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Emotional Design of Packaging: A Bibliometric Analysis

Chang Liu[1], Mat Redhuan Samsudin[2], Yuwen Zou[3]

[1]College of Creative Arts, Universiti Teknologi MARA (UiTM) Kelantan Branch, 15050 Kota Bharu, Kelantan Malaysia

[2]College of Creative Arts, Universiti Teknologi MARA (UiTM) Kelantan Branch, 18500 Machang, Kelantan Darul Naim Malaysia

[3]Faculty of Communication and Media Studies, Universiti Teknologi MARA (UiTM), 40450 Shah Alam, Selangor Darul Ehsan Malaysia

Correspondence: Chang Liu, College of Creative Arts, Universiti Teknologi MARA (UiTM) Kelantan Branch, Bandar Kota Bharu, 15050 Kota Bharu, Kelantan Malaysia.

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Abstract

This study aims to explain the present research status and trends in the field of Emotional Design of Packaging (EDOP). A total of 129 scholarly articles were selected from high-quality journals in the Web of Science (WoS) database, and a systematic review of the EDOP field was undertaken, utilising a combination of CiteSpace and VOSviewer for bibliometric analysis. The findings reveal substantial advancements over the past two decades, with prospects for continued expansion. There exists a pressing requirement for enhanced collaboration across countries, institutions, and authors within this field. The core research themes in this area are Emotional Communication of Brand Packaging, Emotional Triggers for Packaging Design, Emotional Experience and User Satisfaction, and Emotional Design and Consumer Behaviour. It is worth mentioning that these four research themes correspond to the evolutionary trend of EDOP research history, with crossovers between periods arranged in an overlapping relationship. Additionally, Sensory Characteristics of Food Packaging and Emotional Measurement of Users, Modelling the Relationship between Packaging Design, Branding and Consumer Behaviour, and the Role of Cigarette Packaging Design in Tobacco Marketing collectively form the fundamental knowledge base in this area. This study not only addresses the current research gap in this field but also provides valuable references and guidance for future researchers.

Keywords: emotional design, packaging, bibliometric, CiteSpace, VOSviewer

1. Introduction

Emotional design, a theory and methodology first formalised by psychologist and design scholar Norman (2004) aims to evoke emotional resonance and experiences in users through innovative products. This approach underscores the role of product design in stimulating specific emotions, meeting users' emotional needs, and fostering emotional engagement (Kamil & Abidin, 2013). Today, this emotional design approach extends beyond product design, finding successful applications in various design fields, including consumer products (Kongprasert & Wangphanich, 2023). Traditionally packaging design has been a subordinate position relative to product design and production system design, but in recent years it has attracted considerable attention from scholars as its strategic role continues to be recognised in theory and practice (Azzi et al., 2012). Modern packaging is constantly given new connotations along with technological advances and changes in consumer demand, paying more attention to the scientific and innovative nature of packaging.

Research on the Emotional Design of Packaging (EDOP) is gaining momentum among scholars. For example, Félix & Duarte (2018) investigated the application of emotional design in the creation of lunchboxes. Their findings indicate that the design of lunchboxes influences consumer perceptions of food product value, thus making it a significant factor in consumer evaluation. In another study, Kongprasert & Wangphanich (2023) examined the integration of emotional design, product personality, and environmental impact assessment into the design process. They proposed an innovative approach to charcoal packaging design to meet customer needs. Their research suggests that this innovative design approach can guide designers in creating charcoal packaging that meets customer requirements, showcases product characteristics, and is environmentally friendly. The value of EDOP research extends beyond providing designers with a deeper understanding of consumers' perspectives and needs. It also aids companies in enhancing their product's added value and communicating

their brand values, thereby improving their market competitiveness. Despite the emergence of numerous valuable studies, a comprehensive systematic review of the EDOP research field has yet to be conducted by scholars.

This study seeks to bridge this gap through the use of bibliometric analysis methods. The goal is to gain a more comprehensive understanding of the current research status and development trends in the field of EDOP. This will provide valuable references and guidance for future researchers interested in this area. To achieve this, we analysed literature data retrieved from the Web of Science (WoS) database to answer the following research questions:

1) What are the primary research themes in the EDOP field?

2) How have these major themes evolved over time?

3) What are the emerging research frontiers in the EDOP field?

4) What constitutes the knowledge base for research in the EDOP field?

5) What implications does existing research in the EDOP field have for future studies?

2. Research Design

2.1 Research Methods

Bibliometrics is a set of methods used to quantitatively analyse scientific, technical and professional literature, involving the quantitative analysis of publications and their citation counts (De Bellis, 2009). As bibliometrics continues to evolve, it has become a crucial research method for summarising historical research findings and identifying future research trends, garnering significant attention and research in recent years (Mayr & Scharnhorst, 2015). Compared to traditional literature reviews, bibliometrics offers a more scientific and objective approach through its quantitative method of statistical analysis of literature information. This not only minimises the risk of subjective judgement by researchers but also provides objective results based on textual discourse analysis (Wang et al., 2021). Therefore, this study employs bibliometric analysis as a key method to analyse the literature related to EDOP research, with the aim of identifying the current research hotspots in the field, analysing the evolutionary path of the research themes, and providing insights and references for current research trends and future research directions.

CiteSpace is a bibliometric visualisation and analysis tool for detecting and visualising emerging trends and fundamental changes in scientific disciplines over time, allowing for the exploration of professional dynamics based on time-varying mappings from research frontiers to their knowledge bases (C. Chen, 2006). VOSviewer is also a bibliometric visualisation and analysis tool for constructing and viewing bibliometric maps (Van Eck & Waltman, 2010). The former focuses on outlining the process of knowledge evolution in the temporal dimension. The latter is more advantageous in visualising scientific collaborative network relationships as well as in ease of operation. As the mainstream visualisation software in the market for scientific knowledge mapping, the two tools can complement each other when used together. Therefore, this study will employ CiteSpace (version 6.2.3) and VOSviewer (version 1.6.19) as the research tools for bibliometric visualisation.

2.2 Data Sources

Web of Science Core Collection (WoSCC), as a world-renowned citation index database, is widely used in scientific research and evaluation for its groundbreaking content, high-quality data and long history (Odriozola-Fernández, Berbegal-Mirabent and Merigó-Lindahl, 2019; Tan et al., 2021). Its compatibility with econometric analysis software, along with the completeness and high quality of its entry information, makes it an excellent resource for accessing research data (Y. Chen et al., 2023). Therefore, this study has chosen WoSCC as its data source. The citation indexes included in our research are Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (AHCI), Book Citation Index-Science (BKCI-S), Book Citation Index-Social Sciences & Humanities (BKCI-SSH), and Emerging Sources Citation Index (ESCI).

The data search was conducted on June 26, 2023, using the search formula [TS= ((emotional design OR affective design) AND (package OR packaging))]. The publication time span was set to 30 years, from June 1, 1993, to June 1, 2023. This initial search yielded 451 publications. To refine the results, the document type was set to 'article' and the language was restricted to English, which resulted in 402 documents. Further manual filtering was conducted to eliminate documents with low relevance, leaving 129 documents. After checking for duplicates and ensuring the quality of the documents, a total of 129 qualified articles were retained for subsequent research. The research flow is illustrated in Figure 1.

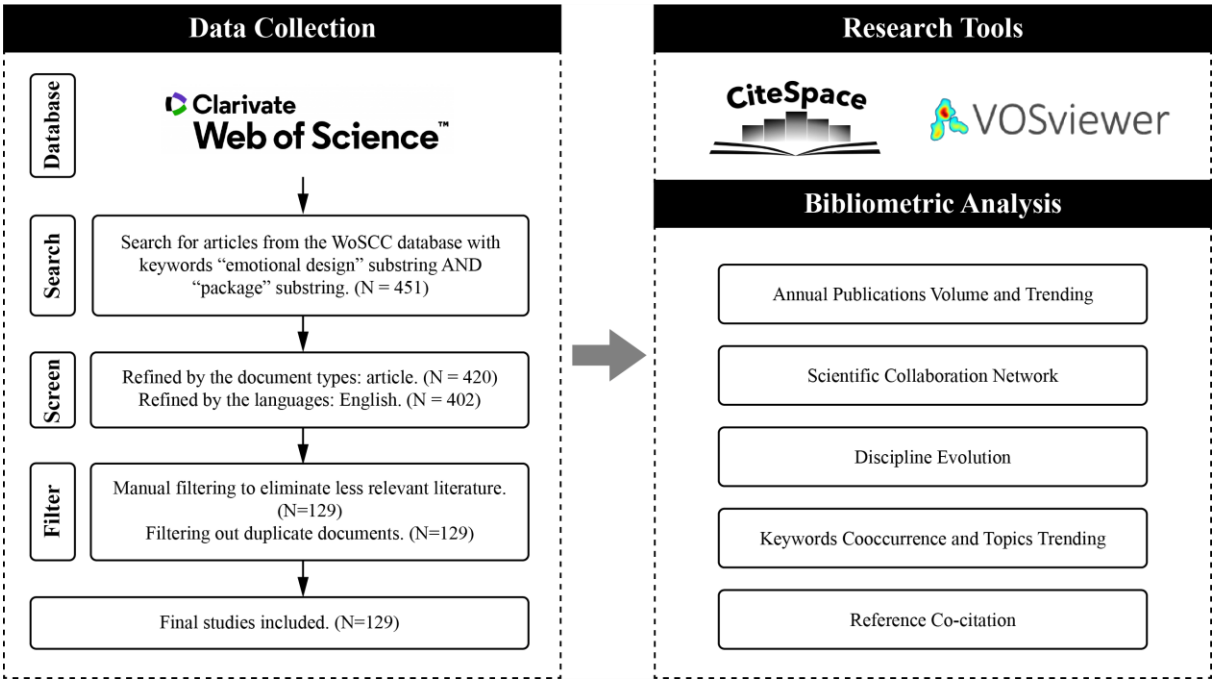

Figure 1. Research flow

3. Research Results and Discussion

3.1 Annual Volume of Publications and Trends

The 129 academic articles analyzed in this study were authored by 449 authors from 249 institutions in 42 countries. These articles were published in 78 different journals and cited 6,296 references from 2,560 journals.

By analysing the changes in the number of publications in a given field, it is possible to gain a direct insight into the development and future trends of the field as well as the concentration and active period of research in the field (Wei et al., 2022). Figure 2 shows the temporal distribution of publications in the field of EDOP research. The growth in the total number of EDOP research publications can be broadly divided into three main phases based on the scientific output per year: the initial growth stage (2001-2008), the slow development stage (2009-2016), and the rapid development stage (2017-2023). These phases saw 4, 31, and 94 publications respectively. It is worth noting that the number of papers published in 2020 and 2021 will be slightly lower than in 2019, interrupting the growth trend. Considering that there is usually a time lag of one or two years between conducting experiments and publishing papers, this deviation may be due to the impact of the COVID-19 epidemic, which may hinder some experimental progress in 2020 (Y. Chen et al., 2023). Overall, the number of papers published in this field is on the rise, especially since 2016, the number of papers published has grown rapidly, and from 2018 to 2022, the number of papers published has remained stable at more than 10, which shows that this research field has attracted more and more attention from scholars in recent years. It can be inferred that this field will receive more extensive attention in the future.

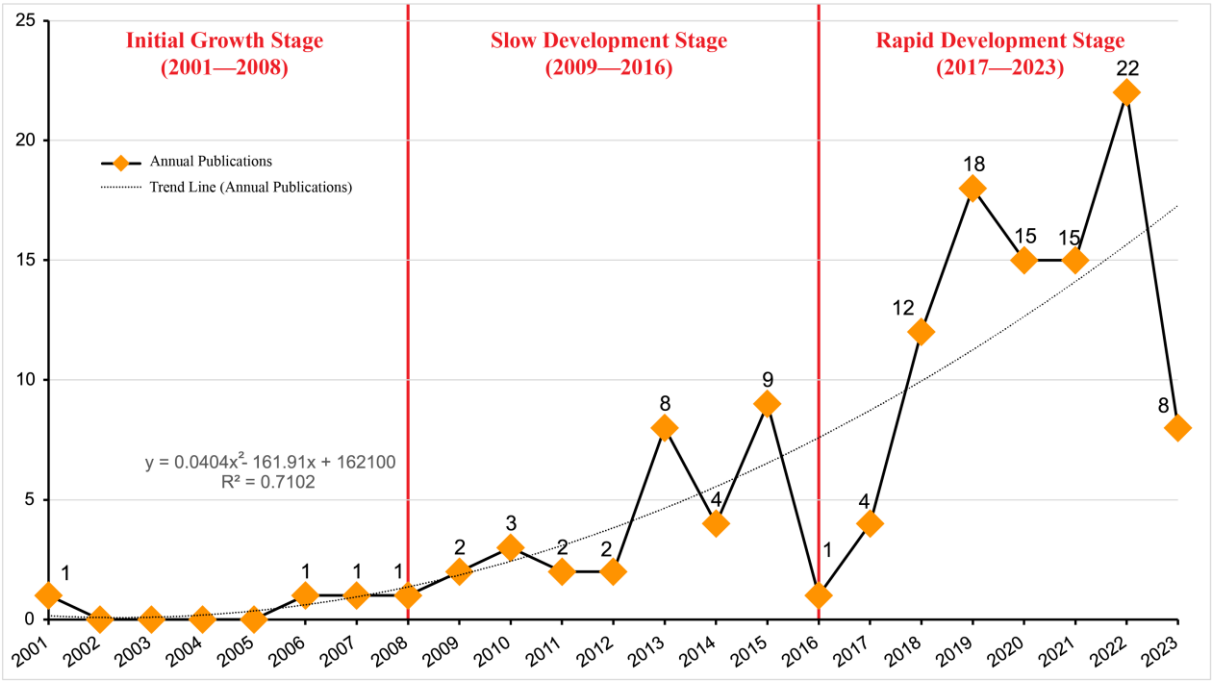

Figure 2. Annual publications from 2001 to 2023

3.2 Scientific Collaboration Network

3.2.1 National and Institutional Collaboration Networks

In order to understand which countries are the most prominent contributors in the field of EDOP research, this study analysed the number of publications in 42 countries. Firstly, the volume of publications from different countries was visualised by VOSviewer, and the results are shown in Figure 3. The larger nodes indicate more issuance; the node connecting lines represent the strength of association, the thicker the connecting lines, the more collaborative issuance between countries (H. Li et al., 2016); and the node colours represent different clusters. In terms of the distribution of publishing countries, the field is somewhat unbalanced, with the majority of papers being authored by scholars from a few countries. From the perspective of international collaboration, there are some cooperative relationships in this field, but the overall network is not closely knit. There are still some countries individually dispersed on the map, and although there is frequent cooperation between some countries, there is still room for strengthening cooperation.

Further analysing the highly productive countries in the field, Table 1 presents the top 8 countries in terms of publications in the field. By analysing the data in Table 2, it can be seen that US scholars have not only contributed the most research papers in the field (a total of 30 papers), accounting for 23% of the total number of publications in the field but also the most citations in the literature, up to 2,826, with the average number of citations per article being as high as 94.2. This shows that the US has considerable strength in the field of EDOP research, which is directly related to the strong scientific research strength of the US and its role as the birthplace of emotional design. This is followed by the UK, with a total of 24 publications and 744 citations. The country with the 3rd highest total number of publications is China, with a total of 18 publications, but its literature citation is low (153 citations).

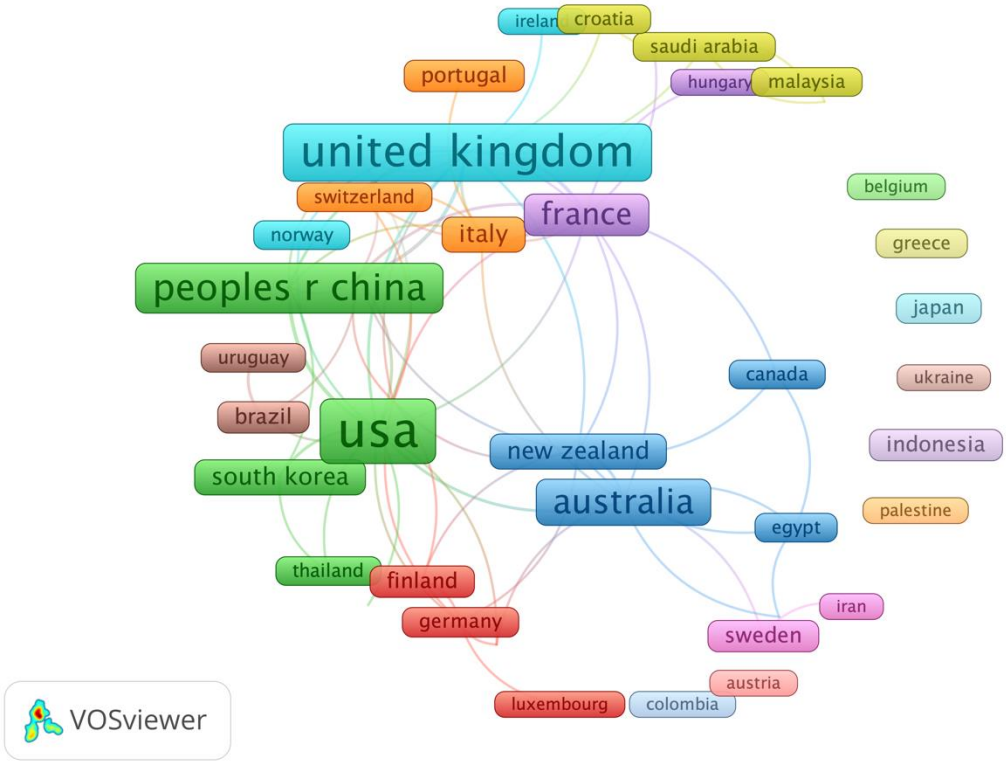

Figure 3. Collaboration network of countries

Table 1. Top countries ranked by number of publications

Rank	Country	Number of publications	Citations	Citations per paper
1	USA	30	2826	94.2
2	United Kingdom	24	744	31
3	China	18	153	8.5
4	Australia	15	373	24.87
5	France	12	434	36.17
6	Spain	8	261	32.63
7	New Zealand	6	132	22
8	Italy	6	391	65.17

In terms of issuing institutions, universities and public research institutions are the primary contributors to EDOP research. This field encompasses a total of 249 institutions, and Table 2 lists the top eight institutions in terms of publications. The top four institutions are all located in the UK, namely N8 Research Partnership (143 citations, 7 publications), University of Leeds (143 citations, 7 publications), White Rose University Consortium (143 citations, 7 publications), and RLUK-Research Libraries UK (24 citations, 4 publications). In addition, the top 3 institutions are consistent in terms of publications and total citations, and the 4th ranked institution is closer to the top 3 institutions in terms of publications and total citations, which is closely related to the network of institutional cooperation formed between them.

Table 2. Top institutions ranked by number of publications

Rank	Institution	Country	Number of publications	Citations	Publication start year
1	N8 Research Partnership	United Kingdom	7	143	2006
2	University of Leeds	United Kingdom	7	143	2006
3	White Rose University Consortium	United Kingdom	7	143	2006
4	RLUK-Research Libraries UK	United Kingdom	4	24	2013
5	University of Pennsylvania	USA	4	134	2013
6	California State University System	USA	3	101	2010
7	Curtin University	Australia	3	19	2019
8	East Carolina University	USA	3	15	2018

3.2.2 Author Collaboration Network

Analysing the authors of the literature can provide insights into the representative scholars and core research power in the field. Table 3 lists the top eight authors with two or more publications and citations in the EDOP research area, offering a preliminary understanding of the main authors' research areas and collaborators. The author with the highest number of publications is Brian Henson, with a total of four journal publications, 30 citations, and an average of 7.5 citations per article. His main research interests lie in the areas of affective design and human-centred design of rehabilitation devices. He has collaborated extensively with Cathy Barnes and Fabio R. Camargo. Additionally, the top three most cited authors are Martin Remann (248 citations, 2 publications), C. Chaya (124 citations, 2 publications), and J. Hort (124 citations, 2 publications). These authors constitute a core group of authors and researchers in the field of EDOP research, demonstrating a strong presence in the field.

Table 3. Top authors ranked by number of publications

Rank	Author	Number of publications	Citations	Citations per paper
1	Henson, Brian	4	30	7.5
2	Lee, Joseph G. L.	3	15	5
3	Camargo, Fabio R.	3	11	3.67
4	Remann, Martin	2	248	124
5	Chaya, C.	2	124	62
6	Hort, J.	2	124	62
7	Ng, M.	2	124	62
8	Piqueras-Fiszman, Betina	2	111	55.5

3.3 Distribution and Number of Journals and Disciplines

When analyzing the distribution of papers in journals, Bradford's law is usually used for verification. Bradford (1985) proposed that if scientific journals are arranged in descending order according to the number of papers published on a specific topic, a core area, a relevant area, and a non-related area can be divided, and the number of papers published in

each area is roughly equal. At this time, the number of journals in the core area, relevant area, and non-related area is in a 1: n: n^2 relationship. In the field of EDOP research, the regions of journals are divided according to the number of papers. The results are shown in Table 4. At this time, the number of papers in the three regions is 45, 43, and 41, which are roughly equal in number, and the ratio of the number of journals is 8: 29: 41, which is close to 1: 5: 5^2. This shows that the distribution of literature in journals in this study is basically consistent with Bradford's law.

Table 4. Journal zones according to Bradford's Law

Zone	Intervals ranked by number of journal publications	Number of journals	Number of publications
core zone	1-8	8	45
relevant zone	9-37	29	43
non-relevant zone	38-78	41	41

Journal statistics can reveal the journals that publish the most papers and contribute the most to the field (Tan et al., 2021). Table 5 shows the 8 core journals in the core zone determined according to Bradford's law. These journals account for 6.2% (8 articles) of the total number of journals, and the number of published articles accounts for 34.89% (45 articles) of the total number of published articles. Among them, the top three journals in the number of publications are Food Quality and Preference, Tobacco Control, and Journal of Retailing and Consumer Services, which have published 15, 7, and 5 articles respectively, which shows their important influence in the field of EDOP research.

Disciplinary classification can provide insights into scholars' research perspectives, methods, and fields of results. From the perspective of discipline distribution, the field involves several areas. These include Business (36 publications, accounting for 23.69% of the total), Food Science & Technology (27 publications, accounting for 17.76% of the total), Substance Abuse (14 publications, accounting for 9.21% of the total), Public Environmental & Occupational Health (13 publications, accounting for 8.55% of the total), Management (10 publications, accounting for 6.58% of the total), Applied Psychology (7 publications, accounting for 4.61% of the total), Imaging Science & Photographic Technology (4 publications, accounting for 2.63% of the total), and Multidisciplinary Engineering (4 publications, accounting for 2.63% of the total), among others. According to this discipline distribution, most of the literature can be categorised into three main disciplines: Business, Food Science & Technology, and Psychology. This not only reflects the multidisciplinary research background of the EDOP research field but also indicates the uneven development of the research structure in the discipline distribution of this research field.

Table 5. Core journals based on Bradford's Law

Rank	Journal	Number of publications	Citations	Citations per paper	Category quartile	Impact factor
1	Food Quality and Preference	15	762	50.8	Q1	5.6
2	Tobacco Control	7	150	21.43	Q1	5.7
3	Journal of Retailing and Consumer Services	5	47	9.4	Q1	10.5
4	Journal of Consumer Psychology	4	464	116	Q3	5.9
5	Foods	4	51	12.75	Q1	5.5
6	Color Research and Application	4	23	5.75	Q3	1.5
7	Psychology & Marketing	3	201	67	Q2	6.3
8	BMJ Open	3	102	34	Q2	3.3

3.4 Research Hotspots and Trends

3.4.1 Keyword Co-occurrence and Clustering

Keywords represent the core content of an article, and the analysis of keyword co-occurrences can identify the hot and emerging frontiers of research in a knowledge domain (Callon et al., 1991). The higher the frequency of keyword co-occurrence, the higher the degree of hotness in the research field. In this study, the top 10 high-frequency keywords were statistically obtained from the econometric analysis of a sample of 129 documents, which were (F and C represent frequency and centrality respectively): "perception" (F= 28, C=0.28), "design" (F=20, C=0.27), "packaging design" (F=20, C=0.18), " impact" (F=18, C=0.24), "consumer behaviour" (F=14, C=0.32), "responses" (F=13, C=0.11), "consumers" (F=11, C=0.20), "attitude" (F=11, C=0.19), "brand" (F=8, C=0.11), and "food" (F=8, C=0.10). In this case, the mediator centrality indicates the mediating role of the keyword in the mapping. The higher its value, the more influential the node is in general, and a value higher than 0.1 means that the node occupies an important position in the network (C. Chen, 2012). Based on the co-occurrence frequency and centrality of the above keywords, it indicates that the hotspot of the EDOP research field focuses on the consumer perspective, and in addition, the terms "consumer behaviour", "perception" and "design" have become the key nodes in this field, which means that the research on the impact of packaging design on consumer perception and consumer behaviour has occupied an important position in this field.

The analysis of keyword clustering mapping can uncover the core research themes in the field. In this study, the keyword co-occurrence network was clustered by the Likelihood ratio (LLR) algorithm, as shown in Figure 4, and a total of eight main clusters were obtained: "instantaneous desire" (cluster #0), "brand image" (cluster #1), "impact" (cluster #2), "product design" (cluster #3), "mental representations" (cluster #4), "health warning label" (cluster #5), "consumer behaviour" (cluster #6), "mere exposure" (cluster #7). The Modularity Q value of the clustering module obtained from CiteSpace mapping was 0.6346, >0.3, indicating a significant network structure, and the Weighted Mean Silhouette S value was 0.8406, greater than 0.7, indicating that the clustering results were reliable and met the criteria for scientific clustering (Wei et al., 2022). The clustering labels were inductively classified according to the principle of homogeneity and divided into four major research themes, as shown in Table 6, which are Emotional Communication of Brand Packaging, Emotional Triggers for Packaging Design, Emotional Experience and User Satisfaction, Emotional Design and Consumer Behaviour.

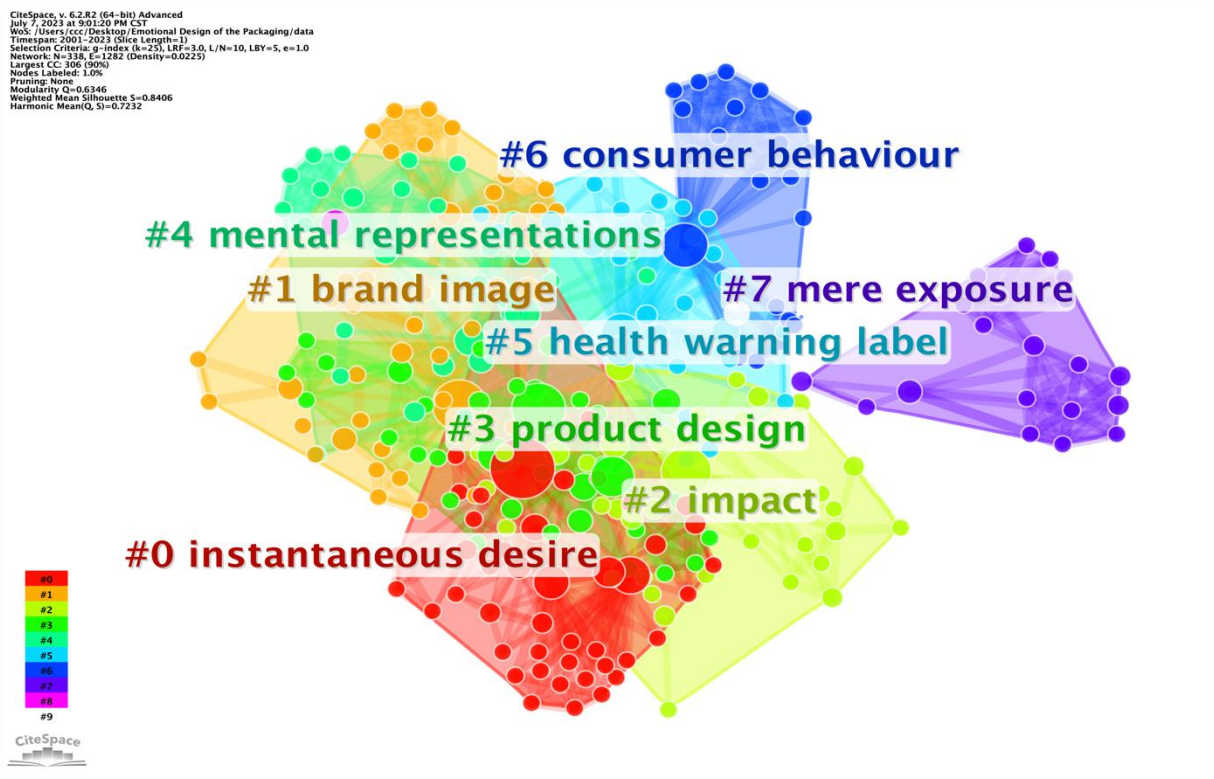

Figure 4. Network clustering of keywords co-occurrence

Table 6. Classification of research topics for network clustering of keywords co-occurrence

Cluster	Cluster size	Keywords	Research topics
#0 Instantaneous Desire	46	Perception, Design, Attitude, Brand, Choice, Emotion, Quality, Brand Image	Emotional Communication of Brand Packaging
#1 Brand Image	44		
#2 impact	41	Impact, Consumers, Consumption, Risk, Smokers, Intentions, Labels, Visual Appearance	Emotional Triggers for Packaging Design
#5 health warning label	30		
#3 product design	35	Product Design, Packaging Design, Mental Representations, Responses, Expectations, Sensory Marketing, Acceptability, Preferences	Emotional Experience and User Satisfaction
#4 mental representations	31		
#6 consumer behaviour	21	Consumer Behaviour, Product, Trust, Mere Exposure, Dual Process Theory, Cross Modal Interactions, Auditory Cues, Buying Process	Emotional Design and Consumer Behaviour
#7 mere exposure	20		

Research theme one is Emotional Communication of Brand Packaging, which contains two clusters, #0 and #1, with keywords "perception", "design", "attitude", "brand", "choice", "emotion", "quality", and "brand Image". This theme focuses on how brands communicate their image, identity, and values through packaging design. Scholars have explored how packaging design can be used to establish an emotional connection between the brand and the consumer and to communicate the brand's uniqueness and personality through packaging. For example, Bajaj & Bond (2018) explored the impact of visual design on brand perception and brand personality, and their findings suggest that a brand's visual design elements can have a significant impact on brand personality, which in turn influences consumers' attitudes and behaviours towards the brand. Chaya et al. (2015) explored how packaging design can influence the emotional attributes of beer and consumers' beer liking, which showed that packaging cues exerted a stronger influence on the emotional attributes of beer and the final product positioning, while the study also noted that congruence between the consumer and the brand image was more likely to elicit strong positive emotions. Therefore, packaging design can help establish an emotional connection between brands and consumers.

Research theme two is Emotional Triggers for Packaging Design, which contains two clusters, #2 and #5, and the keywords are mainly "impact", "consumers", "consumption", "risk", "smokers", "intentions", "labels", and "visual appearance". This theme focuses on how to evoke specific emotional responses from consumers through visual, colour, shape and material elements in packaging design. Scholars explore the effects of different emotional triggers and how they can be used to create packaging designs that resonate with consumer emotions. For example, Brennan et al. (2011) examined the effectiveness of mass media campaigns in promoting pictorial health warnings on cigarette packs and their impact on smokers' awareness of the health effects associated with smoking, cognitive and emotional responses, and willingness to quit, and their findings suggest that TV adverts and pictorial health warnings on cigarette packs can work in a complementary way to positively influence perceptions of the health effects of smoking and motivation to quit. Liao et al. (2015) used self-reported and physiological measures to jointly assess emotional responses to three typical packaging elements: colour, graphics and typeface. The results of their study suggest that food packaging can have an emotional impact on consumers and that by using both types of measurements, a more comprehensive understanding of the emotional responses that may be generated to food packaging can be gained. produce emotional responses.

Research theme three is Emotional Experience and User Satisfaction, which contains two clusters #3 and #4, and the keywords are mainly "product design", "packaging design", "mental representations", "responses", "expectations", "sensory marketing", "acceptability", and "preferences". This theme focuses on the impact of packaging design on user experience and satisfaction. This includes aspects of packaging such as ease of use, functionality, and sensory interaction, as well as the emotional responses and emotional connections that users make to packaging. Scholars have worked to optimise packaging design to provide positive emotional experiences and enhance user satisfaction. For example, Chang et al. (2018) focused on consumers' emotional responses to the shape of bottled beverage containers and explored how

possible corporate social responsibility (CSR) can be assessed at the conceptual design stage of product packaging, and their findings suggest that packaging design can significantly influence consumers' emotional responses and purchasing decisions. Sester et al. (2013) conducted a study through an empirical study that explored participants' mental representations of beer, their results indicated that consumers in the packaging condition paid more attention to the description and natural attributes of the beer, while consumers in the blind tasting condition paid more attention to the sensory attributes of the beer. This suggests that consumers' mental representations are influenced by factors such as packaging and brand image, which has important implications for product development and marketing in the beer industry.

Research theme four is Emotional Design and Consumer Behaviour, which contains two clusters #6 and #7, and the keywords are mainly "consumer behaviour", "product", "trust", "mere exposure", "dual process theory", "cross-modal interactions", "auditory cues", and "buying process". This theme focuses on the impact of affective design on consumers' purchasing decisions, brand loyalty and word-of-mouth communication, as well as the mediating mechanisms between emotional design and consumer behaviour. Mere Exposure Theory was first developed by psychologist Zajonc (1968), the main idea is that when a person is exposed to a certain stimulus (e.g. product, brand, advertisement, etc.) several times, their preference and goodwill towards this stimulus will gradually increase. The Mere Exposure effect is important in consumer behaviour research because it explains why repeated exposure to brands and advertisements affects consumers' purchase decisions. Dual Process Theory, first proposed by psychologist Stanovich (1999), focuses on two different thinking processes that people use when processing information and making decisions: System 1 (emotional-based thinking process) and System 2 (rational-based thinking process). Understanding these two thinking processes and their role in consumer decision-making can help companies and brands better design products, marketing strategies and communication methods to meet consumer needs and preferences. Mere Exposure and Dual Process Theory are classic theories of consumer behaviour that support a better understanding of brand preferences, purchase decisions and advertising effectiveness.

3.4.2 Evolution of Trending Themes

By analysing the evolutionary path of a particular research area, researchers can derive key information for a clearer understanding of the development of the research topic and its trends, as well as for predicting future research directions (X. Feng et al., 2022). The timeline view can be derived as a representation of the clustering results, presenting a more intuitive picture of their evolutionary path (Tan et al., 2021). Therefore, in this study, by applying the Timeline function of CiteSpace, we obtained Figure 5, which shows the temporal evolution of the trending topics of EDOP-related research during the period 2001-2023, based on the occurrence status of the keywords. In the Timeline view, the X-axis represents the year of publication and the Y-axis represents the number of clusters (Tan & Hao, 2022). The location of the circle in the graph represents the time when the keyword first appeared, the size of the circle represents the frequency of its appearance, the greater the frequency the larger the circle, and the colour of the circle indicates the time of the corresponding appearance, with the thickness proportional to the number of occurrences in the given time (C. Chen, 2006).

From the distribution status of keywords and the node information in the figure, the research history of EDOP can be roughly divided into the following 4 time periods. It is worth mentioning that there are cross-time periods between these 4 time periods, which are arranged in an overlapping relationship. The first time period is Emotional Communication (#0 & #1), which started around 2006 and peaked around 2010, which focuses on how brand packaging establishes emotional links with consumers. Moreover, keywords such as "visual attention", "emotional attachment" and "e-commerce" have become the emerging focus of the topic in recent years, and are likely to be at the forefront of research in this area in the coming years. The second time period is Emotional Factor Triggers (#2 & #5), which started around 2008 and reached its peak around 2014, in which the focus of research gradually shifted to how packaging design can elicit consumers' emotional responses and behaviours through emotional triggers. In recent years, keywords such as "intention", "risk" and "adult smokers perception" have emerged as emerging concerns on the topic and are likely to be at the forefront of research in the field in the coming years. The third time period is the Emotional Experience Phase (#3 & #4), which began around 2010 and peaked around 2018, where research began to focus on how packaging design can influence consumer satisfaction through emotional experience. Additionally, the keywords "appraisal", "approach-avoidance theory" and "edible packaging" represent the current emerging focus of the topic, and it is likely that more research will focus on these aspects in the coming years. The fourth time period, Emotional Design and Consumer Behaviour (#6 & #7), began around 2009 and has continued to evolve, albeit modestly, with a resurgence of interest in recent years. It is worth noting the emergence of the keyword "eco-friendly packaging" under the current research theme, suggesting that as the importance of sustainability issues continues to grow, researchers have begun to explore the combination of emotional design and environmentally friendly packaging, which is likely to be a future frontier for research in this area.

In summary, as market competition intensifies and the experience economy gains prominence, research in EDOP has been driven to evolve, marking four significant research periods: emotional communication, emotional factor triggering, emotional experience, and emotional design and consumer behaviour. Each period investigates the relationship between

packaging design and consumer emotions from different perspectives, offering relevant design strategies for brands and designers. This evolution reflects a deepening understanding of the intricate connection between consumer emotions and packaging design, underscoring the critical role of EDOP in the modern marketplace.

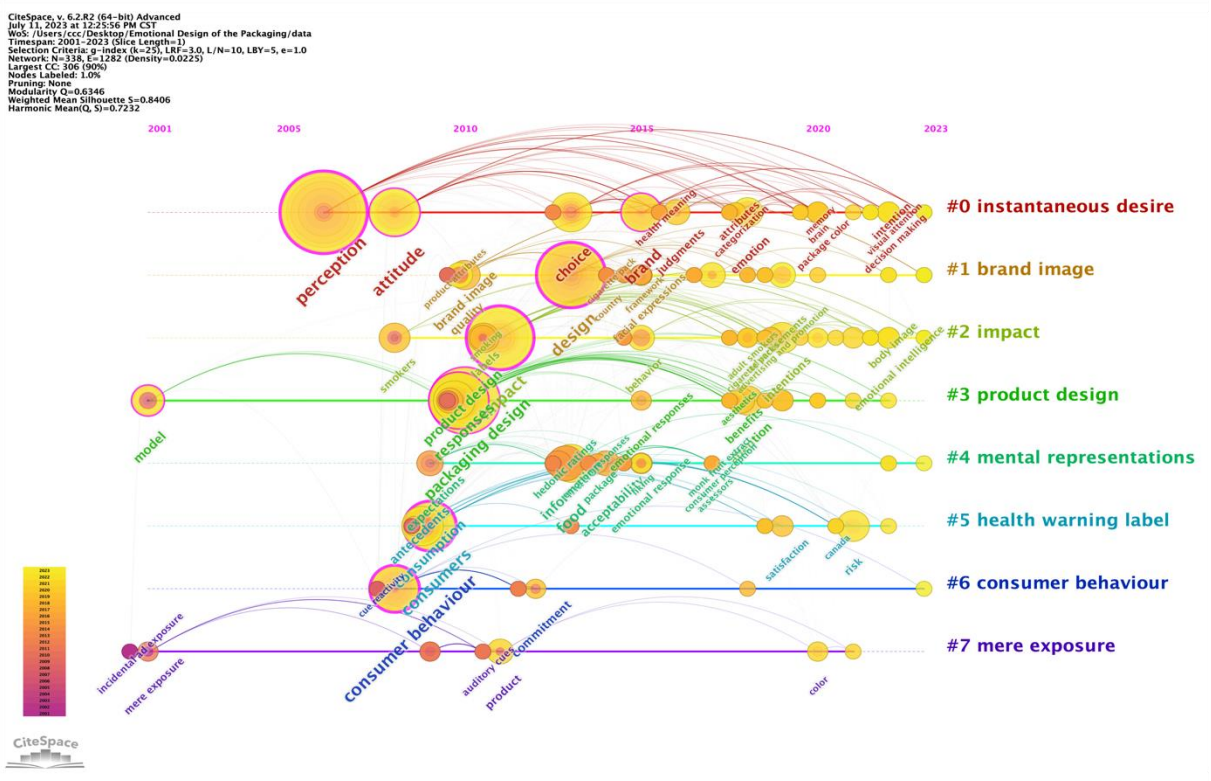

Figure 5. Timeline of keywords co-occurrence

3.5 Co-citation References

The cross-citation of scientific literature reflects the accumulation and continuity of scientific knowledge and is objective (Y. Feng et al., 2019). From the perspective of the co-citation network, the relationship between clusters and their positions can reveal the knowledge structure of a research field and give readers an overall understanding of the field (Sun et al., 2019). Co-citation frequency is the cumulative number of times that two documents appear together in the reference list of a third citing document (R. Li et al., 2022). In this study, we extracted references with co-citation frequency no less than 2 to construct a co-citation network, generating a co-citation cluster of literature consisting of 616 references and 14724 co-citation relationships, as shown in Figure 6 (nodes with thresholds that are too small are hidden in the figure for ease of reading). The clustering network shows co-cited literature with a citation frequency of no less than 2. The numerous nodes form three main clusters: Cluster #1 (yellow) - focuses on research on the sensory properties of food packaging and emotional measurement of users; Cluster #2 (green) - focuses on the modelling of the relationship between package design, branding, and consumer behaviour; Cluster #3 (red) - focuses on the mechanism of cigarette package design in tobacco marketing. The higher co-citation frequency indicates a higher academic influence in the field. Table 7 shows the key literature in the top 3 co-citation frequencies in each cluster, and the literature contained in these 3 clusters constitutes the most significant knowledge base in the EDOP research field.

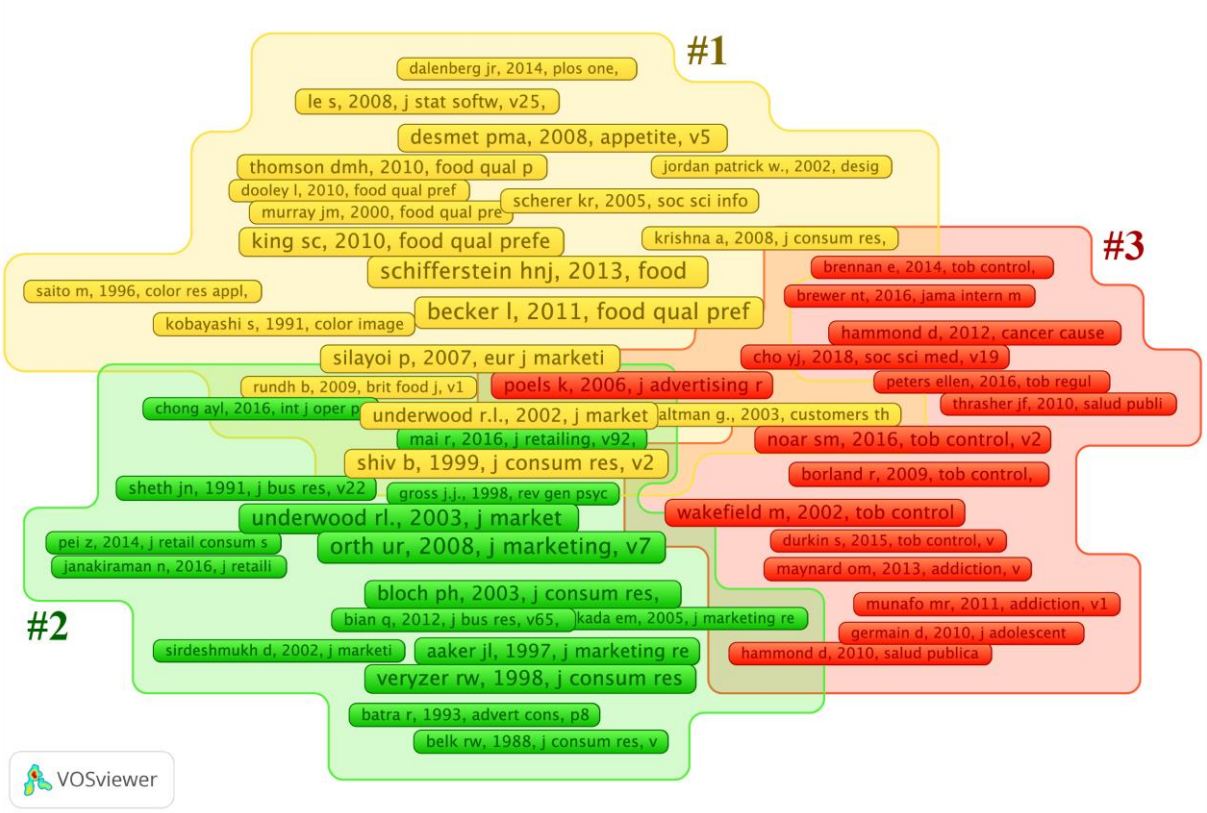

Figure 6. Network clustering of co-cited references

Cluster #1 (yellow) focuses on the study of Sensory Characteristics of Food Packaging and Emotional Measurement of Users. The highest co-cited frequency in this cluster was published by Schifferstein et al. (2013) in the Food Quality and Preference publication, which aims to understand how the sensory properties of food products and the emotional responses to them evolve at different stages of the user's interaction with the product, and the results of this study suggest that all of these properties may vary depending on the stage of product use. The 2nd most frequently co-cited paper was published by Becker et al. (2011) in the Food Quality and Preference journal, which explored the effects of packaging design on flavour impressions, taking into account the effects of participants' sensitivity to design, and the results of this study suggest that associations depicted by shape curvature are particularly transferable to the gustatory experience, but these effects are were most pronounced for participants who were sensitive to design. The 3rd most frequently co-cited document was published by Deliza & MacFIE (1996) in the Journal of Sensory Studies publication, which reviewed the literature on how advertising, packaging and messages generate sensory expectations, contributing to further links between sensory evaluation and marketing.

Cluster #2 (green) focuses on examining Modelling the Relationship between Packaging Design, Branding and Consumer Behaviour. The most co-cited document in this cluster was published by Orth & Malkewitz (2008) in the Journal of Marketing, which discusses the potential trade-offs between overall design type and the impressions generated and illustrates their findings with a large number of real packages. The 2nd most cited paper was published by Reimann et al. (2010) in the Journal of Consumer Psychology, which found that aesthetic package design significantly increased consumer choice response time. The third most frequently cited paper was published by Bloch (1995) in the Journal of Marketing, which introduced a conceptual model and several propositions on how product form relates to consumers' psychological and behavioural responses, which is intended to provide a more systematic approach to the study of design issues and to facilitate empirical work on product design.

Cluster #3 (red) focuses on the study of the Role of Cigarette Packaging Design in Tobacco Marketing. In this cluster, the highest co-citation frequency literature was published by Noar, Hall, et al. (2016) in the journal Tobacco Control, which meta-analysed the experimental literature on pictorial warnings on cigarette packages, with evidence from the international literature supporting that pictorial cigarette box warnings are more effective than text-only warnings. The second most cited paper was published by Poels & Dewitte (2006) in the Journal of Advertising Research, which explores different methods used to measure emotion in advertising, discusses their validity and applicability, and draws further conclusions about the relationship between emotion and traditional measures of advertising effectiveness. The third most frequently cited paper was published by Hammond (2011) in Tobacco Control, which reviews the evidence on the impact

of health warnings on tobacco packages, and concludes that health warnings on packages are one of the most direct and salient ways of communicating with smokers and that larger warnings with pictures are more effective than smaller text-only messages.

In summary, the knowledge base in the field of EDOP research is mainly composed of the above three clusters, which involve multiple disciplines, including psychology, marketing, and design. Basic theories, represented by psychology, correlate EDOP, sensory characteristics, and affective measures. The basic theory represented by marketing science associates EDOP with consumer behaviour. The basic theory represented by design science associates EDOP with graphic design elements and communication effects. It is worth mentioning that although this study is divided into three different research directions there is cross-cooperation between them, and they together constitute the main knowledge base in the field of EDOP research.

Table 7. Top 5 co-cited references in each cluster

Cluster	Title	(Authors, Publication year)	Citations
#1	Influence of package design on the dynamics of multisensory and emotional food experience	(Schifferstein et al., 2013)	277
#1	Tough package, strong taste: The influence of packaging design on taste impressions and product evaluations	(Becker et al., 2011)	604
#1	The generation of sensory expectation by external cues and its effect on sensory perception and hedonic ratings: a review	(Deliza & MacFIE, 1996)	840
#2	Holistic Package Design and Consumer Brand Impressions	(Orth & Malkewitz, 2008)	886
#2	Aesthetic package design: A behavioral, neural, and psychological investigation	(Reimann et al., 2010)	593
#2	Seeking the Ideal Form: Product Design and Consumer Response	(Bloch, 1995)	2852
#3	Pictorial cigarette pack warnings: a meta-analysis of experimental studies	(Noar et al., 2016)	594
#3	How to Capture the Heart? Reviewing 20 Years of Emotion Measurement in Advertising	(Poels & Dewitte, 2006)	560
#3	Health warning messages on tobacco products: a review	(Hammond, 2011)	1154

4. Conclusions and Prospects

Utilising bibliometric tools, this study reviewed 129 academic articles in the field of EDOP. It analysed the annual publication volume, scientific cooperation network, subject distribution, research hotspots and themes, the evolution of research trends, and the knowledge base of the research field. The results indicate that the field has undergone three main stages: the initial growth stage, the slow development stage, and the rapid development stage. Currently, in a stage of rapid development, the field has made significant progress over the past two decades, and further growth is anticipated in the future. In terms of scientific cooperation networks, there are certain national cooperation relationships in this field, but the overall network is not closely knit and requires strengthening. The regional characteristics of institutional cooperation are more prominent. The top four institutions in terms of publications are all located in the UK, yet cooperation between institutions in different regions is dispersed. Similarly, cooperation between authors is relatively scattered, and a core group of authors has not yet formed. According to Bradford's law, the most influential journals were determined to be Food Quality and Preference, Tobacco Control, and Journal of Retailing and Consumer Services. Keyword co-occurrence network clustering identified four major research themes: Emotional Communication of Brand Packaging, Emotional Triggers for Packaging Design, Emotional Experience and User Satisfaction, and Emotional Design and Consumer Behaviour. Notably, these four major research themes correspond to the four research periods of the EDOP

research process, with overlaps between the periods arranged in an overlapping relationship. The literature co-citation network identified three types of knowledge bases: the sensory characteristics of food packaging and the emotional measurement of users, the construction of relationship models between packaging design, brand and consumer behaviour, and the mechanism of cigarette packaging design in tobacco marketing. These constitute the most important knowledge bases in this research field.

Based on the above findings, the following recommendations are made for EDOP research, and the following areas of exploration are expected to be emerging trends in the coming years and will contribute to the development of the field.

(a) In terms of research disciplines, establishing broad and effective scientific collaborations can significantly enhance scientific output and impact across regions or countries. This will pose a challenge in the future but is essential for advancing the field. Moreover, as the research field of EDOP evolves, it is set to encompass a wider array of disciplines, including psychology, design, marketing, and food science, among others. This multidisciplinary approach is expected to introduce more innovative thinking and methodologies to packaging design, playing a pivotal role in furthering the development of the EDOP research field.

(b) In terms of research themes, through the analysis of the current era background and research frontiers, future EDOP research will focus on the themes of personalisation and customisation, sustainability and environmental protection, intelligent packaging and so on. The in-depth study of these research trends will help to meet the increasingly diverse needs of consumers and create more attractive and emotionally resonant product packaging.

(c) In terms of research methodology, the current approach within the field of EDOP research predominantly relies on empirical and quantitative methods, presenting a relatively narrow focus. Future research should embrace a more diverse combination of methodologies, leveraging the strengths of various approaches to achieve more comprehensive results. This multidimensional strategy will enable a deeper understanding of the intricate dynamics within EDOP research.

(d) In terms of research technology, the employment of more sophisticated technologies, such as machine learning and deep learning, can facilitate the analysis and pattern recognition of extensive datasets. This approach is aimed at uncovering the relationships between packaging design and emotional responses. Furthermore, the use of virtual reality, augmented reality, and biometrics technologies—including eye tracking and facial expression analysis—can provide deeper insights into consumers' emotional reactions to various packaging designs. This technological advancement will also demand greater innovation capabilities and research proficiency from researchers, pushing the boundaries of current methodologies and enhancing the depth of understanding in the field of EDOP.

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Authors contributions

Dr. Mat Redhuan Samsudin played a pivotal role in conceptualizing and designing the study, alongside offering essential feedback during the manuscript revision process. Chang Liu was instrumental in shaping the study's design, overseeing data collection and analysis, as well as crafting and refining the manuscript in response to feedback. Yuwen Zou provided valuable support in data analysis and played a key role in the manuscript's final stages of editing and review. All authors have thoroughly reviewed and endorsed the final manuscript for submission, ensuring its readiness and compliance with academic standards.

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