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Analyzing the Price Strategy of Closed-Loop Supply Chain, Carbon Emission Policy and Game Theory Perspective: A Systematic and Bibliometric Review

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Abstract

This paper presents a systematic and bibliometric review of a closed-loop supply chain pricing strategy focusing on the perspective of carbon emission and game theory. A pricing strategy is a model to establish the best price for a product or service to maximize profits while considering consumer and market demand. In this review, carbon emission and game theory are used to reflect the economic and environmental relationship. Price strategy in a closed-loop supply chain is quite complex due to its specific operations involving collection, reuse, recycle, refurbish, repair and or recondition. Using bibliometric data of 165 research articles from Scopus database between year 2010 until 2022, the outcomes are visualized using VOSviewer. The bibliometric analysis was carried out on trends, rankings, authors, countries, universities, citations, and network visualizations. The content analysis is being done to find out the research purpose, carbon emission policy, type of game, condition, and environmental policy of the research. The result shown that this research area has kept growing, especially in the last five years. Journal of Cleaner Production is the leading journal in this field. China is the country that has the highest contribution with the most affiliations of the author referring to Shanghai Maritime University. Most of the research investigates how to minimize cost, reduce carbon emission and maximize profit by using Stackelberg and Nash game in deterministic conditions. Remanufacturing is the highest environmental policy used by researchers. This paper provides a comprehensive bibliometric analysis of pricing strategy considering CLCS and Game Theory perspectives. It will contribute to academics and professional's determining pricing strategies and future research directions.

Keywords
Bibliometric Review; Pricing Strategy; Carbon Emission; Closed Loop Supply Chain; Game Theory

1. Introduction
Global warming and climate change are the main effects of greenhouse gases, particularly carbon dioxide (Lee and Tang, 2018; Gopalakrishnan et al., 2021). Numerous efforts, for example, Conference of Parties (COP), the Kyoto Protocol and the Paris Agreement have been made to establish carbon emission mitigation policies (Van Wassenhove, 2019; Dev et al., 2020). Carbon emission regulations, carbon taxes and carbon limits (carbon caps, carbon caps and trade or carbon offsets) are applied to increase public and corporate awareness about the destructive effects of carbon emissions (Taleizadeh, Shahriari et al., 2021).

Carbon emission sources are transportation, electricity production, industry, commercial, residential and agricultural. The manufacturing industry produces raw materials and goods that we use for daily life contributes significantly to carbon emissions. There are two types of carbon emission from the industrial sector; direct emissions that occur during production and indirect emissions in connection with electricity used for the production facility. In the United States, the manufacturing industry is responsible for 23% of carbon emissions, while in Indonesia, the industrial sector contributes 28% of releasing carbon emissions (Environmental Protection Agency).

Many countries are starting to adopt and enforce carbon emission policies through the supply chain and circular economy approaches. Closed Loop Supply Chain (CLSC) refers to a supply chain with forward logistics for material procurement, production, distribution and reverse logistics to collect, process and return products and/or parts of products to restore the value of sustainable products (Mavi et al., 2017; Batista et al., 2018). By implementing CLSC,

industries are able to redesign their network and collect used products to reduce carbon emissions, save more resources and increase profits (F. Zhang and Wang, 2018; R. Luo et al., 2022). Public and corporate awareness about the harmful and destructive effects of carbon emissions is increasing. Consumers in China with higher education choose low-carbon products (Xia et al., 2011; Xu and Wang, 2018) and consumer in the United States is willing to pay more and consider purchasing from companies that have good social responsibility (BBMG conscious consumer report).

Price strategy in CLSC is more complex because of specific stages such as collecting used products, removing components, cleaning, repairing and reassembling. The method of collection is important because it will involve demand and profits. Quality of collection will affect the reduction of production costs (Taleizadeh et al., 2019b). Game theory is used to determine the optimal price strategy in various formulated CLCS models with different scenarios such as centralized, decentralized and Stackelberg Games (Xu and Wang, 2018; N. Wang et al., 2019; Taleizadeh, Niaki, et al., 2021a).

The purpose of this paper is to present a systematic and bibliometric review of the pricing strategy of closed-loop supply chain focusing on carbon emission and game theory perspective. Several systematic literature reviews and bibliometrics in CLSC, for example, Shekarian and Flapper, 2021, concentrate on the structure of supply chain network and Chakraborty et al., 2021, focus on pricing in remanufacturing conditions. Further this research conducts a comprehensive bibliometric analysis of pricing strategy considering CLCS and Game Theory perspectives that may not establish yet. The purpose of the research to do bibliometric analysis on trends, rankings, authors, countries, universities, citations, network visualization and content analysis to find out the purpose, carbon emission policy, type of game theory, condition and environmental policy of the research. The result of this research to bring insight for academics and professionals to determine the pricing strategies and provide potential direction for future research.

2. Methodology

The bibliometric review was conducted on July 30, 2022, through four stages; keyword filtering, source type filtering, language filtering and subject area filtering as shown in Fig 1. Search and filtering strategies for bibliometric reviews. This research uses data sources from Scopus. Scopus is a database of abstracts and citations consist of curated scientific content for approximately 27 million published records (1966-2004) during its launch. The Scopus database is one of the largest curated databases of bibliographic abstracts and citations to date, around 3 million new items are added every year (Baas et al., 2020). Scopus was chosen because it is the most recommended database for conducting high quality and comprehensive bibliometric analysis (Baas et al., 2020; Paul et al., 2021; Donthu et al., 2021). In this bibliometric review, stage 1 to do the keyword filtering, four keywords of research were determined, “close loop supply chain”, “carbon emission”, “pricing” and “game theory” as shown in Table 1.

Table 1. Bibliometric review keywords

No	Topic	Keyword	Result
1	Close loop supply chain	"supply chain*" or "closed loop*" or "green supply chain*" or "remanufacture*" or "reverse*" or "collection*" or "reuse*" or "recycle*" or "refurbish*" or " repairing*" or " reconditioning*"	2,632,860
2	Carbon emission	"carbon*" or "emission*" or "CO2"	136,297
3	Pricing	"price*" or "pricing*" or “policy*" or “decision*" or “strategy*"	8,827
4	Game theory	"game theory*"	212

The first keyword search on Scopus resulted 2,628,492. Then combined with the word “and” so that the keywords written on Scopus become "supply chain*" OR "closed loop*" OR "green supply chain*" OR "remanufacture*" OR "reverse*" OR "collection*" AND " carbon*" OR "emission*" OR "CO2" yields 136,024. Then recombine the third keyword so that the scope is written "supply chain*" OR "closed loop*" OR "green supply chain*" OR "remanufacture*" OR "reverse*" OR "collection*" AND "carbon*" OR " emission*" OR "CO2" AND "Price*" OR "pricing*" OR "policy*" OR “decision*" OR “strategy*" which yields 8,795. Then combine it with the fourth keyword by writing on the scope, namely "supply chain*" OR "closed loop*" OR "green supply chain*" OR "remanufacture*" OR "reverse*" OR "collection*" AND "carbon*" OR "emission*" OR "CO2" AND "Price*" OR "pricing*" OR "policy*" AND "game theory*" and resulted 212 search results.

The second stage is source type filtering, where at this stage, filtering is carried out on the type source of the document. The types of papers filtered were journal and conference proceeding with 200 publications. The third stage is language screening, where the language chosen is English. By limiting language restriction, 185 publications were obtained. The fourth stage is subject area filtering. In this stage subject areas selected are Engineering, Environmental Science, Energy, Business, Management and Accounting, Computer Science, Mathematics, Social Science, Decision Science, Economics, Econometrics and Finance and Multidisciplinary. Limited subject areas are Medicine, Materials Science, Earth and Planetary Sciences, Chemical Engineering, Agricultural and Biological Sciences, Chemistry and Psychology. In this stage resulted in total 165 publications (Figure 1).

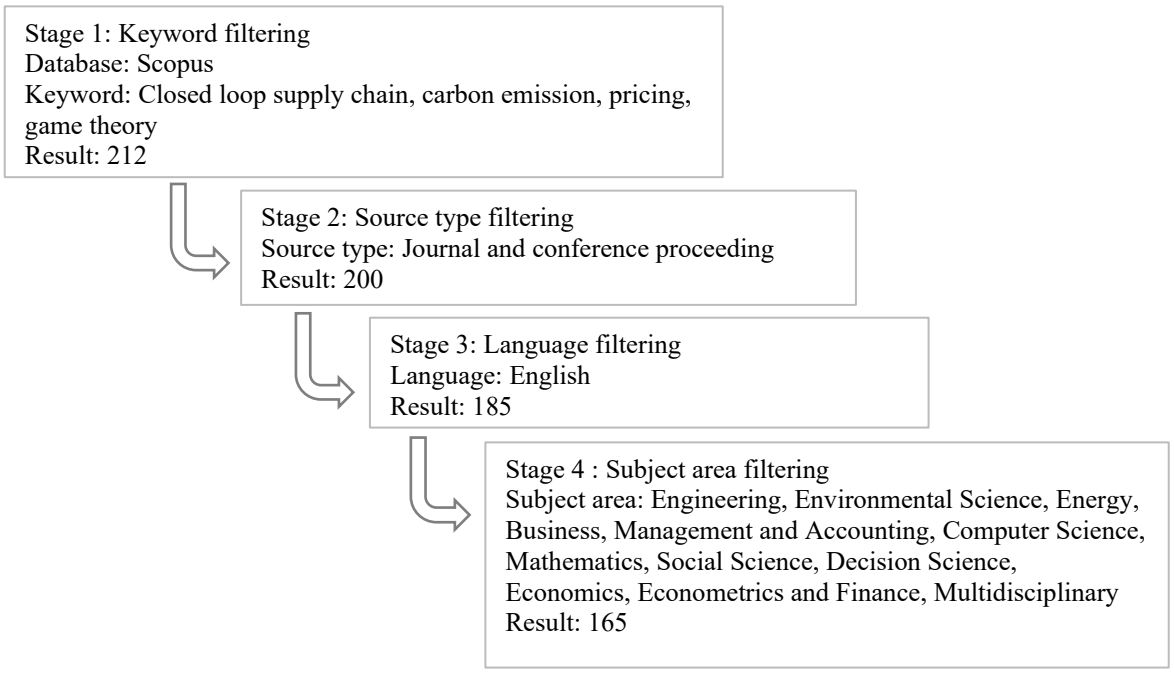

Figure 1. Search and Screening Strategies for Bibliometric Reviews

3. Results and Discussion

Analysis of the bibliometric literature review was carried out on 165 literatures that had been previously obtained from the search and filtering results from the Scopus database. Analysis was carried out on trends, rankings, authors, countries, universities, citations of publications, keywords, research purpose, carbon emission policy, type of game theory, condition and environmental policy used. VOSviewer is used to visualize the bibliometric library review. VOSviewer was chosen because it is easy to use, editable and can be run with various data source formats. The bibliometric literature review analysis strategy is presented in Figure 2.

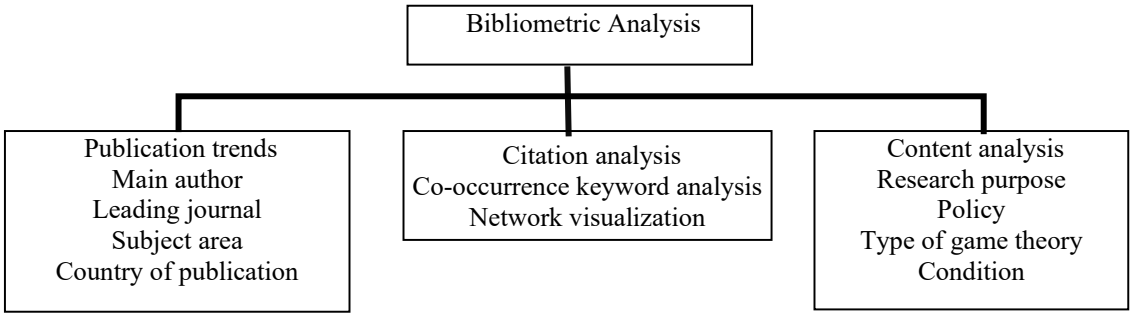

Figure 2. Analysis strategy of bibliometric review

The first analysis to find out the trend of research topics from year to year. Fig 3 present publication growth from year 2010-2022. The graph shown that research topics has increased rapidly from year to year, reach its highest number in year 2021 with 33 articles. Added a trendline with slope $y=0.34774x^2-1.6034x+2.5909$, predicted by end of the year 2022 there will be 40 articles and by year 2023 there will be 48 articles.

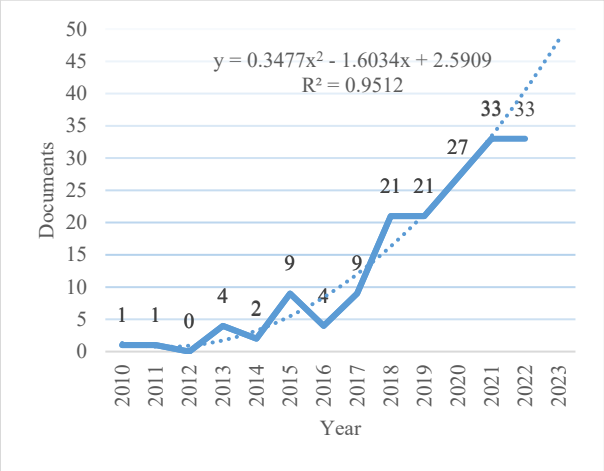

Figure 3. Publications Trends

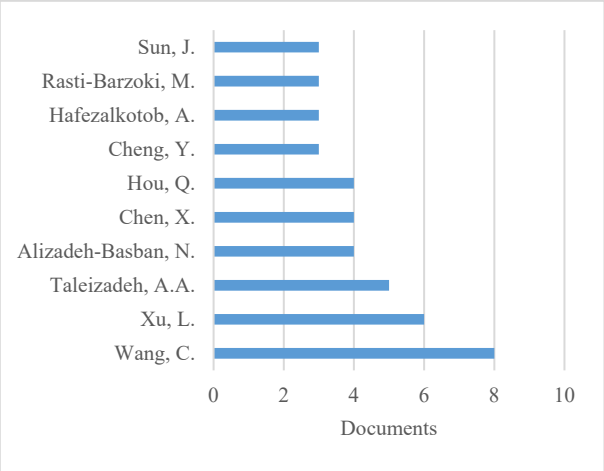

Figure 4. Main Authors

The second analysis as shown in Figures 3 and 4 about research author. The main authors with the most contributions to the research topic are Wang, C. with 8 documents, Xu, L with 6 documents and Taleizadeh, A.A with 5 papers. The following analysis is to group the documents into the journals that published the 165 publications. Figure 5 shown the top 10 journals that actively publish articles with its ranking. H-indexes and journal ranking are obtained from SJR (Scimago Journal and Country Rank). The top three most active journals are the Journal of Cleaner Production (15%), Sustainability Switzerland (12%) and Computers And Industrial Engineering (6%).

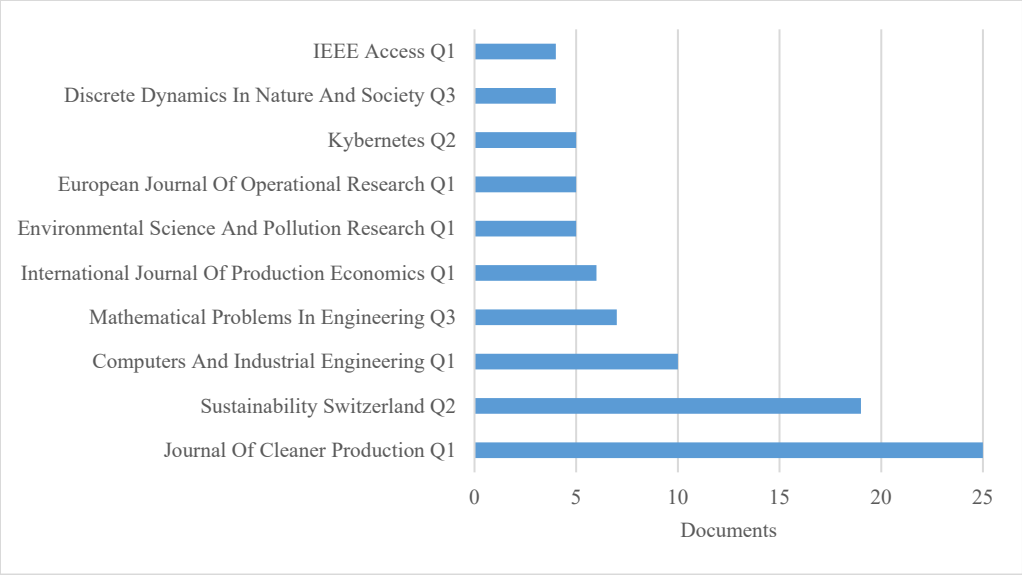

Figure 5. The top ten leading journals

The fourth analysis to group the publication into its subject area. Fig 6 shown that the top three subject areas are Engineering with 94 journals, Environmental Science with 71 journals and Energy with 55 journals. Next analysis is to categorize into country or territory. Fig 7 shown China is the most country that has the highest contribution with 166 papers, followed by Iran and United Stated with 19 documents each.

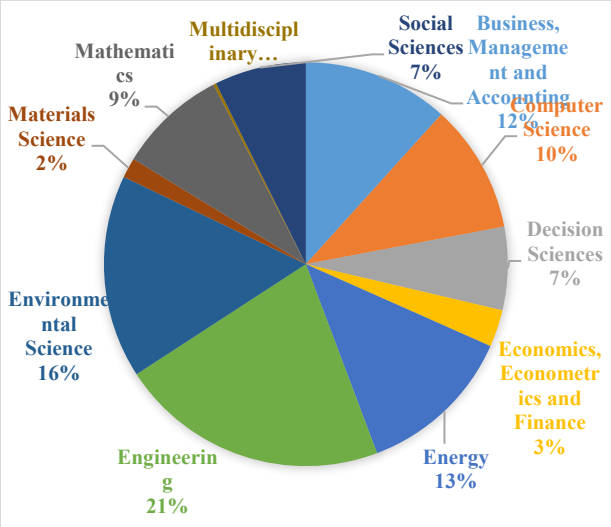

Figure 6. Subject Area

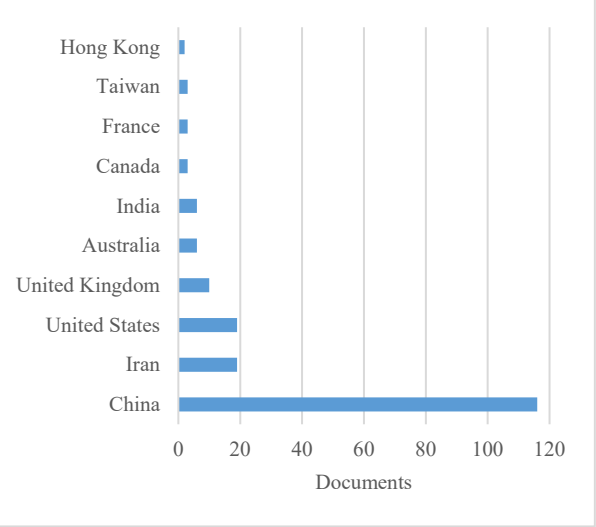

Figure 7. By Country

Figure 6-8 shown the most affiliations of author referring to Shanghai Maritime University with total nine publications, followed by the University of Electronic Science and Technology of China, Islamic Azad University, Sichuan University, Tianjin University, Bristol and Tehran University with five journals each.

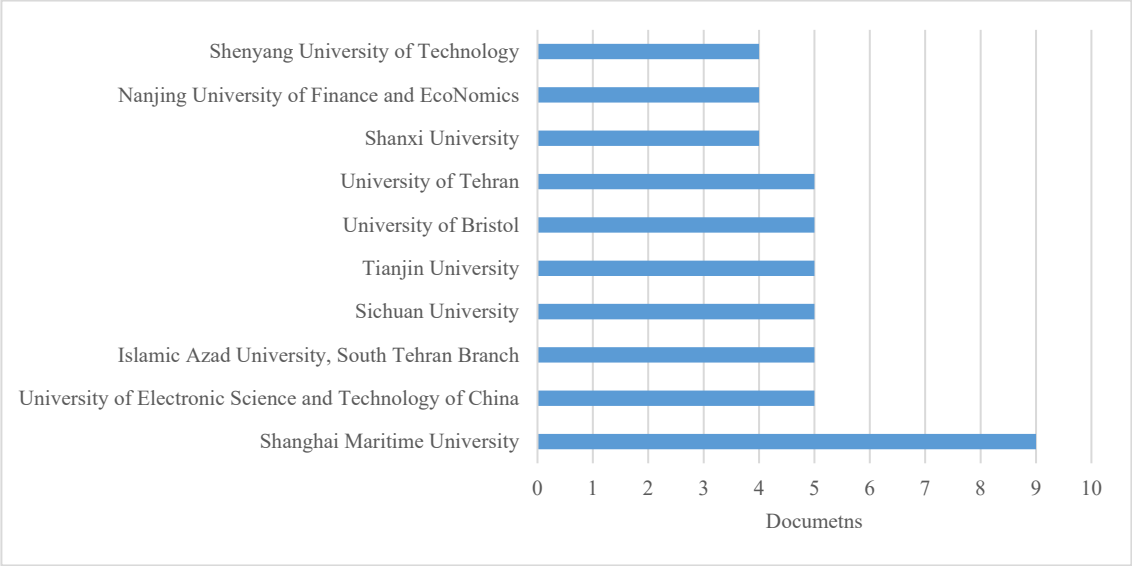

Figure 8. Affiliations of author

The seventh analysis to find the publications with the most citations is described in Table 2. The research entitled "Supply chain analysis under green sensitive consumer demand and cost sharing contract" received the highest citation with a total of 427. Table 2 also presented the name of the author, year and source of publication.

Table 2. Bibliometric review keywords

No	Title	Year	Authors	Source	Cited
1	Supply chain analysis under green sensitive consumer demand and cost sharing contract	2015	Ghosh D., Shah J.	International Journal of Production Economics	427
2	Game-theoretic analysis for an emission-dependent supply chain in a 'cap-and-trade' system	2015	Du S., Ma F., Fu Z., Zhu L., Zhang J.	Annals of Operations Research	176
3	Pricing and carbon emission reduction decisions in supply chains with vertical and horizontal cooperation	2017	Yang L., Zhang Q., Ji J.	International Journal of Production Economics	173
4	Manufacturer and retailer coordination for environmental and economic competitiveness: A power perspective	2017	Chen X., Wang X., Chan H.K.	Transportation Research Part E: Logistics and Transportation Review	135
5	Game-theoretical analysis for supply chain with consumer preference to low carbon	2015	Du S., Zhu J., Jiao H., Ye W.	International Journal of Production Research	134
6	Decision and coordination in the dual-channel supply chain considering cap-and-trade regulation	2018	Xu L., Wang C., Zhao J.	Journal of Cleaner Production	112
7	Sustainable manufacturing in a closed-loop supply chain considering emission reduction and remanufacturing	2018	Xu L., Wang C.	Resources, Conservation and Recycling	101
8	Sustainable supply chains under government intervention with a real-world case study: An evolutionary game theoretic approach	2018	Mahmoudi R., Rasti-Barzoki M.	Computers and Industrial Engineering	98

No	Title	Year	Authors	Source	Cited
9	Sustainable pricing and production policies for two competing firms with carbon emissions tax	2015	Chen X., Hao G.	International Journal of Production Research	91
10	Research on low-carbon strategies in supply chain with environmental regulations based on differential game	2018	Zu Y., Chen L., Fan Y.	Journal of Cleaner Production	82

The keywords in the Scopus metadata were then analyzed using the Vosviewer software as shown in Fig 9. Keywords that appear frequently shown as a large circle size. The larger the circle, the more often these keywords appear. Based on the results of the analysis, it was found 1,182 keywords. Further there are 91 keywords with minimum five times mentioned. It was grouped into four cluster from the main keywords, namely "supply chain", found 1,182 keywords, further there are 91 keywords with minimum five times. It was grouped into four clusters from the main keywords, namely "supply chain", "game theory", "cost", and "carbon emission" with consecutive circle colors, red, green, blue and yellow

Next analysis was carried out to map the year of the publications by using the Vosviewer as shown in Fig 10. Keywords related to the year of research are described in terms of color degradation from purple to yellow. The purple color indicates the oldest year and the yellow color indicates the newest year. This analysis to see whether the research topic is included in the cluster is still being studied (Figure 9-10).

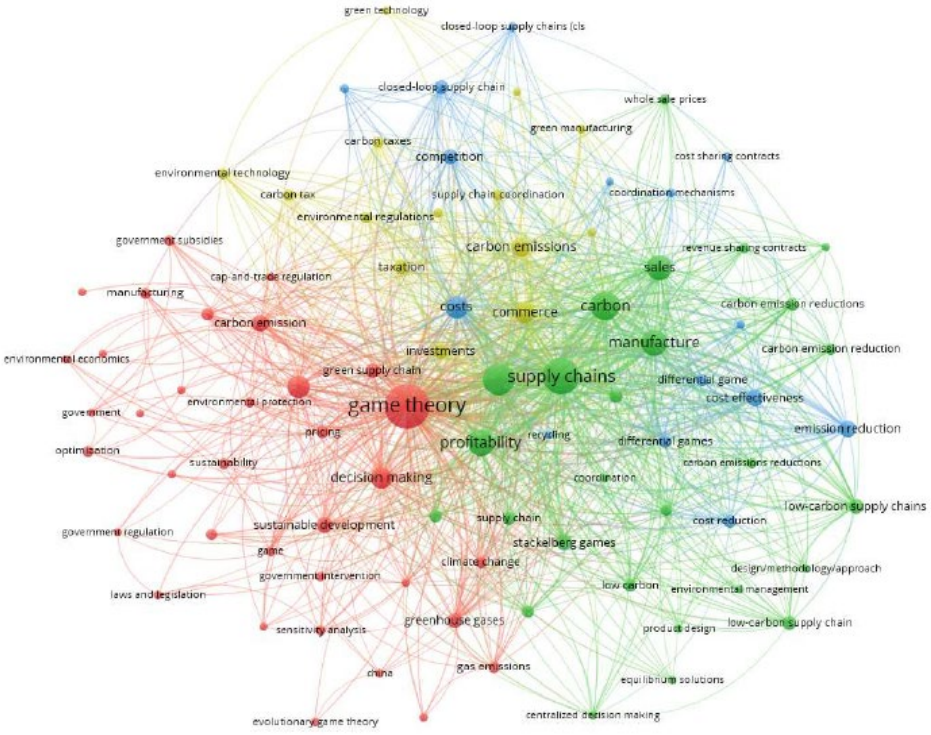

Figure 9. Keyword network visualization using Vosviewer

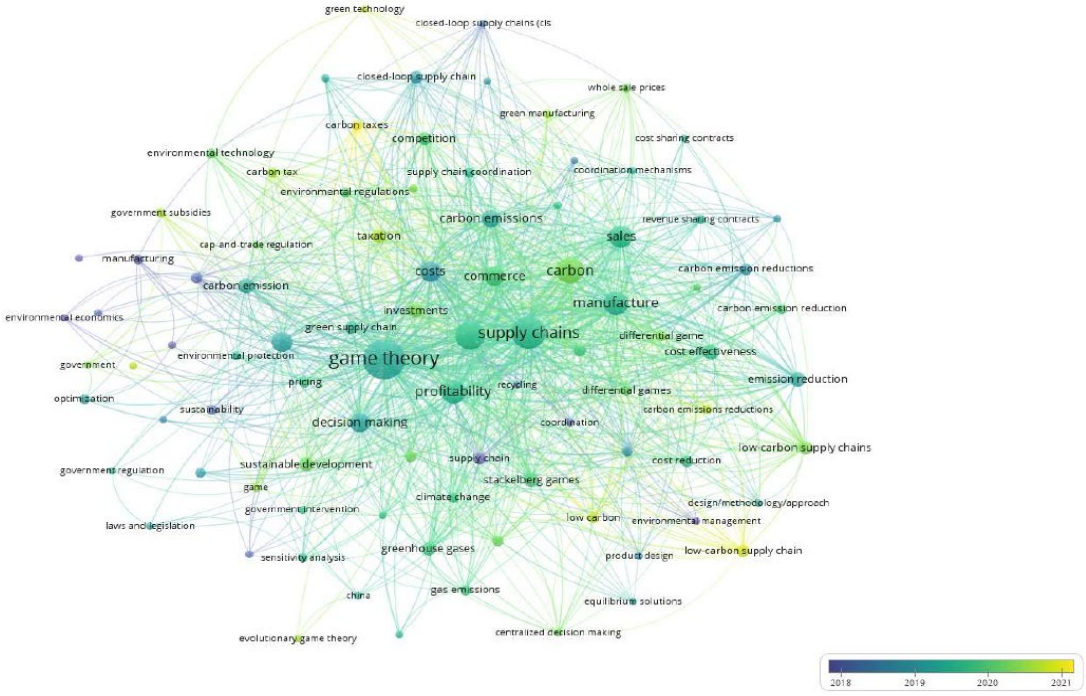

Figure 10. Keyword network visualization based on research years using Vosviewer

The tenth analysis is presented in Figure 11 to show the relationship between co-authors within the research topic. From 356 authors, there are 81 authors with a minimum 2 number of documents. Top author Wang, C and Xu, L shown with the largest blue circle and blue light color. Figure 11 also shown some authors who is not linked.

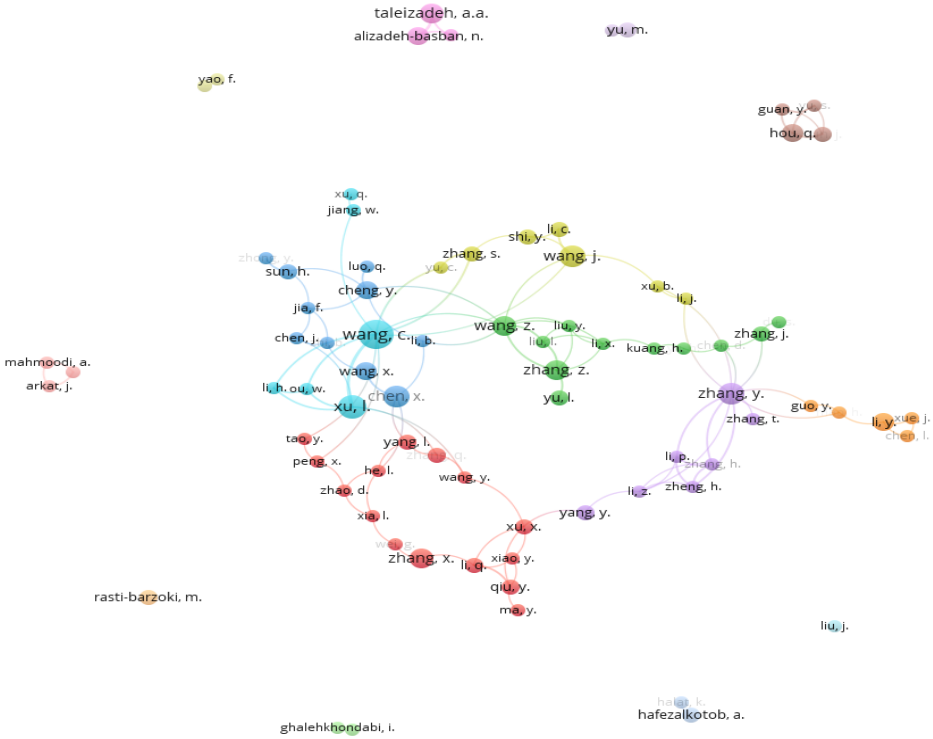

Figure 11. Author network visualization using Vosviewer

The next analysis presents in Figure 12, with regards to the purpose of publication, 38% of the research is to minimize cost, 17% to reduce carbon emission and 14% to maximize profit. Figure 13 shown the policy that use in the journal, most journal concentrate on carbon sensitivity for 36% and carbon cap-and-trade policy for 27%, the remaining documents mention carbon tax.

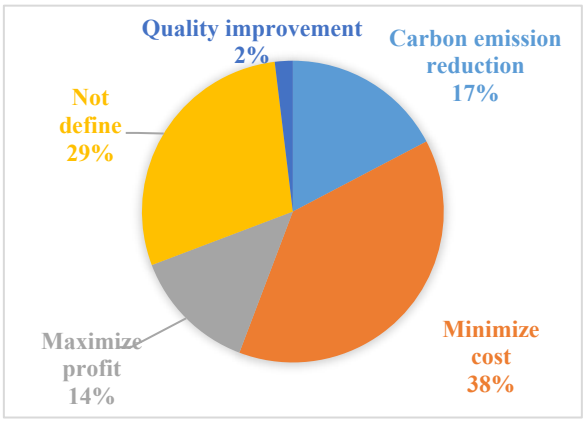

Figure 12. Purpose of Research

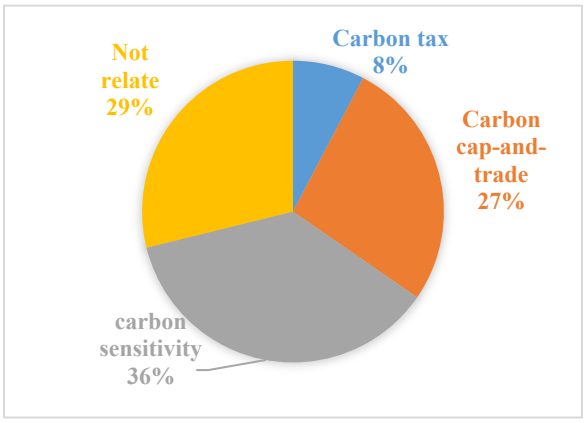

Figure 13. Carbon policy

The most type of Game theory method is described in Figure 14-16 where 34% using Stackelberg Games, 17% use both Stackelberg and Nash game, followed by Evolutionary Games and Nash Equilibrium. The condition in the research was mostly deterministic for 56% and only 6% in stochastic or uncertainty conditions.

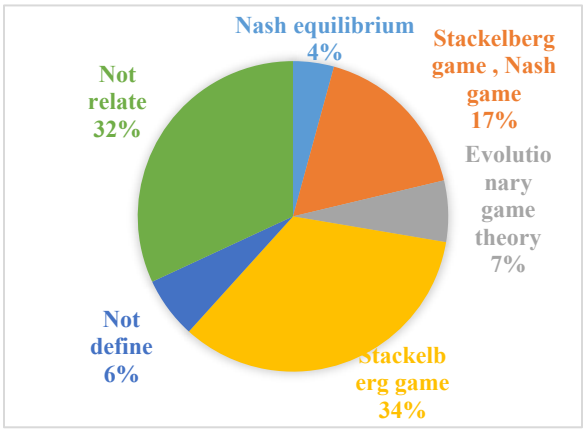

Figure 14. Type of Game Theory

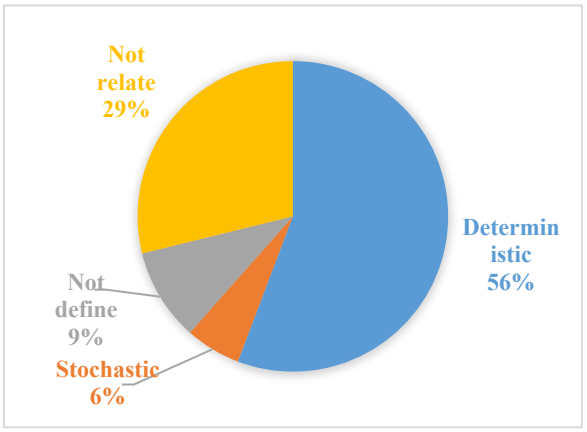

Figure 15. Condition

The most policy used in the research described in ig 16 is remanufacturing for 17% and follow by Refurbish/reuse policy for 2%. Surprisingly other policy such us reuse is not mention in the publication.

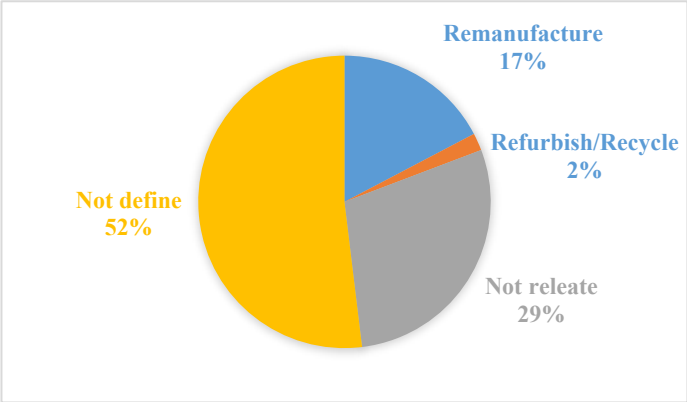

Figure 16. Environmental Policy

4. Conclusion

There are several systematic literature reviews in connection with supply chain and carbon mitigation, Shekarian and Flapper focus on the structure of supply chain network, Chakraborty investigates the pricing in remanufacturing and Zhou et al who concentrate on carbon tax. This research can fill the gap to present a systematic and bibliometric review focusing on the pricing strategy of closed-loop supply chain using the perspective of carbon emission and game theory. The bibliometric analysis was carried out on trends, rankings, authors, countries, universities, citation and network visualization. The content analysis is being done to find out the purpose, carbon emission policy, type of game theory, condition and environmental policy of the research. The result shown that this research area keeps growing especially in the last five years. It is found that the topic of closed loop supply chain and carbon mitigation policy is quite rich however it is not many in the game theory perspective especially in stochastic conditions. Thus, we encourage future studies in this area. We also observe that most environmental policy used is remanufacturing, there is not much research in the area of recycle, refurbish and reuse. We believe it will also be interesting to explore the pricing strategy in this policy.

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