Experience of Urban Solid Waste Management in Russia under the Concept of Smart City and Its Enlightenment to Shenyang

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Abstract. Using digital technology and artificial intelligence to improve the level of municipal solid waste management and to explore the new path orientation of urban management with Chinese characteristics is an important and key task of smart city construction. There are many similarities between Russia and China in urban construction, economic development and so on, so the experience of municipal solid waste management is of great significance to China's urban construction. This paper analyzes the basic situation and reform process of Russian municipal solid waste, investigates the practice of Russian municipal solid waste management in the process of smart city construction, and sums up its successful experience on this basis, combined with the present situation of Shenyang, this paper puts forward some suggestions on the treatment of municipal solid waste under the background of the construction of smart city.

1. Introduction
General Secretary Xi Jinping stressed the importance of "strengthening the disposal of solid waste and garbage, making "resource conservation and Environmental Protection" a basic state policy, and strengthening social awareness of energy conservation and environmental protection, in his report to the 19th CPC National Congress. It is very difficult to collect and treat the solid waste because of its huge volume and mixed types. How to deal with this difficulty effectively becomes an urgent problem to be solved in the process of urbanization in China.

Since the 18th National Congress of the Communist Party of China (CPC), General Secretary Xi Jinping has called for the promotion of smart cities and the use of artificial intelligence to improve public services and social governance. One of the core goals of smart city construction is to achieve the sustainable development of the city. Therefore, solid waste management is a key link in the whole construction of smart city. As an important hub city in northeast China, Shenyang should learn from the construction experience of world-class smart city and improve the level of solid waste management. Russia is actively promoting the construction of "smart cities". According to the Swedish IT company EASYPARK, Moscow ranks 77th out of 500 "smart cities" in the world, in particular, the use of digital technology in urban infrastructure construction has entered the world's leading ranks; In the scale application advanced technology development new business model index also occupies the world front row. In Ernst & Young's rating of satisfaction with digital services in the world's largest cities, Moscow is in the top three [1]. In addition to the cities of Moscow and St Petersburg, Kazan and Yekaterinburg have been found to be more effective in building "smart cities", according to the Russian State Institute of Technology and information [2].
Starting in 2019, the Russian Ministry of Construction and Housing Utilities, within the framework of the state projects "digital economy" and "housing and Urban Environment", began implementing the "smart city" project, which plans to build 18 "smart cities" by 2024, 360 billion rubles will be spent on building the infrastructure of the "smart city" [3, 4]. This paper examines the practice and experience of solid waste management in smart city construction in Russia, with a view to providing reference for the promotion of smart city construction in Shenyang.

2. Basic Facts about Municipal Solid Waste in Russia

The most notable feature of municipal solid waste management in Russia is the classification of waste according to its toxic effects on the environment [5]. Solid waste is divided into five grades, from Grade 1 to Grade 5 the toxicity of waste is gradually reduced, grade 4 and Grade 5 are harmless waste, other countries on the waste is simply divided into harmful and harmless two categories (table 1).

| Grade | Descriptions of harmful level | Examples of waste projects | International definition |
|-------|-------------------------------|----------------------------|-------------------------|
| 1     | Very dangerous               | Mercury-containing fluorescent lamps, mercury-contaminated activated Carbenes, sulfides. | Harmful |
| 2     | High dangerous               | Concentrated acid, Alkali, halogenated solvent, lead-acid battery, dry battery, etc. | |
| 3     | Medium dangerous             | U-type grease, oily sludge and dishcloth, waste oil filter media, non-halogenated solvents, paint waste | |
| 4     | Light dangerous              | Household Waste, Non-ferrous metal waste, certain chemicals, certain construction waste, treated sewage sludge, treated medical waste, water based drilling mud, etc. | Harmless |
| 5     | Almost no danger             | Plastic, Ferrous, inert construction waste, food waste, vegetation, untreated waste. | |

According to the relevant provisions of the Russian environmental protection, some of the hazardous wastes in Category III and all the approved hazardous wastes in category IV are equivalent to urban solid wastes and may be disposed of in landfills. According to the Federal Office for the supervision of Natural Resources (Rosprirodnadzor), the country produces between 5 and 7 billion tons of waste per year, and municipal solid waste (MSW) accounts for 1-2 per cent of all waste. More than 90 per cent of Russia's waste goes to landfills. Figure 1 shows the composition of municipal solid waste.

![Figure 1](image.png)

**Figure 1.** Composition of municipal solid waste in Russia [6].
As can be seen from figure 2, the recycling rate of urban waste in Russia is lower than that in other EU countries. In Moscow, most of the municipal solid waste (about 95 per cent) is disposed of in open landfills without preliminary classification, while in the EU on average about 40 per cent of the waste is recycled as reusable materials, 20% of the trash is recycled as reusable material [7]. Only 4 per cent of Russia's solid waste is currently recycled as energy and 96 per cent is directly treated.

**Figure 2.** A comparative analysis of the Waste treatment [8].

### 3. Reform of Solid Waste Management in Russia

After the collapse of the former Soviet Union, Russia began to carry out a series of reforms to solve the problem of municipal solid waste management. The main elements of the three-stage reform are shown in table 2.

| Evolutionary characteristics | 1990-2004 | 2004-2019 | 2019 to this day |
|-----------------------------|-----------|-----------|-----------------|
| **Federal Policy** | The minimum rules don't work | To formulate national policies and regulations on waste recovery and environmental protection; to give priority to infrastructure development | Waste Management has moved from a stand-alone tool to a concept that focuses on recycling rather than landfill |
| **Local government measures** | There's no version | Devolving responsibility for solid waste management to the municipal level | The regional operator has the right to control all waste management practices during the disposal process, from garbage ponds to pastures or factories |
| **Limitations** | Waste Management is limited to the collection and landfill disposal of solid waste | There is no structured policy; investment is insufficient; the role of business and human resources is low | Incentives for businesses are still inadequate; the infrastructure to collect household waste alone is inadequate |

The Russian solid waste reform launched in 2019 has the following characteristics: (a) management of municipal solid waste according to its life cycle; (b) encouragement of the use of secondary resources for production; (c) implementation of the municipal solid waste classification scheme; (d) establishment of a Eco-industrial park; (e) establishment of a national information system.
for waste accounting (figure 3).

Figure 3. Priorities of the Russian Industrial Development Strategy for waste classification, recovery and disposal until 2030 [10].

The ability of Russian residents to use digital technology is still relatively backward compared to the major European countries (figure 4)

Figure 4. Comparison of digital skills between residents of Russia and major European countries [11].

In order to enhance the ability of residents to use information technology and to enhance the concept of the Waste treatment, Russian enterprises, non-profit organizations and the media are responsible for informing and teaching stakeholders about waste management tools, principles and methods and the use of related equipment [12, 13]. At the same time, it is clear that educators have a responsibility to use up-to-date information and relevant training tools to improve the knowledge and skills of stakeholders in the use of municipal solid waste [14].

4. Discussion
Through knowledge of solid waste management and reform in Russia, we can finally get municipal solid waste management enlightenment for Shenyang.

4.1. Pay Attention to Municipal Solid Waste Management in Smart City Construction
The Russian municipal solid waste management experience shows that we must rely on data analysis, scientific management. At present, Shenyang Information Construction has made remarkable progress, basically reached the city's digital construction, temporarily located in the initial stage of the integration of smart city construction. Although Shenyang Software Park and many other high-tech information industrial parks have accumulated a large number of data resources, but when the situation to the international standard, Shenyang government data disclosure and visualization construction is still relatively lagging, and some of the data update is not timely. At present, the status of municipal solid waste management in Shenyang is far from the prospect of circular economy. At the same time, the process of building smart cities in Shenyang has not fully considered the issues related to
municipal solid waste management. The 38 projects listed in Shenyang's Smart City Master Plan 2016-2020 do not address issues related to municipal solid waste management. Therefore, in the development of smart cities in the future, we should pay attention to the information construction of municipal solid waste management, and use relevant platforms to collect, sort out, analyze and integrate the relevant data of municipal solid waste, to provide strong support for scientific decision-making.

4.2. Leading Large Enterprises to Participate in Waste Treatment and Utilization Activities
Municipal Solid Waste Management is a multi-participation process, government alone can not solve all the problems, must mobilize the enthusiasm of stakeholders, let them take the initiative to participate in it[15]. Shenyang has many large manufacturing and technology-based enterprises, they should be actively encouraged to participate in the development and promotion of Waste Management Technology. Shenyang's science and technology sector could set up a technology fund to encourage large companies to develop technologies for municipal solid waste, offering tax breaks if the technology is made available to the public. In addition, enterprises should be encouraged to cooperate actively with the media, the holding of innovative and creative competitions and popularization of science and other activities targeted at citizens, enterprises and institutions, schools at all levels and different groups of urban solid Waste treatment and their utilization will have a great impact on the public, activities that work well are funded by the government. For companies actively involved in urban Waste treatment and exploitation, a bottom line punishment mechanism could be set up that would not be considered when applying for low interest bank loans, financial subsidies or tax breaks.

4.3. Strengthen the Construction of Intelligent Waste Industry Infrastructure
At present, the technology of Waste treatment in Shenyang is mainly burying, which not only can not effectively recycle the resources, but also becomes the restriction factor of the future urban development of Shenyang. At present, Shenyang is making great efforts to build a smart city. We should take this opportunity to set up a Waste treatment information platform to accurately grasp the waste information and implement the whole process management. At the same time, relevant industries should be supported to improve solid waste disposal processes and technologies by using Internet of things technology and artificial self-energy technology, the Shenyang government should continue to improve the development mechanism of the municipal solid waste (MSW) disposal industry as there is a bright market for providing technical support for the effective recovery and utilization of the useful resources contained in the MSW, we should invest in talents and technology, continuously expand the market of solid Waste treatment, improve the allocation of resources and optimize the structure of resources, so as to promote the stable and positive development of the industry.

4.4. Research and Development of Municipal Solid Waste Management Platform for Residents to Participate in Governance Activities
The solid Waste treatment has externality, many residents think it is a city public service project which has nothing to do with themselves, but the theory of public participation thinks that public participation can directly improve the effect of environmental governance. At present, there is no relevant institutional arrangement in Shenyang to encourage residents to participate in waste management activities. There are two main reasons. One is that residents do not understand how to handle waste in an environmentally friendly manner, second, residents have no way to feedback their own waste management demands. Shenyang is in the process of developing an e-government platform that could be considered for solid waste management. Through the platform, residents can learn about the use of solid Waste treatment technology and related equipment, raise public awareness and awareness of environmental protection, and can also express their demands for waste management to the government, from passive acceptance to active participation in governance.
5. Conclusion
By tracing back and summarizing the reform course and concrete practice of solid waste management in Russia, this paper puts forward practical suggestions for solid waste management in the construction of intelligent city in Shenyang. (1) Pay attention to solid waste management in intelligent city construction. (2) Guide large enterprises to participate in investment waste disposal and recycling activities. (3) Strengthening the infrastructure construction of intelligent waste industry and perfecting the development mechanism of information industry. (4) research and development of smart city solid waste management platform for residents to participate in governance activities.

It is of practical significance to urban governance and development. Especially under the background of the high pursuit of environmental protection and intelligent management, the research on the development direction and construction key points of solid waste management in intelligent city not only responds to the policy call, but also has remarkable help to Shenyang urban construction.

Finally, it should be pointed out that this study should continue in at least the following two aspects: first, the relevant data should be improved. At present, there is no relevant data disclosure in Shenyang, so we can introduce the relevant data of solid waste treatment in intelligent city of Shenyang in the future, such as the degree of infrastructure information, the change of solid waste disposal process, and so on, so as to better compare and develop. The second is to consider the influence of other factors in intelligent urban waste management, such as the location and density of waste infrastructure, the setting of garbage truck transportation route and so on.

Acknowledgements
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