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BIBLIOMETRIC ANALYSIS AND SYSTEMATIC LITERATURE REVIEW IN SOCIAL MANUFACTURING

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Abstract:
This study aims to map out social manufacturing research and the distribution of social manufacturing research, which can be used as a reference for social manufacturing research. Various studies on social manufacturing have been carried out to explore various insights on social manufacturing in different domains. This study was conducted in 2021, and explored the social manufacturing literature using bibliometric analysis methods. The approach used in the bibliometric analysis is the citation analysis to see one article cited by another article, and the co-citation analysis approach to find two or more articles cited by one article. In this study, the data source used is from the Scopus database, with social manufacturing keyword. The results show the types of analysis that have been processed include co-authorship (authors, organizations, countries), citations (authors), and co-citations (sources, cited authors). This research still has limitations, because it use the Scopus database only, so for further research, it could be added with other sources, such as Web of Science, PubMed, Crossref, etc. In addition, there are still many visualization results using VOSviewer software that could be explored further, such as the type of analysis citation-document, citation-organization, bibliographic coupling, which has not been discussed in this study.

Key words: *bibliometric analysis; VOSviewer; systematic literature review; social manufacturing; production system*

INTRODUCTION

The manufacturing industry has become socialized, collaborative, and social oriented [1], so many professional and socialized small and medium-sized enterprises (SMEs) have sprung up to provide product services to meet customer needs [2, 3]. Face this trend, a new social manufacturing model has been proposed to incorporate these SMEs into the community for mass personalized manufacturing [4, 5, 6, 7]. Resources in social manufacturing are consist of the resources of each SME that are socialized and each similar SMEs grouped into one community [3]. The appropriate socialized manufacturing resource communities are selected [1], and then the socialized manufacturing resources are mapped into small and medium enterprises [7]. In traditional manufacturing companies, manufacturing resources such as machinery [8], equipment, etc. [9], represent their core competencies, so they usually don't want to share them with others [10]. However, due to the rapid advancement of the internet and information technology [11], collaboration and interconnection between manufacturing companies have become a trend [12, 13]. Various advanced manufacturing modes have been proposed in recent years, and most of them emphasize collaboration and interconnection, such as Cyber-Physical Systems [14, 15], crowdsourcing [16], cloud-based manufacturing [17] and distributed manufacturing [18, 19].

The social manufacturing model was proposed in 2012 and later researched by several experts [20]. Social manufacturing is a new distributed, collaborative, and intelligent manufacturing [21]. The advantage of social manufacturing is that consumer demand can be directly reflected in a product, where every consumer can participate in the entire process of product design, manufacture, and even marketing [22]. The participation of consumers allows them to get more acceptance and satisfaction of

their products [23]. Personalization can improve user experience [24], potential product demand, and production efficiency [25].

Based on various product types and production quantities, the production model of manufacturing companies has undergone significant changes [23]. It is from handmade production, mass production, mass customization to individual production to meet in-creased efficiency [26], especially since the first industrial revolution [27]. In addition to the social relations and developmental factors mentioned above, these changes also depend on the innovation of production organizations [28], the development of manufacturing technology itself [29], and technological products such as automation, com-puter science, information technology, etc. [30, 31].

Internet-based communication in business has advanced along with the development of the internet, Internet of Things (IoT), and Cyber-Physical System (CPS) technology, creating organizational structures, business interactions in manufacturing companies and between different companies, facing enormous challenges [32, 33]. Manufacturing companies must answer these considerable challenges, for example, by changing their product manufacturing activities during the product life cycle and how they did it [34].

LITERATURE REVIEW

Various studies on social manufacturing have been carried out to explore various insights on social manufacturing in different domains. In Table 1, it is shown that most of the articles discussing social manufacturing have been published in the last five years.

Table 1
Social manufacturing research paper

Author and Year of Publication	Title	Source of Paper	Focus Area	Outcomes
Hamalainen and Karjalainen, 2017 [35]	Social manufacturing: When the maker movement meets interfirm production networks	Business Horizon	Conceptually defining two distinct forms of the firm individual collaboration in manufacturing industries and empirically investigate the nature of firm-individual collaboration	Business models in the manufacturing industry by leveraging individual networks
Jiang and Leng, 2017 [36]	The configuration of social manufacturing: a social intelligence way toward service-oriented manufacturing	International Journal of Manufacturing Research	Provide knowledge in outsourcing and crowdsourcing concepts on social manufacturing for the entire lifecycle of mass personalization processes	A novel approach for enabling individualized mass production
Guo and Jiang, 2018 [7]	An investigation on establishing small- and medium-sized enterprises communities under the environment of social manufacturing	Concurrent Engineering: Research and Applications	Socialized manufacturing resources (SMR) clustering and order allocation in SMEs community	Growing hierarchical self-organizing map and the modified multi-objective bird swarm algorithm
Xiong et al., 2018 [37]	From Mind to Products: Towards Social Manufacturing and Service	IEEE/CAA Journal of Automatica Sinica	Developing social manufacturing prototypes involving 3D printing, the internet of things, cloud computing, and intelligent systems	Development of three transformation models involving social manufacturing and 3D printing in different case studies
Shang et al., 2018 [20]	Social Manufacturing for High-end Apparel Customization	IEEE/CAA Journal of Automatica Sinica	Developing high-end apparel customization using cloud computing technology and crowdsourcing	Developing a social manufacturing model in the apparel industry by improving innovation, design, manufacture, marketing, and service, to be more competitive in the future
Ding et al., 2018 [21]	RFID-enabled social manufacturing system for inter-enterprise monitoring and dispatching of integrated production and transportation tasks	Robotics and Computer Integrated Manufacturing	Propose a radio frequency identification enabled social manufacturing system to realize real-time monitoring and delivery of production and transportation inter-enterprise	Development of social manufacturing prototypes and case studies applied to printing machine companies, and the proposed model is evaluated by industry practitioners

cont. Table 1

Hirscher et al., 2018 [38]	Social manufacturing in the fashion sector: New value creation through alternative design strategies?	Journal of Cleaner Production	Developing a social manufacturing model for the fashion industry, using the do-it-yourself (DIY) and do-it-together (DIT) methods	A social manufacturing framework that has been demonstrated and uses data from Finland and the US
Xiao et al., 2019 [39]	Evaluating of dynamic service matching strategy for social manufacturing in the cloud environment	Future Generation Computer Systems	Computational experiment-based evaluation framework, which can simulate all kinds of actual scenarios to verify the performance of strategy service matching, and has carried out case studies	Adaptive service supply-demand matching to maintain sustainable development in social manufacturing
Guo and Jiang, 2019 [3]	Product Service Systems for Social Manufacturing: A new service system with multi-provider	IFAC Papers OnLine	Implementing architecture and operational logic of Product-Service System (PSS) for social manufacturing	PSS for social manufacturing can help SMEs to improve and develop the transition to product services. Two case studies also confirm the effectiveness and feasibility of PSS for social manufacturing models
Song et al., 2019 [40]	Exploring robustness management of social internet of things for customization manufacturing	Future Generation Computer Systems	Social reliability of the Internet of Things (SIoT) in a customization manufacturing (CM) environment	Improve SIoT resilience under the CM paradigm
Leng et al., 2019 [41]	Makerchain: A blockchain with a chemical signature for self-organizing process in social manufacturing	Journal of Cleaner Production	Blockchain-driven smart contracts for decentralized self-organizing in social manufacturing	A maker chain decentralized application
Xiao et al., 2019 [39]	Evaluating of dynamic service matching strategy for social manufacturing in a cloud environment	Future Generation Computer Systems	Sustainable development of social manufacturing	Computational experiment-based evaluation
Qian et al., 2020 [1]	Exploring the socialized operations of manufacturing resources for service flexibility and autonomy	Robotics and Computer Integrated Manufacturing	Framework for socialized manufacturing resources, resourcing, and service modeling virtually using finite state machines	The initial design of the social network was resource-oriented and provided solutions that allowed for the development of autonomy and flexibility of manufacturing systems.

The majority of this review article focuses on selecting various strategies and technologies used to develop social manufacturing systems. It was also identified that most studies focused on a particular aspect or problem, such as simulation modeling, sustainability indicators, product development techniques, operations research, etc. This systematic literature review is structured to increase understanding of social manufacturing from a different perspective.

This study aims to map out social manufacturing research and the distribution of social manufacturing research, which can be used as a reference for social manufacturing research. The rest of this paper is presented as follows: Section 2 presents the methodology to systematically review the state of the art of research in social manufacturing; Section 3 presents the outcomes of the systematic review and discusses several critical issues of social manufacturing on product personalization; and finally, Section 4 presents the conclusion of this systematic review.

METHODS

This study will explore the social manufacturing literature using bibliometric analysis methods. Bibliometric analysis is a quantitative method for analyzing biblio-graphic data in articles/journals. This analysis is usually used to investigate references to scientific articles cited in a journal, map the scientific field, and classify scientific articles according to a research field. This method can be used in engineering, business, humanities, communication, management, and other fields. In this study, the data source used is from the Scopus database, with the keyword social manufacturing. The method of data selection screening process is presented in Figure 1 and Figure 2.

The approach used in the bibliometric analysis is the citation analysis approach to see one article cited by another article, and the co-citation analysis approach to find two or more articles cited by one article. In analyzing bibliometric data, we need software that is used as an analytical tool. One of the tools that can facilitate the analysis of bibliometric data is the VOSviewer Software. This software could be used to see impactful authors, find out the graph of the year that research publications were popular, and see institutions that research a lot in a research field. With the benefits provided, the data generated by VOSviewer can be used as a basis for developing research in specific areas of science, especially those that are still little researched. In academic terms, the data generated by VOSviewer can also be used as evidence to readers and

reviewers that the topics raised in the research are important topics to discuss.

Fig. 1 The method of data selection process

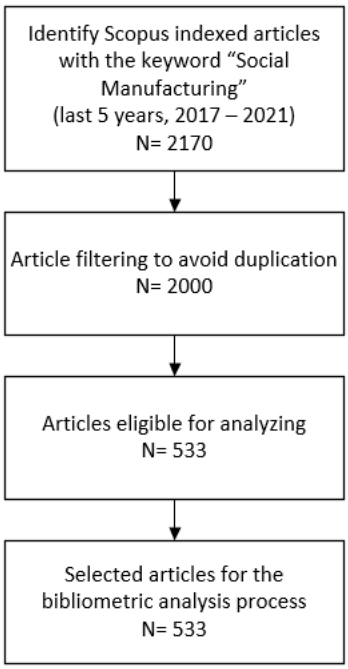

Fig. 2 The data selection process

VOSviewer software-based bibliometric analysis could use data from reputable international journal databases, such as Web of Science, Scopus, Dimensions, PubMed, Crossref, etc. From these bibliometric data sources, the data obtained include the Citation network, Co-authorship network, Co-citation network, Bibliographic coupling, and Co-occurrence network, as presented in Fig. 3.

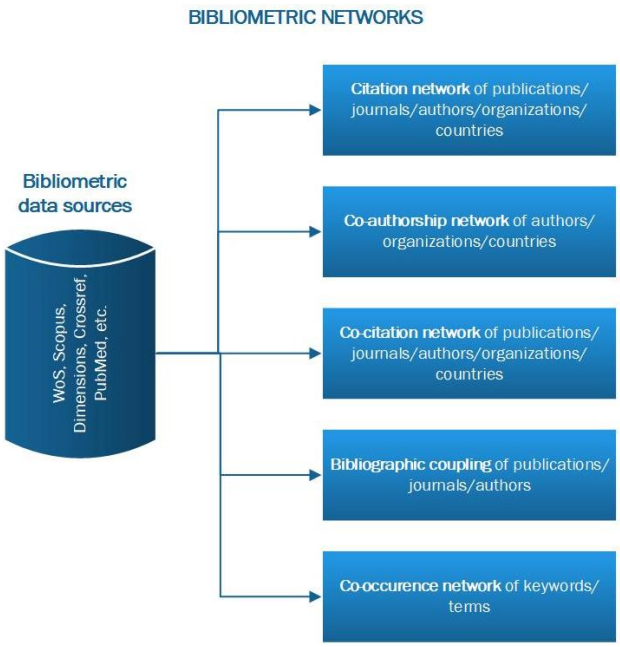

Fig. 3 Bibliographic data sources

For bibliographic data, VOSviewer can perform various analyses. With some modifications, VOSviewer can also be used for other data visualization purposes. The mapping process using VOSviewer software is presented in Figure 3.

Here are some types of analysis in VOSviewer and their functions, as presented in Figure 4.

- Co-authorship analyze the author's collaboration with other authors. The analysis will visualize the results based on the author's name, author's organization, or author's country of origin,
- Co-occurrence displays a visualization of the network between keywords,
- Citation will visualize the observed document. The observed/tested documents will be linked to other (also observed/tested) documents if they cite other similarly observed articles. This analysis is useful for showing citations between documents, and it can also be used to see the author's self-citation,
- Bibliographic Coupling. Articles that are tested/observed will be visualized and networked if they have the same reference. This analysis shows the closeness of the study between the linked documents.

There are several visualization models, the document (observed), the journals, the authors, the organizations, or the countries.

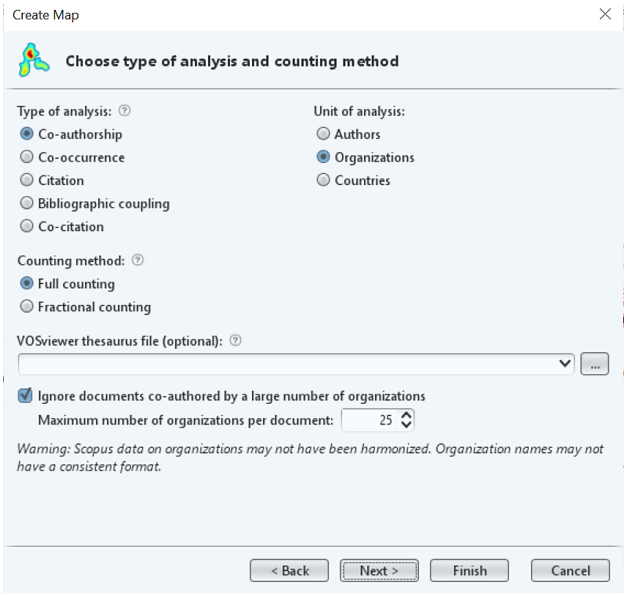

Fig. 4 Create a map on VOSviewer

RESULTS AND DISCUSSION

The total number of data papers from the Scopus database with the keyword social manufacturing, and in the 2017-2021 range is 2170 documents. However, due to the limitations of downloading data in CSV format, the data paper that can be downloaded from Scopus is 2000 documents.

The data paper on social manufacturing from 2017 to 2021 is 2170 documents taken from the Scopus database. The number of papers for that year is shown in Figure 5. In 2021 (533 documents), 2020 (577 documents), 2019 (384 documents), 2018 (347 documents), and 2017 (309 documents).

Fig. 5 Year of Publication

Furthermore, papers on social manufacturing were published in ten groups of publication areas, as presented in Figure 6, which is the Engineering group ranks at the top, meaning that papers on social manufacturing are widely published in engineering journals. In addition to the Engineering area, papers on social manufacturing are also included in other areas, such as Business and Management, Social Sciences, and Mathematics. The least number of papers is in the areas of Physics and Astronomy.

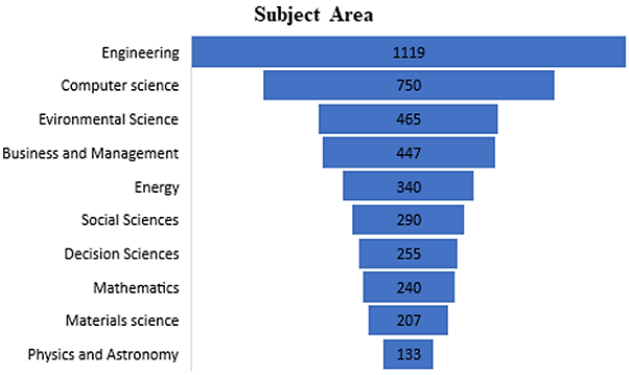

Fig. 6 Subject area

Search papers on social manufacturing from 2017 to 2021 using the keyword "social manufacturing". Descriptive analysis is needed to explore various insights and general characteristics of social manufacturing. This article explores the literature's insights and opportunities by categorizing and analyzing selected articles from January 2017 to September 2021. The selected papers have been organized by year, publisher, journal, country of author, university affiliation, manufacturing industry, research design, and methods used. Based on these studies, this study discusses the development of trends in the social manufacturing system to provide an overview of the social manufacturing system. This review paper also displays a visual graphic that was processed using VOSviewer software.

From 2000 documents, then grouped by the author with the most citations and limited to a minimum of 100 citations. The results of the most citation data are eleven authors, as presented in Table 2, with the most citations is 1640.

In social manufacturing research, each paper has different research methods, one of those methods is through case studies. In this study, the product or object of production from the case study on the social manufacturing system is also mapped, as presented in Table 3.

Then, the document visualization mapping process uses VOSviewer. The data processed is data with Type of analysis: Co-authorship, and Unit of analysis: Authors, the minimum number of a document of an author: 3, the minimum number of citation of an author: 0. Mapping results from VOSviewer, there are 5683 authors who wrote social manufacturing papers, and as many as 308 met the threshold. Then for author and co-authorship connections are 253 authors, which are divided into 18 clusters. The analytical method used in VOSviewer is an analysis based on Association strength. The mapping visualization using VOSviewer is presented in Figure 7.

Table 2
The most citation document

Author(s)	Year of Publication	Title	Source	Cited
Nicola M., et al. [42]	2020	The socio-economic implications of the coronavirus pandemic (COVID-19): A review	International Journal of Surgery	1640
Wang Y.M., et al. [43]	2018	Additively manufactured hierarchical stainless steels with high strength and ductility	Nature Materials	683
Cai H., et al. [44]	2018	A Comprehensive Survey of Graph Embedding: Problems, Techniques, and Applications	IEEE Transactions on Knowledge and Data Engineering	571
Oztemel E. and Gursev S. [45]	2020	Literature review of Industry 4.0 and related technologies	Journal of Intelligent Manufacturing	330
Liu L., et al. [46]	2018	Dislocation network in additive manufactured steel breaks strength–ductility trade-off	Materials Today	277
Tao F., et al. [47]	2017	Advanced manufacturing systems: socialization characteristics and trends	Journal of Intelligent Manufacturing	192
Dubey R., et al. [48]	2019	Can big data and predictive analytics improve social and environmental sustainability?	Technological Forecasting and Social Change	152
Mani V., et al. [49]	2018	Enhancing supply chain performance through supplier social sustainability: An emerging economy perspective	International Journal of Production Economics	146
Tabatabaei M., et al. [50]	2019	Reactor technologies for biodiesel production and processing: A review	Progress in Energy and Combustion Science	115
Helleno A.L., et al. [51]	2017	Integrating sustainability indicators and Lean Manufacturing to assess manufacturing processes: Application case studies in Brazilian industry	Journal of Cleaner Production	104
García de Soto B., et al. [52]	2018	Productivity of digital fabrication in construction: Cost and time nalysis of a robotically built wall	Automation in Construction	101

Table 3
Product mapping from social manufacturing system

Author(s)	Paper Title	Product/Object
Ding, et al., 2018 [21]	RFID-enabled social manufacturing system for inter-enterprise monitoring and dis-patching of integrated production and transportation tasks	Printer Machinary
Shang, et al., 2018 [20]	Social Manufacturing for High-end Apparel Customization	Apparel industry
Hirscher, et al., 2018 [38]	Social manufacturing in the fashion sector: New value creation through alternative design strategies?	Fashion industry
Xiong, et al., 2018 [37]	From Mind to Products: Towards Social Manufacturing and Service	Electrical home appliance
Hamalainen, et al., 2018 [18]	Removing barriers to sustainability research on personal fabrication and social man-ufacturing	Fashion industry
Zhou, et al., 2016 [4]	Social Manufacturing Realizing Personalization Production: A state-of-the-art Re-view	Electrical equipment
Fox and Mubarak, 2017 [30]	Moveable social manufacturing: Making for shared peace and prosperity in fragile regions	Craft production

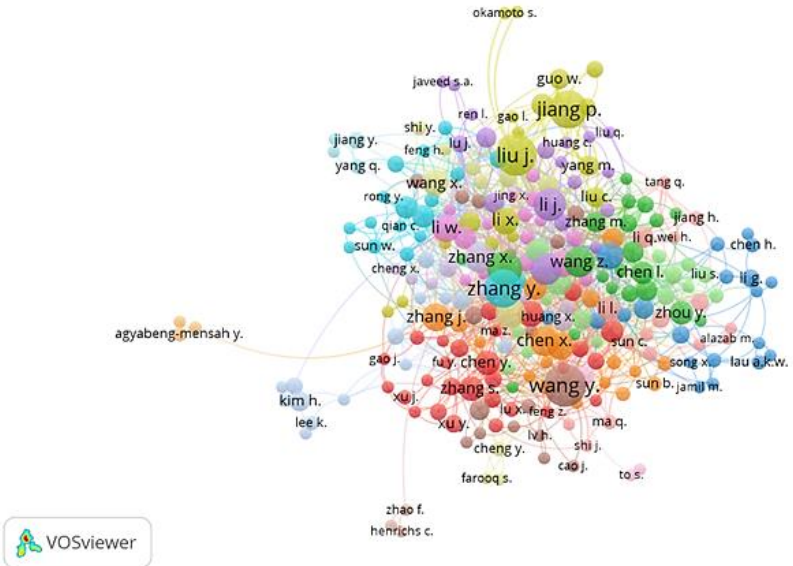

Fig. 7 Co-authorship and author analysis

Total links are 1144, with total link strength is 1335. The maximum number of authors per document: 25. Figure 7 shows that the largest circle is author wang y., with total link strength of 61, citations 174 and number of documents 32. The articles written by Wang include big data on social manufacturing, the performance of SMEs involved in social manufacturing, and the effects of social manufacturing. Then the second is liu j., with a total link strength of 59, citations 176 and the number of documents 29. The articles published by Liu include cyber-physical system connectivity in social manufacturing systems, resources in social manufacturing, smart product personalization, and logistics distribution costs in enterprises. The third is jiang p., with a total link strength of 39, 259 citations and 25 documents, and in this visualization, it is marked with the largest circle. The articles written by Jiang include the architecture and configuration of social manufacturing, social manufacturing fundamentals, manufacturing paradigm, and block-chain processes in social manufacturing. For other data, the number of documents is less than 25. Then, for the next analysis, the type of analysis from the co-authorship group and the unit of analysis from the countries group is presented in Figure 8. Minimum of documents of a country: 1 and minimum number of citations of a country: 0. The mapping results on VOSviewer show 146 countries, and the largest set of connected items consists of 103 items and is divided into 20 clusters. There are 532 total links with 1074 total link strengths. The three countries with the highest number of documents and citations are China, United States, and United Kingdom. China has 592 documents and 4388 citations, with 225 total link strengths. The United States has 328 documents and 4501 citations, with 201 total link strength. The United Kingdom has 157 documents and 3952 citations, with 173 total link strengths. The results of the analysis for co-authors and organizations are presented in Figure 9. Scopus data on the organization may not have been harmonized, and organization names may not have a consistent format.

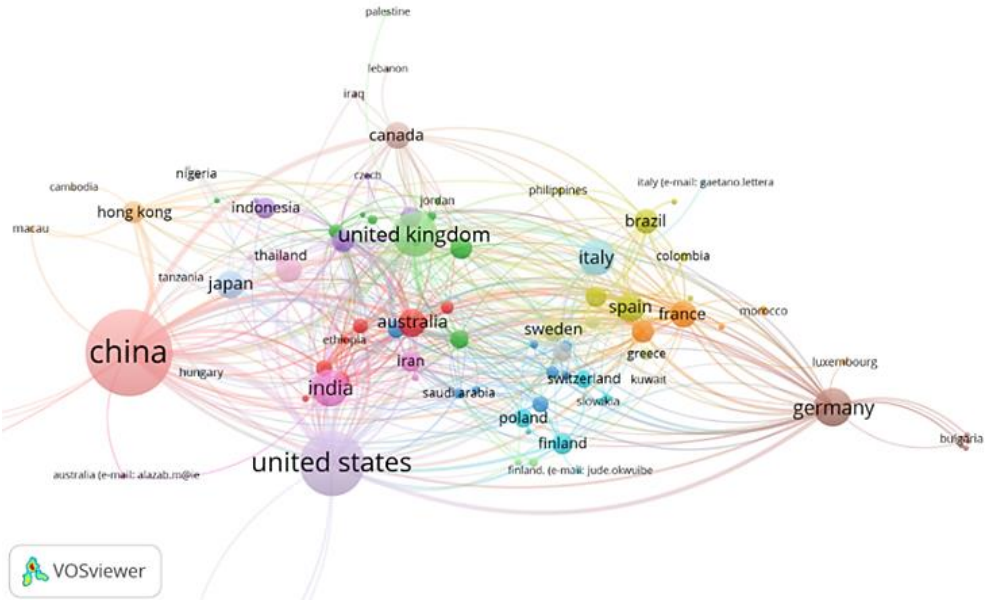

Fig. 8 Co-authorship and countries analysis

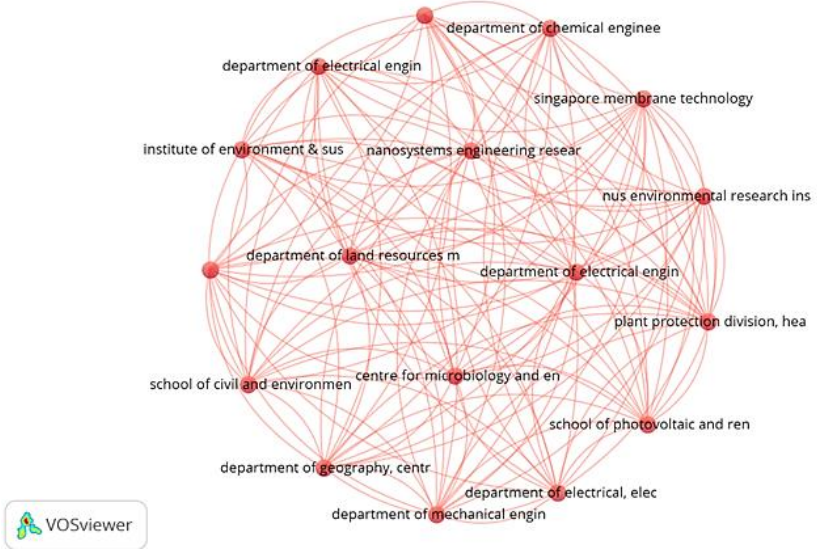

Fig. 9 Co-author and organization analysis

Minimum number of documents of an org:1, minimum number of citations of an organization: 0. The results show that 4236 organization meets the threshold. For mapping, the number of organizations to be selected: 1000. The largest set of connected items consists of 17 items and is divided into one cluster only, with 136 links. Organizations that have more documents than others are inafosservatorio, school of mechanical engineering, school of information engineering, each has three documents, while other organizations, on average, have less than three documents.

The next analysis is the citation group and authors, as shown in Figure 10. Type of analysis: Citation and Unit of analysis: authors, then set the minimum number of documents of an author: 2, a minimum number of citations of an author: 0. Results The mapping shows there are 5683 authors, and 728 authors meet the threshold. The three authors who have the highest total link strength are jiang p., liu j., and liu c., and in this visualization, it is marked with the largest circle. Jiang p. has 25 documents, 259 citations with a total link strength of 140. Liu j. has 29 documents, 176 citations, with a total link strength of 55. Liu c. has seven documents, 66 citations, with a total link strength of 53. The largest set of connected items consists of 212 items, which are divided into 15 clusters. The total number of links in this analysis is 943, with 1196 total link strengths.

Bibliometric analysis of the citations and sources groups is presented in Figure 11.

Type of analysis: Citation and Unit of analysis: Sources, then setting the minimum number of documents of a source: 1, and the minimum number of citations of a source: 0. The mapping results show there are 888 sources, and those 888 sources meet the threshold. For each of the 888 sources, the total strength of the citation links with other sources will be calculated, and the sources with the greatest total link strength were selected. The total link in this group is 190, with 232 total link strengths. The verification process for selected sources shows three sources with the highest total link strength, namely the journal of cleaner production, sustainability (Switzerland), and the journal of intelligent manufacturing. In this visualization, it is marked with the largest circle.

The Journal of Cleaner Production has 82 documents, 1684 citations, with 68 total link strengths. Sustainability (Switzerland) has 83 documents, 754 citations, with 23 total link strengths. The Journal of Intelligent Manufacturing has eight documents, 632 citations, with 22 total link strengths. For other sources, the total link strength is below 22. The largest set of connected items consists of 115 items and is divided into 23 clusters. Mapping results for Type of analysis: Co-citation and Unit of analysis: Authors are presented in Figure 12. They were setting the minimum number of citations of an author: 10. From the mapping process results, there were 115649 authors, and 2969 authors met the threshold.

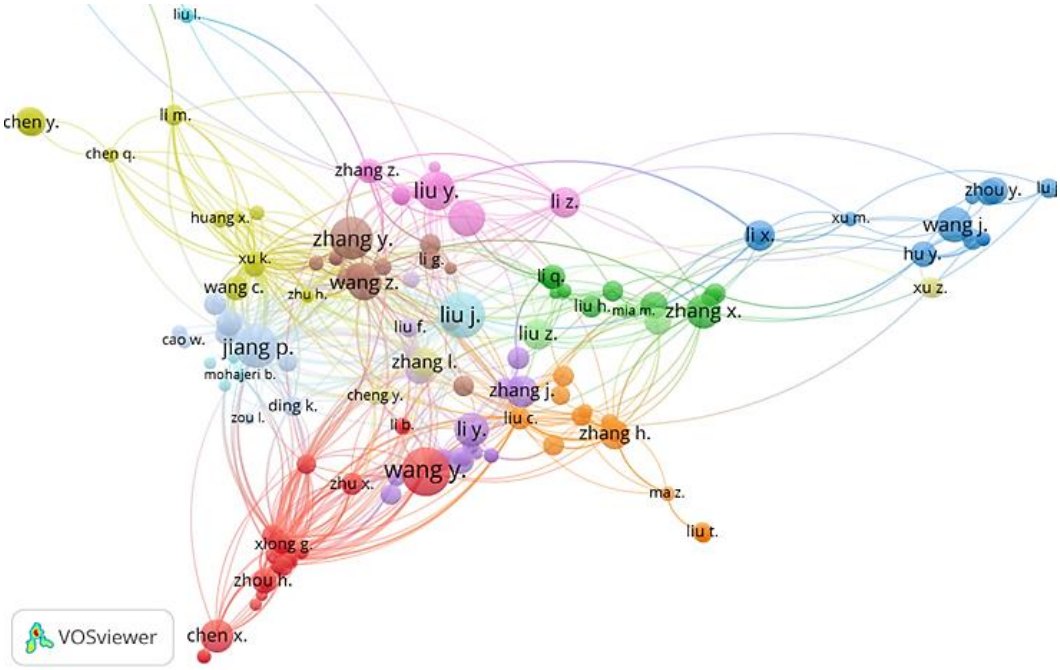

Fig. 10 Citation groups and authors analysis

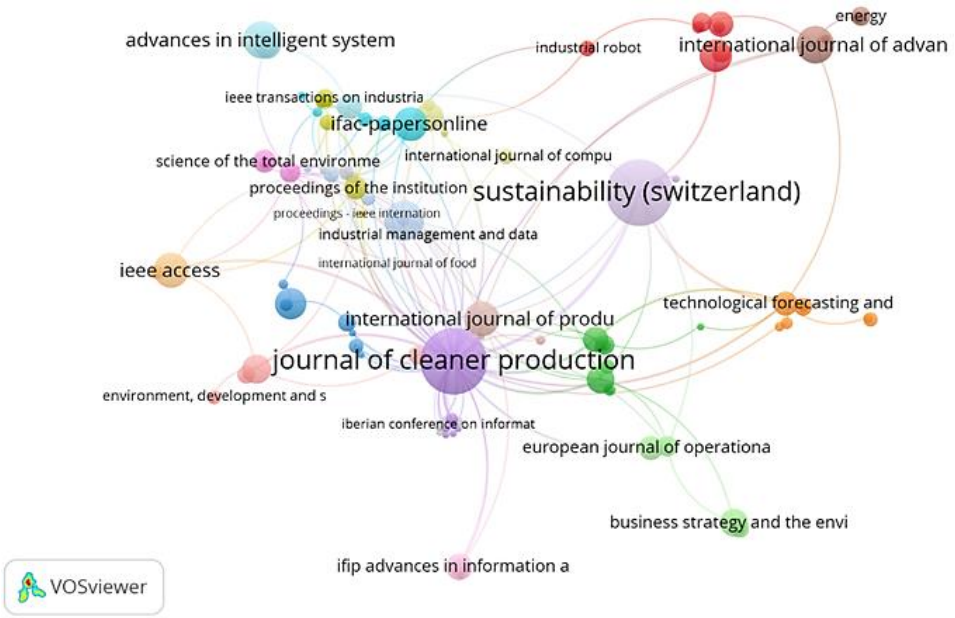

Fig. 11 Citations and sources groups analysis

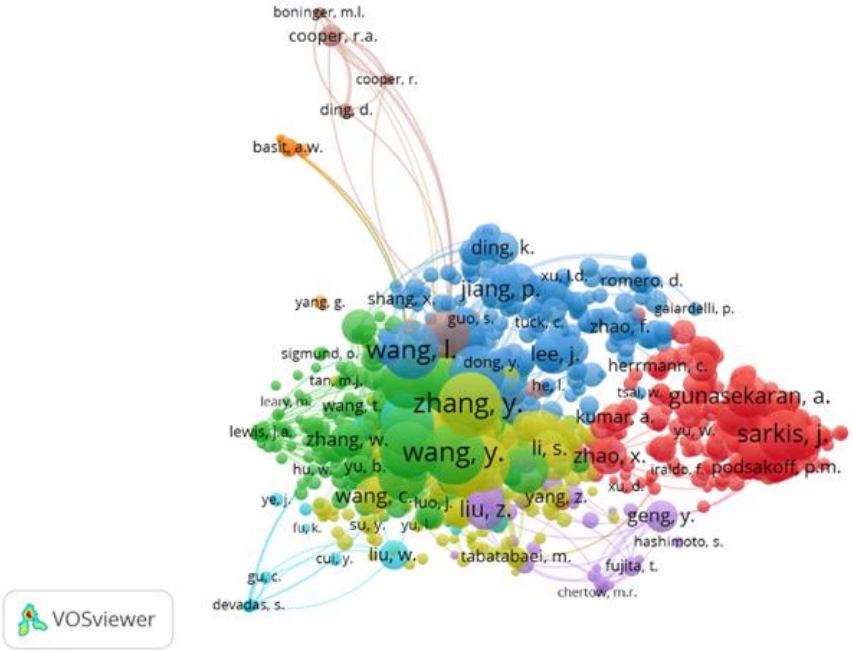

Fig. 12 Co-citation and unit analysis

The number of authors to be selected is limited to 1000. In verifying selected items, there are three authors with the highest total link strength, namely liu, y., zhang, y., and wang, y., and in this visualization, it is marked with the largest circle. Liu, y. has 411 citations with a total link strength of 44788. Zhang, y. has 435 citations, with a total link strength of 40716. Wang, y. had 413 citations, with a total link strength of 40496. The other authors had citations less than 400 and a total link strength below 40000. Then from the 1000 citation items processed, they were divided into 8 clusters, with total links of 280032 and total link strength of 1996024.The development of papers on social manufacturing that have been published in various journals has increased rapidly. This is shown by the number of papers on social manufacturing, which increases significantly every year. The paper's widely raised themes include the social manufacturing system, the cyber-physical system that exists in social manufacturing, and what products can be produced through the social manufacturing system. Mapping the theme of this paper will be very helpful for researchers who will research social manufacturing. Furthermore, the papers were bibliometrically analyzed using VOSviewer.

VOSviewer creates a map based on a co-occurrence matrix. Map construction is a process that consists of three stages. The similarity matrix is calculated based on the co-occurrence matrix in the first stage. In the second stage, the map is constructed by applying the VOS mapping technique to the similarity matrix. And in the third stage, the map begins to be decoded and reflected.

Visualization of the systematic literature review has been done using the VOSviewer software. Other studies using VOSviewer include [53, 54, 55, 56] with different types of analysis, which also displays the results of a visual review,

including data from authors, countries, organizations and the number of citations. The results of this study using the bibliometric analysis with VOSviewer show a mapping of social manufacturing research, including the authors, the number of citations, the author's country and groups analysis.

Most of the papers on social manufacturing were written by authors from China, with a minimum of 5 papers for each author. In addition, these papers have also been cited by many authors in various countries. Related to the country, China produces the most research on social manufacturing, followed by the United States and the United Kingdom. In China, the development of the social manufacturing system is growing rapidly, which could see from studies on social manufacturing with case studies on small, medium, and large industries involved in social manufacturing.

CONCLUSION

Visual exploration of systematic literature review has been carried out using VOSviewer software. Document search using the Scopus database, with the keyword "social manufacturing", from 2017 to 2021. The data is limited to the last five years be-cause the paper is considered the most up-to-date. When searching for documents using the keyword social manufacturing, there are 2170 data papers, but 2000 data papers can be downloaded in CSV format. Then, from 2000 papers, it was filtered to 533 papers. So that can be processed using VOSviewer as many as 533 papers. There are three papers with the most citations, and the types of documents are review papers [42, 45, 50]. Types of analysis that have been processed include co-authorship (authors, organizations, countries), citations (authors), and co-citations (sources, cited authors). This research still has limitations. Namely, the database used is the Scopus database only, so for further research, it can be added with other sources, such as Web of Science, PubMed, Crossref, etc., so there are still opportunities to use other research methods, such as using more databases (Scopus, WoS, and so on). In addition, there are still many visualization results using VOSviewer software that can be explored further, such as the type of analysis citation-document, citation-organization, and bibliographic coupling, which have not been discussed in this study. Another research opportunity that can be done is a systematic literature review using methods other than bibliometric analysis or other software. Other software that can be used to visualize bibliometric analysis include HistCit, BibExcel, Pajek, Sci2, Cytoscape, and Gephy.

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