



Environmental Knowledge and Green Consumption:

A Scientometric Analysis Using CiteSpace

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ABSTRACT The interaction between environmental knowledge and green consumption has been one of the central research domains in the field of sustainable consumption recently. Using a scientometrics analysis of 1,014 academic literature on environmental knowledge and green consumption between 2000 and 2022, this study characterizes knowledge mapping by recognizing and depicting the progression of cooperative networks, co-citation networks, and emerging trends to understand the research directions and trends that have emerged over the past 22 years worldwide. The findings reveal a sharp rise in the number of publications in the area and a trend toward more multidisciplinary research subjects. China, the United States, Malaysia, the United Kingdom, and India are the countries with the most prolific writers and academic institutions in this field. The impact of environmental knowledge on green consumption and the attitudinal behaviour gap, as well as environmental knowledge and other determinants of green consumption, are among the most popular topics in the literature that is currently available on this subject.

Keywords: Environmental Knowledge, Green Consumption, Scientometric, CiteSpace

1. INTRODUCTION

Unsustainable patterns of consumption have been identified as the main driver of environmental deterioration (Akenji & Bengtsson, 2014), and they contribute to a number of environmental issues. Green consumption is considered as the sustainable consumption that effectively reduces negative environmental effects without sacrificing consumption quality or quantity (Liobikienė & Bernatoniene, 2017). Green consumption as a consumer practice is driven by environmental knowledge (Peattie, 2010). Green consumption is also supported by governments who have supported environmental education to enhance information, attitudes, values, and understanding about the environment as well as to develop skills that enable people and communities to take cooperative environmental action (Ardoin et al., 2020). Promoting environmental knowledge is one of the top urgent concerns for government policymakers and green consumer industries, and academic discourses on the subject is growing rapidly (Bertossi & Marangon, 2022; Kumari et al., 2022). Due to the limited scientifically sound support for environmental policy (Karam-Gemael et al., 2018), the interaction among policymakers, industries and environmental research will contribute knowledge practice to a large extent (Unander & Sørensen, 2020). Interfaces between science and politics offer opportunities to find solutions for environmental issues (López-Rodríguez et al., 2015).

Against this background, several studies have made progress in identifying and evaluating literature on environmental knowledge and green consumption. Different perspectives were presented in this analysis, including how consumer knowledge shapes green

consumption (Kim et al., 2016), the impact of environmental knowledge on energy consumption (Paco & Lavrador, 2017), and the influence of environmental knowledge on sustainable consumption behaviour (Saari et al., 2021). The review articles focused on various respondents, including physical school students (Okcu et al., 2011), higher education participants (Al-Nuaimi & Al-Ghamdi, 2022), green building residents (Joyram et al., 2022), households (Tan-Soo et al., 2023), etc. However, most are expert dependent and to some extent this subjective and individual preference leads to a lack of bibliometric quantitative analyzes in this field (e.g., word frequency analysis, authorship analysis, citation analysis, co-citation analysis, co-occurrence analysis). Despite a wide range of publications on environmental knowledge and green consumption, little is actually known about the overall structure of its intellectual landscape.

CiteSpace is a bibliometrics software for mapping responses to knowledge domain through computer algorithms and interactive visualizations (Chen, 2016). Compared to other JAVA applications, it focuses on the potential knowledge contained in scientific analysis in the context of scientometrics data and information. It is widely used for the study of regenerative medicine (Chen et al., 2012), analysis of hotspots and trends related to physical activity, mental health and well-being (Sabe et al., 2022), and environmental, social and governance deployed (Zhao et al., 2023), etc. With the development of bibliometric analysis methods and information technology, the historical dynamic analysis of massive documents and the extraction of multiple information characteristics from documents are constantly being facilitated. Scholars in social governance, marketing and other fields have started using

bibliometrics software such as CiteSpace to analyse the impact of environmental regulation on green technology innovation (Li et al., 2022), the knowledge domain and research progress in green consumption (Huang et al., 2022; Yao et al., 2022), green marketing in sustainable consumption (Geng & Maimaituerxun, 2022).

Despite the popularity of research on environmental knowledge and green consumption, there is no literature analysis conducted with CiteSpace. CiteSpace is a bibliometrics software for mapping responses to knowledge domain through computer algorithms and interactive visualizations (Chen, 2016). The CiteSpace-based scientometric analysis approach was used in this study to undertake a comprehensive and impartial examination of the research on environmental knowledge and green consumption. The bibliometric characteristics will be analysed and the relationship will be visualized between environmental knowledge and green consumption from articles and proceeding papers published in Web of Science (WOS) journals from 2000 to 2022. Different from the traditional qualitative narrative literature criticism based on interpretation and personal opinion, this study will (1) understand the characteristics of research cooperation on environmental knowledge and green consumption; (2) determine the field's top cited authors and works; (3) highlight the key knowledge groups in the area and how they evolved over the past few decades; (4) discover the new themes of environmental knowledge and green consumption research in recent decades.

2. RESEARCH METHODOLOGY

Adopting bibliometric analysis method, this study uses CiteSpace 5.3.R4 software to reveal the mapping knowledge domains related to environmental knowledge and green consumption research. Scientific knowledge mapping can show the research and development process and structural relationships in the form of images by utilizing visualization technology. It can also show the scientific research field through data mining, information processing, knowledge measurement, and diagram display, which can provide beneficial and significant references for disciplinary research. The results allow researchers to more efficiently understand specific research areas, correlations and emerging trends of interest (Chen et al., 2009). Through the analysis of literature keywords and co-citations between keywords, the degree of collaboration between research hot spots and keywords is examined to analyse the theme of the research field and examine the intensity of field hot spots and the centrality of keywords. Additionally, based on the findings, the future research hotspots for environmental knowledge and green consumption are explored, and the reference suggestions for future research are put forward.

Web of Science (WoS) is adopted for the identification of the papers chosen for this investigation. All literature is selected from all editions of the Web of Science core collection, and the literature data includes the author, title, source publication, and abstract of the article. WoS is the oldest and most comprehensive record of citation indicators in bibliometrics surveys, with statistical comparability and stability, and is regarded as a reliable data source (Zhou & Zhang, 2021). As environmental knowledge considered as one of the fundamentals

of environmental education (Otto & Pensini, 2017), and the key goal of environmental education is to capture environmental knowledge. This study will use the terms “environmental knowledge and green consumption” or “environmental education and green consumption” in titles, abstracts, or indexing terms to identify papers related to environmental knowledge and green consumption. Based on the research topic selection, 1144 literature on environmental knowledge and green consumption were published between 2000 and 2022. At last, 1014 literature were collected for further process and analysis by language in “English”, and document types in “article or proceedings paper”.

3. RESULTS AND ANALYSIS

3.1 Research Output and Categories

The number of published papers on environmental knowledge and green consumption from 2000 to 2022 is displayed in Figure 1. A strong up-ward trend with an additional acceleration in recent years, suggests the growing significance of scientific research for environmental knowledge and green consumption. The following three phases may be defined using the growth curve of research on environmental knowledge and green consumption.

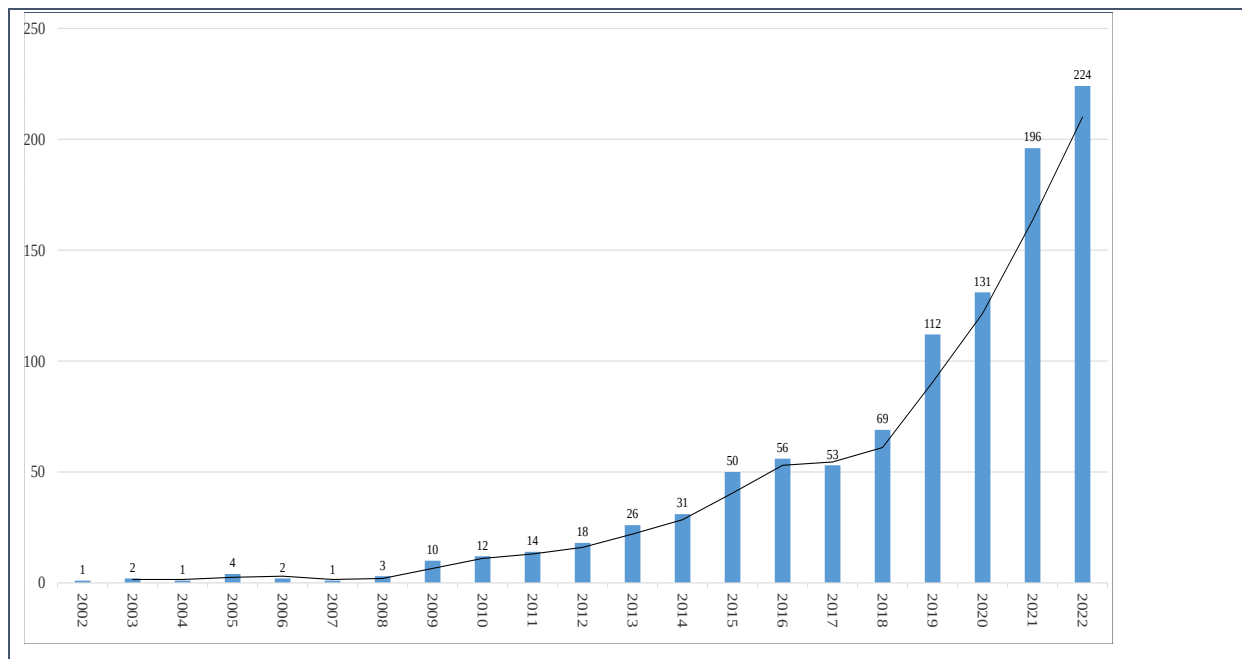


Figure 1 The quantity of published literature on environmental knowledge and green consumption (2000-2022)

A. Preparatory phase (2000-2010). The annual quantity of published literature was less than 14 before 2011. Although some scholars have stated that knowledge has a positive impact on green consumption (Tanner & Wölfling Kast, 2003), most articles included a comprehensive analysis of the challenges of green consumption rather than and in-dept analysis focusing on environmental knowledge and green consumption.

B. Development phase (2011-2018). Many foundational theories had been applied in empirical research on environmental knowledge and green consumption. In addition, the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) was held in 2015, which contributed to the research output growth in 2015 and 2016.

C. Rapid development phase (2019-2022). Since 2019, policymakers, associated academics, and national as well as global organizations have prioritized concerns about

environmental understanding and green consumerism. The Fourth United Nations Environment Assembly (UNEA) in 2019, which aims to "find innovative solutions to environmental challenges and achieve sustainable consumption and production," called on countries to support education and knowledge about sustainable consumption (UNEP, 2019). The quantity of literature has grown rapidly since 2019, increasing by 62.32% compared to 2018. There seems to be a correlation between the UNEA and the increase of the paper and research output related to environmental knowledge and green consumption.

However, when considering the topic categories, the technical and business-related focus is dominating. Another vital observation is, that environmental knowledge and green consumption research have become more interdisciplinary over time. Environmental science and environmental studies have made a great contribution in enhancing customer recognition of environmental impact regarding their unsustainable patterns of consumption consequently supporting green consumption and thus influencing consumption decision.

3.2 The Cooperative network of Environmental Knowledge and Green Consumption

Set the node type as country in CiteSpace 5.3.R4, and get the network map in Figure 2 showing the countries with the publication count of 20 and more. The node size indicates the occurrence frequency of the object represented by the node. The higher the frequency, the larger the node. The line between nodes represents the connection between two nodes, and the colors of lines from cool tones of blue to the warm tones of red indicate the publication time from early to recent times. From Figure 2, both China and the United States have strong connections with other countries, and both countries maintain a high level of collaboration

with other nations.

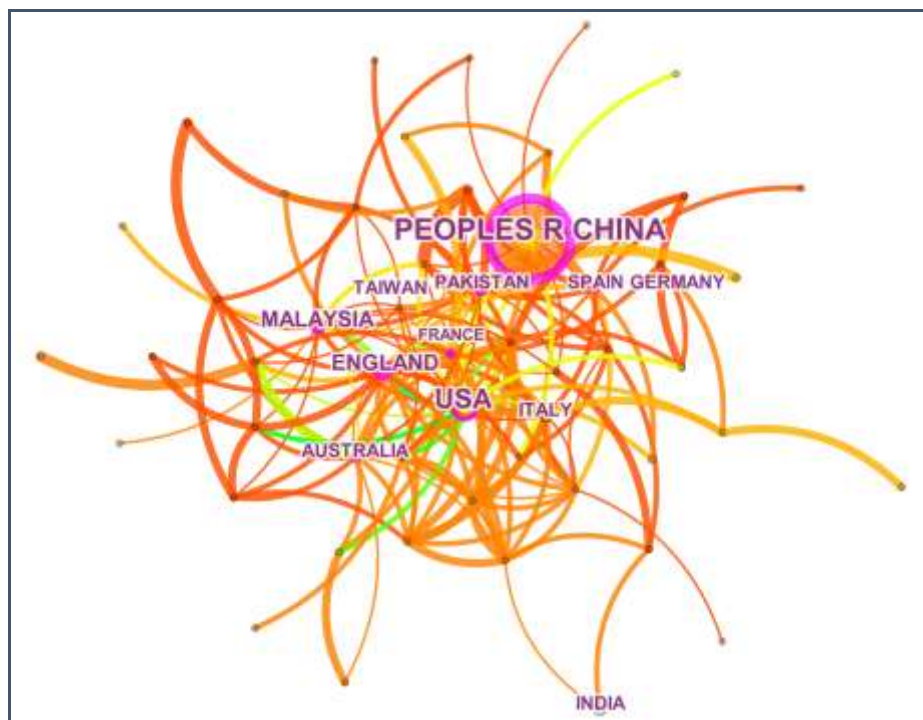


Figure 2 Country Cooperative Network Visualization

China's nodes are located in the centre of the map, indicating that China has a high centrality in the knowledge domain of environmental knowledge and green consumption, and has close cooperation with other countries. From the perspective of the quantity of literature, China is in a leading position in the field of environmental knowledge and green consumption, with the number reaching 167, accounting for 20.24%.

Select the node type as institution in CiteSpace, and get the network diagram as shown in Figure 3. The structure appears relatively loose with limited close relationships, which indicate that the research community is still at an early stage. Jiangsu University has the largest number of published papers and occupies a central position in the graph. For the

quantity of publications, three of the top 10 institutions come from China, reflecting the country's high centrality in the national cooperation network. By analyzing the distribution of research regions and institutions, China has a high international influence in this field, followed by the United States and Malaysia.

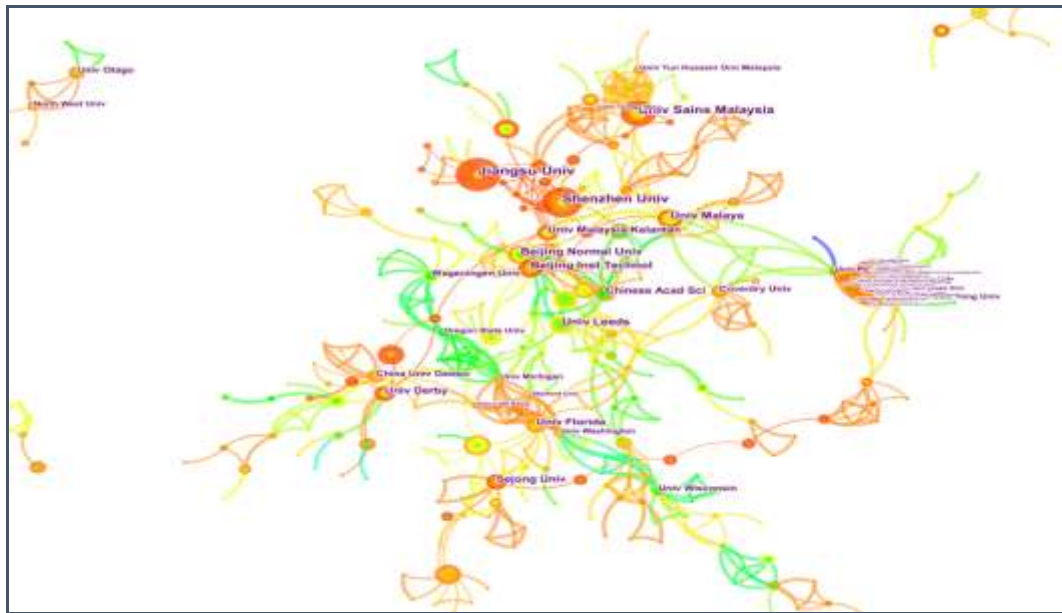


Figure 3 Institution Cooperative Network Visualization

Select the node type as author in CiteSpace 5.3.R4 to get the network diagram as displayed in Figure 4. There is a large number of participants in the network (3107 in total). The relatively loose structure and few close ties suggest that the study authors cooperation is rather limited.

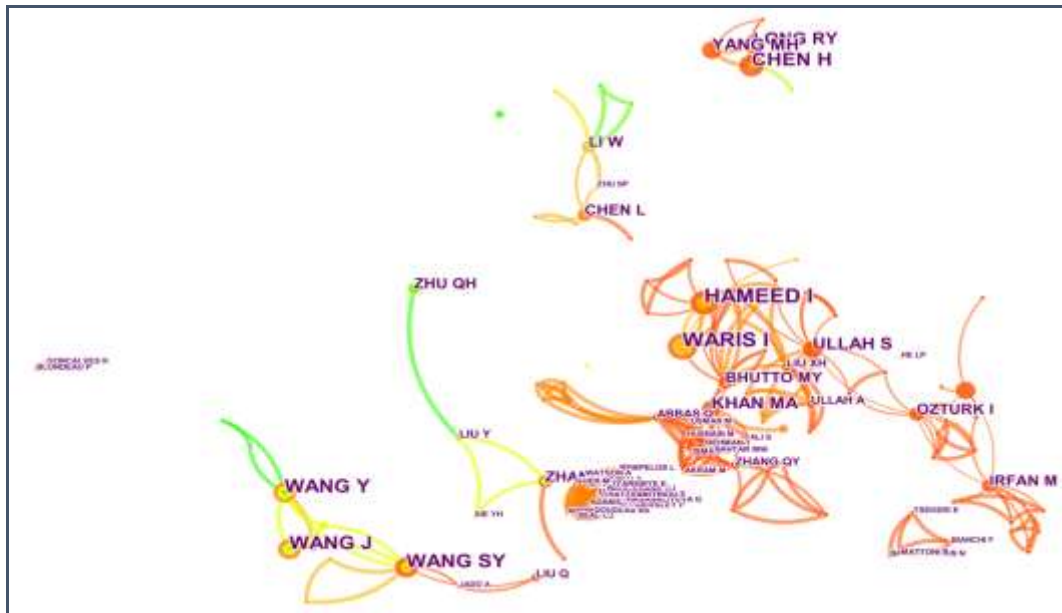


Figure 4 Author Cooperative Network Visualization

3.3 The Co-citation Network of Environmental Knowledge and Green Consumption Research

Figure 5 shows the Document Co-citation Network, which contains 931 references and 1072 co-citation links. The link between two nodes denotes the strength of co-citation, while the size of the nodes represents the frequency of co-citation. The contour percent clusters of the top 20 are all greater than 0.7, suggesting trustworthy quality, as determined by a homogeneity or consistency index to quantify cluster quality (Chen et al., 2015) (Table 2). With 79 member references, the biggest cluster (#0 social media) is significantly higher than the others. The majority of clusters are relatively recent clusters, whereas #3 green brand is an older issue according to the average reference years of each cluster. Spreading environmental awareness via social media is a significant step toward green consumption.

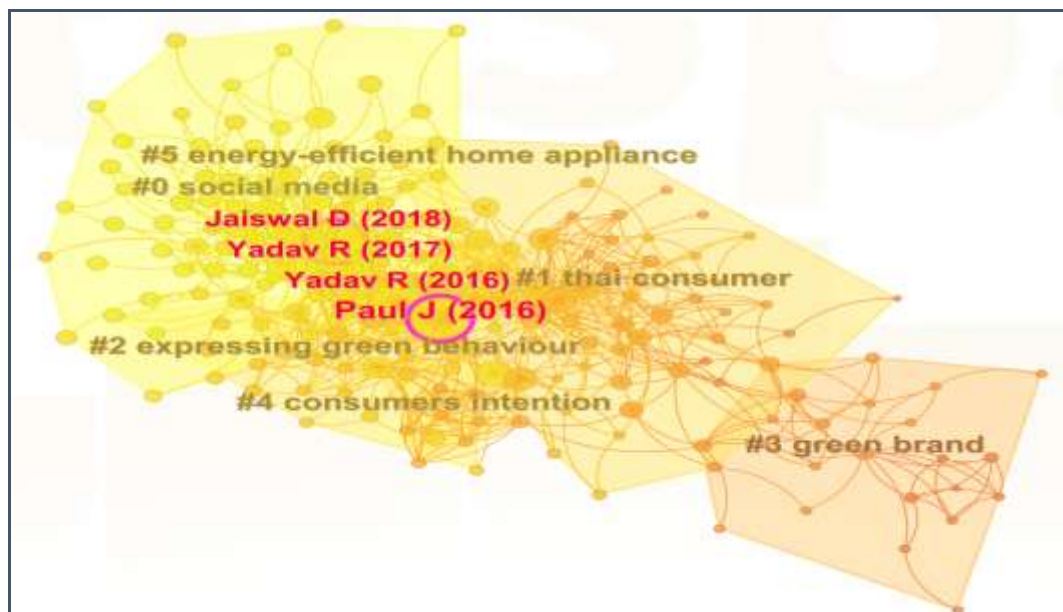


Figure 5 Document Co-citation Network Visualization

Table 1 Top 6 Clusters

Cluster ID	Size	Silhouette	Label (LLR)	Average Year
0	79	0.757	social media	2018
1	51	0.734	thai consumer	2013
2	26	0.79	expressing green behaviour	2016
3	23	0.955	green brand	2010
4	12	0.988	consumers intention	2013
5	12	0.9	energy-efficient home appliance	2017

The most cited articles are generally considered to be landmark articles because of their groundbreaking contributions (Chen et al., 2012). The most frequently cited 10 references with a total frequency of more than 24 citations are listed in Table 3. Six and two of the top 10 most-cited literature came from clusters #0 and #1, respectively, while #2 and #4 contained only one paper.

Table 2 Top 10 Literature with Co-citation Frequency

Citation Counts	References	Cluster ID
62	Paul et al. (2016)	4
49	Yadav and Pathak (2016)	2
48	Yadav and Pathak (2017)	0
44	Jaiswal and Kant (2018)	0
28	Prakash and Pathak (2017)	0
27	Kumar et al. (2017)	0
24	Sreen et al. (2018)	0
24	Zhao et al. (2014)	1
24	Maichum et al. (2016)	0
24	Chekima et al. (2016)	1

3.3 Emerging Trends of Environmental Knowledge and Green Consumption

3.3.1 References with Citation Bursts

Citation bursts, or papers with a sudden spike in citations, might offer some insight into the dynamics of a field. The top 10 references with the most significant citation bursts are listed in Table 3. The increase in citations was in 2011-2018, correlate with the strong upward trend of published paper as indicated in Figure 1, which is consistent with the level of development of research on environmental knowledge and green consumption.

From 2011 to 2018, researchers focused on examining factors that influence green consumption, such as the impact of environmental knowledge on pro-environmental behavior (Vicente-Molina et al., 2013), drivers of consumer choice (Lin & Huang, 2012), green consumption behavior antecedents (Pagiaslis & Krontalis, 2014).

Table 3 Top 10 Literature with the Most Powerful Citation Bursts

References	Year	Strength	Begin	End	2000 - 2022
Biswas and Roy (2015)	2015	7.6919	2016	2020	
Kanchanapibul et al. (2014)	2014	8.2292	2016	2019	
Ritter et al. (2015)	2015	8.3882	2016	2020	
Zhao et al. (2014)	2014	12.7651	2016	2019	
Pagiaslis and Krontalis (2014)	2014	8.6351	2016	2019	
Newton et al. (2015)	2015	3.4449	2016	2020	
Yazdanpanah and Forouzani (2015)	2015	4.9297	2016	2019	
Gleim et al. (2013)	2013	6.4457	2016	2018	
Lin and Huang (2012)	2012	4.1575	2016	2017	
Vicente-Molina et al. (2013)	2013	4.3596	2016	2018	

The above results all confirm the positive correlation between environmental knowledge and green consumption. 2019-2022 was the period of rapid development. Most papers adopted the theory of planned behaviour (Chaudhary & Bisai, 2018; Liobikienė & Bernatoniienė, 2017), and some extended the research focus (Han, 2015; Maichum et al., 2016), while other emphasizing the gap between attitude and behaviour (Moser, 2015; Taufique et al., 2017).

3.3.2 Keyword Analysis

Figure 6 displays a keyword time zone view, a graphical representation that ranks terms according to their peak time, to further identify the research path. Each circle represents

a keyword, and the keyword position corresponds to the year it was first published or peaked. The more frequently keywords appear in this field of research, the larger the circle displayed by the keywords (Chen, 2006). The primary subjects of study on environmental knowledge and green consumerism are described in three research paths based on these significant keywords: knowledge and green consumption, the impact of environmental knowledge on green consumption and attitude-behaviour gap, environmental knowledge and other determinants of green consumption.

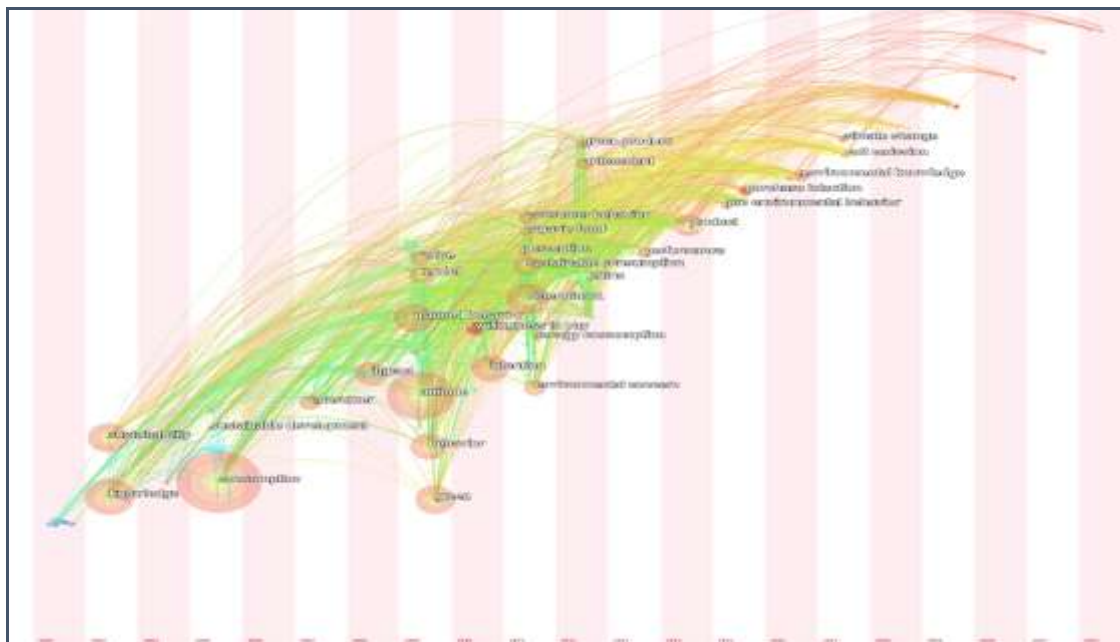


Figure 6 Timezone View of Keywords

A. Knowledge and green consumption. The link between knowledge and green consumption has been extensively researched, and it provides a solid foundation for further studies. Individuals' environmental knowledge relates to their understanding of environmental circumstances, climate change, environmental views, and the environmental

consequences of consumption and production (Pagiaslis & Krontalis, 2014), not only provides information on the harmful impacts of environmental problems, but also information about their positive effects. Individuals in urban area who are better knowledgeable about the environment are more inclined to adopt pro-environmental actions, attitudes, and habits, leading to green consumption patterns (Pothitou et al., 2016). Wang et al. (2014) remind us, that the lack of relevant knowledge will hinder the implementation of sustainable consumption behaviour as education can improve the knowledge and ability requirements to promote the frequency of behaviour occurrence.

B. The impact of environmental knowledge on green consumption and attitude-behaviour gap. Due to discrepancies between client expectations and how they actually perceive green products, many green items on the market fall short of expectations and are therefore undesirable for purchase (Tseng & Hung, 2013). When scholars conduct empirical studies by applying the theory of planned behaviour (Chaudhary & Bisai, 2018; Paul et al., 2016), the effects of willingness to pay, personal norms, and attitudes have been analysed respectively. The influence of attitude on green consumption behaviour is insignificant, indicating the existence of attitude-behaviour gap (Moser, 2015).

C. Environmental knowledge and other determinants of green consumption. Since 2011, academics started to focus on environmental knowledge as the determinant of green consumption. In addition to environmental knowledge, scholars also explored and examined other determinants of green consumption: attitudes (Yazdanpanah & Forouzani, 2015), psycho-graphic variables focusing on environmental values (Pothitou et al., 2016), subjective

norms, knowledge and trust interaction in willingness to pay (Maichum et al., 2016), perceived value and intention to pay a premium (Yadav & Pathak, 2017), environmental concerns and functional properties of products (Joshi & Rahman, 2015), etc.

The connections between environmental knowledge and other determinants for green consumption were explored and examined too. Pothitou et al. (2016) stated that there is very weak evidence on the statistical relationship between environmental predisposition and environmental knowledge. Eco-labels with external verification information can provide consumers with relevant product environmental information needed for ecologically responsible purchases. Taufique et al. (2017) believed that environmental and eco-labelling knowledge is positively correlated with attitudes. In some situations, there is no determining factor for green consumption. Maichum et al. (2016) discovered that customers' intentions to buy green products are not significantly influenced by their environmental awareness. However, it has a significant profile effect through attitudes, subjective norms and perceived behavioural control when purchasing green products.

4. CONCLUSION

Based on CiteSpace 5.3.R4, this study analysed a unique and interesting snapshot of the knowledge domain of environmental knowledge and green consumption. The research findings identified a number of developments. First, data on published papers show that researchers' performance rose substantially from 2000 to 2022, and especially in the latest four years. The dissemination of research has also become an interdisciplinary discipline.

Second, China, the United States, Malaysia, the United Kingdom, and India lead the research with the most prolific scholars and institutions. China is playing an important role in gradually building mutually stable cooperative relations among various countries.

Third, despite the fact that study in this field is getting increasingly extensive and critical, there are several gaps that need to be filled and addressed in various situations (Tripathi & Singh, 2016). For example, environmental knowledge and green consumption research in developing or less developed countries need urgent attention. Early research and practice were mainly concentrated in mature industrialized consumer economies such as Europe, North America and Japan (Peattie, 2010). In recent years, some scholars have studied Thailand (Maichum et al., 2016), China (Wang et al., 2014) and other countries. Nevertheless, there are limited literature on green consumption in developing or less developed countries such as Africa or Latin America (Michel et al., 2022). There is also a requirement for additional research based on different scenarios. According to Figure 6, most research on environmental knowledge and green consumption are concentrated in organic food (Yue et al., 2020), or household (Peattie, 2010). Because of the attitude-behaviour gap, green consumption is influenced by various contextual factors. Environmental knowledge is not always the determinant of green consumption (Maichum et al., 2016), therefore the impacts of determinants of environmental knowledge and green consumption need to be studied.

Using the CiteSpace program, the results extend past bibliometrics studies of research on environmental knowledge and green consumption to provide insight into the disciplinary structure and identify potential connections through their visualization. However, more

research in the following areas can be undertaken to broaden the depth and scope of this study: (1) More papers on environmental knowledge and green consumption in different countries should be analysed, and the research progress of different countries needs to be compared; (2) Scientometric analysis tools such as CiteSpace should be used to explain/solve self-citation problems to draw more reliable conclusions; (3) A thorough field visualization map of environmental knowledge and green consumption research may be produced by combining several knowledge domain visualization methods. As an important and dynamic study subject that contributes to sustainable consumption, many paradigms, indicators, and techniques should be employed to examine and analyse advancements in the field of environmental knowledge and green consumption.

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