sustainability, management, performance, and framework.

5.2.1 Concept proposal

For the concept proposal, the components of the traditional BM include the value proposition, value creation and delivery, and value acquisition. SBMI is regarded as adding elements of sustainable innovation into each component of the traditional BM. Moreover, SBMI delivers value for multiple stakeholders through the triple bottom line, that is, the economic bottom line, social bottom line, and environmental bottom line (Khan et al. 2021). Geissdoerfer et al. (2018) proposed the definition of SBMI based on reviews of key concepts. Shakeel et al. (2020) derived the concept of SBMI from a philosophical point of view. Combining the quantitative results, we see that the concept proposal has always attracted the attention of scholars since the second most influential publication (Aarons et al. 2011) is related to the concept proposal.

5.2.2 Model innovation and design

The core of model innovation and design is the new configuration of value elements and embedding sustainability goals in the process. The elements involve both the components of SBMI and the external environment (Kondoh et al. 2014). Product or service design is conducive to each stage of SBMI, including the value proposition, value creation and delivery, and value acquisition. Innovation related to value creation and delivery involves business activities, resources, and symbiosis. Innovation related to value acquisition focuses on the cost structure and revenue streams. Based on the citation analysis and thematic evolution analysis of SBMI publications, the mathematical model theme has generally been well developed.

5.2.3 Implementation of SBMI

The implementation paths of SBMI consist of the creation, transformation, diversification, and acquisition of BMs (Geissdoerfer et al. 2018). As the hardest path, creation means building a start-up corporation with SBMI. As an easier path, transformation involves adjusting and improving the existing BM according to sustainability principles, diversification indicates developing an additional SBMI based on the existing BM, and acquisition refers to assimilating and integrating the external BM with sustainability goals. Based on the quantitative results, the implementation of the SBMI model focuses on public services, industrial products, the supply chain, and manufacturing.

5.3 Outcomes of SBMI

The outcomes of SBMI can be divided into four aspects: financial performance, organizational performance, social performance, and ecological performance. Financial performance refers to the economic growth of society and the profitability of corporations (Ohara 2015). Organizational performance indicates the competitive

advantage and survival of corporations (Visnjic and Looy 2012). Social performance involves poverty reduction, job growth, and social resource recycling (Sinkovics et al. 2021). Ecological performance includes carbon neutrality and the protection and recovery of the ecological environment (Sinkovics et al. 2021). Based on keyword analysis, there is no doubt that the performance of SBMI has always attracted the attention of scholars.

6 Directions for future research

In this section, we discuss the limitations and some significant improvements in the future directions of SBMI research. Based on the ADO framework mentioned before, the future directions of SBMI research are analyzed from three aspects: future directions regarding antecedents, future directions regarding decisions, and future directions regarding outcomes.

6.1 Future directions regarding antecedents

In terms of the antecedents of SBMI, current research mainly focuses on macroenvironmental drivers. Future research should pay more attention to internal factors, including strategic drivers, sustainability-oriented leadership, and cognitions of social responsibility. Otherwise, the impact of unexpected incidents such as the COVID-19 pandemic is worthy of further study. Here, we propose the following research questions regarding the antecedents of SBMI:

(1) What are the external and internal drivers of SBMI in corporations of different sizes, such as transnational corporations, SMEs, and start-ups?
(2) To what extent do the drivers support SBMI in different industries?
(3) How do each of the drivers interact in SBMI, and what are the connections between internal and external drivers?

6.2 Future directions regarding decisions

Concerning the decisions of SBMI, model innovation and design considering the balance between the goals of profit maximization and sustainability remain to be analyzed. Moreover, future research should pay attention to the interaction between innovation in components and the external environment during the SBMI design process. In addition, a universal design framework with adjustment strategies must be further explored to bridge the gap between the theoretical framework and implementation. On this basis, research questions regarding the decisions of SBMI include the following:

(1) How can a universal framework be designed to help corporations of different sizes undergo SBMI in practice?

(2) How can design thinking be combined with the use of digitalization in the era of big data?
(3) How can strategies be adjusted when corporations face emergencies during the implementation of SBMI?

6.3 Future directions regarding outcomes

Regarding the outcomes of SBMI, current research does not provide a way to quantify the outcomes of SBMI. Future research should focus on the performance mechanism of SBMI. In particular, the quantification and integration of performance indicators need to be further studied. Research questions regarding the outcomes of SBMI include the following:

(1) How can the value efficiency of the SBMI framework and tool be measured in practice?
(2) How can qualitative performance indicators be quantified, such as competitive advantage?

7 Conclusions

In this paper, we conduct a bibliometric analysis and overview of 4509 publications related to SBMI research from different perspectives. First, we present the basic statistical characteristics of publications, including the annual productivity and citations based on the NP, NC, and AC, the types and research categories, and the citation analysis of different items. It is easy to determine that the development of SBMI research is positive by observing the trends of the annual indicators of publications. Then, based on the cooperation network analyses among countries/regions, institutions, and authors, we find that the output of publications has a central tendency in terms of geographical distribution and that the international cooperation among countries/regions is intimate. However, the collaborative relationships among institutions and authors are suboptimal. Furthermore, keyword analysis reveals that the themes of SBMI research are mainly focused on innovation, sustainability, business models, management, and performance. In addition, in SBMI research, the themes of competition, industry, management, and performance need further attention from scholars. Based on the analyses and literature review, we further integrate the antecedents-decisions-outcomes framework for SBMI research and identify future research directions related to drivers, innovation and design, implementation, and performance. SBMI is an important tool for corporations to achieve their profit target and sustainability goal at the same time. Further research directions should focus on how SBMI develops in the era of globalization and digitization, and bibliometric analysis of SBMI research should be conducted from the perspective of corporations with different sizes.

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Author contributions LP is responsible for conceptualization, methodology, validation, writing-original draft, writing-review & editing; ZX provides funding acquisition, supervision, writing-original draft; MS gives resources, investigation and research conceptualization.

Declarations

Conflict of interest The authors declare that they have no competing interests.

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