

Comparison of MFCA research trends in Japan and China

Doctoral Course Ling Zhu

Ph.D. Professor Yang Xu

Faculty of Economics, Nagasaki University

ABSTRACT

In this paper, we review the literature on environmental accounting and environmental management accounting in both Japan and China, and consider the development process of environmental accounting research in Japan and China. In particular, in this development process, we focus on the research trends of MFCA in Japan and China, which promotes the win-win relationship between the environment and the economy, as a key method of environmental management accounting. In conclusion, based on the research survey of MFCA in Japan and China, it is to propose the current state of MFCA research in China at present and the direction of MFCA research in China in the future.

Keywords

Material Flow Cost Accounting, Research literature, Research content, Government, Effect

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Ling Zhu, Yang Xu¹

Nagasaki University

1. Introduction

China has achieved rapid economic growth, but as with Japan's high economic growth, environmental problems such as wastewater, exhaust gas, and fixed waste pollution, as well as the depletion of resources such as raw materials and energy, are becoming more serious. To solve these environmental problems, the Chinese government significantly revised the Environmental Protection Act in 2014 to further tighten environmental regulations for companies. Against this background, the research on "environmental accounting" began in the 1990s, and the "Environmental and Resource Accounting Expert Committee" was established in the Accounting Society of China.

On the other hand, in accounting research in Japan, the development of environmental management accounting methods was carried out under the initiative of the Ministry of Economy, Trade and Industry since 2000. In this project, after introducing "Flow Cost Accounting" in Germany, the "Environmental Management Accounting Methodology Workbook" was published in 2002. Material Flow Cost Accounting (called Material Flow Cost Accounting, which is referred to as MFCA) based on case studies for Japanese companies. It has been recorded as. Since then, the Ministry of Economy, Trade and Industry (METI) has developed measures to promote MFCA-specification simply from 2004 to 2010. MFCA is spreading to Japanese companies.

In this paper, we review the literature on environmental accounting, environmental management accounting, and material flow cost accounting in Japan

¹ Doctoral Course Ling Zhu, Ph.D. Professor Yang Xu. Faculty of Economics, Nagasaki University, 4-2-1, Katafuchi, Nagasaki 850-8506, Japan.

Phone: +81-95-820-6373; Fax: +81-95-820-6373; e-mail: jxuyang@nagasaki-u.ac.jp

and China, and consider the development process of environmental accounting research and MFCA in Japan and China. In this development process, we will focus on and compare MFCA's research trends in Japan and China, which promotes the win-win relationship between the environment and the economy, as a key method of environmental management accounting. This paper points out that it is possible to apply MFCA and develop research in China in the future based on the research survey of MFCA in Japan and China.

2. Research Review of Environmental Accounting and Environmental Management Accounting in Japan and China

2.1 Study on Environmental Accounting in Japan and China

Japan's Ministry of the Environment, with the aim of establishing a common framework for environmental accounting in order to support environmental accounting efforts, was established in March 1999 as a "Guidelines for Understanding and Publication of Environmental Conservation Costs (Interim Summary)", and in May 2000, the Guidelines for the Introduction of Environmental Accounting Systems in March 2002, we published the revised Environmental Accounting Guidelines. Since then, the Environmental Conservation Cost Classification Guide and the Guidelines for Environmental Performance Indicators for Business Operators have been published in April 2003, and the Environmental Report Guidelines in March 2004.

On the other hand, the continuation of economic development based on the development of industry will lead to deterioration of the environment and depletion of resources, and the limit of growth will come sooner or later. In China today, energy conservation and emission reduction are recognized as necessary actions for human survival and development, and China is expected to seek a model of sustainable economic development. The resource and energy issues are the foundation of economic growth, and securing stable energy and resources is an important policy goal in China. To date,

² Press release by the Japanese Ministry of the Environment on March 28, 2002
<https://www.env.go.jp/press/3240-print.html>

policies and laws on the theme of energy conservation and emission reduction have been enacted. The main policies established in recent years are as follows.

| | |
|------|---|
| 2005 | <ul style="list-style-type: none"> ● 1st 1st Five-Year Plan (2006 -2010) (Targeted energy consumption per unit of GDP by about 20% compared to the end of 2000) |
| 2006 | <ul style="list-style-type: none"> ● China Festival Can Technology Policy |
| 2007 | <ul style="list-style-type: none"> ● Measures for monitoring the reduction of total major pollutants (2007) |
| 2008 | <ul style="list-style-type: none"> ● China People's Republic Energy Conservation Law (revised in 2008) |
| 2010 | <ul style="list-style-type: none"> ● Guidance on further strengthening energy conservation and emission reduction for small and medium-sized enterprises |
| 2015 | <ul style="list-style-type: none"> ● Environmental Protection Law of the People's Republic of China (revised in 2014) |
| 2016 | <ul style="list-style-type: none"> ● Water Law of the People's Republic of China(revised in 2016) ● China People's Republic Energy Conservation Law (2016) ● China People's Republic of Solid Waste Pollution Environmental Prevention and Control Law (2016) |
| 2018 | <ul style="list-style-type: none"> ● Environmental Impact Assessment Law of the People's Republic of China (revised in 2018) ● China People's Republic of China Air Pollution Prevention and Control Law (revised in 2018) ● Energy Conservation Law of the People's Republic of China (2018 Revision) |

Table 1-1 Policies for Energy Conservation and Emission Reduction (Partial)

(Source) From the website of the Ministry of Ecology and Environment of the People's Republic of China (October 22, 2019)

Table 1, The Chinese government has a lot of efforts to protect the environment from the legal aspect, which shows that awareness of environmental conservation is increasing. However, the existing environmental laws were surveyed, but there were few. It was found that environmental accounting information was delayed by companies in China and there were no environmental accounting standards or related regulations. The only ones related to environmental information disclosure

of Chinese companies are “Corporate Information Disclosure Content and Format Guidelines for Public Offering of Securities No. 1 - Prospectus (Revised in 2015)” issued by the China Securities Regulatory Commission. There was only.

The contents are the following three.

(1) Promotion of environmental accounting, reinforcement of education and supervision

(2) Strengthening environmental accounting theory

(3) Establish and improve environmental accounting laws and regulations.

They do not have guidelines for introducing environmental accounting systems and detailed guidance on handbooks for companies, and it is difficult to disclose them to corporate environmental accounting information, and it is considered that sufficient effects cannot be obtained.

The research trends of environmental accounting in China were reviewed by using China National Knowledge Infrastructure (CNKI), China's largest academic information data service, to enter the keyword "environmental accounting" and to review the literature written in Chinese. As a result of the survey, 3512 academic papers for 26 years from 1992 to 2018 are shown (Chart 1). The first to appear in the literature of environmental accounting research in China was Sun Yi (1992), and then conducted a questionnaire survey on environmental accounting for the first time in a company. It turned out to be Wang Liu Li (1998).

For the research trends of environmental accounting in Japan, we entered the keyword "Environmental Accounting" using the National Institute of Informatics (abbreviated as CINI) and reviewed the literature written in Japanese. The first paper was published by Masao Tokutani (1972) called "The Concept of Environmental Accounting" As Shown in Chart 1, in the 1990s, research on environmental accounting tended to increase, especially in 2000, when the number of research literature reached its peak with 159. From Figure 1, we can see the results of a survey of 1048 academic papers for forty six years from 1972 to 2018. Furthermore, from Chart 1, the number of research papers on environmental accounting shows that China has three times more than the Japanese side, and that

interest in environmental accounting and research awareness are higher than in Japan.

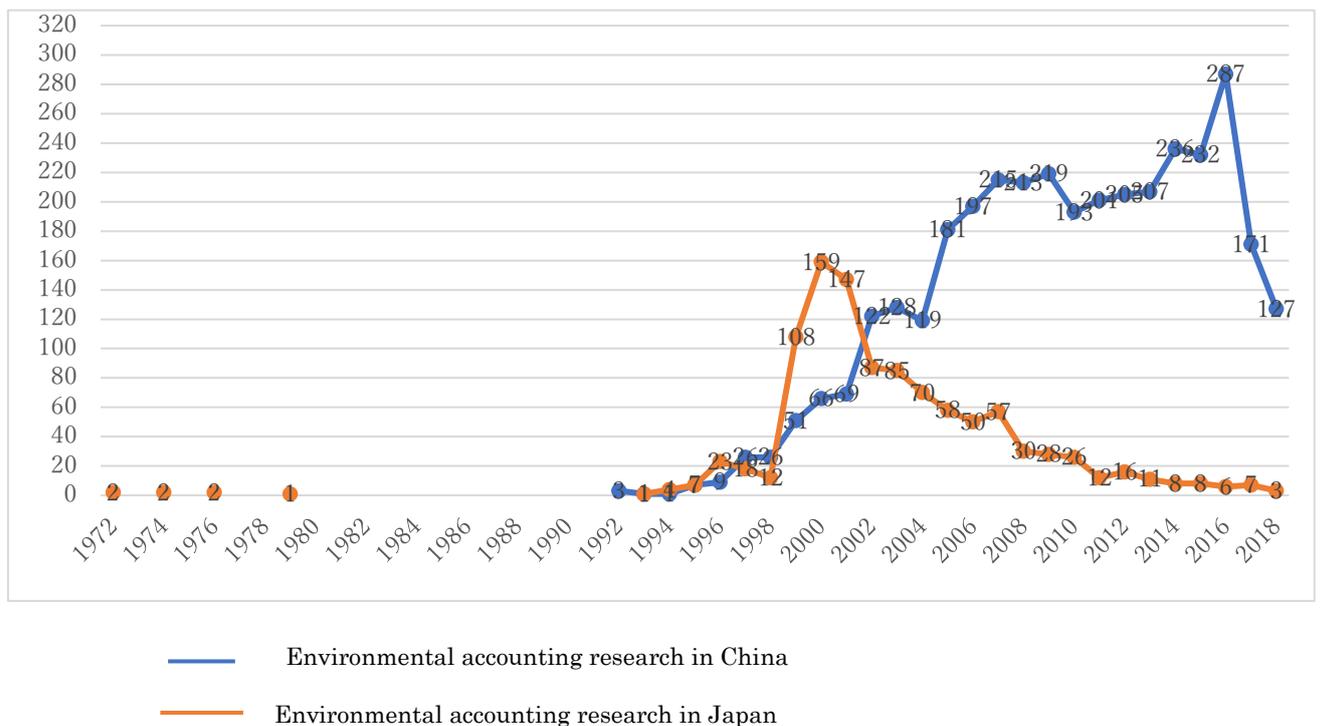


Fig. 1 Comparison of the number of research literature on "environmental accounting" in Japan and China

Source : CNKI, authored using CiNii.

2.2 A Study of Environmental Management Accounting in Japan and China

For the study of environmental management accounting in China, we entered the keyword "Environmental Management Accounting" using CNKI, China's largest academic information data service, and reviewed the literature written in Chinese. The results are shown in Chart 2. A total of 301 papers on environmental management accounting have been published over the 18 years from Figure 2 to 2018, and environmental management accounting research is on an increasing trend.

For the research of environmental management accounting in Japan, we entered

the keyword "Environmental Management Accounting" using CINII, an academic information database in Japan, and reviewed the literature written in Japanese. The results, as Shown in Chart 2, were earlier than in China in 1993 when the first paper was published, but the number of research literature was not as high as in China.



Fig. 2. Comparison of the number of research literature on "Environmental Management Accounting" in Japan and China

Source : CNKI, authored using CiNii.

3. Comparison of Research on Material Flow Cost Accounting (MFCA) in Japan and China

3.1 Introduction to MFCA

The MFCA, focusing on the loss of resources and energy in the manufacturing process, material costs associated with the loss, processing costs, equipment depreciation costs and the like as "negative product cost", it is that the costing method to perform comprehensively. It is noted that this method can achieve both the economic performance of environmental conservation and cost reduction by reducing environmental impact (resource usage) by using the information of the loss provided by MFCA for the decision-making of management and site managers. Using

MFCA to visualize the waste of resources in the manufacturing process leads to resource saving and energy saving³.

3.1.1 MFCA Principles

The most important theoretical basis for MFCA is the mass balance that captures the flow of materials in quantity units. The basic principle of mass balance is the law that represents the relationship between chemical changes and mass, called the "law of mass preservation". Based on this principle, MFCA, focusing on the material flow in the production process, observing the mass balance, focusing on the loss of resources and energy in the manufacturing process, in detail the contents of these losses in the process, material costs, processing costs, Equipment amortization costs and the like as "negative product cost", comprehensively performs cost evaluation, excised problems in the production process, a method of trying to help to improve the problems that cause loss. MFCA, as the origin of the mass balance, the raw material (material) in the process calculates the amount of material for each input material in accordance with the actual flow (flow and stock), to evaluate the cost by multiplying the unit price to it is a method of performing calculation. By adding the cost information by multiplying the unit price to the mass balance to capture the flow of material stowing the material in units of material, it is shown that the calculation method of MFCA has been developed. Professor Wagner, a developer, said adding cost information has greatly increased management's interest in the flow of materials⁴.

3.1.2 MFCA Calculations

In MFCA, it is necessary to collect the view and data of the site different from traditional production management and cost accounting. MFCA calculation is a method of calculating the amount of raw materials (materials) in the process for each input material according to the actual flow (flow and stock), and calculating the cost by multiplying the unit price to it⁵.

³ Kube and Nakashima (2018) page 4.

⁴ Nakashima (2018) page 5.

⁵ Kube and Nakashima (2018) page 6.

In this calculation procedure, the "positive product cost", the cost that was introduced to those passed to the next step (positive product), the "negative product cost" and the cost that was introduced to the waste and recycled (negative product) It is described. In particular, for "negative products", according to the Ministry of Economy, Trade and Industry of Japan (2009), "waste in various stages in manufacturing, but loss of raw materials occurs, it is waste in processing⁶".

- 1) Waste in processing is as follows. Material loss during processing (end material, chips, etc.), defective products, impurities, residues remaining in the device at the time of switching
- 2) materials (such as volatile materials such as solvents, detergents that clean the device when switching, catalysts, etc.)
- 3) Raw material inventory, intermediate stock, product inventory, etc. that can no longer be used due to quality reduction, etc.

Fig. 3. "Negative Products" in MFCA

Source: Ministry of Economy, Trade and Industry of Japan (2009) page 3

As Shown in Fig. 3, MFCA says that the materials that have become products are "positive products", and materials that have not become products, that is, waste and emissions are all "negative products." However, unlike normal costing, MFCA distributes MC, SC, and EC all to "positive products" and "negative products" in the weight ratio of the material.

3.2 Outline of MFCA's Research in Japan and China

The method that is the prototype of MFCA was developed in Germany in the 1990s, and has been actively developed in Japan since the 2000s under the leadership of the Ministry of Economy, Trade and Industry. Under a proposal from Japan, internationally, after the publication of the international standard of MFCA by ISO14051 in 2011, the international standard ISO14052 concerning the introduction of MFCA into the supply chain in 2017 was published, and in 2018, We have been discussing MFCA's international standard ISO14053 for small and medium-sized

⁶ Ministry of Economy, Trade and Industry (2009) page 5.

enterprises (Kashiwabe, Nakashima 2018, P3). Although the introduction of MFCA is being developed internationally in this way, the status of the publication of academic papers on MFCA in Japan is the results of searching for the status of publication from 2000 to 2018 are shown in Chart 4. As for the number of papers from 2000 to 2018, it was found that there were 312 MFCA research documents in Japan in 18 years.

On the other hand, in order to consider the current state of MFCA's researching China, we use CNKI and The status of the publication of the paper on MFCA was examined and surveyed. As a result, from 2008 to 2018, the MFCA research literature published in Chinese for the year is 132 It turns out that there is a book. Figure 4 shows a comparison of the number of research literature on MFCA during Japan and China. ◦

As the first research paper in Japan, from Satoshi Matsumoto, Ken Left, Takumi Iwao (2002), MFCA is a series of material flows from the production process of the city's food system to the disposal and disposal process, In addition, the relationship between the input structure of energy and packaging materials associated with it can be systematically grasped, and the availability of scenario analysis of food waste countermeasures and comparative evaluation of multiple cities (regions) was discussed. Research literature published, whereas in China, for the first time from Zhao Sakune (2008) MFCA theoretical and useful for corporate management and environmental conservation.

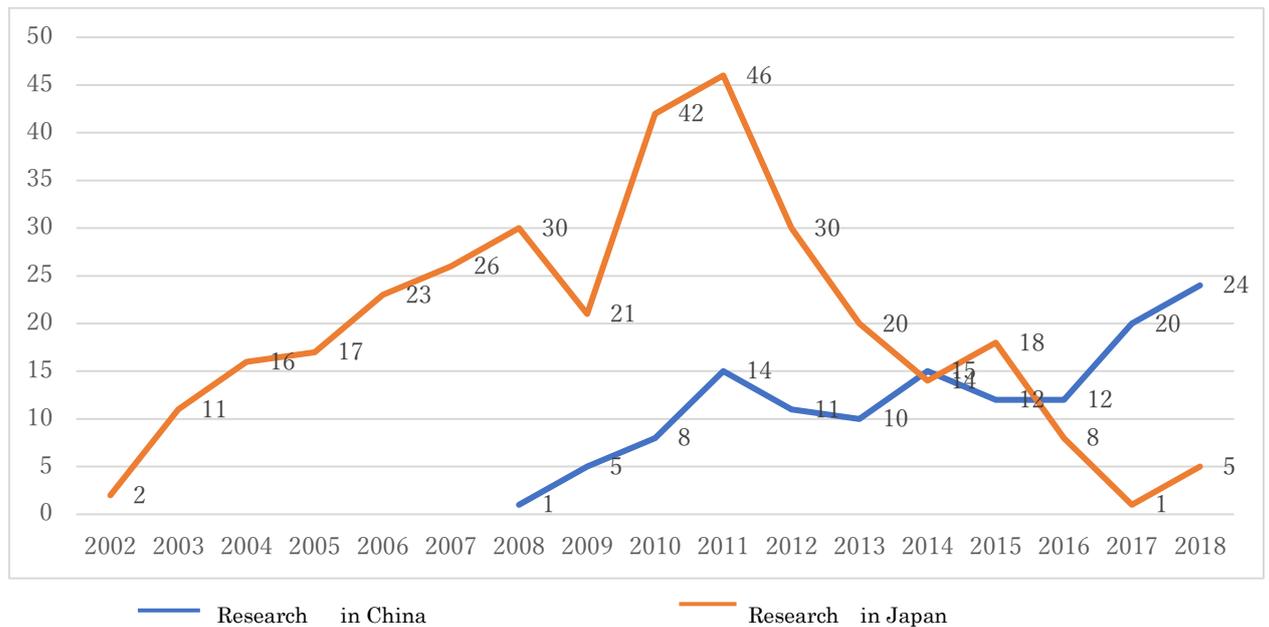


Fig. 4 Comparison of the number of research literature on "MFCA" in Japan and China

Source : (2018)and Using CNKIandCiNii, he created a writer.

In addition, Fig. 4 shows the following:

- A. As for the number of papers, there are 132 in China compared to 312 in Japan by 2018, and from the number of papers, China has fewer researchers and results on MFCA than in Japan.
- B. ISO14051, an international standard for MFCA, was published in 2011, the number of papers in both China and Japan is large in the current year.
- C. In Japan, the number of papers has declined sharply since 2012, while china has the largest number of MFCA papers in 2015, and MFCA research in China is expected to continue to develop more and more.

3.3 Comparison of studies on MFCA during Japan and China

From the review of the previous research of MFCA in Japan, up to now, there have been many normative research or case studies on MFCA, and the research subject sits are major to the manufacturing industry, and the research content is largely "international trends", "domestic trends", "MFCA techniques", It can be classified into "application" and "results".

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| Research content | | Previous Research in Japan | Previous Studies in China |
|----------------------|---|--|--|
| International Trends | <ul style="list-style-type: none"> International standardization of MFCA: | Kashiwabe, 2008; Furukawa-Tachikawa, 2011; Nakajima/Kimura, 2012 | Kiei, XiaoYi, 2009; Kieyi, XiaoYi, 2012; |
| | <ul style="list-style-type: none"> Introduction to MFCA research in other countries | China (Ga, Kabe,2013) South Korea (Zhang,2009; Kim and Zhengbe,2013), Vietnam (Nakashima, Kimura,2012) Malaysia (Tachikawa,2012a; Nakashima/Kimura 201,2012) | Japan (Mr. Liu Ming, Liu Ming, Liu Ying, Huang Zheng, 2009; Hot Water Ryoichi, Zhao Zheng, 2009; Huang, 2011; Hongoe, 2014) Indonesia (FERDINAND EFFEND, Lee Jun, 2017) Latin America (Kei-An, Liu Zhizhi, 2014) |
| | <ul style="list-style-type: none"> Introduction of MFCA research by international conferences | Kube,2012; | |
| Domestic Trends | <ul style="list-style-type: none"> Government-led MFCA adoption | Ministry of Economy, Trade and Industry's MFCA Promotion Project (Ministry of Economy, Trade and Industry,2007) | |
| | <ul style="list-style-type: none"> MFCA spread by region: | Shiga Prefecture (Maekawa,2006), Tohoku region (Imada,2008), Osaka and Kyoto (Nakashima,2008; Okada and Kitada,2009)), Nagano Prefecture (Seki,2012) | |
| Techniques | <ul style="list-style-type: none"> Study on MFCA's Explanation, Consideration, and Problem Arrangement | Nakashima-Kashibe, 2003; Buttocks,2005; 2007; 2009; Ito,2009; Nakashima,2012; Shimogaki,2013b; Buttocks,2014 | Sakune Tsuji, 2008; Xiao Jian, 2009; |
| | <ul style="list-style-type: none"> Considering mfcA's functionality | Buttocks,2003; Nakashima,2003; Kashiwabe, Nakashima,2003; Shimogaki,2005; Shimogaki/Anjo, 2011; Anjo,2012 | Zhao Ming-kun, 2009; Cheng Zheng, 2010, 2010 |
| | <ul style="list-style-type: none"> A study considering the cooperation between MFCA and other management | MFCA and traditional costing collaboration (Nakanaka, Sakai,2008),TPM(Total ProductiveMaintenance) (Asahikawa,2007), TRIZ(Theory of | Collaboration between MFCA and Traditional Costing (Kei, 2014, 2017), collaboration with PDCA: Kim Yu-ryo, |

| | | | |
|---------|---|--|--|
| | <p>systems</p> <p>Collaboration in terms of production control and on-site improvement</p> <p>Collaboration from the viewpoint of reducing environmental impact</p> | <p>Inventive Problem Solving) (Nakashima, Yamada,2009),cooperation with budget management (Nakashima and Thu Mura,2012), Collaboration with TOC(Theory of Constraints) (Tobita et al.2013))</p> <p>LIME (LifeCycle ImpactAssessment) as an integration with LIFE CycleAssessment (LCA) Method based on Endpoint Modeling) (Kono,2007; Shimogaki,2007a; 2007b) and environmental impact integrated metrics (LIME, JEPIX, (Mato, Yamada,2007), co-tracking methods for CO 2 (Ito, 2010)</p> | <p>Wang Zheng, 2017),</p> <p>LIME (LifeCycle ImpactAssessment) as an integration with LIFE Cycle Assessment (LCA) Method Based on Endpoint Modeling): (Zhao, 2010;</p> |
| Apply | <ul style="list-style-type: none"> • Significance and understanding of MFCA promotion | Kono,2006; 2007; Tsujioka,2008; Sakuma,2010 | Atsumi, Shinya Nagata, 2011; Michiya Nakashima, Teruji Oka, Yuki, 2014; Liu Zhao, 2017 |
| | <ul style="list-style-type: none"> • MFCA Select What to Apply | Kono,2006; 2007 | |
| | <ul style="list-style-type: none"> • MFCA Application Purposes | Kono,2006; Anjo,2007 | |
| | <ul style="list-style-type: none"> • MFCA Systematization and Data Sharing | Kono,2006; 2007; Funasaka/Kono, 2008; Sakuma,2010; | |
| | <ul style="list-style-type: none"> • Involvement of top management | Tsujioka,2008; Harada,2009 | |
| | <ul style="list-style-type: none"> • Research on problems that inhibit MFCA application | Anjo,2007; Kashiwabe,Shimogaki,2008; Imai,2012; Sekiri/ Anjo 2016 | |
| | <ul style="list-style-type: none"> • Application to financial institutions | | Aoi, 2013 |
| Results | <ul style="list-style-type: none"> • Reduce costs and environmental impact by reducing material loss: | A collection of corporate cases issued by the Ministry of Economy, Trade and Industry, | Kiei, Xiao Jiei, 2011; Satoshi, 2017; Wang Zheng, 2018; |
| | <ul style="list-style-type: none"> • Changes in environmental activities in the field | Anjo,2006; 2007; Kashiwaoka,2008 | |
| | <ul style="list-style-type: none"> • Sharing and speeding up information on manufacturing sites and management | Numata,2006 | |
| | <ul style="list-style-type: none"> • Increase employee motivation | Seki,2011 | |

Fig. 5 Comparison of the contents of the MFCA's previous research during the day (partial)

Source: Kuwabe, Nakashima (2018) Chapter 8 is referred to and author created using CNKI.

Figure 5 shows the following:

- A. It turns out that research on international trends in China is concentrated on Japan, where MFCA research is progressing.
- B. As for the research of domestic trends, it was found that there was no trend to lead the spread of MFCA by the correlation organization of the Chinese government in response to the action such as the MFCA spread project issued by the Ministry of Economy, Trade and Industry of Japan. Furthermore, it was found that there was no research or report on the spread of MFCA in each region of China for the active promotion of the Japanese side about the spread of MFCA by the region.
- C. As for the research of domestic trends, it was found that there was no trend to lead the spread of MFCA by the correlation organization of the Chinese government in response to the action such as the MFCA spread project issued by the Ministry of Economy, Trade and Industry of Japan. Furthermore, it was found that there was no research or report on the spread of MFCA in each region of China for the active promotion of the Japanese side about the spread of MFCA by the region.
- D. As for MFCA's techniques, prescriptive research accounts for a large number of them, and it can be viewed that there is significant research on MFCA.

However, from the practical point of view of MFCA, it was found that the number of research documents and the number of researchers were small compared with Japan in the study on the application and results of MFCA in China. Considering the reason for the application effect of MFCA, there are few cases of applying MFCA to Chinese companies, and there is room for research on the effect obtained through the introduction of MFCA.

4. Conclusion

Comparing the study of material flow cost accounting during Japan and China, it was found that the following. (1) In China, the disclosure of environmental accounting information has been delayed by companies, and there are no environmental accounting standards or related regulations. It is necessary to establish a common framework for environmental accounting (publication of environmental accounting guidelines, environmental report guidelines, etc.) and establish it quickly in order to support environmental accounting efforts, as in the Ministry of the Environment of Japan. These are considered to be the premise of applying and promoting environmental management accounting and material flow cost costs to Chinese companies. (2) It was found that there were many prescriptive studies on material flow cost accounting in China, and that there were few cases and case studies. In response to this situation, the application case to companies led by the Ministry of Economy, Trade and Industry of Japan is helpful in the MFCA study in China. Based on the research survey of MFCA in Japan and China, it can be seen that the application and research of MFCA will be developed in China in the future. From now on, it is thought that it is possible to increase the problem related to environmental management accounting and MFCA practical use if the Chinese government supports academic research in the field of environmental management accounting.

In this way, if there is a lead to promote environmental management accounting and material flow cost accounting by the Environment department of the Chinese government and the Economic Relations Department to companies, it is possible that the case study on the application of material flow cost accounting of Chinese companies will be further increased. Finally, the reason why the number of MFCA research literature in Japan has decreased so severely since 2012, MFCA is considered to have some limitations. I want to make it a research topic next time.

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