The Statistics of Recyclable Resources in Beijing: Status, Problems and Countermeasures

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Abstract. Utilization of recyclable resources not only contributes to resource conservation, but also to the reduction of environmental pollution. The statistics on recyclable resources provides effective data support for the promotion of waste recycling and utilization. However, the research and practice concerning recyclable resources statistics are still at initial stage. By investigating and analysing the statistical status quo of Beijing’s recyclable resources production and recycling, this study pointed out problems such as undefined statistical types, incomplete statistical scope, nonstandard statistical methods, absence of supervision, and low integration of statistical resources among different departments. Based on the problems mentioned above, the implications for recyclable resources management were discussed. Establishing and issuing recycling catalogue, standardizing the statistical methods and process, building a sharing mechanism for the data monitoring, innovating the data collection method, and establishing statistical supervision system and appraisal mechanism are suggested to improve the recyclable resources management.

1. Introduction

According to the Guidance on Comprehensive Utilization of Resources during the 11th Five-Year Plan, launch by National Development and Reform Commission (NCDR) on December 24, 2006, and Regulations for Recyclable resources issued by Ministry of Commerce People’s Republic of China (MOFCOM) on March 27, 2007, recyclable resources refer to all kinds of wastes produced in production and living consumption, which have lost original use values but could obtain new use values through recycling, classification, and processing. With the exacerbating resource shortage and environmental pollution, the government is gradually focusing on the recycling and utilization of recyclable resources [1-2]. The rational utilization of recyclable resources and the recycling of waste material not only contribute to resource conservation, but also to the reduction of environmental pollution [3-4]. The precondition for the recycling and utilization of recyclable resources is a clear understanding of current situation of recyclable resources production and recycling, which includes information such as production & recycling types, quantity, main body and circulation channel. However, the current statistical works of recyclable resources still remain at initial stage, which means that it is in urgent need of carrying out related statistical works in a systematic way and establishing statistical system. In light of the statistical status quo of recyclable resources, Beijing Municipal Commission of Development and Reform, Beijing Municipal Bureau of Statistics and Beijing Municipal Bureau of Finance together issued the Notes on Related Issues of the Further Construction of Beijing’s Energy Conservation and Emission Reduction Statistical System in 2013, which has raised requirements for the construction of recyclable resources statistical system. Based on the Notes, after having a clear understanding of the statistical status quo of Beijing’s recyclable resources...
production and recycling, existing problems in Beijing’s recyclable resources statistics are pointed out and some countermeasures and suggestions are put forward. This study will provide support for the establishing statistical system of recyclable resources in Beijing.

2. Review of Literature
The statistics of recyclable resources can be divided into direct and indirect statistics. The typical direct statistical ways include general census, statistical statement, sampling survey, key-point investigation and typical survey. Among them, statistical statement is usually used by government to gather the recycling data and sampling survey is often used by scholars to estimate the recycling amount of recyclable resources[5-6]. Liu used sampling survey to estimate the total quantity of recyclable household solid waste in Beijing and mentioned the statistical system for waste management needed to be improved[6]. The indirect statistical way is mainly through the estimation by various models to get the generation data, such as market supply A method, Stanford model, Carnegie Mellon model, time series or material flow analysis (MFA)[7-10]. Stanford model and MFA are widely used for the estimation of waste electrical and electronic equipment (WEEE). Steubing et al. (2010) used the MFA to estimate the E-waste generation in Chile from 1996 to 2020 [11]. Meanwhile, some studies combined the direct with indirect way to estimate the waste generation and recycling data. Population balance model were used[12-13]. Kim et al. conducted a survey with questionnaires and population balance model estimate the e-waste for 8 products in South Korea from 2000 to 2020[13]. Although the statistics of recyclable resources should be studied as a system[6], all the studies mentioned above are focused on the estimation or forecasting one type of several types of recyclable without showing the whole picture. The study on recyclable resources status, existing problems and suggestions for building the statistics system is needed.

The statistics data are generally issued by the government and industry association. For example, the Environmental Protection Department of Hong Kong government issued the waste recycling and disposal data on Hong Kong Waste Reduction Website. The Statistics Finland released the generation and treatment data of municipal waste every year on the Statistics Finland official website. However, the statistical method and channel were not indicated. Due to the variety and complication of recyclable resources generation and collection, the statistical system should be developed. Policymakers need sound waste statistics to assess and develop waste management policies. The premise is to identify the current statistical status and problems.

3. Statistical Status Quo of Beijing’s Recyclable Resources

3.1. Statistical Types
As a megacity driven by consumption, Beijing has various and complicated production and recycling types of recyclable resources. According to the Medium and Long Term Planning for the Construction of Recyclable resources Recycling System (2014-2020) compiled by Ministry of Commerce People’s Republic of China in 2014, recyclable resources consist of the following nine major types: waste metal, scraped car, WEEE, waste plastics, waster paper, waste tire, lead-acid battery, discarded energy saving lamp and waste glass. Each of the above-mentioned type could also be subdivided into different varieties. For instance, the waste paper includes waste magazines, newspapers, books, etc. It is difficult to conduct statistics due to the diversity and complexity of recyclable resources types.

Currently, the statistical types of Beijing’s recyclable resources production mainly include household refuse, WEEE and scraped car. According to the data provided by Beijing Municipal Commission of Development and Reform, in 2010, the total amount of Beijing’s household refuse is 6.35 million tons, the amount of WEEE is 4.6 million, and the amount of scraped car is 140,000.

The statistical types of Beijing’s recyclable resources recycling mainly consist of waste paper, waste metal, waste plastics, waste glass and others. According to the estimated data provided by Beijing Municipal Commission of Commerce, the recycling amount of Beijing’s recyclable resources is 4.67 million tons in 2010, 4.8 million tons in 2011, 4.9 million tons in 2012 and 5 million tons in 2013. The proportion of waste recycling types is shown in figure 1.
3.2. Statistical Methods
It is difficult to conduct statistics due to complicated recyclable resources type, various main production body and extensive circulation channel. In particular, the most important problem faced by statistical works of recyclable resources is how to ensure scientific statistical methods, to enable statistical results to reflect the actual situation to a greater degree.

At present, the main statistical methods applied recyclable resources production amount in Beijing are investigation and registration. For example, the investigation of the recyclable resources amount of household refuse is calculated based on the statistics of material recycling system. According to the recycling system, the average production amount of recyclable resources of every household per week in Beijing is 7.5 kilograms. In 2010, the household registration amount of Beijing is 4.88 million, and the average amount of per household is 2.55. Moreover, there are about 8.74 million temporary residents. If the average recyclable resources production amount of temporary population is calculated according to the 50% of registered population, the total amount of recyclable resources produced by Beijing’s households (namely the source of life) is around 2.6 million tons. The WEEE comes from offices, public institutions, enterprises, social organizations and individuals. Among which, the amount of WEEE that come from offices and public institutions is obtained based on the data related to fixed asset management registered in Bureau of Finance. Systematic statistical methods concerning the amount of WEEE that come from enterprises, public institutions and individuals could not be found. But government sectors and research institutions calculate the theoretical amount of waste production partly on the basis of product sales volume and theoretically-discarded life. The amount of scraped car mainly comes from the data registered in Beijing Municipal Vehicle Administration.

The main statistical methods adopted in the statistical works of recyclable resources recycling amount in Beijing are investigation and statistical statement. Beijing Municipal Commission of Commerce uses the following method to calculate the recycling amount of recyclable resources: First, it asks the commissions of commerce from 16 districts and counties to report the recycling amount of recyclable resources that come from major recycling enterprises and several social unrecorded enterprises. According to the practical situation, the recycling data reported by district and county commission of commerce roughly account for 50% of the practical total recycling amount, and the recycling data of social unrecorded enterprises roughly account for 50%, based on which Beijing Municipal Commission of Commerce calculates statistics. At last, it calculates the total recycling amount of recyclable resources in Beijing. In addition, industry institutions, colleges and universities also use investigation and mathematical model to calculate the recycling amount of recyclable resources. For instance, by investigating Beijing Tiantianjie Recyclable resources Recycling & Utilization Limited Company, Beijing Recyclable resources and Secondhand Goods Industry Association have found out that in 2013 the monthly average recyclable resources recycling amount of per household in Beijing is 7 kilograms. Based on the 50,310,000 households in Beijing, the recycling amount of recyclable resources produced by residents is calculated to be 422,600 tons.

3.3. Main Body and Statistical Channel
Statistics of recyclable resources involves various main bodies and channels (as shown in figure 2). The main body of statistics includes governmental department, industry association, advanced research institutes, etc., among which many government departments are engaged in statistics of recyclable resources. The statistical channel of recyclable resources production amount could be divided into resident and organization according to the main production body of recyclable resources, and the organization includes enterprise, public institution, social organization, office, army, etc. The statistical channel of recyclable resources recycling amount could be divided into formal recycling enterprise and informal recycling enterprise, among which the former includes recycling companies and individual businesses for recyclable resources registered in industry and commerce department, while the latter mainly refers to private itinerant vendors that do not have business licenses.

Currently, the main statistical body concerning recyclable resources production amount in Beijing includes government function department such as Beijing Municipal Commission of Development and Reform, Statistical Bureau, Finance Bureau and Vehicle Administration. In addition, associations, colleges and universities also investigate and calculate to provide statistical data. Beijing Municipal Commission of Development and Reform counts the production amount of recyclable resources that come from household refuse, the amount of WEEE and of scraped car. The production amount of household refuse is counted and reported by Beijing Municipal Commission of City Management; the amount of WEEE is partly counted and reported by Finance Bureau, and partly obtained from investigation. The amount of scraped car is counted and reported by Vehicle Administration.

The main statistical body concerning recyclable resources recycling amount in Beijing includes governmental department such as Beijing Municipal Commission of Development and Reform, Statistical Bureau, Commerce Commission and Environmental Protection Bureau. In addition, Beijing Recyclable resources and Secondhand Goods Industry Association, colleges and universities also investigate and calculate to provide statistical data. Beijing Municipal Commission of Development and Reform is also in charge of National Urban Mining Base, so the Commission controls the statistical data of “urban mining” that come from Beijing Green Focus Industrial Base of recyclable resources. According to the statistics, the total recycling amount of recyclable resources in the base is around 630,000 tons, among which, the amount of waste paper is 250,000 tons, of waste steel is 200,000 tons, of waste plastics is nearly 80,000 tons, of WEEE is 1.15 million (about 26,000 tons), of scraped car is 24,000 (about 24,000 tons) and of other recyclable resources is 50,000 tons. Statistical Bureau has started to count municipal recyclable resources enterprise above a certain scale since 2005. However, because the Bureau only counts recyclable resources enterprises above a certain scale instead of recycling enterprises, the annual statistical amount of enterprise is around 10. In 2012, only nine enterprises in Beijing were counted. Beijing Municipal Commission of Commerce has developed the management information system for recyclable resources recycling enterprise since 2010, thus recycling enterprises could report statistics conveniently through Internet. The main recycling enterprises are required to report statistics, while other medium and small sized recycling enterprises registered in Industrial and Commercial Bureau can report voluntarily. The statistical types of recyclable resources mainly include the following five types: waste paper, plastics, glass, metal, household appliances, etc. In addition, related enterprises will systematically report their monthly changes of recycling websites, the recycling amount of all kinds of resources and business volume, thus providing relatively authoritative data. Furthermore, Beijing Municipal Commission of Commerce also takes charge of the “old for new service” related to products such as household appliances. When institutions or individuals purchase appliances in this way, the discarded products will be sent to recycling enterprises, and the data will be reported to Commission of Commerce.

**Figure 2.** The main statistical department and channel of Beijing’s recyclable resources
4. Existing Major Problems in Beijing’s Recyclable Resources Statistics

4.1. Undefined Statistical Types and Complicated Statistical Contents of Recyclable Resources
There are various types of recyclable resources. However, the government of Beijing has not established or issued unified illustration and catalogue regarding the statistical types of recyclable resources, which is a major problem in statistical works. In other words, the government of Beijing has not stipulated what kinds of recyclable resources are required to be counted. There are disagreements over the existing recyclable resources type too. Taking the waste metal as an example, waste metal could be divided into waste aluminium, waste steel, waste copper, etc. The waste aluminium could be subdivided into aluminium come from pop-top cans and from scraped doors and windows. The waste steel could also be subdivided into construction waste steel and waste steel come from automobile dismantlement. In different recycling links, different enterprises and departments divide recyclable resources according to their own standards. In addition, the statistical types of the production amount could not correspond to those of the recycling amount. The undefined statistical types led to the disordered statistical contents. The statistical statement could be created with a definite purpose and the statistical works could be conducted in systematic way only when the government has a clear understanding of the recyclable resources types that are required to be counted and built the recycling catalogue.

4.2. Incomprehensive Statistical Scopes and Poor Traceability of Data
Although the related government’s functional departments and industry associations in Beijing have carried out part of statistical works of recyclable resources, the overall statistical works have presented a problem that the statistical scope is relatively incomprehensive. For instance, in 2013, there were altogether 1479 recycling enterprises that registered in industrial and commercial departments and 3475 individual businesses in Beijing. However, when it came to the recycling amount of recyclable resources, standard recycling enterprises reported statistics autonomously while some registered enterprises and individual businesses did not report statistics at all. Meanwhile, the existing statistics lack of systematic statistics and investigation of itinerant nonstandard retailers. It is difficult to trace the source of statistics even if the related statistics could be referred to. As a result, the incomprehensive statistical scope could have a negative influence on the accuracy of statistical results.

4.3. Relatively Nonstandard Statistical Methods and Existing Cross Statistics
The sources of recyclable resources are very extensive and huge in amount. Many complicated factors such as the types of waste products, space-time condition, consumption, recycling, and the features of utilization group have combined influences on the production and recycling amount, which has inevitably brought great challenges to the construction of statistical model of recyclable resources. When conducting statistical works of recyclable resources, the government mainly depends on the data reported by enterprises, and calculates statistics based on related information. The standard statistical process and scientific calculating methods have not been built yet. The statistics reported by enterprises conclude the recycling amount of some itinerant retailers and non-principal enterprises, which are not removed when calculating the total recycling amount of the society, thus leading to the problem of cross statistics. How to ensure scientific statistical methods and make statistical results reflect actual situation to a greater degree are the major problems faced by statistical works.

4.4. The Absence of Supervision and Difficulties in Verifying the Accuracy of Data
The statistics of recyclable resources recycling mainly come from the report of enterprises, and there are no specialized functional organizations or personnel to verify the reported statistics. The statistical information is closely related to the interests of some departments and large-scale enterprises. For example, to enjoy preferential policies such as government subsidies, some departments or enterprises make a false report of the recycling amount. In addition, since the majority of recycling enterprises object to the existing tax revenue system and half of the enterprises have been transformed into privately-owned ones, it is even more difficult to conduct statistical work now than previous days.
Moreover, some enterprises do not record the recyclable resources into the account in light of their own economic benefits, thus influencing the accuracy of statistics.

4.5. The Imperfect Statistical System and Low Integration of Statistical Resources among Different Departments

The statistical system and methods of recyclable resources are not unified. There are no responsible organs and professional personnel to take charge of the statistical woks on a national scale. The related statistical works are conducted only by scattered administrative units that count and calculate statistics according to their benefit demands. Thus it leads to major problems in aspects such as the standard of statistical types, calculating methods and accounting principles. In addition, the related responsible organs do not share information with each other and there is no leading department to coordinate. As a result, it is very difficult to obtain complete and effective statistics.

5. Suggestions on the Construction of Beijing’s Statistical System in Recyclable Resources

Currently, the statistical works of recyclable resources in Beijing are still at initial stage. When it comes to aspects such as statistical types, methods and mechanism, there is room for improvement and perfection. After studying the statistical methods and analyzing those methods in practical situations, the following suggestions have been put forward for the implementation and perfection of statistical works in recyclable resources.

5.1. To Establish and Issue Recycling Catalogue

The establishment and issue of recycling catalogue contribute to the classification of recyclable resources, thus laying a foundation for the creation of the statistical statement. At the same time, the recycling catalogue also plays an important guiding role in employees and related interest bodies in recyclable resources industry. It is suggested that Beijing Municipal Commission of Commerce should join hands with departments such as Municipal Commission of Development and Reform, Municipal Commission of City Management, Environmental Protection Bureau, Department of Transportation and Construction and Department of Information-based Economy to establish and issue the recycling catalogue of recyclable resources, in order to determine matters such as the recycling type, recycling standard, and utilization guidance of recyclable resources. Meanwhile, based on the recycling catalogue, Beijing Municipal Commission of Commerce should work together with departments that participate in the statistical works of recyclable resources, such as Municipal Commission of Development and Reform and Statistical Bureau, to establish the statistical statement, in order to determine the types and contents of recyclable resources that are required to be counted.

5.2. To Standardize the Statistical Methods and Process

Scientific statistical methods can ensure the effective obtainment of statistics and increase the reliability of statistics. The statistical works of recyclable resources could be conducted according to different major bodies in production and recycling link. It is suggested to count production amount by using the method that combines sampling statistics, statistical statement and model-based estimation together. When it comes to the recyclable resources such as waste paper, plastics, clothes and household appliances that come from households and retail businesses, it could be estimated and counted on the basis of Statistical Bureau’s sampling survey and according to the per capita production amount and population size. When it comes to recyclable resources such as WEEE and discarded office furniture that come from offices, public institutions and commercial office buildings, it could be counted on the basis of statistical statement. The recycling amount could be counted by using the method that combines sampling statistics and statistical statement together. For example, the recycling data of formal enterprises (including principal enterprises) could be counted by using statistical statement, and the recycling data of informal retailers could be counted by using sampling survey. Furthermore, the whole statistical process should also be standardized, which requires the leading departments of statistical works to take the lead, and cooperate with other related departments and industry associations to complete statistical and investigation works.

5.3. To Build a Sharing Mechanism for the Data Monitoring
Due to the various statistical types of recyclable resources and complicated statistical channels, the statistical works need the cooperation and coordination among different departments, in order to broaden statistical scope to a greater degree, distribute resources effectively, share existing statistics, reduce repetitive statistics, and increase efficiency. According to the function analysis of related functional departments and their participation in existing statistical works of recyclable resources, it suggested that different departments should work together to determine the statistical mechanism. In addition, Municipal Commission of Commerce and Statistical Bureau should take the lead, and join hands with other related departments such as Municipal Commission of City Management and Environmental Protection Bureau to build a sharing and supervision platform for the statistics.

5.4. To Innovate the Data Collection Method
Considering the ever-changing life style of residents, the recycling model should be innovated by using the technology of mobile internet. It is suggested to design a specialized mobile application to track the recycling trading information and obtain trading statistics. For instance, after downloading and installing such a mobile application, residents could search nearby recycling enterprises that have recycling qualification on their phones. Recycling enterprises could offer their prices online. After recycling enterprises providing door-to-door collecting or residents sending waste goods to recycling enterprises, both the recycling enterprises and residents could directly trade online. As a result, the trading statistics could be updated online, and information such as production types, recycling amount and distribution scope of recyclable resources could also be obtained online. At the same time, by strengthening the qualification management of recycling enterprises that participate in the online trading, the disruption of illegal enterprises to the market could also be lessened.

5.5. To Establish Statistical Supervision System and Appraisal Mechanism
It is suggested to enforce the supervision over enterprises that report statistics and departments that participate in statistical works, and establish statistical supervision system. The commission of commerce of all districts and counties should send specially-assigned personnel to regularly verify the statistics reported by enterprises. At the same time, Municipal Commission of Commerce should regularly go to all districts and counties, to inspect and supervise the reported recyclable resources statistics. An appraisal mechanism should also be established, to reward those enterprises that regularly report accurate and effective statistics, and punish those enterprises that do not report or make a false report. In addition, it is suggested to make statistical work as a performance index when assessing the performance of leaders that directly take charge of statistical works of recyclable resources, in order to advance and improve statistical works.

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