Tourist destinations are facing environmental issues such as climate change, water pollution, air pollution, depletion of natural resources, and loss of species (Budeanu, 2007), and many phenomena indicate that environmental degradation in tourism destinations is related to tourist activities (Budeanu, 2007; Onwezen & Bartels, 2013), such as producing a large amount of harmful gas (Russell & Russell, 2010), damaging to the vegetation (Xiao & Huang, 2010), and the surface (Marín-Yaseli & Martínez, 2003) of the tourist destination. In a way, the pro-environmental behavior of tourists (PEBT) and the ecologically sustainable development of the destination have a robust symbiotic relationship (Weaver & Lawton, 2011). When tourists reduce the damage to the environment of tourist destinations or try to protect the environment actively, a series of environmental problems faced by tourist destinations will be improved. In recent years, encouraging and guiding tourists to implement pro-environmental behaviors have been considered as beneficial methods for sustainable development of the region (Bhati & Pearce, 2016; T. H. Lee et al., 2013; Miao & Wei, 2013).

PEBT refers to tourists’ efforts to minimize the damage to the destination environment or even protect the destination environment (Kollmuss & Agyeman, 2002; Steg & Vlek, 2009). PEBT has attracted widespread attention from folklore scholars and professors since it was proposed (Han, 2015). Tourists’ environmentally responsible behavior (T. H. Lee et al., 2013), Tourists’ ecological behavior (Minciu et al., 2012), Tourists’ environmentally friendly behavior (Dolnicar & Grün, 2009), Tourists’ sustainable behavior (Ballantyne & Packer, 2016), and other related series of term have been proposed one after another. However, their essential connotations are the same (Qiu et al., 2018). To explain the complex social phenomenon (Moghimehfar & Halpenny, 2016), scholars have introduced the theory of planned behavior (TPB), norm activation model (VAM), value-belief-norm theory (VBN), place attachment theory (PBT), goal-oriented theory (MGB), and other theoretical models to explain the formation mechanism of PEBT, to analyze the driving factors of PEBT from multi-dimension such as values, personal norms, experience, satisfaction, place attachment, destination image, expected guilty, self-efficacy, and demographic characteristics. However, Antimova et al. believe that PEBT is a problem that needs to be continuously explored for
promoting the sustainable development of destinations (Antimova et al., 2012).

This study aims to clarify the academic ecology of research on the PEBT, which lays a foundation for the further development of research in this field. To achieve the above research objectives, this study will take the literature related to PEBT in the Web of Science database as the research object and analyze the following problems using bibliometric analysis: (a) The external characteristics of the research on PEBT; (b) The characteristics of sequential development; (c) Core knowledge groups, main research contents, and research trends of existing knowledge accumulation. Specifically, this study will clarify the key literatures and scholars in this field, focus on analyzing the core knowledge accumulation in research on PEBT, and find out the research trend by analyzing the knowledge evolution process of this field. As the main research method of this study, the bibliometric analysis method has been regarded as a mature and effective method of document analysis and information mining, which can perform statistical and quantitative analysis of academic literature results, so as to relatively objectively deduce the development status and development trend of the discipline (Y. Chen et al., 2015). As the first literature review with the method of bibliometric analysis of research on PEBT, this study is able to help the scholars understand the research progress in the field and to provide a reference for the determination of the direction of subsequent research on PEBT.

**Research Methods and Data Sources**

**Research Methods and Tools**

To comprehensively obtain a complete picture of research on PEBT, analyzing the overall characteristics, core basic knowledge, development history, recent research characteristics, and trends of PEBT are the key points of this article. With the help of CiteSpace and Vosviewer, the visual and quantitative analysis of the literature in the field of PEBT is performed. Among them, CiteSpace can implement co-occurrence analysis in the subject area, national co-occurrence analysis, author co-occurrence analysis, and keyword co-occurrence analysis. Thus, we can explore the key points of the subject area or knowledge area at various development stages and understand the dynamic mechanism of knowledge development and change (Y. Chen et al., 2015). However, Vosviewer can generate a knowledge map of map visualization, overlay visualization, and density visualization based on literature data and document data, as well as form a detailed and clear cluster of knowledge units to represent the relationship between the document data (Gao, 2015). Based on CiteSpace and Vosviewer, the research team will combine traditional literature analysis with a bibliometric analysis method to analyze important literature and comprehensively and accurately grasp the research landscape of PEBT.

**Data Sources**

This study selects the five major citation index data sets of the Web of Science (WOS), which includes SCI-EXPANDED, SSCI, A & HCI, CPCI-S, and CPCI-SSH. Although WOS is the only data source of the study, there are a series of reasons for choosing the database. First, the WOS database is comprehensive, which includes more than 9,000 kinds of journals with international level. Citation retrieval in WOS database can track the existing related research during the last 100 years. Second, the data format processed by Citespace software is based on the data format downloaded from WOS database (C. Chen, 2015). Third, WOS can provide more perfect references, indexes, and other literary analysis elements. There are many scholars in the field who...
have taken WOS as the data source of literature review and analyzed the research situation of relevant fields with the method of bibliometric analysis (Albort-Morant et al., 2017; Zyoud et al., 2017).

Furthermore, based on the combing of terms related to PEBT, this article uses (“environmentally responsible behavior” OR “responsible environmental behavior” OR “environmentally friendly behavior” OR “environmentally concerned behavior” OR “environmental protection behavior” OR “pro-environmental behavior” OR “ecological behavior” OR “eco-friendly behavior” OR “environmentally significant behavior” OR “sustainable behavior”) AND (“touris*” OR “visit *” OR “travel *”) as the search terms, selects all years as time span, selects “article,” “review” and “proceeding paper” as types of this research, and retrieved 262 related literature on June 21, 2019. Furthermore, to ensure the scientificty of the analysis results and avoid invalid or duplicate literature in the search results, our research team selects three researchers in this field to conduct a comprehensive and detailed screening independently based on search results. Through reading the downloaded literature one by one to screen out the effective documents, the screening criteria are that the research object of the literature is tourists and the research topic is pro-environmental behavior. Finally, it was imported into CiteSpace for data cleaning, and 159 valid literature was defined as data of PEBT.

**General Characteristics**

**Chronological Analysis**

*Time-series analysis of published papers on PEBT.* The number of literature on PEBT has continued to rise, and it is found that its growth trend basically conforms to the exponential growth law using curve fitting analysis, but it has experienced a sharp increase in 2018. Combined with the growth characteristics of the literature in the field, it can be divided into three periods: slow growth period (2003–2012), volatile growth period (2013–2017), and rapid growth period (2017–2018).

In the slow growth period, the word of PEBT is clearly proposed by Taniguchi et al. (2003), and Travel Feedback Program (TFP) will have a positive impact on PEBT. The number of publications in this field basically maintained a growth level of less than or equal to four articles per year, and the annual research output was small. In 2012, the validity of the “Kyoto Protocol” was extended at the 18th United Nations Climate Change Conference, and member states are increasingly paying attention to environmental issues.

In the volatile growth period (2013–2017), the number of articles published per year fluctuates between 10 and 20, except for 2014. To some extent, the increase in the number of documents at this stage is mainly due to many scholars from China gradually entered the research field during this period, just as Lee et al. The number of articles published during this period is five and has a high number of citations, which lays a foundation for the rapid development of research on PEBT. In December 2017, the Third United Nations Environment Conference was held in Nairobi, Kenya, advocating creating a “zero pollution planet” and put forward that environmental issues should be concerned.

In the rapid growth period (2017–2018), more scholars from mainland China, the United States, and South Korea began to enter this field, and the annual increase of research on PEBT rose from 18 to 52, and the number of literature produced is up to 14 papers, 13 papers, and 8 papers, respectively. The field of research on PEBT has entered a rapid development period in 2018, and the number of literature has increased rapidly.

*Time-series analysis of disciplines.* Using the citese space, select “category” as the analyzing point based on the data set of PEBT. According to the criteria (the Modularity Q >0.3, Silhouette score > 0.4; Newman, 2004), the analyzing result (the Modularity Q = 0.3216, Silhouette score = 0.6167) of the Figure 2 is reasonable. Figure 2 shows the evolution of the disciplinary field of PEBT. The nodes, connections lines between nodes, and the nodes’ purple outer circle are the key indicators of the knowledge map. The size of each node in the map is proportional to the number of co-occurrences of the subject area. Moreover, the thicker the connection lines between the nodes are the stronger the disciplines’ connection. As well, the purple outer circle of the nodes represents the betweenness centrality of the nodes and reflects the importance of this discipline in the research on PEBT (Y. Chen et al., 2015). Overall, 23 nodes and 80 connection lines (Figure 2) indicate that the research on PEBT involves multiple research areas and mainly focuses on the ecological environment, sociology, and leisure reception. Furthermore, analysis from the time dimension reveals that the research on PEBT was mainly related to economics, ecological environment, sociology, psychology and leisure reception, and other subject areas in the early stage. In the middle and later stages, research on PEBT has begun to involve management, education, and transportation science due to knowledge spillover effects. It is worth noting that a noticeable purple ring appears in the co-occurrence node of economics, ecology, and psychology, indicating that these disciplines in the PEBT play strong knowledge spillovers and are to become an important point connecting the new subject areas.

*Analysis of International Research Pattern*

The distribution of regional research power. To analyze the international research pattern and identify the academic influence of different regions in this field, the data set of PEBT was imported into Citespace, select “country” as the analyzing point and convert the analyzing result into the strength distribution table of PEBT (Table 1). Analyzing from the table, the research power is uneven in regions distribution. The primary research power circle of research on PEBT includes China, the United States, and Korea.
Australia and England are in the secondary research circle of research on PEBT, and there are a few scholars in Spain, Canada, India, Austria, Germany, Norway, and Slovenia who have published documents in this field. What’s more, Australia, China, England, and the United States have strong betweenness centrality. Betweenness centrality is a key indicator of the importance of nodes in the map structure. Highly betweenness centrality means an important link between two different countries (Y. Chen et al., 2015), which shows that the United States, Australia, England, and China have a strong influence on this research field.

**Core research scholars.** Scholars are the source of motivation for the development of the discipline, and the co-author map can be used to identify core authors, the scientific community, the strength of cooperation and mutual citations among scholars in this field (Hu et al., 2013). Select “author” as the analyzing point, and the co-author map was generated by citespace (Figure 3). 159 articles in the data set of research on PEBT involved 358 scholars. As shown in Figure 3, there are 23 nodes in the co-author map, 21 connection lines, 8 cooperative groups, which shows that cooperation among authors in this area needs to be strengthened, and there are only eight-core scientific communities in this field. Among them, the first and second scientific communities have relatively high occurrence frequency, and they are more closely linked. In addition, it is worth noting that more scholars have published 1 article and did not appear in the co-author map, but this also conforms to the general law of bibliometrics that a few scholars produce most research results in each scientific field.

According to the analysis in Table 2, Han, Kim, Hyun, and Lee are the largest scientific community in this research field. Moreover, Han is the core author in the first community and the most influential author in the field. In his early studies, he mainly analyzed PEBT in the hotel context from multiple perspectives of theory such as value-belief-norm theory, the theory of planned behavior, norm activation...
model, and goal-oriented behavior theory, and gradually expand the case of the study from hotels to cruise, conference and museum scenarios and limit the sample of the research to young groups such as college students, focusing on exploring the impact factors and formation mechanism of PEBT in specific scenarios or segmented groups (Han, 2014, 2015; Han et al., 2016; Han & Hyun, 2017, 2018; Han, Hwang & Lee, 2017; Han, Kim, & Kiatkawsin, 2017; Han, Kim & Lee, 2018). Besides, Lee and Jan are the second-largest scientific community in this field, working at the Yunlin University of Science and Technology in Taiwan, China, and cooperating closely based on academic relationships. Their research direction in this field is to explore the influencing factors and related measuring scales of PEBT in the context of eco-tourism and community tourism (T. H. Lee, 2011; T. H. Lee et al., 2013; T. H. Lee & Jan, 2015a, 2015b, 2018a, 2018b, 2019b).

The Core Basic Knowledge

Highly cited literature in this field can be presented by creating a reference mutual citation map based on co-citation analysis. The high cited literature in PEBT is the core basis for further related study (Gao, 2015). The data set of PEBT

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**Table 2.** List of Core Authors for Research on PEBT.

| Frequent | Author            | Author            |
|----------|-------------------|-------------------|
| 14       | Heesup Han        | Yu Wang           |
| 7        | Wansoo Kim        | Lujun Su          |
| 6        | Tsung Hung Lee    | Peng Yu           |
| 6        | Fenhaeun Jan      | Xiaohong Chen     |
| 3        | Minseong Kim      | Yenting Helena Chiu|
| 3        | Shanyong Wang     | Huan Hu           |
| 3        | Sunghyup Sean Hyun| Scott R Swanson   |
| 3        | Brijesh Thapa     | Wani Lee          |
| 2        | Tsunghsiung Chen  | Ljubica Knezevic Cvelbar |
| 2        | Jinhe Zhang       | Jing Wang         |
| 2        | Jun Li            | Sara Dolnicar     |
| 2        | Sanghyeop Lee     |                   |

Note. PEBT = pro-environmental behavior of tourists.

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**Figure 3.** Author co-occurrence knowledge map.
was imported into Vosviewer and used co-citation analysis to analyze the field’s core basic knowledge group. In Figure 4, there are 33 nodes, 499 connection lines, and 4 groups with different colors, which means that there is 33 core cited references, closely tied among the 33 cited references, and four core knowledge groups have been formed for the research on PEBT (Table 3).

The green part (Figure 4) is the core knowledge group 1 in this field, mainly about the definition and measurement of PEB, and an important knowledge base for defining and measuring PEBT. Kollmuss and Agyeman (2002) and Steg and Vlek (2009) define PEB which are cited by many scholars in the field of behavior research, minimizing the harm to the surrounding environment by individual behavior and

Table 3. List of Literature Co-Cited Knowledge Groups.

| Research contents                      | Knowledge group                                      | Category                                      | Author of the cited literature of the Communist Party of China |
|----------------------------------------|-----------------------------------------------------|-----------------------------------------------|-----------------------------------------------------------------|
| **Definition and Related Measurements**| Knowledge Group 1: Definition and Related Measurements of Pro-Environmental Behavior | Definition of pro-environmental behavior      | Kollmuss and Agyeman (2002)                                      |
|                                        |                                                     | Measurement of pro-environmental behavior and related variables in general scenario | Steg and Vlek (2009)                                           |
|                                        |                                                     | Measurement of pro-environmental behavior in specific scenarios | Smith-Sebasto and D’Costa (1995), Dunlap et al. (2000), Stern (2000), Ballantyne et al. (2011) |
|                                        |                                                     | “Rational driven” perspective                | Halpenny (2010), Vaske & Kobrin (2001), T. H. Lee et al. (2013) |
|                                        |                                                     | “Ethical Drive” Perspective                 |                                                                 |
|                                        | Knowledge Group 2: Mechanisms for Pro-environmental Behavior | Combined “rational drive” with “moral drive” |                                                                 |
|                                        |                                                     | Formation mechanism                          | Fishbein and Ajzen (1975), Ajzen (1991)                          |
|                                        |                                                     | Factors                                      | Schwartz (1977), Onwezen and Bartels (2013), Stern et al. (1999) |
|                                        | Knowledge Group 3: The Formation Mechanism and Influential Factors | Formation mechanism                          | Bamberg and Schmidt (2003), Klockner (2013)                     |
|                                        | Knowledge Group 4: Influential factors of Pro-Environmental Behavior | Factors                                      | Han (2014), Kim and Han (2010), M. F. Chen and Tung (2014), Han (2015) J. Lee et al. (2010) |
|                                        |                                                     |                                               | W. H. Lee and Moscardo (2005), Powell & Ham (2008), T. H. Lee (2011), Chiu et al. (2014) |

Note. PEBT = pro-environmental behavior of tourists.
even protecting the environment is at the core of the definition of PEB (Kollmuss & Agyeman, 2002; Steg & Vlek, 2009). According to the characteristics of highly cited literature, PEBT can be divided into two types. One is the related measurement of PEB in general scenarios: Smith-Sebasto and D’Costa (1995), Dunlap et al. (2000), Stern (2000), and Ballantyne et al. (2011) developed the measurement scales of PEBT in the general scenarios. Among them, Smith-Sebasto and D’Costa (1995) consider the PEB consists of education, citizenship, finance, physical strength, law, and persuasive behaviors, using deductive methods to develop the scale of PEB (Smith-Sebasto & D’Costa, 1995) for the individual in general situations. As well, a new ecological paradigm (NEP) scale developed by Dunlap et al. (2000) is currently widely used to measure the ecological values and consciousness of individuals in research on PEB (Dunlap et al., 2000). Also, the scale of biosphere value (Stern, 2000) designed by Stern (2000), and dimensional view of environmental knowledge proposed by Ballantyne et al. (2011) have been recognized by most scholars in this field (Ballantyne et al., 2011). In fact, the scale of biosphere value was first proposed by Stern, and Ballantyne rejected the single-dimensional view of environmental knowledge and proposed that the measurement of environmental knowledge needs to be distinguished according to subjective norms and objective norms, as well as personal norms. As a key indicator of behavior and is affected by personal attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). With a “moral-driven” perspective, PEB of personal is mainly based on an altruistic perspective in the second category. Schwartz (1977) proposed the norm activation model (NAM), which indicates that individual PEB is mainly affected by personal norms, as well as, personal norms are driven by problem awareness and responsibility relationships (Schwartz, 1977). Moreover, based on the norm activation model, Stern et al. (1999) incorporated value theory, new ecological perspectives and put forward value-belief-norm theory (VBN) to explain the formation mechanism of PEBT (Stern et al., 1999). The third category combined “rational-driven” with “moral-driven” views. Specifically, Bamberg and Schmidt (2003) combined the theory of planned behavior with the norm activation model, finding that incentives, morals, and habits have a predictive effect on college students’ car use choices (Bamberg & Schmidt, 2003). Onwezen and Bartels (2013) used norm activation theory, expected pride, and guilt to proposed a framework based on norm activation theory, indicating that the extended model can be a better way to explain the formation mechanism of individual PEB in specific situations (Onwezen & Bartels, 2013). Besides, combined with the norm activation model, the theory of planned behavior, value-belief-norm theory, and habitual variables, Klockner (2013) proposed a comprehensive action decision model (CAIM) by using Meta-analysis, that considers subjective and objective environmental constraints can enhance the interpretation of repetitive behaviors (Klockner, 2013).

Needless to say, each theoretical perspective of this knowledge group can be effective guidance when studying the formation mechanism of the PETB of specific scenarios, but Bamberg and Schmidt (2003) questioned the adequacy of the theory, such as rational action theory, the theory of planned behavior, and norm activation model, and argued that authors who put forward these models did not explain the degree of interpretation of each theoretical model in different scenarios (Bamberg & Schmidt, 2003). Put the tourists as a research subject, the applicability of each theoretical model in different situations needs to be further tested.

The red part (Figure 4) is the core knowledge group 2 in the field, which mainly involves researching the formation mechanism of PEB from different perspectives and is an important knowledge base for exploring the formation mechanism of PEBT. At present, there are mainly three types of cited literature related to the formation mechanism of PEB: The first category, with the “rational-driven” perspective, “rational-driven” insists that it is mainly based on rational thinking. Fishbein and Ajzen (1975) proposed a rational action theory (TRA) from the perspective of social psychology that human behavior is a rational choice and be influenced by their behavioral intentions, attitudes, and subjective norms (Fishbein & Ajzen, 1975). Furthermore, Ajzen (1991) proposed the theory of planned behavior based on the Rational Action Theory, which considers intention as a key indicator of behavior and is affected by personal attitudes,
perspective with a moral perspective, M. F. Chen and Tung (2014) proposed an expanded theoretical model of TPB, which adds the consumer's perceived responsibility to the theoretical framework of TPB (M. F. Chen & Tung, 2014). Studies have shown that the expanded theoretical model of TPB has a stronger explanatory effect on the PEB of consumers. Therefore, based on the perspectives of rationality and morality, Han (2015) considered the factor of scenario and combined the theory of planned behavior with value-belief-norm theory to explore the PEBT in green hotels, indicating that the definition of its comprehensive theoretical determinants and the scale of consequences awareness have attracted more attention from scholars (Han, 2015), which is the highest co-cited literature in knowledge group 3 with a total of 37 citations. However, only one highly cited literature was related to research on factors of PEB in the context of green hotels. J. Lee et al. (2010) initially began to explore the impact of the green hotel image on consumers' intentions of PEB and found that PEB of green hotels is good for establishing the image of green hotels and promote environmentally friendly behavior of consumers (J. Lee et al., 2010), which has been cited 18 times and has a strong guiding significance for the image management of green hotels.

The yellow part (Figure 4) is the core knowledge group 4 in this field, which mainly explores the factors of PEB of eco-tourists and is an important basis for exploring the influencing factors of PEBT. Among them, empirical research results of W. H. Lee and Moscardo (2005), Powell and Ham (2008), T. H. Lee (2011), and Chiu et al. (2014) have attracted more scholars' attention in the field of PEBT, and their total citations in this field have reached 19, 20, 26, and 22, respectively. Furthermore, the empirical research of W. H. Lee and Moscardo (2005) found that the satisfaction of tourist experience will affect the PEBT (W. H. Lee & Moscardo, 2005). By exploring the relationship between environmental knowledge and PEB of island tourists, Powell and Ham (2008) found that tourists' pro-environmental knowledge has a positive effect on PEBT (Powell & Ham, 2008). T. H. Lee (2011) found that commitment of tourists to protection is a prerequisite for recreational involvement to affect PEB (T. H. Lee, 2011), and Chiu et al. (2014) first explored the impact of perceived value on PEB in eco-tourism scenarios (Chiu et al., 2014). Overall, it can be seen that experience, environmental knowledge, protection commitment, and perceived value of tourists are the factors that scholars are currently paying more attention to in this field. Based on the analysis of the highly cited literature and its citing literature, the factors of PEBT involve multiple fields, most of which are closely related to choices of their theoretical perspective and mainly originated from the field of social psychology.

Based on the literature co-cited analysis, it can be found that group 1, group 2, group 3, and group 4 contains the definition, measurement, formation mechanism, and influencing factors of PEBT. Among them, group 1 and group 2 belong to the research results in the field of PEB under general scenarios, and the results in the field of PEB under general scenarios are the important accumulation of the research on PEBT, which is a beneficial supplement and perfection to the research of PEB in tourism scenario. However, only group 4 belongs to the specific contents of the study of PEBT, which also reflects that the study of PEBT needs to be further developed.

**Evolution Characters and Development Trend**

The keywords in academic papers are the core content of the academic paper, so that the keywords can be called key points of the academic paper. At the same time, “spot to face” is an important way in academic research. Therefore, using the keyword is an efficient way to analyze knowledge evolution in a specific field. The method of effectiveness has been justified by Multiple subject areas such as communication and library science (G. X. Yu & Dai, 2017).

To clarify the development of research on PEBT, the data set of research on PEBT is divided into three data subsets according to the chronological characteristics: data subset 1 (data set of research on PEBT in 2003–2012), data subset 2 (data set of research on PEBT in 2013–2017), and data subset 3 (data set of research on PEBT in 2017–2018). Furthermore, each data subset was imported separately to CiteSpace and used keywords co-occurrence analysis and set the consistent threshold (select top 20 levels of occurred keywords co-occurrence from each slice). Three researchers (two doctoral students and one graduate student) performed data preliminary processing and merged numbers, and so on, for the co-occurrence keywords extracted by CiteSpace. As well as re-imported into CiteSpace, generate a knowledge graph (Figure 5A to 5C) of the keyword of highly frequency co-occurrence and emergence table of the keyword (Table 4).

### Table 4. Burst Words of Research on the PEBT.

| Keywords      | Strength | Begin |
|---------------|----------|-------|
| attitude      | 2.7726   | 2009  |
| determinant   | 2.2538   | 2013  |
| place attachment | 1.8579  | 2014  |

*Note: PEBT = pro-environmental behavior of tourists.*
Table 5. Key Staged Co-Occurrence Keywords of Research on PEBT.

| Phase | Phase I (2003–2012) | Phase II (2013–2017) | Phase III (2018–) |
|-------|---------------------|----------------------|------------------|
| Type  | Keywords Frequency of co-occurrence Bet-ween-ness Central-ity | Keywords Frequency of co-occurrence Bet-ween-ness Central-ity | Keywords Frequency of co-occurrence Bet-ween-ness Central-ity |
| Related terms | ecological behavior 3 0.18 | pro-environmental behavior 25 0.39 | pro-environmental behavior 31 0.24 |
| | Environmentally responsible behavior Environmentally responsible behavior 2 0 | Environmentally responsible behavior 14 0.29 | Environmentally responsible behavior 20 0.05 |
| | | ecological behavior 6 0.06 | ecological behavior 5 0.07 |
| | | conservation behavior 5 0.06 | conservation behavior 2 0.09 |
| | | ecotourism 5 0 | green hotel 13 0.18 |
| Research scenarios | protected area 2 0.25 | place attachment 13 0.1 | place attachment 11 0.06 |
| | ecotourism 5 0.91 | norm attachment 5 0.03 | Value-belief-norm theory 7 0.09 |
| | | norm activation model 5 0.03 | personal norm 6 0.0 |
| | | personal norm 4 0.03 | social norm 3 0.0 |
| | | social norm 3 0 | norm activation model 5 0 |
| Theoretical perspective | planned behavior 5 0.18 | planned behavior 18 0.3 | planned behavior 24 0.07 |
| | personal norm 2 0.16 | place attachment norm activation model 5 0.03 | personal norm 6 0.0 |
| | | personal norm 4 0.03 | social norm 3 0.0 |
| Influence factors | attitude 5 0 | attitude 15 0.14 | attitude 26 0.66 |
| | value 3 0.29 | satisfaction 11 0.07 | satisfaction 10 0.19 |
| | personal norm 2 0.16 | destination image involvement 7 0.21 | knowledge 9 0.0 |
| | identity 2 0.21 | experience 5 0.11 | experience 8 0.0 |
| | | perception 5 0.09 | perception 5 0.0 |
| | | personal norm 4 0.03 | trust 3 0.0 |
| | | identity 4 0 | value 3 0.09 |
| | | value 4 0.03 | belief 2 0.14 |
| | | education 3 0 | personal value 2 0.3 |
| | | social norm 3 0 | biospheric value 2 0.37 |
| | | conservation 15 0.06 | conservation 10 0.08 |
| | | intention 14 0.18 | decision making 9 0.13 |
| Research line and goals | impact 3 0 | conservation 14 0.18 | determinant 7 0.11 |
| | intention 2 0.14 | decision making 7 0 | impact 8 0.13 |
| | management 2 0.68 | antecedent 2 0.12 |
| | association 2 0.16 | impact 4 0.04 | antecedent 2 0.12 |
| | conservation 2 0.68 | decision making 4 0.04 | determinant 7 0.11 |

Note. PEBT = pro-environmental behavior of tourists.

Keywords in the data set of PEBT one by one. In particular, the high-frequency co-occurrence keywords are analyzed, classified, and compared. After being guided by experts in the field, they are organized into a list of important co-occurrence keywords for research on PEBT (Table 5). Combining Figures 5, Tables 4 and 5, protection (conservation) of the tourism destination environment is an important development demand in this field at all stages. Scholars mainly explore the impact/determinant and decision-making process of PEBT or behavioral intentions (decision making), which is mainline of research on PEBT, aiming to provide a series of management solutions for environmental protection of tourism destinations. In the three phases (2003–2012, 2012–2017, 2017–2018), related terms of PEBT have gradually diversified, but overall the termed “pro-environmental behavior of tourists” has the highest value of co-occurrences and betweenness centrality. Besides, the research scenarios explored by scholars have gradually expanded from ecotourism, protected areas to the specific green hotel, national parks, seashore, intangible cultural heritage sites, and museums. Through the three-stage high-frequency co-occurrence keyword knowledge map, it can be seen that the number of nodes and the number of connections lines between nodes in each stage of keyword co-occurrence knowledge map is on
the rise, and the research field of PEBT is becoming more and more abundant.

To further analyze the research characteristics of each stage, the three researchers read the literature of co-occurrence keywords in the data set of PEBT one by one (Figure 5A to 5C), the high-frequency co-occurrence keywords are selected, analyzed, classified, they are organized into a list of important co-occurrence keywords for research on PEBT (Table 5). Combined with the traditional method of literature review, the series of evolution characters can be drawn out, combining Figure 5 and Tables 4 and 5.

1. Research line and goals: Protection (conservation) were one of the most common co-occurrence keywords during the three stages (Figure 5), which indicated that protection (conservation) of tourism destination environment is an important development demand in this field at all stages. In a way, scholars mainly explore the impact/determinant and decision-making process of PEBT or behavioral intentions (decision making), which is the main research line on PEBT. The purpose of most studies aims to provide a series of management solutions for the environmental protection of tourism destinations.

2. Related terms: For phase and frequency of related terms of PEBT, related terms emerged in Phase I, but its co-occurrence frequency is low. In Phase II and Phase III, related terms gradually diversified, and the total current frequency is more than 50 for each phase. Overall the term, “pro-environmental behavior of tourists” has the highest value of co-occurrences and betweenness centrality. Among them, the definition of PEBT proposed by Halpenny (2010) has been widely applied in this field.

3. Research scenarios: In Phase I, the research scenarios mainly focused on eco-tourism, protected areas and expanded to specific scenarios in Phase II and Phase

Figure 5. Knowledge map of high-frequency co-occurrence keywords for all period. (A) 2003–2012, (B) 2013–2017, and (C) 2018–.
III, such as green hotels, national parks, seashore, intangible cultural heritage sites, and museums. Moreover, for research on PEBT in specific scenarios, scholars tried to use the revised scale of PEB to designing a new scale (T. H. Lee et al., 2013), and the research sample is gradually segmented, scholars have begun to pay attention to the PEBT in segmented tourism markets such as the young and participators in specific tourism activities (T. H. Lee et al., 2018).

4. Influence factors: The factors influencing PEBT mainly involved internal factors of the tourists such as attitude, value, personal norms, satisfaction, involvement in Phase I. Among them, attitude became a research hotspot in 2009 (Table 4) and was an important factor in research on PEBT for all periods because attitude can be considered a potential expression of behavior (Ajzen & Fishbein, 1977). Furthermore, the determinant was the research hotspot in 2013. In phase II and phase III, Scholars started to pay more attention to external factors such as destination image, social norm, and education in research on PEBT. Moreover, many scholars began to use multidisciplinary theoretical perspectives to deeply explore the factors of PEBT, including the perceived reputation of destination on PEBT and subjective well-being from the perspective of information economics (L. J. Su et al., 2018), violation of norms on the intention of tourists to use cars in national parks from the perspective of criminal psychology (H. M. Zhang et al., 2018), employee quality perception and value perception on the PEBT from the perspective of marketing (He et al., 2018).

5. Theoretical perspective: In Phase I, “planned behavior,” “personal norm” emerge in Figure 5A, which respectively represents the theory of planned behavior and the norm activation theory and is used to explain the formation mechanism of PEBT. In Phase II and Phase III, the place attachment theory and value-belief-norm theory have been getting wide attention from scholars in this field, the place attachment theory based on the perspective of the human–earth relationship set off a wave of an upsurge in this field from 2014 to today (Table 4). Overall, there are two main research paradigms on the formation of PEBT at present. One is modifying the early theory such as rational action, norm activation theory, the theory of planned behavior, value-belief-norm theory, place attachment theory, and goal-oriented theory to explain the formation mechanism of PEBT, new variables are introduced into the original theoretical model, and an extended theoretical model is proposed based on the research scenario or the specific characteristics of the research object (Han, Olya, Kim, & Kim, 2018), to improve the ability of the original theoretical model to explain the formation mechanism of PEBT. Another one is driven by a theoretical perspective, combining multiple theoretical models (Han, Hwang, et al., 2019; T. H. Lee & Jan, 2018; Liu et al., 2017) or introducing other theoretical models such as neutralization technology theory (Chuang et al., 2018) to propose a comprehensive theoretical model to explain the formation mechanism of PEBT.

Besides, the research methods involved in this field have begun to diversify. Quantitative research methods such as multivariate linear regression and structural equation models are still mainstream research methods, but due to the possibility of multicollinearity or low model fitting (Han, Kim, & Kiatkawsin, 2017; Y. G. Zhang & Wang, 2019), scholars have begun to use ethnography (W. F. Wang et al., 2018), a meta-analysis (Lanzini & Khan, 2017), eye movement experiments (Penz et al., 2017), and qualitative comparative studies (Yadav et al., 2019; H. M. Zhang et al., 2019).

Directions for Future Research on PEBT

The Formation Mechanism of PEBT From Multidisciplinary Perspective

Based on the co-citation analysis and co-occurrence keywords analysis, the formation mechanism of PEBT is one of the main research contents in this field. The research on the formation mechanism of PEBT is mainly based on the research paradigm of PEB and takes the theoretical perspective of “rational-driven” and “moral-driven” as the main theoretical perspectives. Because the complexity of people makes it difficult to fully understand its formation mechanism (H. M. Zhang et al., 2019), the related research on the formation mechanism of PEBT needs to be further strengthened in the future. Meanwhile, Chuang et al. (2018) analyze the formation mechanism of PEBT by introducing theories from other disciplines. It is an important direction to study the formation mechanism of PEBT from multiple disciplines, such as S-O-R theory, which is based on environmental psychology.

The Scale Development of PEBT and Related Variables Under Special Scenarios

The development and related research of measurement scales of PEBT and related variables in specific scenarios need to be further strengthened. The first is to focus on the design and development of measurement scales of PEBT in specific scenarios. Based on the core knowledge group, the scale currently used by most scholars to measure the PEBT in specific situations is based on a revised version of the scale of PEB in general scenarios. Based on the eco-tourism scenario, only T. H. Lee et al. (2013) in the cited literature redesigned the scale of PEBT according to the specific scenario (T. H. Lee et al., 2013), but some environmental management scholars believe
that the role of contextual factors in PEB cannot be ignored (Grimmer et al., 2016; Steg & Vlek, 2009). The second is to develop measures of related variables in the context of tourism. In recent years, more scholars in this field have begun to explore the PEFT based on different theories of the subject and introduce new variables into this research field, which will help further exploration of the driving factors of PEFT, but the existence of disciplinary boundaries also cannot be ignored, such as destination social responsibility (L. J. Su & Swanson, 2017), environmental destination image (W. Lee & Jeong, 2018) and other variables in tourism research need to be further clarified. The third is to strengthen the research on the PEFT in a specific scenario. Based on the core knowledge group research, we can know that research on the PEFT in green hotels and eco-tourism forms a respective knowledge group, and there are many highly cited literatures, but the relevant research results from other tourism scenarios have not yet appeared in the core knowledge group.

**The PEFT in Segmented Tourism Markets**

The PEFT in segmented tourism markets such as silver-haired tourism and parent-child tourism need to be further researched. At present, scholars in this field have begun to explore the formation mechanism of PEB of young tourists (Han, Kiatkawasin, et al., 2019; Han, Kim, & Kiatkawasin, 2017). To a certain extent, it can be regarded as the beginning of the research object’s segmentation. Following the trend, exploring the PEFT in the segmented market can offer more practical recommendations for promoting the sustainable development of tourism destinations (Larson et al., 2018; T. H. Lee & Jan, 2019). In fact, the proportion of the global elderly population is growing, of which the Chinese aging population may exceed 30% (G. Z. Wang, 2019). The number of silver-haired tourists will continue to increase and may become the crowd that affects the development of tourism destinations. Therefore, the PEB of silver-haired tourists urgently needs to be further explored. At the same time, parent-child tourism is becoming more and more popular with various parent-child shows airing such as “Dad, Where Are We Going?” In parent-child tourism, parents have an important impact on children’s behavior, resulting from children staring at their parents in parent-child tourism (Zhong et al., 2018). It reflects that parental behavior has a demonstration effect on children (N. Su, 2001). Therefore, the PEB of parents in tourism not only directly affects the current environment of tourist destinations but also may affect the future environment of a tourist destination by affecting the long-term behavior of children. The PEB of the parent in parent-child tourism is worthy of further research in the future.

**Expansion of Research Data Sources of PEFT**

Attempt to obtain relevant research data using experimental equipment such as eye trackers, mutual reports, or online surveys. Currently, the acquisition of research data through self-reporting is the main source of research data in the field of research on PEFT. Individuals may be affected by social expectations or social norms when performing self-reporting (Fisher et al., 1993). The reliability of self-reported data is questioned (Gifford & Nilsson, 2014). Experimental equipment such as eye trackers and VR are gradually becoming popular, and research data are obtained by designing mutual reporting scales or using questionnaires online and offline. In fact, these methods have been widely used in the fields of sociology, psychology, management, and other disciplines. Therefore, it can be seen that scholars can try to obtain relevant data in various ways to improve the reliability and validity of research data in research on PEFT.

**PEBT and Biodiversity Conservation**

Will the enhancement of tourists’ awareness of species conservation strengthen their behaviors of species conservation? Mann et al. (2018) and Clayton et al. (2014) believe that visiting wildlife parks can help cultivate tourists' awareness of species conservation and strengthen their behaviors of species conservation. MacDonald (2015) implemented a persuasive communication campaign for the zoo and found that the quantified zoo protection information will enhance the tourists’ behavior toward species protection. However, Ballantyne et al. (2007) and other scholars believe that the safari experience can enhance tourists’ awareness of species conservation, but it is not enough to change tourists’ behaviors toward species conservation. Bueddefeld and Van Winkle (2017) also found that the species protection behaviors of wildlife tourists are less affected by general wildlife tourism. What about the relationship between wildlife or other eco-tourism activities and PEFT? Does it have a material impact on biodiversity conservation? The underlying mechanisms of these problems need to be further clarified to help protect biodiversity and promote the sustainable development of tourism.

**Discussion**

**Discussion About the Method**

Bibliometric analysis and traditional literature review methods are the main methods used in this article, aiming to fully combine the advantages of the two methods and avoiding the one-sidedness of the research results. As for the bibliometric analysis method, it can present the research characteristics of the field in a quantitative way, and it is more direct and objective than the results presented by traditional literature review methods. In addition, quickly analyzing a large number of literature samples is an important advantage of bibliometric analysis (Y. Chen et al., 2015). However, the number of related literature samples finally obtained in this article is small, and this advantage cannot be fully reflected in this article. In comparison, the entire process of data collection,
analysis, and processing of traditional literature review methods is done manually. Therefore, the traditional literature review method has three outstanding characteristics: (a) it is extensive, which is mainly since the manual collection of selected text data, data screening, and processing methods can be more extensive. (b) It is uncertain, the entire process of manual processing of documents is generally uncertain, and the analysis results will be affected by the characteristics of the researchers. (c) The high cost, the traditional literature review method generally requires researchers to spend a lot of energy and time, making the research results more specific and detailed.

In this article, the bibliometric analysis method is used to process the whole research data to reduce the research scope and clarify the core research objects of the research. Furthermore, the traditional literature review method is used to analyze the characteristics and specific connotations of the core research objects and reveal the characteristics of the entire research field. Also, the amount of literature in the field of research on PEBT is relatively small in recent years, basically representing the latest research results in this field. Therefore, the traditional literature review method is used to explore the latest research results of PEBT in recent years, aiming to grasp the latest development trends in this field and lay the foundation for subsequent research on PEBT.

Discussion About the Result of This Article

This article mainly reveals the overall characteristics of the research on PEBT from three aspects: a time-series analysis of the number of documents, time-series analysis of disciplines, and the analysis of international research pattern. It can be found that the number of documents in this field has increased rapidly in recent years, and the distribution of disciplines has become more extensive. But the number of core authors and the number of documents by most of the core authors are small in this field. There are some possible reasons for this phenomenon, the small number of documents by most core authors may be determined by the laws of bibliometrics, and fewer scholars produce most research results in each field. As well as, the small number of core authors may be due to the fact that the field is still in the development stage and the basic core author group is also in the development stage. Moreover, the other possible reason is the WOS database does not include all the documents in this field. Thus, some of the documents are not included in this research data set, which directly leads to some core authors’ loss.

In addition, combining the results of bibliometric analysis, main results of research on PEBT were divided into four parts: the formation mechanism of PEB, the definition and measurement of PEB, and some factors of PEBT, but further analysis of research results in recent years shows that scholars have gradually explored the mechanism and factors of PEBT in various scenarios and come up in knowledge groups, which may be caused by the following reasons. First, research on the PEBT is in the development stage. Although scholars have begun to study the PEBT, the amount of relevant literature is small, and no core knowledge group has been formed. The second is that not all studies on the PEBT in different scenarios have been included in the WOS database, resulting from missing data.

Conclusion

In the research field of PEBT, this study first adopts the bibliometric analysis to review the literature in research on PEBT. Through systematically exploring the overall characteristics of the core, basic knowledge groups, knowledge evolution process and development trend of the field, it can be found that they have recently shown new characteristics and trends, no matter from the chronological characteristics or the specific content of the research results.

In particular, the number of literature in this field has increased dramatically in recent years, and the perspective of the subject has transformed from the perspective of early economics and ecology to diversified perspective, the research pattern has basically formed, and results of Chinese research in this field has gradually increased and become one of the core research areas in this field. As well as, the research methods involved have expanded from mainstream quantitative research to ethnography, meta-analysis, and the research content has been greatly improved in-depth and breadth even as a qualitative comparative study, which is specifically reflected in the application of multidisciplinary theoretical knowledge in the analysis of the influence mechanism of PEBT.

The limitation of this article is that Citespace or Vosviewer will set the same threshold value for documents at different points in time when performing bibliometric analysis. The core collection database of WOS has search restrictions, which may cause a small number of documents have been ignored. Other scholars can collect the relevant research results on PEBT based on other databases to analyze the research characteristics in this field with the help of relevant software to better promote the development of follow-up research in this field.

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ORCID iDs

Chu Feng Yu https://orcid.org/0000-0002-2291-7069
Yong Ma https://orcid.org/0000-0003-0445-3085
Jie Ren https://orcid.org/0000-0001-9135-475X

Notes

1. About Web of Science: wokinfo.com/
2. Data sources: Google Scholar search.
3. Overview of Citespace application suite: http://cluster.ischool.drexel.edu/~cchen/citespace/download/

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