Bibliometric Analysis of Water Conservancy Talent Development Research in China

Qiuli Ge*, Long Zhang
College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu, 211100, China
*Corresponding author’s e-mail: geqiuli@nuaa.edu.cn

Abstract. In order to study the overall status of the research on water conservancy talent development in China, 6135 articles on the water conservancy talent development published in the past 30 years were downloaded from CNKI. Taking these articles as the sample, the time distribution, hot topic, topic cluster and research frontier of the water conservancy talent development research were quantitatively analysed with CiteSpace software. The results indicate that the scale of water conservancy talent development research has increased significantly in the past 30 years, but it has not become a popular school in the field of water conservancy research. Moreover, the research on the development of water conservancy talent involves a wide range of topics, including water conservancy reform, talent management in enterprises, talent education, rural water conservancy talent development, but the research appears extensive on the whole, so the future research can develop in a more refined way.

1. Introduction
The development of water conservancy is of great significance to the overall situation of national economy. Moreover, the reform and development of water conservancy in the new era cannot do without human resources. It is of great value to do research on the talent development of water conservancy industry. In China, researchers have carried out numerous related studies [1-3]. However, there has been no bibliometric review that analyses the existing research which focuses on the water conservancy talent development. The aim of this paper is to explore the overall situation of water conservancy talent development research in China and predict the future research trend.

In recent years, bibliometrics approach which allows the academic literature to be analysed statistically has been widely used in many disciplines. In the field of human resource management research, some studies use bibliometric methods to review specific topics, such as international human resource management [4] and Chinese human resource management [5]. The unique advantages of bibliometrics approach in literature review have been fully recognized.

Drawing on previous research, this study explored features of water conservancy talent development studies through the bibliometric analyses of all related studies published between 1990 and 2019. More concretely, this study applied a bibliometric method using CiteSpace software to present an overview of the water conservancy talent development studies, by identifying the evolutionary trend, hot topic, topic cluster and research frontier.

2. Data and methods
CNKI database was used to collect bibliographic data in this study. We searched for articles published between 1990 and 2019, which contained at least one of the following terms in their abstract: "Water
Conservancy & talent", "Water Conservancy& personnel", "Water Conservancy& human resources", "Water Conservancy& staff", "Water Conservancy & Cadres" and "Water Conservancy & staff" ( means and).

A total of 8938 articles were collected. In order to ensure the accuracy and reliability of the research, these data were checked and cleaned. Through reading the abstract of each article, 2,803 invalid documents were found and deleted, including 2,609 invalid documents like news, announcements, notices and congratulatory words, 159 documents with low relevance and 35 duplicate articles. Finally, a total of 6135 valid articles were imported into CiteSpace for bibliometrics analysis.

3. Results & Discussion

3.1. Time distribution

The number of publications is an important indicator to measure the development status and future trend of a certain discipline or research field in a specific period of time [6]. Figure 1 shows the number of publications on the water conservancy talent development in China every year. The minimum number of publications (42 articles) appeared in 1990, and the maximum number (406 articles) appeared in 2015. It can be seen that the research scale of water conservancy talent development has increased significantly over the past few decades. However, it should also be noted that the research on water conservancy talent development has also experienced a rollback. The number of publications decreased after 2015.

![Figure 1. Annual number of publications from 1990 to 2019.](image)

3.2. Hot topic

Keywords indicate the basic content of articles, and the high-frequency keywords usually reflect hot topics in the field. 6135 valid articles were imported into CiteSpace, and 12572 keywords were identified with a cumulative frequency of 29938. The keywords are ranked according to their frequency of occurrence and the top 50 keywords are listed in Table 1.

According to this list, we can make the following preliminary judgments on the contents of water conservancy talent development research in China. Firstly, the research area covers a wide range of topics, including general topic, organizational management, organization type, output and talent management function. Secondly, the importance of water conservancy talent development has been fully recognized, but the discussion on it is not deep enough. This can be seen from the presence of a large number of generic keywords in the high-frequency keyword lists.
Table 1. Top 50 keywords.

| Keyword                                      | Freq | Keyword                     | Freq |
|----------------------------------------------|------|-----------------------------|------|
| water conservancy                            | 708  | rural                       | 72   |
| water conservancy project                    | 409  | reform                      | 72   |
| water resources and hydropower engineering   | 257  | school                      | 70   |
| the water conservancy industry               | 204  | the mode of talent training | 64   |
| enterprise                                   | 171  | the masses                  | 59   |
| enterprise management                        | 166  | practice                    | 58   |
| department of water resources                | 142  | fiscal management           | 58   |
| countermeasures                              | 135  | current situation           | 57   |
| hydraulic system                             | 135  | utilities                   | 53   |
| ministry of water resources economic         | 122  | talent team construction    | 52   |
| innovation                                   | 120  | agricultural                | 50   |
| cultivation of talents                       | 104  | construction                | 50   |
| ideological and political work management    | 97   | leading group               | 50   |
| water conservancy talent                     | 97   | leading party group         | 48   |
| water conservancy in basic units             | 93   | water conservancy           | 48   |
| water conservancy business                   | 85   | market economy              | 48   |
| water conservancy bureau                      | 82   | management office           | 48   |
| educational reform                           | 81   | water conservancy economy   | 47   |
| human resource                               | 79   | curriculum system           | 47   |
| human resource management                    | 77   | economic structure          | 46   |
| water conservancy and hydropower problem     | 77   | practical teaching          | 45   |
| water conservancy reform and development     | 76   | rural water conservancy     | 44   |
| water conservancy management unit            | 75   | higher vocational education | 44   |
|                                             | 73   | economic benefit            | 43   |

3.3. Topic cluster

By clustering keywords, the research topics can be divided into several categories, which is helpful for understanding the overall framework of water conservancy talent development research. The clustering analysis of keywords was completed by CiteSpace and log-likelihood ratio (LLR) technique was used. LLR is considered to be the most reliable technique for generating high-quality clusters with minimum overlapping [7]. In addition, modularity and silhouette values were used to evaluate the efficacy of the cluster analysis results [8].

Most keywords were divided into eight large groups. Table 2 provides the general information about the eight clusters. Overall, the whole network has modularity (Q=0.64), which reflects that the boundaries between clusters are clear. And the silhouette values of all clusters are all above 0.5, which indicates that the keywords in the same cluster have high homogeneity. The average year in which all keywords first appear in the cluster is also listed in the table. The average year of Cluster 4 is 2000, which is the latest. It can be considered that the research topics in the field of water conservancy talent development are relatively mature, and the new topics emerging in the recent 20 years have not developed into subject areas with a certain scale. The eight main clusters are further explained below.
Table 2. Summary of topic clusters.

| ID | Cluster name                               | Size | Silhouette | Average year |
|----|--------------------------------------------|------|------------|--------------|
| #1 | water conservancy reform and development   | 25   | 0.690      | 1992         |
| #2 | strategy research                         | 19   | 0.867      | 1998         |
| #3 | water conservancy                         | 19   | 0.813      | 1992         |
| #4 | teaching mode                             | 16   | 0.844      | 2000         |
| #5 | water conservancy project                 | 15   | 0.921      | 1992         |
| #6 | workers                                   | 14   | 0.924      | 1990         |
| #7 | school                                    | 14   | 0.792      | 1992         |
| #8 | economic system                           | 8    | 0.917      | 1991         |

The largest cluster (#1) is labelled as "water conservancy reform and development". This cluster focuses on how to accelerate the reform and development of water conservancy in China. The representative keywords in the cluster include "promoting water conservancy through science and education", "personnel system reform", "construction of water conservancy staff team" and "vocational skill appraisal". In addition, the construction of a clean and honest government is also an important topic of concern in this cluster.

The second cluster (#2) is labelled as "strategy research". The articles related to this cluster mainly analyse the current situation and problems of talent management in water conservancy industry, and then put forward countermeasures and suggestions accordingly. The specific measures and suggestions involve many aspects, such as personnel training, human resource allocation, informatization of human resource management and incentive mechanism. The representative keywords in this cluster include "countermeasure", "problem", "current Situation", "measures" and "suggestion".

The third cluster (#3) is labelled as "water conservancy". This cluster focuses on how to manage the employees in water conservancy enterprises. For example, some papers analysed the causes of talent drain in water conservancy enterprises and put forward some corresponding countermeasures [9]. The representative keywords in this cluster include "enterprise", "enterprise management", "innovation", "talent team construction", "economic benefit", "long-term plan" and "construction enterprise".

The fourth cluster (#4) is labelled as "teaching mode". The articles related to this cluster mainly explore how to improve the quality of water conservancy talent cultivation in universities. The representative keywords in this cluster include "teaching model", "talent training", "higher vocational education", "course system", "practice teaching" and "school-enterprise cooperation".

The fifth cluster (#5) is labelled as "water conservancy project". The related articles pay attention to the personnel management during the operation of water conservancy projects. For example, some papers discussed how to manage the daily maintenance team, professional maintenance team and operating team of the water conservancy projects [10]. The representative keywords in this cluster include "water conservancy and hydropower project" and "water conservancy project management".

The sixth cluster (#6) is labelled as "workers". The related articles mainly concern the labour management in the rural water conservancy construction. Rural water conservancy projects have been increasing in size and scale in recent years, but the phenomenon of uneven comprehensive quality and insufficient work motivation of the constructors is still common [11]. One of the core research directions in this subfield is to identify the personnel management problems in rural water conservancy project construction and propose solutions.

The seventh cluster (#7) is labelled as "school". This cluster also focuses on water conservancy education, but the articles related to this cluster pay more attention to the talent education in secondary professional schools and technical schools.

The eighth cluster (#8) is labelled as "economic system". The articles related to this cluster mainly discuss how to strengthen the water conservancy project management under market economy. This topic cluster emerged under the background of the development of Chinese marketing economy. With the improvement of market economy in China, the relevant discussion has gradually decreased.
3.4. Research frontier

Burst detection can reveal topics that increased abruptly over time [12], and it has been considered as an important means to identify research frontiers [13]. All keywords from 6135 articles were analysed for their burstiness. Among all 154 keywords with occurrence bursts, we are particularly interested in those keywords that started to burst from 2015 (Table 3). These emerging keywords reveal what is new in water conservancy talent development. In the past five years, the keywords with occurrence bursts include "personnel training", "human resources management", "higher vocational colleges", "curriculum system" and "school-enterprise cooperation".

It can be seen that there are two important research directions. One is to study the training and education of water conservancy talent. The other is to study how to improve the human resource management level of the water conservancy enterprises. Further, the keyword "influence factor" deserves attention because it indicates that some empirical studies are emerging in the field of water conservancy talent development research, and this could be a promising research direction in the future.

Table 3. Keywords with occurrence bursts (2015-2019).

| Keyword                                      | Strength | Begin year | End year |
|----------------------------------------------|----------|------------|----------|
| personnel training                           | 12.6     | 2015       | 2019     |
| human resource management                    | 10.2     | 2016       | 2019     |
| higher vocational colleges                   | 8.2      | 2015       | 2019     |
| problem                                      | 8        | 2015       | 2019     |
| school-enterprise cooperation                | 6.8      | 2015       | 2019     |
| general secretary Xi Jinping                 | 6.5      | 2015       | 2019     |
| water conservancy unit                       | 6.2      | 2015       | 2019     |
| curriculum system                            | 5.8      | 2015       | 2019     |
| countermeasure                               | 5.8      | 2015       | 2019     |
| influence factor                             | 5.7      | 2016       | 2019     |
| govern the party strictly                    | 5.4      | 2015       | 2019     |
| integration of production and education      | 4.5      | 2015       | 2019     |
| water conservancy                            | 4.4      | 2015       | 2019     |
| remote sensing centre                        | 4.4      | 2016       | 2019     |
| water conservancy enterprise                 | 4.2      | 2016       | 2019     |
| explore                                      | 3.9      | 2016       | 2019     |
| targeted poverty alleviation                 | 3.6      | 2015       | 2019     |

4. Conclusions

Based on the bibliometrics analysis of the literature published in the past 30 years on the talent development in water conservancy industry, this paper draws the following conclusions. Firstly, the scale of water conservancy talent development research has increased significantly in the past 30 years. But it has not become a popular school in the field of water conservancy research. Secondly, the research on the development of water conservancy talent involves a wide range of topics, but it appears extensive on the whole. Among the high-frequency keywords, many keywords have broad semantics. It suggests that the research on the development of water conservancy talent may still be in a relatively extensive stage. Specific topics such as talent planning, performance management and talent retention have not been explored in depth. Therefore, researchers can carry out more refined research in the future. In addition, with the research more refined, the practice of water conservancy talent management also needs to be deepened. The specific measures include strengthening post management and improving employee motivation.

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