Comparison of Smart City Development in Japan and China by Text Mining Analysis

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Abstract. With the information technology development, Smart city has become popular worldwide in recent years. However, the applications of smart cities are diversified among countries to achieve different objectives. This research compared how the smart city concept has been applied differently in China and Japan, two major economies in East Asia, through text mining techniques on relevant journal articles. The journal articles in either countries are analyzed by software, KH-Coder, which automatically extracts word, count the frequency of each word then using statistic method to classify and find the relationship among each high-frequency word. The results imply that in the case of Japan, energy efficiency in local level is a primary focus while the smart city concept is applied as a basic infrastructure for economic development in China.

1. Introduction

1.1. Background
Modern cities face major challenges such as population, resource, and environment. New form of information and communication technologies (ICT) such as the internet and smartphone have provided a solid base for creating new city development concept, smart city to tackle those challenges.

A smart city concept, which incorporates ICT to better control city operation and optimize the use of limited resource, has popularized worldwide. However, application of smart cities is diversified among countries and cities due to their needs and objectives. While promotion of smart cities often initiated by private sectors, it is also essential for central and local governments to play major roles in smart city building for better coordination among different sectors such as transportation, energy supply, and urban planning. Thus, it is crucial to better understand how the smart city concepts are applied differently and how major actors in smart city building play different roles among different countries and cities.

1.2. Research Objectives
The primary focus of this research is that compare how the smart city concepts are applied differently in China and Japan, two major economies in East Asia, as a case study, through text mining analysis to look at the frequency of keywords on relevant journal articles.

1.3. Literature Review
Research on smart city can be broadly divided into smart city policy and concept analysis, smart city comparison, and smart city evaluation.
1.3.1. Smart City Policy and Concept Analysis
The roles of local governments in smart city building and management are critical, especially for better coordination among different sectors. Both policy and concept are significant for smart city research. Reference [1] found that smart city policy is positively and significantly affect the innovation of the city by propensity score matching and difference-in-difference method. Reference [2] analyze and compare the smart city policy in the first 20 smart cities prioritized among 100 smart cities in India by identifying smart city dimensions and find the relationship among each policy and dimensions. Reference [3] focus on the application of smart city concept into single-industry towns of Russia and Kazakhstan. Technology of smart city application into the socio-economic system is also in the research. Reference [4] do the case study of Japanese smart city project and classify each case into several categories by developing stage: decision making, planning and operations. Reference [5] focus on the unicorn planning and combine it with smart city development in North America. Unicorn planning is a techn-optimist attitude of economy and smart cities.

1.3.2. Smart city comparison and experience learning
A number of researchers conducted research on comparing smart cities cases in different countries. Reference [6] compare the smart business continuity management of buildingss and facilities of smart city in China and Japan by taking the Tokyo disasterpreventionn plan as a sample. Reference [7] compare the Chinese smart city and American smart city by concept, key dimension, technology and governance structures. The result is that the US governments focus on the public service to attract business, while the Chinese governments emphasize the technology development. In the smart city, Reference [8] use questionnairesurvey of more than 300 hundred Greek municipalities to compare the convergence and divergence of smart cities through evaluating and classifying the smart city actions perceived by citizens.

1.3.3. Smart City Evaluation
For a better quantitative evaluation of smart cities, evaluation indicators are in researcher’s consideration. Reference [9] explore the difference of indicator systems through the comparison of smart city evaluation indicators. Reference [10] prove the Quantitative Incidence Matrix by case comparing of two Italian cities, Sicilian residential district and Rome.

1.4. Characterization of Thesis
According to the literature review, there is some existing research on the comparison of smart city. The most papers focus on the comparison between cities in the same country such as China or the same region such as European or American cities. However, there is little existing research focusing on East Asia, specifically, to juxtapose China and Japan comprehensively. This research sheds light on those points. In additions, this research first introduces text mining technique to compare how the smart city concept differs between China and Japan.

Regardless of China or Japan, smart city development is still in the initial stage. Thus, it might be valuable for researchers and practitioners in two countries to share and learn knowledge and experiences of smart city building from each other.

2. Materials and Methods

2.1. Text Mining
Text mining is an analysis method that automatically extracts word by computer and utilizing a statistic method to analysis the word. The extracted word can be classified and analyzed. Then several information such as word frequency and word connection would be visible. The target is qualitative material such as article, voice.
2.2. KH-Coder
In this research, KH Coder would be used as a material for analysis. KH coder is a software to conduct multivariate analysis. It is possible to extract keyword and count the frequency of occurrence. The keywords would be categorized and the relationship among each word can be showed in co-correlation figures that show the relationship of each word intuitively.

The process is that first, find the same number of articles in China and Japan. In this research, find 49 papers randomly of either country from 2013 to 2019. Chinese papers are collected from academic website “Zhiwang”, while Japanese papers are collected from “J-stage”. The method of collecting is that search keyword “Smart City”, if the number of articles is not enough, then search “Smart Community” as the supplement keyword. According to the relativity order by website, choose several papers during the 7 years. The number of Chinese academic articles in each year is 7. Because of the limitation of Japanese online academic article, therefore, the number of Japanese articles from 2013 to 2019 is 11, 7, 7, 10, 7, 5 and 2.

Then, using KH Coder to analysis articles respectively in China and Japan to obtain the keyword in high frequency (top 150) After analyzing of KH Coder, it is possible to obtain the list of frequencies of each keyword. Then count the percentage of each word in the whole frequency of either country. The co-correlation figures can be obtained to know the relationship of each keyword. Finally, compare the result from China and Japan.

3. Results & Discussion

3.1. Keyword Analysis
For finding the similarities of smart city development in two countries, it is necessary to find the keyword, which is high-frequency word both in Japan and China. However, it is difficult to visually compare them by frequency. Since the total frequency of keywords is different in the two countries, the percentage of each word in the total frequency of two countries was calculated. By calculating the percentage of occurrences of each word in the first 20 words, the same keywords in Japanese and Chinese articles were selected and compared.

“City”, “Smart”, “Data”, “System”, “Information”, “Society”, “Technology” and “Service” are the same keywords shows in both top 20. The main keyword “Smart City” in Japanese papers, most of it showing on keyword, however, the title of each article is about specific areas of smart city. In Chinese articles, keyword “Smart city” is most showing on the title, while the contents of each article are about the total development of smart city. Figure 1 shows a comparison of the same keywords in Japan and China.

Figure 1 shows the comparison of high frequency keywords both in the top 20 list. Besides that, other keywords in Top 20 frequency in Chinese text is: “Government”, “Developing”, “Management”, “Resource”, “Planning” and “Construction”. In Japanese text mining, “Transportation”, “Electric Power”, “Infrastructure”, “Model”, “Evaluation”, “Project”, “Enterprise”, “Local” and “Energy” are also mentioned into top 20. It is also clear that the concentration of smart city in two countries are similar, but they account different percentage. In China, the word about a concept such as “Smart” and “City”, which are in majority. Then comparing with Japan, Chinese focus more in “Information” and “Technology” and “Data”, “Service” Japan focus much more on “Society”, “Environment” and “System”.

Further, information technology is the most important development for smart city in both countries, also can be
obtained. Both Japan and China are concerned about the environment, but Japan is more concerned about the environment than China. Building a smart city in the society, improving the level of service, and building a smart city system are important goals of both. For a given region, smart city in Japan is decentralized planning by local authorities, especially in the transportation and energy sectors. In recent years, the development of smart city in China is at the basic stage, while the development of smart city in Japan is concentrated in the transportation and energy sectors. It focuses more on the planning and management of smart cities. The Chinese smart city is unified by the central government.

3.2. Co-correlation Network Analysis

The co-correlation network, which shows the connection and categories of each keyword can be obtained. The smallest appear word frequency is 160 and the number of words in a figure is 80. The Jaccard edge index is used. Only noun, verb and adjective are in the network. As the original co-correlation networks are in Chinese and Japanese. For comparison, it is necessary to translate them into English. Figure 2 and 3 shows the co-correlation network of Japan and China, respectively. According to each cluster in different colors, it can be categorized and analyzed.

Obviously, the keywords are clearly divided into several clusters in Figure 2. The aim of smart city development in Japan is sustainable development, economic and environmental protection. Another aim of smart city development, in conjunction with Japanese urban policy, is to link each individual local city into a system. The energy efficiency, especially the power supply efficiency, is the main problem that the city faces and needs the help of the smart city. The specific development field of intelligent city is traffic, especially automatic automobile. Another cluster is about smart city technology. Data is the core of smart city, and information technology is the main technology of smart city. In addition to this explicit clustering, other smaller clusters elaborate on details such as emissions reduction, Internet standards and project management. Because of the synonyms, there are two "cities" in Figure 2, but in the original correlator network, the city colored green is in Kanji and the city colored red is in Katakana.

Figure 1 The Comparison of Same Keyword both in Japan and China.

Figure 2 The Co-correlation Network of Japan
According to Figure 3, China has fewer categories than Japan, and the scope of each category is unclear. The keywords are complete and clustered together. However, the core of smart city in China can also be divided into information technology, construction system, smart city construction, management, and application. This means that Chinese smart city development is in the overall planning stage and has been fully launched. Second, the yellow category is about purpose: Government and social services, economic development, and the reduction of environmental pollution. Other small clusters involve citizen participation, evaluation index system, personal data security and protection.

It is obvious that the keywords of China are gathered together, while Japanese keywords are divided into several categories clearly. As Figure 2 shows, the purpose of Japanese smart city is sustainable development, economy, and environment protection. The energy efficiency is the main problem which need utilize smart city development to solve. Information technology is also the main technology and transportation is a specific development area. Figure 3 shows that the core of Chinese smart city is information technology, building information system, smart city construction, management, and application. The purpose is the government and social service, economic development and decrease environment pollution.

Table 1  The comparison of smart city in Japan and China

| Purpose                        | Common                  | China                  | Japan                  |
|--------------------------------|-------------------------|------------------------|------------------------|
| Economic Development,          |                         | Social and Public      | Industry Development   |
| Environmental Protection       |                         | Service                |                        |
| Main Technology                | Information Technology  |                        |                        |
| Nearest Word                   |                         | Technology, Construction, Information | Environment, Transportation, Infrastructure |
| Specific Area                  | Information Technology  | Basic Construction     | Transportation (Autonomous Vehicles) |
| Management                     |                         | Central Government    | Local Government Project |
| Future Plan                    |                         | Set Emergency Response System, E-Government | Connection of each city, Create Evaluation Indicator |
| Specific Problem               |                         | Information Privacy    | Energy Efficiency      |
Comparing with Figure 2 and 3, Table 1 summarizes the characteristics of smart city in China and Japan in different directions, such as purpose, main technology, future plan etc. Smart cities in both countries are targeted for economic development and the environment. Actually, the purpose decides the development of smart city. Based on the Co-correlation network figures, even two countries hope that smart city will promote economic growth and environmental protection. However, Different purposes determine the direction of their smart city development.

Information Technology is the main technology and main developing area of smart city development in China and Japan. It means that the application and development of technology play a significant role in the development of smart city in both countries. The two countries will also continue their information technology research for urban planning. However, Japan also wants to develop industry through smart city, while China wants to improve social and public services.

4. Conclusion

In this paper, how the smart city concept has been applied differently in China and Japan was compared through text mining techniques. The study found, in recent years, China has paid more attention to macro issues such as technology, construction and information, while the most important issues in Japan are specific areas such as environment, transportation and infrastructure, which is an obvious feature of Japan's smart cities.

In particular sectors, China also focuses on the overall infrastructure, while Japan focuses on specific sectors such as transport and data access. Therefore, Chinese overall smart city development is mainly managed by the central government, while Japanese smart city is a combination of local projects. Because of the characteristics of smart city, the specific problem of Chinese smart city is the information privacy after the construction of sharing information system spreading to all aspects into the city, while the actual problem of Japanese smart city is the energy efficiency, especially the power supply efficiency. In short, the Chinese smart city is a complete city, it uses information technology to reset the city and hope the technology will spread to all services into a smart city in the future. By contrast, Japanese smart city is unique in that they solve specific local problems such as transportation and energy. However, it is temporary. Based on the analysis result, the future plan of smart city in Japan increases the connection of each smart city, which is the next step of Japanese smart city development.

The reason is that Chinese smart city development is based on the central government's policy, therefore, the Chinese smart city focuses on macro-construction and the keywords gather together. The development of smart city in Japan is based on the specific problems of local governments, the policies of the central government as a supplement and suggestion, therefore, the classification of each smart city project in Japan focuses on specific areas.

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