Knowledge mapping of technology management data

--A visual analysis using CiteSpace

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Abstract

Technology management data constitutes a considerable accumulation of data for follow-up studies. This study used CiteSpace to analyze investigations and make knowledge mapping. This application resulted incomprehensive knowledge maps of technology management data research. The study identified major disciplines that provide knowledge and theories for the technology management data discipline.

Keywords

Technology management data, CiteSpace, knowledge mapping..

1. Introduction

1.1 Why knowledge map the technology management data

With the advance of information society and the wide application of network information source, the demand for large data and massive data storage, transmission, retrieval and classification is increasingly urgent. There are many important information behind the data. People hope to carry on thorough analysis in order to better use these data. Scientific knowledge map, a new field in recent years, is driven by information technology. It has become a new hot spot for scientometrics. With the help of scientific knowledge map, people can perspective structure of each large field of knowledge system, straighten out the complex knowledge network because of the big bang of contemporary knowledge formation, forecast the latest trend of the development of cutting-edge science and technology.

In recent years, with the increasing prosperity of science and technology innovation activities in China, government departments and technological innovation entities have become increasingly demand for the aim of technology management work and the analysis for scientific and technology management data. There are many hidden important information behind the explosion of data, people want to analyze them in a higher level in order to make better use of these data. Technology management data refers to all kinds of data related to technology management, including technology project data, technology achievement data, technology expert data, technology institution data, technology enterprise data, technology input data, et al.It plays an important role in many aspects of government decision-making, scientific and technological innovation and economic development [1].

1.2 Knowledge mapping and CiteSpace

CiteSpace Previous review works on technology management data research were either quantitative or qualitative in naturewhile no attempt has been made to visualize knowledge maps. Knowledge mapping is defined as processes, methods and tools for analyzing knowledge areas to discover meanings and to visualize them in a comprehensive and transparent format. It is one of the most important steps in knowledge management and can present concepts, knowledge and links in visual/graphic formats. Various techniques could be used in creating knowledge maps, such as Yellow Paging, Social Network Analysis and Knowledge Domain Visualization (using CiteSpace). CiteSpace is one of the most popular tools for knowledge mapping. It is particularly designed to

support the analytic process of visualizing and it can produce co-citation networks based on article citations to reveal the structure of a particular research field.

2. Research method and Data sources

2.1 Research method

Knowledge mapping is a newly developed scientific research method which integrates scientific metrology, statistics, machine learning and computer graphics. It sets up the relationship between scientific documents on a statistical basis, and then visually reflects them. It plays an important role in the discovery and interpretation of potential and hidden regularities or disciplinary evolution paths in scientific literature [2].

The knowledge map consists of two basic and interrelated aspects: Structured Modeling and graphical representation. According to different principles, there are many ways to draw a map of scientific knowledge. Chinese American scholar Dr. Chen Chaomei designed free CiteSpace II software, is one of the many knowledge mapping software. It is the scientific literature as the data source, converts it to a geometric problem and statistical problems to use geometry intuitive and based on the perspective of mathematics, study the inner link. To research front and mode of assessing some subject or field [3][4][5].

2.2 Data sources

The reference data used in this paper mainly comes from the Web of Science database. Data retrieval strategy: the scope obtain SCI and SSCI database; the subject is ''technology management data''; the publication period is confined from ''between year 2007 and 2016''.Accurately retrieved reference type is ''article''; language is ''English''; category of Web of Science is refined by the subject ''management''. A total of 1458 references is obtained. The data set for download "records and references", all recorded output 500 every time, save as text files.The file is named download_tmd_M_1.txt~ download_tmd_M_3.txt, the final time of the data downloading is July 20, 2017. We specify 2 years as the length of a single time slice.

3. Knowledge mapping results and analysis

The relevant Citespace parameters which are established include: time slicing (year 2007 and 2016). Years per slice (2 year), term source (title, abstract and author keywords and keywords plus), and node type (author, country, institution, keyword, cited reference, cited author, cited journal). TF*IDF weighting is used to analyze the content of each cluster.

3.1 Analysis of Country Distribution

When country and institution is selected as the node type, running Citespace resulted in a country distribution with 200 nodes and 357 links (Fig. 2). This distribution map will provide valuable information for researchers to easily find where their colleagues and institutes are in different parts of the world, which should help to establish some collaboration.

The top 3 countries are USA, England, People's Republic of China, which published 563,145,135 papers respectively. What need to notice is that many papers have several authors who represent different countries, so the sum number of publications is larger than that of papers. The largest contribution rate of literature is the United States, much higher than in other countries, accounting for approximately 40% of the total volume of publications, followed by England, People's Republic of China. The United States sends such a high number, which is inseparable from the United States' strong economic strength, huge scientific research input and high-level scientific research staff. Secondly, English developed countries economic are not inferior in their investment and output in this field. Although China's output is relatively near the front. However, we should continue to strengthen investment in the frontier areas.
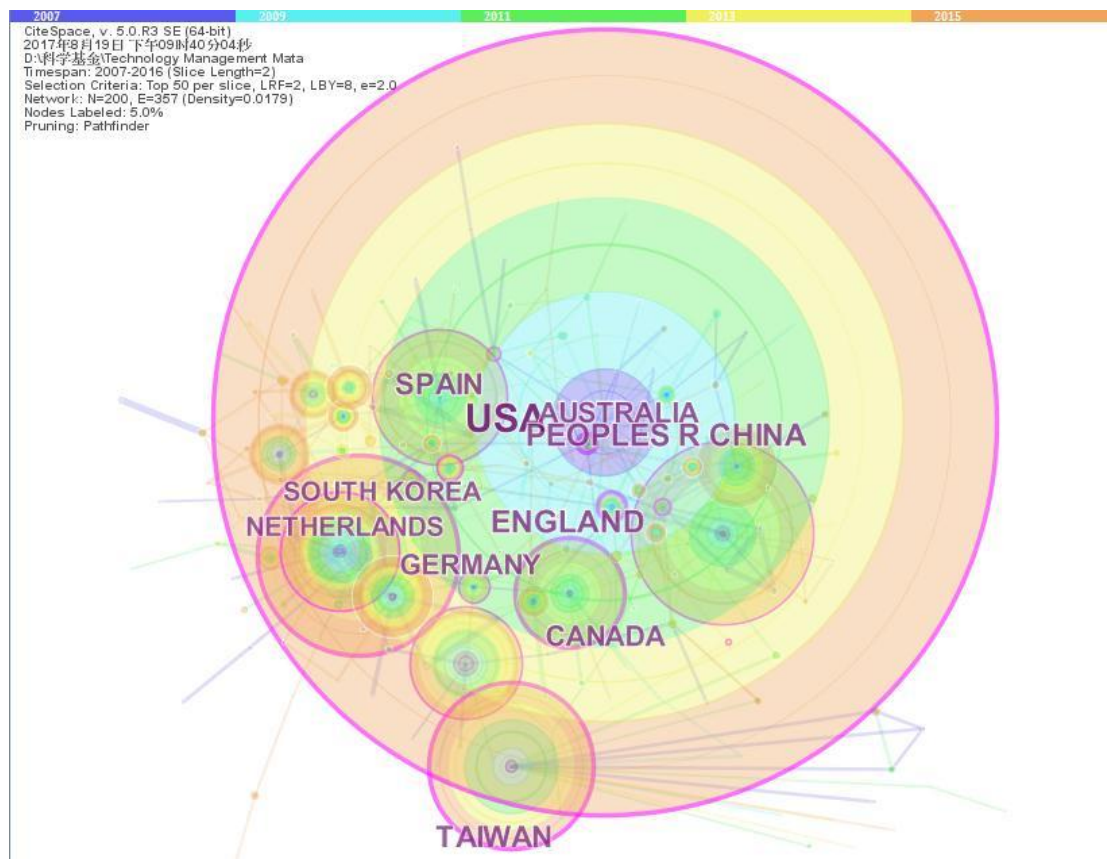
Fig. 1 mapping of country

3.2 Analysis of Institution Distribution

Fig. 2 Mapping of institution

When country is selected as the node type, running Citespace resulted in a country distribution with 241 nodes and 253 links (Fig. 3). The statistical analyses demonstrate that institution with the largest

number of postings is Hong Kong Polytech University and the vast majority of research institutions are Universities.

3.3 Analysis of the Cited Author Cluster

Table 1. Top 10 Cited Author by frequence

Freq	Centrality	Author	Year
261	0.46	Fornell C	2007
253	0.27	Podsakoff PM	2007
236	0.15	Eisenhardt KM	2007
213	0.51	Teece DJ	2007
201	0.12	Cohen WM	2007
176	0.08	Nonaka I	2007
175	0.05	Nunnally J	2007
172	0.24	Barney J	2007
163	0.12	Grant RM	2007
145	0.06	Kogut B	2007

For an author co-citation link which can reflect a close relationship between two authors, the thicker it is, the stronger their research closed. The bigger a node is, the more important the author is.

This suggests that these authors have large impact on technology management data field. The top 1 cited author is Fornell C and the top 1 Centrality is Teece DJ.

3.4 Analysis of Cited Reference Cluster

Co citation analysis is an important content of citation analysis, which has attracted wide attention of scholars at home and abroad. Computer visual information processing software is through the visual information processing of dynamic image, showing the complex phenomenon of interdisciplinary professional in the field, so as to obtain detailed information of the analysis results of frontier science. The results of these information analysis will help scientists understand and predict cutting-edge research trends in the shortest possible time. It helps to open up new unknown fields in complex scientific research information, and provides objective basis for fast, independent and scientific judgment[6].
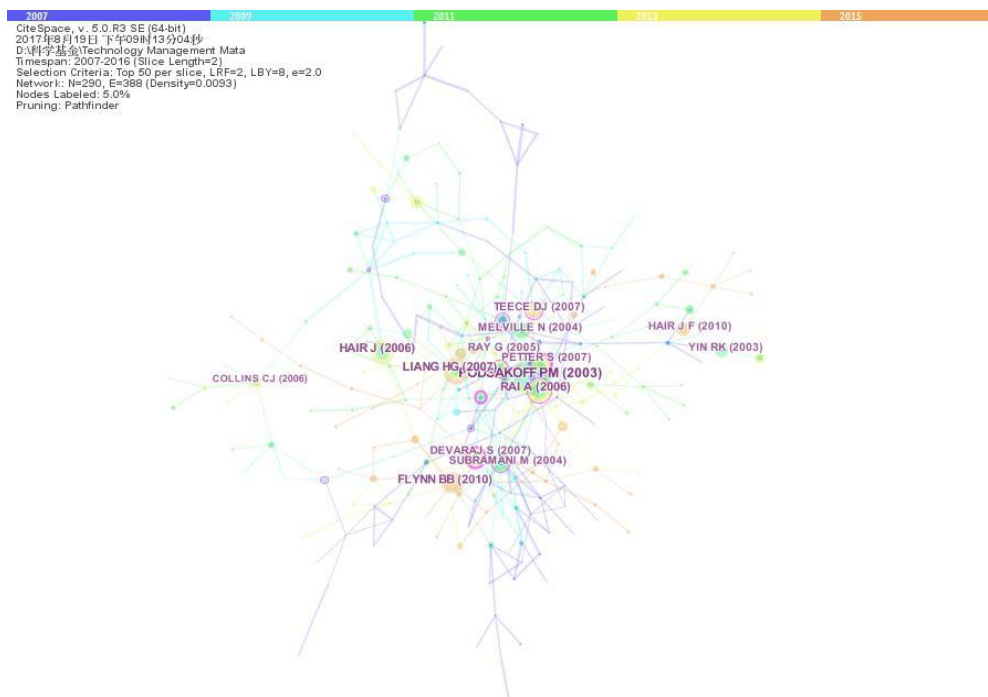

Fig. 3 Mapping of Cited Reference

Table 2. Top 10 Cited Reference by frequency

Freq	Burst	Centrality	Author	Year	Source
55	15.95	0	Podsakoff PM	2003	J APPL PSYCHOL
40		0.18	Rai A	2006	MIS QUART
39	5.27	0.3	Liang HG	2007	MIS QUART
37	5.02	0.2	Hair J	2006	MULTIVARIATE DATA AN
34		0.13	Flynn BB	2010	J OPER MANAG
31	3.52	0.1	Teece DJ	2007	STRATEG MANAGE J
28	4.54	0.04	Subramani M	2004	MIS QUART
27	5.14	0.28	Petter S	2007	MIS QUART
25	6.54	0.02	Yin RK	2003	CASE STUDY RES DESIG
25	4.37	0.17	Ray G	2005	MIS QUART

A cited reference map is created by running Citespace with 290 nodes and 388 links.The deep blue, the sky blue, green, yellow and orange circle stand for references publicated in the year of 2007,2009,2011,2013 and 2015 respectively. References cluster result shows that different years have different themes related to technology management data field.

Specifically, from Table 2 we can see that the cluster ranked first is Social Support "Common method biases in behavioral research: a critical review of the literature and recommended remedies" written by Podsakoff and Philip M, published in Journal of Applied Psychology.It has been cited 55 times.This article examines the extent to which method biases influence behavioral research results, identify potential sources of method biases, discuss the cognitive processes through which method biases influence responses to measures, evaluate the many different procedural and statistical techniques that can be used to control method biases, and provide recommendations for how to select appropriate procedural and statistical remedies for different types of research settings. This article can be regarded as the foundation of behavioral sciences.

4. Discussion

In the field of technology management data over the past 10 years as the research object, through data processing and analysis of CiteSpace software, using the knowledge map shows the way of distribution of power in the field of technology management data and related academic literature, popular keywords, analysis the knowledge structure and the current development trend of the current development on the field of technology management data, hoping to provide a reference for research and development of the discipline of the technology management data in china.

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