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MAPPING THE LITERATURE ON GEN Z PURCHASING BEHAVIOR: A BIBLIOMETRIC ANALYSIS USING VOSVIEWER

Abstract

Generation Z makes up the largest proportion of the world's population and owns active spending power. Born in the internet information age, they have diverse values and consumer behaviors compared to other cohorts of generations. While there has been a significant increase in research on the purchasing behavior of Generation Z in recent years, there are particularly few bibliometric studies in this field. This study aims to sort out the current research status on the purchasing behavior of Generation Z, identify the evolution of purchasing behavior research of Generation Z, determine key research hotspots, and explore future research directions and priority suggestions by analyzing the current literature. The bibliometric analysis is based on the citation information of 638 literature items about Generation Z purchasing behavior in the Scopus database. The results sort out the knowledge structure of the purchasing behavior domain of Generation Z and draw a visual map of the network. Four popular research themes are identified based on keyword co-occurrence analysis, namely the influencing factors of Generation Z consumption behavior, the comparative study with other generations of consumers, the analysis from the perspective of human demography, and the study of sustainable consumption behavior. Studies on Generation Z consumers' spending habits from 2001 to 2022 may be divided into three stages related to the growth process of Generation Z. Future research should focus on the influence of social media on the purchasing behavior of Generation Z and the sustainability of their consumption patterns.

Keywords

Generation Z, purchasing behavior, VOSviewer, Scopus, bibliometric analysis, research evolution, research trends

JEL Classification

M30, M31, N30

INTRODUCTION

Generation Z refers to the group of young people born between 1995 and 2010 (Chaney et al., 2017; Priporas et al., 2017). Generation Z has a large population. Derbani et al. (2022) point out that about a quarter of the global population currently belongs to Generation Z. Born in the internet information age, Generation Z is more influenced by digital information technology such as instant messaging device systems and smartphone products (Dolot, 2018). Hence, they are also called the "Internet generation" and "digital media natives" (Guo et al., 2008). They also have more diverse values and spending attitudes than baby boomers, Gen Xers, and millennials (Munsch, 2021).

Generation Z has a distinct personality. They have different consumption habits, choices, and ways and form unique consumption patterns and characteristics. Generation Z is an exceptionally large consumer group. In recent years, there has been an increase in studies on their consumption behavior. Especially in the last five years, there has been an explosive growth trend, and scholars have conducted a wealth of

research on the consumption characteristics of Generation Z, the differences in the behaviors of consumers from different generations, sustainable consumption, online consumption behavior, and other aspects. Although there are many related studies and diversified research directions, there are few systematic literature reviews, limited research on the internal evolution law of related studies, and even less bibliometric analysis of literature.

1. LITERATURE REVIEW

1.1. Purchasing behavior of Generation Z

Generation is defined as “persons or groups belonging to the same age group who have experienced, or will accordingly experience, similar life experiences during the years in which they are likely to shape their lives.” (Hung et al., 2007). “Generation” refers to “an identifiable group of people who share the same age of birth, experience similar life events, grow up in fairly similar circumstances, and have equal resources, opportunities, and challenges (Thangavel et al., 2022). A group of people born, raised, and sustained during a certain period of time who share common characteristics and views as a result of the events that occurred during that period belong to the same generation (Berkup, 2014).

The division of the four generations has been generally accepted, such as the Silent Generation, the Baby Boomers, Generation X (also known as the 13th Generation), and Generation Y (often referred to as the Millennial Generation) (Andrea et al., 2016; Shatto & Erwin, 2016). The concept of Generation Z is derived from the terms Generation X and Generation Y (Shatto & Erwin, 2016). Generation Z is also seen as Generation I, the Web generation, and digital natives (Turner, 2015). They grew up extensively exposed to digital communications technology, including mobile phones, Wi-Fi, and interactive computer games (Bassiouni & Hackley, 2014). The most prominent characteristics of Generation Z are dependence, freedom, individualism, addiction to technology, and inclination to socialize through the Internet. Social media, such as Facebook and Twitter, play a significant role in their lives. They prefer to be responsive and online 24 hours a day, get information, and share something online constantly (Andrea et al., 2016; Chillakuri & Mahanandia, 2018; Schroth, 2019; Munsch, 2021).

Before 2013, there was relatively little research on the consumption behavior of Generation Z. Bassiouni and Hackley conducted a thematic review of previous literature, explored children’s adaptation to digital consumption culture, and proposed that the positive or negative role of digital media plays on children’s growth depends on cultural and family issues (Bassiouni & Hackley, 2014). As Generation Z has been growing to become primary consumers, increasing attention has been paid to this group since 2014, and many research studies have been conducted. It was evidenced that Generation Z consumers expect a variety of new devices and electronic processes to be more widely available, giving them more autonomy and faster transactions (Priporas et al., 2017). By exploring factors related to the online purchase intention of millennials and Gen Z in Malaysian universities, Isa et al. explored that impulse buying tendency is the strongest predictor of consumers’ online purchase intention (Isa et al., 2020). Environmental concerns and perceived consumer effectiveness are important factors influencing green and sustainable buying behaviors for specific generations (X, Y, and Z). However, collectivism only has an impact on sustainable buying behavior for Generation Z (Casalegno et al., 2022).

1.2. Bibliometric studies on Generation Z purchasing behavior

In recent years, the number of papers using bibliometric analysis as a scientific research tool has been increasing (Aria & Cuccurullo, 2017; Moral-Muñoz et al., 2020). Compared with the traditional literature review method, bibliometric analysis can process a large amount of literature and analyze it from various perspectives while simultaneously producing reliable data analysis results and visualized results. (Aria & Cuccurullo, 2017; Mongeon & Paul-Hus, 2016; Zupic & Čater, 2015). Bibliometrics analysis is becoming increasingly influential and is regarded as an effective method to evaluate scientific achievements because of its

advantage in predicting the development trend of the discipline. (Cobo et al., 2011; Cobo et al., 2015).

There are relatively few bibliometric studies on Generation Z, while none on the purchasing behavior of Generation Z. Ortiz-Pimentel et al. (2020) analyzed the focus of generations (namely Generation X, Y, and Z, Baby Boomers, and the Silent Generation) based on the Web of Science database through a bibliometric analysis of inter-generational papers in business and management journals. They indicate that most of the studies are mainly concentrated in economically developed countries and regions, and there is a lack of qualitative research on Generation Z (Ortiz-Pimentel et al., 2020). To better understand Gen Z in the labor market, Benítez-Márquez et al. (2022) used bibliometrics techniques to evaluate 102 Web of Science papers on Gen Z employees from 2009 to 2020 and found that research in this field has been attracting widespread attention since 2018. However, the stability of research keywords in each period is low, and all aspects must be further developed (Benítez-Márquez et al., 2022). Thus, a bibliometric measurement of publications in the field of Gen Z's purchasing behavior must be conducted as they are an exceptionally large consumer group.

2. METHODOLOGY

As a large database, Scopus, or Web of Science, is often used as the data source for analyzing metrological literature (Van Eck & Waltman, 2010). This study is mainly based on the data retrieved from the Scopus database. There are two main reasons for adopting the Scopus database in this study. The first reason is that it is the largest database of literature abstraction and scientific research information citation in the world, and it is widely recognized in the academic circle because it contains high-quality peer-reviewed research results. Second, to derive the entry results from the database is more convenient for text mining and bibliometric analysis (Deng & Romainoor, 2022). To enrich the results of this study, part of the data – such as the statistics of the number of cited achievements – is taken from Google academics.

The main analytical tools used in this study are VOSviewer (version 1.6.18) for the co-occurrence

network analysis and SPSS (version 20.0) for the descriptive statistical analysis. VOSviewer is a free Java-based software developed by Van Eck and Waltman in 2009, mainly oriented to literature data and suitable for visualizing co-occurrence network analyses and scientific knowledge (van Eck & Waltman, 2010). This study also used Mapchart (<https://mapchart.net/world.html>) to create a map of the global distribution of publications. The data derived during the study and some statistical analysis charts were completed using Microsoft 365.

This study combined two search themes such as Generation Z and purchasing behavior. After defining the research topic, it is essential to understand the key terms of the area within which the topic is located and to establish a concept map or logic network (Aromataris & Riitano, 2014). Thus, broad literature search criteria containing terms related to Generation Z and purchasing behavior were employed for this purpose.

A preliminary search in the Scopus databases revealed that related to the theme of Generation Z, the keywords “Generation Z”, “Z generation”, and “gene Z” could be used. At the same time, “purchasing”, “buying”, “consumption”, “shopping”, and “consumer” could be used for the theme of purchasing behavior.

The literature search was conducted in the Scopus databases on January 2, 2023. The literature search results were filtered for the following five categories of literature to recover as many key articles as possible in the domain of Generation Z purchasing behavior: (1) articles, (2) conference papers, (3) reviews, (4) conference reviews, and (5) data papers. “TITLE-ABS-KEY” (i.e., “title-abstract-keyword”) was used as the search formula. Thus, if a keyword was used in any literature's title, abstract, or keywords, then the relevant document would be presented in the search results. The search string used in this study is as follows: TITLE-ABS-KEY (generation AND z AND consumption) OR TITLE-ABS-KEY (gen AND z AND purchasing) OR TITLE-ABS-KEY (generation AND z AND purchasing) OR TITLE-ABS-KEY (gen AND z AND consumption) OR TITLE-ABS-KEY (Generation AND z AND buying) OR

TITLE-ABS-KEY (gen AND z AND buying) OR TITLE-ABS-KEY (generation AND z AND consumer) OR TITLE-ABS-KEY (gen AND z AND consumer) OR TITLE-ABS-KEY (generation AND z AND shopping) OR TITLE-ABS-KEY (gen AND z AND shopping).

The search results based on the above search strategy were exported as a CSV format document. The document contains data, including the author, title, keyword, journal, year, country, document type, subject category, number of citations, affiliation, and author keyword. The document was imported to VOSviewer for bibliometric analysis. Based on these data, this paper conducted the analysis and co-occurrence of country, journal, author, citation, and keywords. VOSviewer has three rendering modes: network visualization, overlay visualization, and density visualization. The layout and clustering parameters are adjusted according to the content and data for better visualization. Generally, the larger the nodes, the more lines connect them, and the more important or connected they are. Some of the statistical charts were created using Microsoft 365.

3. RESULTS

3.1. Document type, subject categories overview

Based on the search strategy, 638 literature items were retrieved from the Scopus database. Most literature types were articles (n=502, 78.7%), followed by conference papers (n=112, 17.6%), and then reviews (n=15, 2.4%). Table 1 classifies the sample studies focusing on Gen Z purchasing behavior into subjects. The top three subject categories with the highest proportion of documents were “Business, Management, and Accounting” (n=205, 16.0%), followed by “Social Sciences” (n=177, 13.8%) and “Engineering” (n=143, 11.1%). Subject categories with more than 70 pieces of literature include “Computer Science” (n=131), “Energy” (n=82), “Environmental Science” (n=79), and “Economics, Econometrics, and Finance” (n=79). Other subject categories were less represented in the Scopus database.

Table 1. Subject categories focusing on Generation Z purchasing behavior

Subject categories	Frequencies(n)	Percentage (%)
Business, Management and Accounting	205	16.0%
Social Sciences	177	13.8%
Engineering	143	11.1%
Computer Science	131	10.2%
Energy	82	6.4%
Economic, Econometrics and Finance	79	6.1%
Environmental Science	79	6.1%
Agricultural and Biological Sciences	47	3.7%
Medicine	43	3.3%
Decision Sciences	39	3.0%
others	286	20.2%

3.2. Trends of publications and citations

The annual number of publications could reflect the development status of a certain research area in this study. The trends of publications and citations on Generation Z purchasing behavior are shown in Figure 1. Before 2012, fewer than eight documents were published each year, and the number of literatures was zero in some years. From 2012 to 2016, the number of publications began to rise slowly, and the average annual number of publications was 12.75. A significant increase in the amount of literature published appeared after 2016. The highest number of articles was published in 2022 (n=210, until October 28), nearly double the previous year’s number.

The trend of citations is similar to the trend of publications. A significant increase in the number of citations emerged after 2016. This research analyzed the 10 documents with the highest number of citations, the most cited document being “Generation Z consumers’ expectations of interactions in smart retailing: A future agenda” (n = 227) (Priporas et al., 2017). The average number of citations of the 10 documents was 107.6.

3.3. Country co-authorship analysis

Country co-authorship analysis identifies the most influential countries that contribute the most to the field of generation Z’s purchasing behavior.

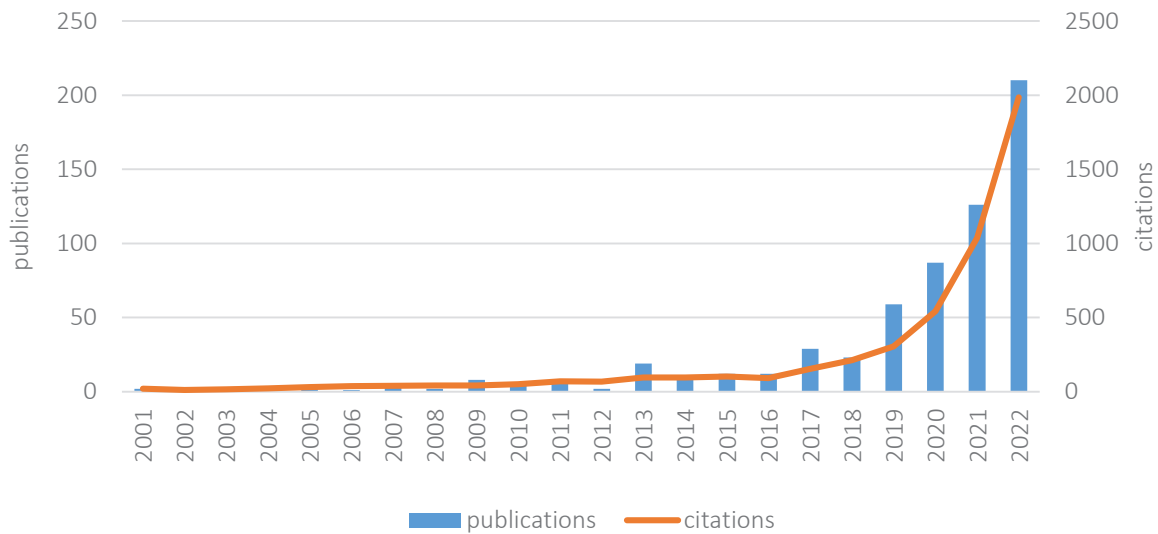


Figure 1. Trends of publications and citations on Gen Z purchasing behavior

The results of countries' co-authorship analysis by VOSviewer are shown in Figure 2. The node size was proportional to the number of publications; the more publications there were, the larger the node. The thickness of the lines connecting countries in the figure shows how related research is closely linked between countries.

Figure 2 shows that the United States had the highest number of publications, the highest number of citations, and the highest citation link strength (with 95 documents, 1,076 citations, and total link strength of 35) in the field of Generation Z purchasing behavior. China (with 58 documents, 667 citations, and total link strength of 18) and India (with 57 documents, 201 citations, and total link strength of 12) ranked second and third, respectively, in terms of the overall number of documents published. Meanwhile, the United Kingdom

(with 32 documents, 539 citations, and total link strength of 31) and Malaysia (with 32 documents, 122 citations, and total link strength of 22) ranked second and third in terms of total link strength.

The publications on Generation Z purchasing behavior came from 76 different countries. Figure 3 demonstrates a global map of documents published in different countries. Based on the figure, countries with more than 50 publications include the United States (n=96), China (n=58), and India (n=57). These three countries accounted for 33.1% of the total literature. Geographically close countries have similar numbers of publications focusing on Gen Z buying behavior. Figure 3 also shows that these studies were concentrated in more economically developed countries and regions. Notably, there were fewer studies from emerging economies in Latin America, Africa, and the Middle East.

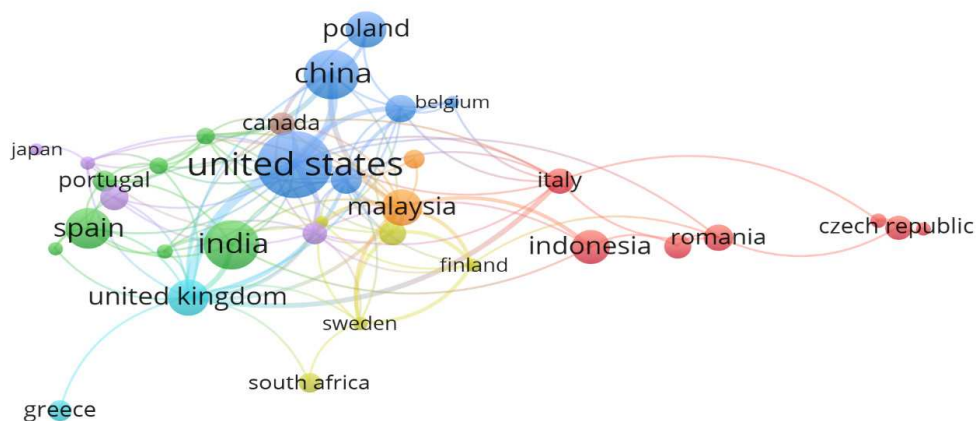


Figure 2. Visualization of country co-occurrence

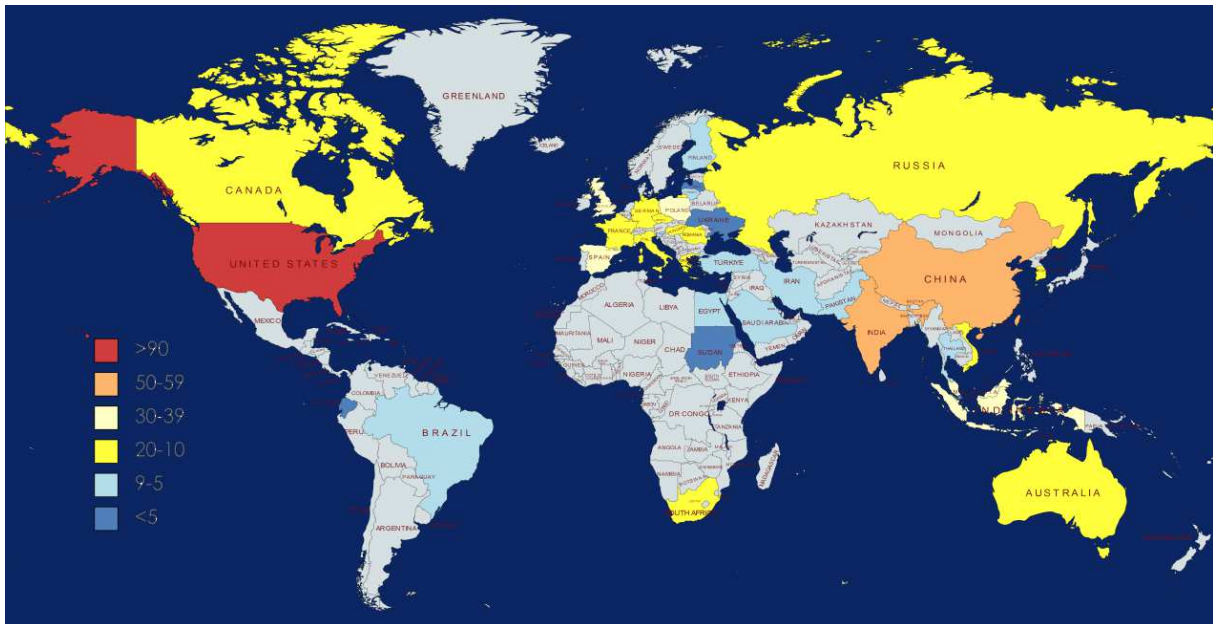


Figure 3. Global map of documents published in different countries

3.4. Author co-citation analysis

In the Generation Z purchasing behavior field, 1,923 authors contributed 638 papers, with an average of 3.01 authors per paper. According to Table 2, the top ten authors with the highest number of citations came from 6 different countries. The countries with the most cited authors were the United Kingdom, the United States, and Germany, respectively, which was consistent with the results of the countries' co-authorship analysis.

The study with the highest number of citations (227 citations) was “Generation Z consumers’ expectations of interactions in smart retailing: A future agenda” by Priporas et al., published in *Computers in Human Behavior* (Priporas et al., 2017). However, the authors who published the most papers in the field did not have the most cita-

tions. The top three authors in the number of published documents were Dabija, D.C. (with 6 documents, 96 citations), Kamenidou, I. (with 5 documents, 22 citations), and Stavrianea, A. (with 4 documents, 25 citations). The results indicated that those three authors’ papers were new and published between 2020 and 2022; hence, the number of citations was not high.

3.5. Keyword co-occurrence analysis

According to keyword co-occurrence analysis performed through VOSviewer (Figure 4), keywords that appear more than 10 times in the field of Gen Z purchasing behavior research include Generation Z, Human, Social Media, Consumer Behavior, Marketing, Sustainability, Sustainable Development, Generation Y, Millennials, Generation X, Commerce, Male, Purchase Intention, Perception, Purchasing,

Table 2. The most cited authors in the field of Gen Z purchasing behavior

No.	Author	Country	Institution	Citations
1	Priporas C.-V.	United Kingdom	Middlesex University Business School	227
2	Duffett R.G.	South Africa	Cape Peninsula University of Technology	128
3	Kassel J.D.	United States	University of Illinois at Chicago	112
4	Koch J.	Germany	Muenster University	99
5	Gazzola P.	Italy	University of Insubria	81
6	Skinner H.	United Kingdom	Manchester Metropolitan University	73
7	Djafarova E.	United Kingdom	Northumbria University	70
8	Su C.-H.	United States	Iowa State University	65
9	Kondou C.	Japan	Kyushu University	65
10	Pilgrim K.	Germany	Witten/Herdecke University, Witten	63

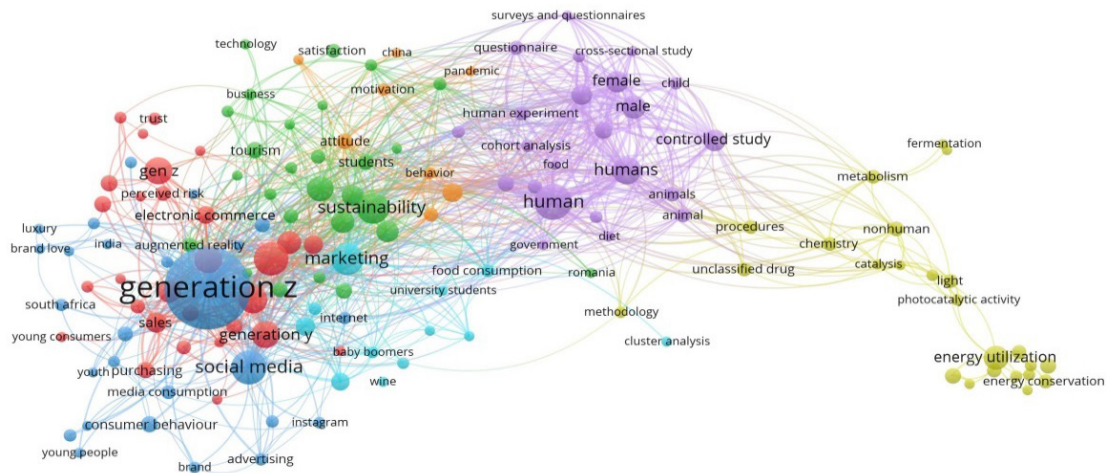


Figure 4. Network visualization of keyword co-occurrence

Controlled Study, Electronic Commerce, Adult, Sales, Social Networking (online), Technology Acceptance Model, Tourism, Attitude, Online Shopping, Decision Making, and Adolescent. The high-frequency keywords reflect the hotspots in the current research field.

Furthermore, this study conducted a consistency analysis for the keywords that appeared more than 5 times (153 in total). In Figure 4, the number of keyword occurrences is proportional to the size of the node; the larger the node, the more attention it receives.

Cluster 1 (blue): It mainly explores the influencing factors of the purchasing behavior of Generation Z (Duffett, 2017; Isa et al., 2020; Priporas et al., 2017), namely branding, advertising, promotion, influencer marketing (Wielki, 2020; Zatwarnicka-Madura et al., 2022), and media consumption (Sun & Xing, 2022). Social media’s impact on Generation Z’s consumption behavior is an important research focus (Elmira Djafarova & Tamar Bowes, 2021).

Cluster 2 (red): The main research areas are comparative studies of Gen Z and other intergenerational consumers (Bulut et al., 2017; Eastman & Liu, 2012; Laor & Galily, 2022; Thangavel et al., 2021). This includes the comparative discussions of Generation X (Kamenidou et al., 2020; Lissitsa & Kol, 2021), Generation Y (Laor & Galily, 2022), and baby boomers (Bulut et al., 2017; Parment, 2013). This also includes discussions of Generation

X (Kamenidou et al., 2020; Lissitsa & Kol, 2021), Generation Y (Laor & Galily, 2022), and baby boomers (Bulut et al., 2017; Parment, 2013).

Cluster 3 (light purple): The research mainly studies the consumer behavior of Generation Z from the perspective of human demographics, such as gender (Bulut et al., 2017; Su et al., 2019) and occupational identity (Duffett, 2020). Many researchers adopted controlled study and quantitative analysis methods.

Cluster 4 (green) The main research topic involves the sustainable consumption behavior of Generation Z, including the attitude toward green marketing, the consumption behavior of fashion products (Kovacs, 2021; Tran et al., 2022; Williams & Hodges, 2022), and sustainable food consumption (Mahasuweerachai & Suttikun, 2022; Su et al., 2019).

3.6. Most active and cited journals

The number of relevant papers published and the number of citations can reflect the importance of a journal in a particular research field. In particular, the number of publications and citations is directly proportional to the contribution. Table 3 shows the top ten journals in terms of publication volume in the field of purchasing behavior of Generation Z. Their publication volume accounts for 13.5% of all relevant literature. The largest number of related papers were published in *Sustainability* (Switzerland) (N=32, 5.0%). Among the ten journals, the highest CiteScore (2021) is the *Journal of Retailing and Consumer Services* (CiteScore =11.4).

Table 3. The most cited journals in the field of Gen Z purchasing behavior

No.	Name of journal	Number of documents	Percentage	Citations	CPP (citation per publication)	CiteScore (2021)
1	Sustainability (Switzerland)	32	5.0%	406	12.69	5
2	Young Consumers	12	1.9%	259	21.58	4.1
3	British Food Journal	6	0.9%	56	9.33	4.3
4	Energies	5	0.8%	10	2.00	5
5	International Journal Of Environmental Research And Public Health	5	0.8%	34	6.80	4.5
6	Foods	5	0.8%	13	2.60	4.1
7	Asia Pacific Journal Of Marketing And Logistics	4	0.6%	2	0.50	6.1
8	Electronic Commerce Research	4	0.6%	36	9.00	6.3
9	Journal of Retailing and Consumer Services	4	0.6%	93	23.25	11.4
10	Journal of Tourism Futures	4	0.6%	107	26.75	5.1

The top three journals with the highest number of overall citations are *Sustainability (Switzerland)* (n= 406), *Young Consumers* (n=259), and *Journal of Tourism Futures* (n=107). However, the top three journals with the highest number of citations per paper are the *Journal of Tourism Futures* (n=26.75), the *Journal of Retailing and Consumer Services* (n= 23.25), and *Young Consumers* (n=21.58).

4. DISCUSSION

4.1. Evolution of research on Generation Z purchasing behavior

The number of published papers can reflect the development status and attention of a certain research field; the more papers, the higher the attention. By combing through 638 literature items on Gen Z purchasing behavior, this study found that the number of relevant literature is closely related to the growth stage of Gen Z. From 2001 to 2022, the research on the purchasing behavior of Generation Z can be divided into three stages. First, from 2001 to 2010 can be noted as start-up stage. During 2001–2010, Generation Z, born between 1995 and 2010, was still in the childhood stage. At this time, most of their consumption behaviors were carried out by their parents or guardians, so there were few relevant studies. During this period, most research on Generation Z was related to the psychology or education of Generation Z (Young, 2009). Meanwhile, from 2011 to 2016 can be marked as Slowly-growth stage. From 2011 to 2016, Generation Z was in the adolescence stage, when they gradually began to participate in pur-

chasing behavior regularly; however, the influence of parents was still relatively large. Although relevant studies began to increase, they still received little attention. Some scholars began to pay attention to Generation Z’s attitude toward advertising or social media when studying Generation X and Generation Y consumption behaviors (Kaplan, 2014; Sima, 2016). In addition, since 2017 can be considered as an explosive-growth stage. Since 2017, Generation Z individuals have become adults and the world’s largest and most powerful consumer group. Their personality traits differ from those of Generation X and Y (Dolot, 2018). Research on their purchasing behavior has attracted scholars’ attention, leading to numerous related research results. Priporas et al. put forward a research result that has been cited more frequently. They found that intelligent technology can effectively improve the shopping experience of Generation Z consumers, thus improving business competitiveness (Priporas et al., 2017). In addition, Duffett proposed that social media marketing communications positively impact Generation Z consumers’ cognitive, affective, and behavioral attitudes (Duffett, 2017). Djafarova suggests a significant gender difference in impulse buying behavior among Gen Z consumers on Instagram (Djafarova & Bowes, 2021).

4.2. Future of research trends on Generation Z purchasing behavior

The research trends in related fields can be analyzed by combing the keywords in the last five years. After sorting out the keywords related to the buying behavior of Generation Z

in the recent five years, this study determined two future research directions worthy of attention. The first direction is concentrated on the role of social media on Generation Z purchasing behavior. Since 2017, social media has been used as a keyword in the relevant literature 44 times, especially after 2020. Social media marketing communications significantly influenced Generation Z consumers' cognitive, affective, and behavioral attitudes (Duffett, 2017). The social media platforms frequently used by Generation Z include Instagram, YouTube, Line, Facebook, and Twitter. They primarily use these social media channels for communication, consumption, shopping, social networking, and entertainment (Wijaya et al., 2020).

In addition, there is another research direction worthy of attention. Sustainability consumption behavior of Generation Z. "Sustainable" refers to a level and pattern of consumption that meets the needs of the present without compromising the ability of future generations to meet their own needs (Thogersen, 2010). "Sustainability" first appeared in 2019 as a keyword in the literature related to Generation Z consumer behavior and has appeared 33 times since 2019–2022. The consumer behavior of Generation Z greatly differs from that of Generation X and Y. Generation Z is more environmentally friendly and sustainable and prioritizes companies or brands that can connect with them and bring them a good experience (Dabija et al., 2019).

CONCLUSION

This study made a bibliometric analysis on the literature related to the purchasing behavior of Generation Z. The results of the bibliometric analysis show that increased scholars began paying attention to this area in 2012, which developed into a research hotspot after 2017 and USA is the leading country. These studies were mainly concentrated in more economically developed countries and regions. In addition, the results show that the amount of relevant literature is closely related to the growth stage of Generation Z. The research from 2001 to 2022 can be divided into three stages: start-up stage (2001–2010), slow-growth stage (2011–2016), and explosive-growth stage (since 2017). These three stages correspond to Generation Z's childhood, adolescence, and adulthood. Furthermore, there are four popular research topics in this field: influencing factors of behavior, comparative study of Generation Z and other generations of consumers, relevant research from the perspective of human demographics, and sustainable consumption behavior of Generation Z. As for the future research trends, the study determined two future research directions worth exploring: the role of social media on the purchasing behavior of Generation Z and the sustainable consumption behavior of Generation Z.

Moreover, this study has some limitations, which can be used as a reference for future research. First, the data collected in this paper is limited to literature in the Scopus database written in English. Therefore, the results may be biased. Second, the literature retrieved is mostly concentrated in developed countries, and few came from emerging markets. Future researchers can use more data sources and search non-English literature, such as Chinese literature (China's largest Generation Z population), to get more comprehensive results.

AUTHOR CONTRIBUTIONS

Conceptualization: Pingxiu Li, Siti Hasnah Hassan.
Data curation: Pingxiu Li.
Formal analysis: Pingxiu Li.
Investigation: Pingxiu Li.
Methodology: Pingxiu Li.
Resources: Pingxiu Li, Siti Hasnah Hassan.
Software: Pingxiu Li.

Supervision: Siti Hasnah Hassan.
 Validation: Pingxiu Li, Siti Hasnah Hassan.
 Visualization: Pingxiu Li.
 Writing – original draft: Pingxiu Li.
 Writing – review & editing: Pingxiu Li, Siti Hasnah Hassan.

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