A Bibliometric Study of Research Topics and Sustainability of Packaging in the Greater China Region

Rui-Liang Wang 1,2, Tzu-Fan Hsu 3,* and Chen-Zhong Hu 4

Abstract: The consumption and sustainability of packaging are significant concerns. With development of the division of labor during economic globalization, packaging issues are viewed differently in different regions. This study focused on the Greater China region, which has recently experienced rapid economic growth. Bibliometric analyses were performed using data from two Chinese academic databases, CNKI-CAJD of Mainland China and CEPS of Taiwan; 24,790 journal papers on packaging published between 1989 and 2019 were investigated using keyword co-occurrence analyses and cluster maps. The history of research on packaging in Greater China is summarized and the research areas are categorized into five common subjects: design and consumption assessment, marketing and image packaging, food packaging, special item packaging, and structure and materials. Among these subjects, CNKI-CAJD mostly focuses on industrial applications in packaging institutions and industry, division of labor in the packaging industry, and foreign trade commodity packaging, while CEPS focuses on diversified aspects of green design and education in packaging and environmental protection and packaging development. The results map out Chinese research on packaging and can serve as a reference for applying environmental sustainability in the packaging field.

Keywords: packaging; bibliometrics; Greater China region; sustainability; green packaging; literature review

1. Introduction

1.1. Packaging, Consumption, and Sustainability

Sustainable development is a global issue of concern. With global diversified development, research on differences in developmental changes from a regional perspective is receiving greater attention [1]. During the past three decades, Chinese-speaking regions have experienced significant economic development [2]. Generally speaking, the Greater China region in the Asia-Pacific region refers to the four Chinese-speaking districts of the Cross-Straits, namely Mainland China, Taiwan, Hong Kong, and Macau. As consumption continues to grow, packaging has become an important factor in the competitiveness of products by enhancing the attractiveness of brands and promoting market sales.

The essential purpose of packaging is to ensure that goods remain intact during transit from producers to consumers [3]. In other words, packaging must satisfy the requirements of containing, transporting, and wrapping the product, and promoting sales. In addition, to increase attractiveness, packaging design must beautify the goods and facilitate their display. Through advertising and the strengthening of product images, packaging may promote the economic objectives for a product [4,5]. Broadly, the external form of all things with use-value in the realm of human activity can be categorized as packaging [6,7].
This definition indicates that many items in life, including packaging of space, costume design, image design, media, or even Internet marketing, can be considered clienteles and categories of packaging to varying degrees.

However, issues such as excessive packaging, cumbersome structures, complicated material processing, and disposable consumables, which result from improper packaging design, do not increase convenience in practical use; in fact, they further damage and unbalance the ecological environment. The pollution from packaging, caused by careless consumption processes, has prompted reflections on the importance of sustainable development that strikes a balance between economic development and environmental ecology [8]. To ensure that products meet specific environmental protection requirements through the entire life cycle from production to consumption, in recent years the field of green design has advocated design behaviors from the perspective of planning and attempts to further incorporate environmental protection concepts.

Packaging hinges on a balance between economic development and sustainability. As this is a topic that researchers have long explored, the development of relevant topics reflects the phased characteristics of various regions. Therefore, the purpose of this study was to perform a systematic literature review of packaging research in the Greater China region to examine the categories and fields of packaging, investigate the possibility of integrating sustainable development, and facilitate awareness of sustainability in packaging research.

1.2. Applying Bibliometrics to a Review of Packaging Research

From the perspective of replacement and innovation, reviews may examine the relationship between a research subject and supporting data. Such reviews are pillars of particular areas that allow the continuous renewal of follow-up research [9]. For the selection of sources for reviews, three methods may be applied.

From the perspective of the research subject (or the field): Based on the research subject, this method provides retrospective analyses and evidence for research. It focuses on the discourses, comments, and analyses of selected sources and identifies research trends and outlooks on the issue. For instance, the development and perspective on negative air ions in Taiwan and Mainland China [10] and the trends in empirical studies of aesthetics in the past century [11] have been studied using this review method.

From the perspective of specific publications (e.g., journals): As academic journals provide academic content marked by novelty, truth, and continuity, they are the first choice of source type in reviews. Retrieving materials from representative journals of specific fields has become another common research method. For example, the Journal of Design was selected as a research object in 2007 to examine the research trends in design and conduct a citation analysis of design [12].

From the perspective of literature databases (i.e., citation databases): in recent years, the constructions of academic literature databases have greatly improved, becoming increasingly convenient sources with complete lists of references for research. For example, the research trends and topics of information communication have been analyzed using the database of the National Digital Library of Theses and Dissertations in Taiwan [13]. As the completeness and richness of published material have increased with the development of academic research, this method has become the main choice for reviews in recent years.

Currently, reviews in the field of packaging methods are rare, and few studies reflect overall academic research in the field. In this study, exploration of databases was carried out on the subject of packaging research. Digital tools were also applied to examine and clarify the current situation and development of research in the field of packaging.

Furthermore, bibliometrics is an effective and reliable method to analyze the masses of material in databases [14]. It is widely used in library and information science, management science, and design studies research. For example, in one e-learning study, subject analysis and keyword co-occurrence were applied to the literature cited in the SSCI database using CATAR, an automated exploration toolkit for bibliometrics research [15]. In addition, as graph visualization tools for bibliometrics analyses such as VOSviewer, CRExplorer,
SciMAT, and CiteSpace have gradually improved, this method of literature review, which is systematic and yields objective data, not only reduces the risk of the subjective judgment of researchers in the field but also presents the results of text discourse analysis.

1.3. Research Issues

As Chinese database technologies have developed, libraries for academic research have become increasingly complete. Citation formats have been increasingly standardized, though databases have different specifications of construction. Other issues in processing include support of certain language families, transcoding, and analyses with current bibliometrics tools (such as visualization tools). As a result, bibliometric studies of Chinese databases are relatively rare. Therefore, in this study, bibliometric methods were applied in an investigation of citation databases to organize and analyze literature on packaging in the Great China Region. The text materials underwent artificial preprocessing for compilation. Next, the historical development of the field of packaging was examined, and relevant scopes of subjects were compared regarding environmental sustainability to enhance the richness and completeness of packaging research in the Greater China region.

2. Materials and Methods

2.1. Theories of Bibliometrics

Bibliometrics, which has become an independent discipline in recent years, refers to research that organizes and analyzes aspects of literary works using mathematics, statistics, and logic [16,17]. Various bibliometric approaches may be used, including subject, evaluation, and prediction bibliometrics [18,19]. For example, subject bibliometrics explores the principles of evaluating academic research subjects using relational analysis and maps the distribution structure of the literature in a particular period or field; it is also used to visualize the distribution of various units of measurement by mapping knowledge domains, affording more concise results [20].

Co-occurrence analysis is a method of bibliometric analysis based on the proximity connection rule of psychology, and knowledge structure and mapping principles that allow quantitative investigation, revealing the associated features of content and implicit knowledge framework in a text corpus [21–23]. “Co-occurrence” refers to the frequency at which two terms appear concurrently by chance in the corpus. Such terms appearing concurrently are considered semantically related or treated as idioms [24]. Co-occurrence analysis can be categorized into three types by purpose and the object evaluated:

Cocitation analysis: Cocitation refers to concurrent citation of two or more documents by another document. This method is suited to exploring popular or frequently cited representative pieces of literature [25].

Coword analysis: This is a quantitative evaluation method based on statistical analysis of the frequencies of the “sets of terms” (or “chunks”) common to documents with the same scope. The frequencies of words appearing concurrently are used to measure their similarity and elucidate the knowledge structure of that field [26]. For example, keyword co-occurrence analysis is a type of coword analysis of the keywords of a corpus. Partnerships of authors and partnerships of institutions can also be analyzed with these methods.

Coterms analysis: A co-occurrence evaluation of semantically related terms used in various corpora with the same scope. As the sampled texts come from a more extensive source, the relational analysis emphasizes their parts of speech and semantics to judge their distribution relationships.

In the discussion of disciplinary fields (or subjects), coword analysis and coterms analysis are common choices for co-occurrence analysis. Coword analysis is more accurate and simpler, whereas coterms analysis is complicated by the fact that the wider choice of sources may introduce uncertainties in the semantic analysis [27]. However, at present, bibliometrics software mainly supports content in English and languages of the same family in coword analysis. Therefore, it is more appropriate and feasible to apply coword analysis to Chinese citation databases.
2.2. Sampling of Literature Databases

Currently, databases of Chinese journals in Greater China are mainly distributed across Mainland China, Taiwan, Hong Kong, and Macau; of these, the databases of Mainland China and Taiwan are relatively complete. In Mainland China, some better-known databases for simplified Chinese journals include such index systems as the China Academic Journal Network Publishing Database (CNKI-CAJD), Chinese Science Citation Database (CSCD), and Chinese Humanities and Social Science Citation Database (CHSSCD), of which the CNKI-CAJD database is a crucial project of Mainland China’s “Integrated Knowledge Resources Database” publishing plan, and covers most journals found in the CSCD and the CHSSCD. Specifically, 8000 journals from Chinese-speaking regions published from 1915 to the present are included. Hence, CNKI-CAJD was adapted as the sampling database of simplified Chinese journal. Conversely, better-known databases for traditional Chinese journals in Taiwan include the Chinese Electronic Periodical Service (CEPS), HyRead Journal, and Index to Taiwan Periodical Literature System. Of these, the CEPS contains the full texts of Chinese journals published in the Greater China region since 1960, including more than 2000 Taiwanese journals, and is the largest database of traditional Chinese academic journals in Taiwan. The Chinese journal databases in Hong Kong and Macau include HKInChiP and the Macau Public Library database. However, these databases are largely included in CNKI-CAJD and CEPS, and the distribution results are as shown in Figure 1. Considering the inclusiveness of the above databases comprehensively and the authority, validity, and completeness of the data sources, this study selected the CNKI-CAJD and CEPS journal databases for investigation.

![Sampling Databases](image)

**Figure 1.** Sampling range of the electronic academic journal databases in Chinese-speaking regions.

For query criteria on the CNKI-CAJD and CEPS databases, the keyword “packaging” was used for queries on 30 May 2020, and the search area was limited to Chinese publications from Chinese-speaking regions. The time range of inclusion was set between 1989 and 2019. The above criteria were applied for a precise query.
The text data derived from the literature in the databases need to be preprocessed before analysis, depending on the adaptability of the analysis software [28–30]. Therefore, before being imported into the bibliometrics software for analysis, the text materials were preprocessed with Notepad++ code editor using UTF-8 format for encoding. Combined with manual operations, the following contents of the text data underwent combing and adjustments (called disambiguation for preprocessing) individually: unification of Traditional Chinese and Simplified Chinese, merging of synonyms, punctuation format, symbol format, recovery of abbreviations, language and text correction, and deduplication. The credibility of the data read can be ensured via the standardization of text data.

Regular expressions are used in the Notepad++ code editor (V7.8.1) to process the text data with standardized rules. Regular expressions are computer language algorithms that embody certain rules [31]. Therefore, the regular expression syntax applied to the database samples is as follows:

1. **Step 1: Remove contents including redundant keywords and abstract texts.**
   - Find: input ("ˆ(KW|AB)-([\x{000e}-\x{4dff}]+)\n")
   - Conversion: output ("")

2. **Step 2: Regularize the codes of keywords.**
   - Find: input ("([\-s]+?)\s*")
   - Conversion: output ("KW-1")

After the abovementioned standardization, 24,340 journal papers were retrieved from the query in the CNKI-CAJD database, while 2431 journal papers were retrieved from the query in the CEPS database. After the data were organized and merged, 24,790 journal papers formed the database used as the sampling source of academic research on packaging in this study.

### 2.3. Selection of Bibliometric Tools

The Visualization of Similarities Viewer (VOSviewer) is a bibliometrics analysis software tool [32,33] developed by Nees Jan van Eck and Ludo Waltman of The Centre for Science and Technology Studies of Leiden University, Netherlands. The tool can present the results via mapping knowledge domains based on bibliometric analysis principles. Like SCI2, CiteSpace, citNetExplorer, and SciMAT, VOSviewer is commonly used in the bibliometric research.

As VOSviewer (Version 1.6.15) is one of the few software tools that support traditional and Simplified Chinese [34–36], it is best suited to analyzing the text code format derived from literature databases in Chinese-speaking regions, and was thus selected for the bibliometric analysis in this study.

Furthermore, in the knowledge domains produced by VOSviewer, circles are shown in the network cluster maps whose sizes reflect the frequency of co-occurrence of the keywords in the nodes. The distances between the circles represent the similarities (relationship strength) of keyword co-occurrence, and the widths of the linking lines represent the association strengths of keyword co-occurrence. Circles with similar colors are marked as the same cluster, and the results effectively reflect the categories of the research topic and research hotspots of a disciplinary field [35–37]. This study applied the above principles to analyze the sample retrieved from CNKI-CAJD and CEPS and interpret the development of packaging research in the Greater China region.

### 3. Results

#### 3.1. Analysis of the Current Situation of Packaging Research in the Greater China Region

**3.1.1. Development of Packaging Research**

To analyze the 24,790 journal papers retrieved from the CNKI-CAJD and CEPS databases, a single year was treated as the interval for aggregating the numbers of papers in each publication year. Academic research papers on packaging in the Chinese-speaking region from 1989 to 2019 were categorized into four stages: initiation, development, maturity, and transition. The results are shown in Figure 2.
The number of papers concerning packaging in the initial stage from 1989 to 1993 was relatively low. The topics largely pertained to industrial functions, including the functions, production and technology, and product exports (foreign trade) of packaging. The first packaging research paper discusses the processing and development of product collections of emblics at the Yuan He Tang Candied Fruit Factory in Quanzhou, China, focusing on canned products [38]. In addition, packaging for export-oriented products was gaining attention, such as a study of how clothing compression packaging, a technology introduced from Japan, was utilized in Mainland China [39].

Research was in the development stage from 1994 to 2009. After Deng Xiaoping’s southern tour, Chinese economic reform commenced in Mainland China. Packaging research flourished as the number of papers began to grow and their topics diversified. Simultaneously, the focus gradually shifted from industrial functions to commercial consumption. Research focusing on packaging design also began to appear in 1999, including an investigation of containers for fresh fruit packaging design [40] and a discussion-based study of the effect of the visual design of tea beverage packaging on consumers’ psychological cognition [41]. That year can also be regarded as the starting point for research on packaging design in the Greater China region. During the same period, the economic structure of Taiwan shifted from labor-intensive to an industrial form that emphasized high technology and value-adding. The amount of packaging research also increased rapidly. In addition, keywords such as “excessive packaging” and “packaging waste” appeared in Chinese packaging research in 2000, reflecting increased research on the reduction of packaging waste and the construction of recycling systems, which promoted the study of environmental conservation in packaging research.

In the stage of maturity from 2010 to 2015, the annual number of publications concerning packaging research remained steady, while the topics further expanded, including consumer psychology studies, sustainable care, and the elderly, to explore the possibilities of packaging [42,43].

Finally, during the stage of transition, from 2016 to 2019, as the Chinese-speaking regions gradually entered the post-industrial era, the extreme maturity of industrial technology in the packaging field led to a reduction in packaging research. With the rise of online consumption in the information age, people’s consumption patterns and habits have changed, while experiential consumption has received more attention. Thus, the focus of packaging research has shifted to related disciplines such as Internet marketing, experiential consumption, and Kansei engineering. The fluctuations and characteristics of packaging research were closely related to the development of society and economy.
of the stages detailed above show that along with the development of the social economy and the improvement of living standards, the subjects in packaging research also reflect the characteristics of the atmosphere in different periods.

### 3.1.2. Key Journals of Chinese Packaging Research

According to the statistics of the databases, in the past three decades, 24,790 papers concerning packaging research were published in 4075 journals, while most of the issuing institutions were associations and research institutes of universities. Specifically, 2603 (63.9%) journals published one or two relevant papers, while 7008 (28.3%) papers were published in the top ten journals. The publication was highly concentrated, indicating the importance of high-ranking journals. The journals that ranked in the top ten in the number of publications of packaging research papers in the Greater China region are listed in Table 1.

**Table 1.** Top ten journals in the packaging field in 1989–2019 (according to CNKI-CAJD and CEPS).

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Journal</th>
<th>Number of Publications</th>
<th>Publication and Issuing Institution</th>
<th>Subject Category</th>
<th>Academic Indicators</th>
<th>Focused Fields of the Journal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Packaging Engineering</td>
<td>1883</td>
<td>No. 59 Institute of China Ordnance Industry</td>
<td>Engineering Technology</td>
<td>CN-Core, CA, JST</td>
<td>Comprehensive packaging</td>
</tr>
<tr>
<td>2</td>
<td>China Packaging Industry</td>
<td>1186</td>
<td>China Packaging Industry Publishing House</td>
<td>Engineering Technology</td>
<td></td>
<td>Comprehensive packaging</td>
</tr>
<tr>
<td>3</td>
<td>Packaging World</td>
<td>911</td>
<td>Zhejiang Packaging Technology Association</td>
<td>Engineering Technology</td>
<td></td>
<td>Comprehensive packaging</td>
</tr>
<tr>
<td>4</td>
<td>Shanghai Packaging</td>
<td>896</td>
<td>Shanghai Packaging Technology Association</td>
<td>Engineering Technology</td>
<td></td>
<td>Comprehensive packaging</td>
</tr>
<tr>
<td>5</td>
<td>China Packaging</td>
<td>780</td>
<td>China Packaging Federation</td>
<td>Engineering Technology</td>
<td>CN-Core, JST</td>
<td>Comprehensive packaging</td>
</tr>
<tr>
<td>6</td>
<td>Printing Technology</td>
<td>547</td>
<td>China Academy of Printing Technology</td>
<td>Engineering Technology</td>
<td>CN-Core</td>
<td>Printing technology, management of printing, printing market</td>
</tr>
<tr>
<td>7</td>
<td>Print Today</td>
<td>245</td>
<td>Beijing Printing Machinery Research Institute</td>
<td>Engineering Technology</td>
<td></td>
<td>Printing technology, management of printing, printing market</td>
</tr>
<tr>
<td>8</td>
<td>Hunan Packaging</td>
<td>219</td>
<td>Hunan Packaging Technology Association</td>
<td>Engineering Technology</td>
<td></td>
<td>Comprehensive packaging</td>
</tr>
<tr>
<td>9</td>
<td>China Food Industry</td>
<td>174</td>
<td>China National Food Industry Association</td>
<td>Engineering Technology</td>
<td></td>
<td>Food and safety, packaging industry</td>
</tr>
<tr>
<td>10</td>
<td>Packaging and Food Machinery</td>
<td>167</td>
<td>Chinese Mechanical Engineering Society</td>
<td>Engineering Technology</td>
<td>CN-Core, CA, JST</td>
<td>Food and safety, packaging industry, mechanical technology</td>
</tr>
</tbody>
</table>
The results in Table 1 show that the top ten journals that published the most papers are all included in the CNKI-CAJD database, and they fall in the subject category of engineering technology. This suggests that as Mainland China’s industrialized production and consumption market grows, more resources are invested in packaging research. Additionally, there is a large base of researchers; thus, the total number of papers included in the CNKI-CAJD database is higher than in the CEPS database.

3.2. Subject Areas of Packaging Research

Keywords specify the core essences of a paper. By extracting the co-occurrence frequency of keywords and constructing a matrix, the association strengths between phrases can be analyzed [44,45]. To examine the characteristics of the subjects of CNKI-CAJD and CEPS, VOSviewer was used to perform keyword co-occurrence analyses of the papers sampled from the two databases. Keyword coword analysis was used to visualize the associated network, while the established network cluster maps were used to explore the subject categories in academic packaging research and analyze the scopes of the subdivided subjects.

3.2.1. Subject Categories of the CNKI-CAJD Database

A total of 24,340 journal papers were retrieved from the CNKI-CAJD database, which mainly included papers from Mainland China. Standardization was performed using the keywords of the selected papers to yield 42,048 keywords. For effective convergence of the subgroups, semantically related keywords were merged and removed. Keywords with a co-occurrence frequency of more than five were selected to establish the network cluster map, as shown in Figure 3.

![Figure 3](image-url)

**Figure 3.** Network cluster map from the keyword co-occurrence analysis of the CNKI-CAJD database.

Based on the attributes of the keywords shown in each cluster, the subjects of packaging research in CNKI-CAJD were grouped into eight categories: (A) design and consumption assessment, (B) marketing and image packaging, (C) packaging institutions and industries, (D) packaging technology and process, (E) foreign trade commodity packaging, (F) food packaging, (G) special item packaging, and (H) division of labor in the packaging
industry. The keywords of each subject cluster are organized and shown in Table 2 to reflect the knowledge structure of relevant issues and name the subject clusters accordingly.

Table 2. Exploration of subject categories of packaging research in the CNKI-CAJD database.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Research Subject</th>
<th>Research Issue</th>
<th>Keyword Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Packaging design and consumption assessment</td>
<td>Packaging design elements</td>
<td>Color, text, visual element, graphic design, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regional packaging</td>
<td>Culture, ethnicity, souvenir, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green design</td>
<td>Environmental protection, green packaging, circular economy, sustainable development, reduction, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Consumption assessment</td>
<td>Consumers’ preference, emotion, consumer psychology, consumer behavior, etc.</td>
</tr>
<tr>
<td>B</td>
<td>Marketing and image packaging</td>
<td>Packaging as a marketing tool</td>
<td>Marketing strategy, business management, after-sales service, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Image packaging</td>
<td>Brand image, commodity, image advertising, visual identity, etc.</td>
</tr>
<tr>
<td>C</td>
<td>Packaging institutions and industry</td>
<td>Packaging institutions</td>
<td>Printing technology association, publishing house, Hunan Province, cultural institutions, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packaging industries</td>
<td>Packaging industry, light industry, packaging competition, book industry, etc.</td>
</tr>
<tr>
<td>D</td>
<td>Packaging technology and process</td>
<td>Packaging technology</td>
<td>Packaging equipment, expert, packaging machine, exhibition, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packaging process</td>
<td>Printing equipment, materials, ink, processing plant, cardboard, etc.</td>
</tr>
<tr>
<td>E</td>
<td>Foreign trade commodity packaging</td>
<td>Foreign trade destination (country)</td>
<td>USA, Europe, North America, South Asia, India, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Content of Foreign trade commodity</td>
<td>Paper product, sales, differentiation, etc.</td>
</tr>
<tr>
<td>F</td>
<td>Food packaging</td>
<td>Food packaging</td>
<td>Packaging bag, fruit, food safety, agricultural product, etc.</td>
</tr>
<tr>
<td>G</td>
<td>Special item packaging</td>
<td>Medicine packaging</td>
<td>Medicine, expiry date, veterinary drugs, healthy food, pesticide, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chemical packaging</td>
<td>Chemical contaminant, iron drum, cardboard barrel, etc.</td>
</tr>
<tr>
<td>H</td>
<td>Division of labor in the packaging industry</td>
<td>Packaging engineering</td>
<td>Transportation, warehousing, management, logistics, subcontracting, etc.</td>
</tr>
</tbody>
</table>

3.2.2. Subject Categories of the CEPS Database

The CEPS database includes journal papers that are mainly from Taiwan. After standardization, 2431 journal papers and 4966 keywords were retrieved. As in the above-mentioned steps, semantically related keywords were merged and removed, and keywords with a co-occurrence frequency of more than five were selected. After co-occurrence analysis, a network cluster map was established (Figure 4).
mentioned steps, semantically related keywords were merged and removed, and keywords with a co-occurrence frequency of more than five were selected. After co-occurrence analysis, a network cluster map was established (Figure 4).

Figure 4. Network cluster map from the keyword co-occurrence analysis of the CEPS database.

Based on the distribution of the network cluster map shown in Figure 4, the subjects of packaging research in CEPS were grouped into eight categories: (a) design and consumption assessment, (b) packaging and environmental protection, (c) food packaging, (d) packaging structure and container, (e) development of packaging, (f) marketing and image packaging, (g) special item packaging, and (h) packaging technology and materials. Similarly, to clarify the subdivisions of each category, the keywords of each subject cluster were organized as in Table 3.

Table 3. Exploration of subject categories of packaging research in the CEPS database.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Research Subject</th>
<th>Research Issue</th>
<th>Keyword Set (from Cluster Results)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Packaging design and consumption assessment</td>
<td>Packaging design elements</td>
<td>Visual representation, text, creativity, color psychology, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regional packaging</td>
<td>Tradition, ethnicity, culture, art of calligraphy, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Consumption assessment</td>
<td>Consumer psychology, image, consumer, emotion, market, personalization, etc.</td>
</tr>
<tr>
<td>b</td>
<td>Packaging and environmental protection</td>
<td>Green design</td>
<td>Green packaging, sustainable development, green packaging design, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packaging and education</td>
<td>Teaching reform, personnel training, packaging education, etc.</td>
</tr>
<tr>
<td>c</td>
<td>Food packaging</td>
<td>Food packaging</td>
<td>Package safety, food safety, plastic packaging, evaluation, etc.</td>
</tr>
</tbody>
</table>
Table 3. Cont.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Research Subject</th>
<th>Research Issue</th>
<th>Keyword Set (from Cluster Results)</th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>Packaging structure and container</td>
<td>Packaging structure</td>
<td>Packaging structure, structural design, packaging methods, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packaging container</td>
<td>Packaging container, packaging carton, etc.</td>
</tr>
<tr>
<td>e</td>
<td>Development of packaging</td>
<td>Packaging research development</td>
<td>Development trend, modern packaging, preservation packaging, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packing strategy</td>
<td>Countermeasure, environment, recycling, modern logistics, etc.</td>
</tr>
<tr>
<td>f</td>
<td>Marketing and image packaging</td>
<td>Packaging as a marketing tool</td>
<td>Marketing, packaging art, evaluation system, packaging management, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Image packaging</td>
<td>Brand, advertising image, brand image, corporate identity, etc.</td>
</tr>
<tr>
<td>g</td>
<td>Special item packaging</td>
<td>Medicine packaging</td>
<td>Medicine packaging, transportation, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Military packaging</td>
<td>Ammunition, vibration, military product packaging, etc.</td>
</tr>
<tr>
<td>h</td>
<td>Packaging technology and materials</td>
<td>Packaging technology</td>
<td>Control system, nanotechnology, vacuum packaging, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packaging materials</td>
<td>Corrugated cardboard, Plastic, optimum design, buffer packaging material, etc.</td>
</tr>
</tbody>
</table>

4. Discussion

4.1. Analysis of Packaging Research in the Greater China Region

When the abovementioned results of the subjects of CNKI-CAJD and CEPS were compared, the common subjects and individual subjects were organized based on the keywords and categories of each subject (Table 4); thus, the development of packaging research subjects in the Greater China region can be further analyzed.

Table 4. Comparison between the subject categories of packaging research in Chinese databases.

<table>
<thead>
<tr>
<th>Database</th>
<th>Common Subjects (Cluster)</th>
<th>Individual Subjects (Cluster)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNKI-CAJD</td>
<td>Design and consumption assessment (A&amp;a)</td>
<td>Packaging institutions and industries (C)</td>
</tr>
<tr>
<td></td>
<td>Marketing and image packaging (B&amp;f)</td>
<td>Division of labor in packaging industry (H)</td>
</tr>
<tr>
<td></td>
<td>Food packaging (F&amp;c)</td>
<td>Foreign trade commodity packaging (E)</td>
</tr>
<tr>
<td></td>
<td>Structure and materials (D&amp;d&amp;h)</td>
<td>Packaging and environment protection (b)</td>
</tr>
<tr>
<td></td>
<td>Special item packaging (G&amp;g)</td>
<td>Development of packaging (e)</td>
</tr>
</tbody>
</table>

4.1.1. Organization of Common Subjects

In the packaging-related research in the Greater China region, the results of Table 4 show that there are five common subjects: (1) design and consumption assessment, (2) marketing and image packaging, (3) food packaging, (4) special item packaging, and (5) structure and materials. The content scopes of each subject were analyzed as follows.
Design and Consumption Assessment

The main concerns of this subject category are commercial activities, since it regards packaging design as a means to encourage consumption behavior. The category is mainly composed of packaging design and consumption assessment. The former focuses on enhancing the appearance of products through the design presentation of the packaging, such as the visual elements of images, labels, colors, and text, constrained by the labeling regulations of product information, such as a compliance study of nutritional labeling on marketed food packages in 2007 to discuss the labeling regulations and the real situations [46], while other studies [47–49] explores the use of regional cultural characteristics such as culture, customs, and symbols as reflected in packaging design, structure, and modeling to increase the consumers’ inner identification characteristics, apart from the increase in visual appeal. The corresponding significant keywords include visual design, culture, tradition, ethnicity, and art of calligraphy. The latter, consumption assessment, focuses on the analysis and research of consumer behavior. The assessments of purchasing willingness and consumption choice provide feedback on the information of consumption status, adjustments of packaging design, and strategies of production and sales so as to improve products’ economic and environmental efficiencies. The major keywords and researchers in this field pertain to consumer psychology [50,51], consumers [52,53], and consumer preferences [54,55]. Additionally, in the studies of consumer survey, relevant researchers pointed out that establishing consumers’ awareness and attitudes towards green consumption are two important factors in enhancing green packaging and sustainable consumption behavior [56,57].

Marketing and Image Packaging

With the prosperity of the market economy, packaging as a marketing tool is much needed in product promotion to strengthen the image theme and increase contacts and possibilities through communicative efficiency. Thus, there is a considerable proportion of research papers that focus on matching packaging with marketing. This category mainly subsumes two subjects, i.e., packaging as a marketing tool and image packaging. The effectiveness of packaging as a marketing tool must be assessed by research using packaging market and consumer analyses before the construction of marketing strategies with packaging as the means and the application of visual image design of packaging to influence consumer behavior. Moreover, packaging image and strategic sales are suggested by relevant researchers to be an effective marketing method for consumers to accept sustainable packaging and build brand trust of ecofriendly products [58,59]. Therefore, the major keywords and research topics of related subjects include marketing strategy [60,61], packaging management [62,63], and after-sales service [64,65]. Furthermore, image packaging is a broad packaging concept that refers to the image advertising of the product [66,67], brand image [68,69], product image [70], and visual identity [71,72]. In recent years, the prevalence of internet marketing has also been a part of the cross-disciplinary issues discussed in this subject.

Food Packaging

Packaging has the closest contact with people in their consumption of food in everyday life. Various factors such as how to protect, store, and transport food, and promote sales, reduce pollution, and ensure safety, have made food packaging an important research issue. Based on word frequencies, drinking water [73], agricultural products [74], food and plastics [75], chemicals [76], and testing and evaluation [77] are the major keywords in this subject. This indicates a strong correlation between the safety assessment of materials and food packaging, which is the main point of discussion on this subject. Therefore, edible inks such as water-based inks and soy inks are suggested for the printing of food packaging materials to reduce the pollution of volatile organic compounds and the chance of accidental ingestion [78]. Furthermore, the concave–convex technology is also an effective way to prevent the ink from contacting food [79,80].
Special Item Packaging

The protection of the contents is the main purpose and value of packaging. To meet the needs of certain special items, the packages of the items need to be compatible with other requirements on transport, storage, and handling to keep the item intact and in good shape. Owing to the particularity of the content, the category of special item packaging makes up less of the total volume than other categories, and it is a small but unique category. Based on the distribution of keywords, the content can be divided into medicine, chemical, and military packaging. For the first area, the major keywords include pesticides, medicine, healthy food, expiry date, and veterinary drugs. For the second area, the major keywords include chemical contaminant, cardboard barrel, and iron drum. Finally, for the third area, the major keywords include ammunition, military product packaging, vibration, and transportation. In order to effectively implement the regulations on special items packaging, economic incentives and policy advocacy are suggested by relevant researchers to reduce the impact on environmental pollution [81,82].

Structure and Materials

This category of subjects includes two aspects: hardware structure and materials of packaging. In this category, cross-disciplinary research in such sciences as physics, chemistry, mechanics, and electrics plays a predominant role. First, in terms of structure, the issues can be divided into packaging structure and container experiments, and packaging structure and container materials. The significant keywords include structure design, packaging container, and packaging methods [83–85]. Second, the significant keywords in materials include nanotechnology, vacuum packaging, plastics, corrugated cardboard, optimum design, and control system. Additionally, relevant technical research concerns the packaging box structure for the requirements of shipping and marketing functions [86], the materials and hygienic safety monitoring of plastic containers [87], and the material processing issues related to packaging [88,89].

In addition to the main research issues of the five common subjects, keywords in the subcluster imply that some researchers conducted research from the perspective of sustainability, such as optimizing the design of paper packaging products and streamlining the packaging structure, thereby reducing the amount of paper materials and avoiding environmental problems after use [90–93]. Moreover, integrating the function of accessories such as quick start guide [94] and combining packaging materials with ecofriendly materials have also been proposed in practical applications [95–97]. Therefore, some keywords such as environmental protection [98,99] and green packaging design [100,101] appear in the subcategory.

4.1.2. Comparison of Individual Subjects

The main source of a database can reflect the thoughts on research subjects in a particular region. Hence, there are some individual subjects in both CNKI-CAJD and CEPS, which can reveal socioeconomic differences and the diversity of academic research in different regions.

The CEPS Database

The journal papers of the CEPS database mainly come from Taiwan. As economic growth gradually slowed after the 1990s, packaging research began to shift its focus to aspects besides the consumer market. Therefore, the individual subjects include exclusive categories, namely (1) packaging and environment protection and (2) the development of packaging. The major keywords of the former include sustainable development, green packaging design, and sustainable packaging. The distribution of these keywords in the cluster map appears to center around green packaging and have lines that reflect significant strength links between each other. Additionally, in keywords such as teaching reform, personnel training, and packaging education, the same trends of correlation were also observed. This means that in addition to nurturing packaging talents, Taiwanese researchers
seek to integrate the spirit of sustainability into teaching strategies, hoping to turn it into one way to solve environmental problems, as in one study that integrated the concept of environmental value into the curriculum in 2001 to cultivate students’ environmental awareness from compulsory education [102]. The above information indicates that green design and packaging education are the focus of the subject content of packaging and environmental protection.

Further, the individual subjects concerning the development of packaging involves more diverse aspects, which include packaging research trends, Kansei engineering, modern logistics, packaging and environmental sustainability, and packaging materials and safety. In addition, besides the functional orientation, packaging research entered a mature and stable period and began to focus on evaluating the impact on the environment at all stages, from design, production, packaging, transportation, consumption and use, and recycling to disposal. For example, one study from 2012 investigated the acceptance of packaging reduction in Taiwan in response to possible changes in the development of packaging [103]. In addition, the development of packaging products has shown a trend in which special groups come to the attention, such as research on welfare design of the elderly that investigated their acceptance of healthy food packaging design [43].

CNKI-CAJD Database

CNKI-CAJD is a database that mainly includes journal papers from Mainland China. During economic development in the Chinese-speaking region during the past three decades, the Chinese market opened to the world and prospered. As a result, the division of labor in packaging became finer and clearer, as the specifications of management and industry matured. Three key topics have been developed in the individual subjects in packaging research: (1) packaging institutions and industries and (2) division of labor in the packaging industry, which concern local markets, and (3) foreign trade commodity packaging, which concerns foreign markets.

First, research on packaging institutions and industries largely concerns the specifications and standards of packaging activities in related industries, such as plastic packaging specifications, food packaging standards, and packaging applications in annual forums, competitions, and exhibitions [104,105]. Such discussions mostly appeared in the early stages of Mainland China’s economic opening from 1990 to 2005, presented in the form of reports on the situation of the packaging industry.

Second, owing to the huge domestic demand of Mainland China and its position as a major manufacturer, the division of labor in the packaging industry has become an individual subject in related research. This category focuses on various technical activities to satisfy the operational needs of the packaging industry, including project contracting, project management, and project construction, which are usually referred to as “project subcontracting” in a general sense in Mainland China. The significant keywords for this topic include project subcontracting, management, logistics, transportation, and warehousing. Overall, it can be summarized into two directions: packaging industry management [106,107] and packaging distribution system [108,109].

Third, with the formation of the global market, the specific requirements of different foreign trade destinations must be met. Foreign trade commodity packaging has thus become the last individual subject. The main destinations of trade include the United States, Japan, North America, Europe, South Asia, and India. Word frequency statistics indicate that previous research mainly focused on packaging-related trade in North America and Europe, followed by that of the Asia–Pacific region. In addition, the significant keywords for products include paper products and materials, sales volume, food and industry, beverage, ISO standards, and differentiation. This indicates that the research on this subject has multifaceted contents, and its aspects include types of product packaging trading, specifications and standards of packaging trade, sales evaluation of packaging trade, packaging trade, and regional culture.
As the individual subjects of CEPS and CNKI-CAJD are jointly considered based on the differences in the social, economic, and cultural development of the regions, packaging and environmental protection is an important sub-branch in the CEPS database that constitutes an exclusive subject category. In contrast, the individual subjects of CNKI-CAJD focus on the characteristics of the market and economy, among which is foreign trade commodity packaging. Some relevant research focuses on the subdivided subjects of specifications and standards of green environmental protection between the two trading parties, such as research on the packaging of Chinese agricultural products under the constraints of WTO’s green trade barriers, which aimed to achieve more environmentally friendly packaging of agricultural products [110], and research on the European Union’s green specifications regarding the classification, labeling, and packaging of chemicals, which aimed to solve the problems of green trade barriers [111].

In summary, as an indispensable part of daily product consumption, packaging facilitates the lives of people; however, people should be cautious of the balance between human behavior and environmental protection while using packages. Based on the analysis of the categories of the common subjects and individual subjects, the development and changes of packaging in the Greater China region can be observed, helping to consider how to strike a balance in development between economic consumption and sustainability through the green design education and the corporate social responsibility of industries.

5. Conclusions

Academic bibliometric research on packaging in the Greater China region remains rare. Therefore, this study explored and analyzed journal papers concerning packaging in the leading academic journal databases of Chinese-speaking regions (CNKI-CAJD and CEPS), and summarized the developments and changes in academic research on packaging. Through the analysis of crucial common subjects and individual subjects that show regional differences, the opportunity for the incorporation of environmental sustainability in the field of packaging is contemplated. The conclusions can be summarized as follows.

First, packaging research in the Greater China region can be divided into four stages: initiation (1989–1993), development (1994–2009), stabilization (2010–2015), and transition (2016–2019). In 1999, as the focus gradually shifted from industrial functions to commercial consumption, subjects concerning packaging design and environmental impact emerged. From 2016, online consumption has gained popularity in the information age and has become a new cross-disciplinary object of packaging research.

Second, the common subjects of Chinese language packaging research include five categories, namely design and consumption assessment, marketing and image packaging, food packaging, structure and materials, and special item packaging. The commerce, design, content, and manufacturing process are important aspects of packaging. Concerning environmental sustainability, the ratio of papers on structure and materials is relatively high. Some researchers try to optimize packaging design by streamlining the structure and reducing materials to reduce the impact on the environment.

Finally, owing to the differences between individual regions and economic development in the Greater China region, the focus of individual subjects is also different. The CNKI-CAJD database, which mainly includes papers from Mainland China, focuses on applications of packaging, including the subjects of packaging institutions and industry, foreign trade commodity packaging, and division of labor in the packaging industry. The CEPS database, which mainly includes papers from Taiwan, focuses on the research subjects of packaging and environmental protection and the development of packaging; it also has more diversified subdivided subjects of green design. Simultaneously, the awareness of sustainability is integrated into teaching strategies as a solution to environmental problems.
From the topic classifications of packaging research, this study provides an objective basis to further explore a specific topic, such as investigating the key factors, which enhance the satisfaction in green consumption on the topic of design and consumption assessment. In addition to the quantitative foundation of bibliometrics, it is also recommended to collaborate with literature review of highly cited papers to complete and enrich the diversity of packaging research in future studies.

**Author Contributions:** Conceptualization, T.-F.H.; methodology, T.-F.H. and R.-L.W.; data collection and analysis, T.-F.H. and R.-L.W.; formal analysis, T.-F.H.; writing—original draft preparation, T.-F.H., R.-L.W. and C.-Z.H.; writing—review and editing, T.-F.H. and R.-L.W. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by Taiwan’s MOST Research Program grant number MOST 109-2410-H-141-003.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflict of interest.

**References**


18. Garfield, E. From the science of science to Scientometrics visualizing the history of science with HistCite software. *J. Informetr. 2009*, 3, 173–179. [CrossRef]


37. Van Eck, N.J.; Waltman, L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics* 2010, 84, 523–538. [CrossRef] [PubMed]


47. Wang, M.; Yan, R.S. Analysis on the regionality and branding of Jingdezhen ceramic packaging. *Packag. World* 2010, 35, 132–133. [CrossRef]


51. Sun, H. Gender differentiated performance strategy in packaging design based on consumer psychology. *Packag. Eng.* 2012, 33, 96–99. [CrossRef]


64. Zhang, R.R. Overall product design and market effect. J. Zhuang Shi 1996, 2, 13–15. [CrossRef]

65. Li, J.S. Differentiated marketing strategy and application. Enterp. Reform Manag. 2000, 1, 39–40. [CrossRef]


72. Zhao, Z.F. Application of design psychology research in packaging visual design. China Packag. Ind. 2015, 6, 137–138. [CrossRef]


81. Li, C. The key to pesticide pollution treatment is scale: “Small packaging and big pollution”. J. Orient. City 2015, 1, B01.


89. He, X.Q. Research on Printing Process Design of Packaging Carton. China Packag. Ind. 2015, 22, 8–11. [CrossRef]


91. Huang, S.W. Application and research on reduction technology of electrical packaging. Shanghai Packag. 2014, 12, 35–38. [CrossRef]


99. Li, Y. Packaging design of native products under the concept of low carbon. *Packag. World* 2011, 1, 52–53. [CrossRef]

100. Cao, S. Green packaging design and ecology. *Aesthetics* 2007, 6, 75–77. [CrossRef]


111. Huan, J. EU chemical classification, labeling and packaging “green barriers”. *Shanghai Packag.* 2011, 2, 60–63. [CrossRef]