

# **Urban Recycling Center**

A Recycling District Along Suzhou's Ancient Canal

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**Abstract**

Urban Recycling Center: A Recycling District Along Suzhou's Ancient Canal

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The relationship between architecture, waste and city is inextricably linked but full of problems throughout China and in specific Chinese cities. Today, the production and consumption of goods and foods are the most extensive in human history. Waste generation continues to increase with the growth in consumption. The issue of waste then comes because of the unsustainability of the development model and waste management that harms environmental and social balances.

The thesis critiques the current waste management system in Chinese cities which is a necessary but undesirable invisible infrastructure. The thesis aims to generate a sustainable system of waste management within the design of public space, architecture and city. The goal of the thesis is to encourage the public and waste pickers to work together to reinforce each other through architecture. The thesis will seek to tightly link public activities and waste process through the merging of architecture and landscape to create public engagement and break the physical and mental 'border' between the public and waste.

**Keywords**

Architecture, Waste Management, Public Engagement, Waste Picker, Invisible Infrastructure

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## Chapter 1 Introduction

### Problem

#### 1. Waste of the city

Waste of the city has been a serious problem these years all over the world, especially in China. The 2019 ban from Chinese market to recycle most of plastics, glass and mixed paper further indicates that solving the problem of “waste siege” is so urgent in China. The thesis tries to explore the issue of waste, which is commonly missing in the field of architecture. Waste management infrastructure is usually invisible to the public, while it is important to the planning of the city. As part of the informal system of waste management, waste pickers have made great contributions to keep the city clean and tidy, but their worth is only acknowledged when they do not do this job. “Sanitation is the most important uniformed force on the street...No city can thrive without a workable solid waste management plan.”<sup>1</sup> How can design play its role in such kind of invisibility? How would the city benefit the public with visible engagement? The thesis tries to explore the potential of waste pickers in the field of architecture, and solve two problems — how to combine architecture with waste management in the city and how to let waste pickers gain social identity in order to break the invisible ‘border’ between the rich and the poor? The thesis not only focuses on the daily issue of the public’s relationship to the waste in the city, but also concerns about how can architecture play its role in terms of designing a sustainable system of waste management and engaging the public together with waste pickers into the system. A healthy city should be able to support itself in a way that is sustainable to nature by using waste as food in the ecosystem. Although some Chinese cities have already taken action to make residents aware of the importance of

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<sup>1</sup> Robin Nagel, *Picking Up: On the Streets and Behind the Trucks with the Sanitation Workers of New York City* (New York, Farrar, Straus and Giroux, 2013), page 24.

recycling waste, most cities still function solely and only export waste. How can Chinese cities start to think of themselves as self-sustainable ecosystems?

## 2. Lack of architecture in waste management

As there is always a missing link between architecture and waste management, the thesis is going to find a way to talk to architecture, waste management and public activities by using the design ability to significantly improve people's relationship with waste.

Harvard University has already paid a lot of attention on the problem. The WtE (Waste to Energy) Design Lab founded in 2014 at Harvard Graduate School of Design has made a lot of research on it. "The mission of the WtE Design Lab is to rethink the relationship between architecture and waste, through research and design...The goal of the WtE Design Lab is to develop hybrid WtE building typologies which not only re-connect and communicate to the public, but also weave new public or institutional programs with energy production in a mutually beneficial way."<sup>2</sup> The online website of WtE Lab has a bunch of information to get.

Because of economic and environmental reasons, the activities of waste management are usually invisible from public eyes. In this case, it's hard for the public to reaccept waste management with new technologies such as waste to energy strategy. "But while such alternative methods are safer and more efficient, they are not necessarily regarded by the public as healthier. With NIMBYism rampant, residents object precipitously to plans that site waste facilities—whether alternative systems or landfills—in their immediate surroundings."<sup>3</sup> Therefore, architects can play an important role in promoting the dialog between the public and waste management process, and they can offer opportunities to create a more healthy and integrated community.

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<sup>2</sup> "About," Harvard Graduate School of Design Waste to Energy. <https://research.gsd.harvard.edu/wte/>.

<sup>3</sup> Andreas Georgoulas, Hanif Kara, and Leire Asensio Villoria, "The Missing Link: Architecture and Waste Management," Harvard Design Magazine no.40 (July 2015), <http://www.harvarddesignmagazine.org/issues/40/the-missing-link-architecture-and-wastemanagement>.

With the growth of consumption and the high dense population, the missing link between architecture and waste management should be considered much more seriously than any of time before. We are not at a point without any sustainable technology support, so it's time for sustainable infrastructure to be put in place to support the situation. Architects have the chances to engage and bridge the invisible infrastructure of urban environments back to the interconnected realm of public activity.

### 3. Boundary between waste and the public

What is waste? With a review of multiple waste literatures, a lot of definitions and concepts are discussed. From the relations between people and materials, as the abject “other” of modernity, waste is something excess that does not belong to city, it is “matter out of space”<sup>4</sup>. Part of the value of waste is realized as waste is removed, taken away from specific spaces, sorted in others, and transported out of the city at last. From an environmental point of view, the presence of waste seems to be against the intentions towards sustainable development and environmental protection. There are a lot of NIMBY-style public protests against waste management facilities all over the world, and they all reflected the complicated spatial politics of waste. People are aware of social and individual responsibility for waste, but they demand that waste go somewhere else. As a result of human's overconsumption, it's inevitable to pollute the environment, thus makes the public ignore locations which are used as physical sites for waste management tools.

Because of people's ignorance and indifference to waste, waste pickers are generally either ignored or looked down on because of the work they do, which is perceived as dirty<sup>5</sup>. However, we can't deny their contributions to environmental sustainability. They

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<sup>4</sup> Mary Douglas, *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (1966)

<sup>5</sup> Rinie Schenck • Phillip Frederick Blaauw, “The Work and Lives of Street Waste Pickers in Pretoria—A Case Study of Recycling in South Africa's Urban Informal Economy”, *Urban Forum*, 2011.

make great efforts in reducing the amount of waste that goes directly into landfills and providing sorting support for recycling process. Architects need to do something to reduce the distance between residents and waste pickers, and meanwhile make up for the missing link in waste management.

## **Claim**

### 1. Defining types of waste

Municipal Solid Waste (MSW) is something “consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. This comes from our homes, schools, hospitals, and businesses”<sup>6</sup>, defined by EPA. These types don’t include any other liquid waste, organic waste, agriculture waste, toxic waste and hazardous waste, which have totally different collecting systems.

### 2. Waste pickers’ contributions to the public

The definition of the waste picker is a person “who salvages reusable or recyclable materials thrown away by others to sell or for personal consumption”<sup>7</sup>. Despite waste pickers’ invisibility in most cities, their contributions to solid waste management systems, the environment, and quality of public space are largely ignored and undervalued by city planners. However, in cities or communities with no household collection or municipal waste management systems, waste pickers are important roles in solving this more and more serious waste problem. Waste pickers even increase the lifespan of landfills by reducing the amount of waste to be picked. They also protect the environment by reusing or reprocessing waste and materials. For example, in Brazil,

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<sup>6</sup> “Municipal Solid Waste,” US Environmental Protection Agency, last modified March 29, 2016, <http://www3.epa.gov/epawaste/nonhaz/municipal/>.

<sup>7</sup> “Waste picker,” Wikipedia, last modified December 2, 2019, [https://en.wikipedia.org/wiki/Waste\\_picker](https://en.wikipedia.org/wiki/Waste_picker).

informal recycling is responsible for the country's 80% of cardboard and 92% of aluminum recycling.<sup>8</sup> Informal workers also contribute to material recovery. There is a growing acknowledgement that informal waste pickers supplement formal municipal solid waste management in various ways.

What's more, informal waste pickers promote the quality of life around the areas where they work. This is especially happening in developing countries, such as China, where waste pickers wander around the streets gathering waste, making its value meaningful and visible to citizens and keeping the streets clean. They protect the public space while executing an important environmental activity.

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<sup>8</sup> Dias, Sonia Maria, "Statistics on Waste Pickers in Brazil", WIEGO Statistical Brief No 2, Cambridge, MA and Manchester, UK, page 3.

## Chapter 2 Framework

### Literature Review

#### 1. Robin Nagel's *Picking Up*

People's ignorance to waste pickers, or "sanitation workers" called by Robin Nagel, can be seen in this book with her comment that they are "willfully unseen by the public":

"[He] exists along both physical and cognitive edges...He occupies in between physical spaces—the street, yes, but specifically the curb, the alley, the end of the driveway. He moves garbage, the ultimate unloved Stuff, to areas zoned mostly for industrial uses. He starts and finishes his workday in a garage that is usually on the outskirts of a neighborhood. He is the intercessor between the uncomfortable here and now of an individual's own refuse and a safely mythical 'away'".<sup>9</sup>

The living situation of sanitation workers in New York can be seen from above. Around areas which are usually occupied and used to manage waste live crowds of sanitation workers, and both these physical spaces and sanitation workers are unwelcome and unnoticed to citizens, because they are dirty, untidy and unpleasant. However, the book isn't just to make us take notice of sanitation workers, but to make people aware that these workers are the most essential people in New York. "Sanitation is the most important uniformed forces on the street... if sanitation workers aren't out there, the city becomes unlivable, fast."<sup>10</sup> Apart from this, Robin Nagel also points out the dangers of sanitation workers' job, which might put them at a much higher risk of death than policemen or firemen.

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<sup>9</sup> Robin Nagel, *Picking Up: On the Streets and Behind the Trucks with the Sanitation Workers of New York City* (New York, Farrar, Straus and Giroux, 2013), page 23.

<sup>10</sup> *Ibid.*, page 36.

## 2. David Orr's *Architecture, Ecological Design, and Human Ecology*

In this article, David Orr raises the principles of ecological design. Ecological design is more than just theoretical supports, but a design practice that aims to revise what humans do in the world in order to make humans live in harmony with nature. In this sense, design is a large concept having to do with as much with politics and ethics as with buildings and technologies. David Orr questions how the design of a building can fit well in the overall fabric and a city and its community.

Orr talks about great impacts of design when the designer tries to engage in the dialogue with the site in order to identify its potentials. He mentions that we must think of a building as not just a building but a smaller cog in a larger machine. He describes ecological design as “a kind of navigation aid to help us find our bearings again.”<sup>11</sup> Architecture and design is more than a tool to build, but a tool to change things in shaping the world around us and our experiences in it.

Orr has suggested better design, which does not mean to design more beautifully, but to design more wisely with specific solutions and goals at hand. He has suggested “a more sophisticated and ecologically grounded understanding of place and culture.”<sup>12</sup> With this in mind, ecological design is not only an option, but a necessary need. The ways to help foster design solutions are not abstract imposition, but explorations of a specific place which could reveal and possibly reinforce a cultural narrative. We cannot have change without also changing these factors for so much of our living is rooted in these pediments, “A real design revolution will have to transform human intentions and that larger political, economic, and institutional structure that permitted ecological degradation in the first place.”<sup>13</sup> In this case

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<sup>11</sup> David Orr, “Architecture, Ecological Design, and Human Ecology”, page 30.

<sup>12</sup> Ibid., page 23.

<sup>13</sup> Ibid., page 21.

the measurable indicators would fall into two broad categories: the ability to go beyond the more traditional methods of site analysis and represent the experiential character of the site, and the ability to use these perceptions in the sensitive integration of buildings within the landscape.<sup>14</sup>

Many theories about ecological design can be seen in alternate thinking such as closed loop system and cradle to cradle theories. Each of these theories has its own voice about what should be done to improve ecological design. With ecological design, we can make full use of waste and return it to its goodness.

## **Precedent Analysis**

The legal origins of modern public solid waste management can be traced to 19th-century English legislation, which introduced the concept of waste collection as a public service.<sup>15</sup> As the second-largest producer of municipal solid waste and a country with the largest population in the world, China is bound to face serious trash problems. However, China is not the first country to pay attention to this issue, and its waste management system has gone through many twists and turns. In this part, the origins and evolution of Chinese municipal solid waste management system and the life situation of informal waste pickers will be discussed.

### **1. History of waste collection in China**

Waste collection has developed in three stages since the People's Republic of China was founded in 1949. During China's planned economy in 1950s, the supply and disposal of commodities in villages were under control of state-run supply and marketing cooperatives (SMCs). At that time, there was no complex division of waste. Household

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<sup>14</sup> Santiago Hernández, *Eco-architecture III: Harmonisation Between Architecture and Nature* (WIT Press), page 113.

<sup>15</sup> Velis, Costa A and Karl C Vrancken (2015), "Which material ownership and responsibility in a circular economy?", *Waste Management & Research* Vol 33, No 9, pages 773–774.

trash was only divided into recyclable and non-recyclable waste. Because of the problems of economy, there was widespread poverty which meant villagers with low income were eager to reach a better life by selling recyclable waste to their local SMC. (Figure 1)



*Figure 1 People selling recyclable waste to the SMCs from South China Morning Post*

In 1978, with the introduction of Deng Xiaoping's market economy reforms, the SMCs began to decline. Scavengers and private recycling businesses replaced the role of SMCs in sorting and recycling waste. Scavengers picked valuable trash in public trash bins (Figure 2), and businessmen collected valuable waste from citizens' homes by riding tricycles. The collected waste was then sold to middlemen who transferred materials to warehouses on the outskirts of the city. However, these private operators only picked those trash of high commercial value to recycle while left other waste still in the landfills on urban edges. The government continued to focus on waste management of unrecyclable household waste in order to relieve such situation.

After entering 20<sup>th</sup> century, the rapid urbanization urged the government to explore pilot waste management strategies. At the same time, the decline of certain raw materials destroyed the market of private scavengers and recycling businesses, which made the waste management problem more acute in China. In recent years, with the rapid development of e-commercial industry, the increasing delivery package waste threatens the cities too.



*Figure 2 Scavengers picking waste from public trash bins from South China Morning Post*

## 2. Municipal solid waste in China

Most Chinese MSW usually includes residential, institutional, commercial, street cleaning, and non-process waste from industries.<sup>16</sup> According to China's National Bureau of Statistics, there are about 660 cities in China that generate and transport about 215

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<sup>16</sup> Dong Qing Zhang, Soon Keat Tan, Richard M. Gersberg, "Municipal solid waste management in China: Status, problems and challenges", *Journal of Environmental Management*, 91 (2010), page 1624.

million tons of municipal solid waste in 2017 (Figure 3), account for about 29% of world's MSW generation, and equivalent to 0.72 kg per urban resident per days.

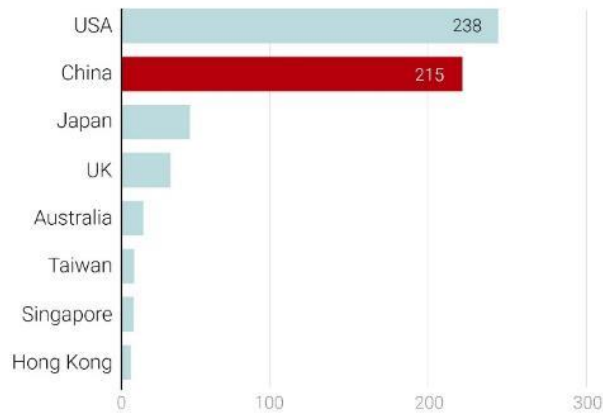


Figure 3 Total municipal solid waste generated in million tonnes from China's National Bureau of Statistics

The circles on Figure 4 show the top cities which generated the most MSW in 2017. Beijing, with a population of 21.7 million, generated the most. Most of are also among cities with top economies by GDP in China. Of the 46 major cities, most are the provincial capitals or big municipalities directly administered by the central government.



Figure 4 Top 10 cities generated the most municipal solid waste

Table 1 presents a comparison of MSW composition in various cities. In general, the dominant composition of MSW in China is basically organic garbage including vegetable food waste and moisture content, since the proportion of kitchen waste makes up about 60% of the overall composition. Compared to other western countries with a higher ratio of recyclable and lower bio-degradable organic MSW composition, the situation in China is partly due to the Chinese diet, like more fresh vegetables and fruit compared with Western culture, and a preference for unprocessed and unpacked food. This means that although the industry might grow, people's wealth may increase and their living conditions would improve, this high organic composition of MSW will not change. In this case, kitchen waste will continue to occupy a high ratio of MSW in the future in China.

Table 1 Comparison of typical distribution of municipal solid waste composition in various cities in China

| Composition (%)               | Organic garbage | Paper | Plastic | Glass | Metal | Textile fiber | Wood timber | Ash   |
|-------------------------------|-----------------|-------|---------|-------|-------|---------------|-------------|-------|
| Beijing (2006) <sup>a</sup>   | 63.39           | 11.07 | 12.70   | 1.76  | 0.27  | 2.46          | 1.78        | 5.87  |
| Shanghai (2009) <sup>b</sup>  | 66.70           | 4.46  | 19.98   | 2.72  | 0.27  | 1.80          | 1.21        | 2.77  |
| Tianjin (2007) <sup>c</sup>   | 56.88           | 8.67  | 12.12   | 1.30  | 0.42  | 2.47          | 1.93        | 16.21 |
| Shen Yang (2007) <sup>d</sup> | 73.70           | 7.60  | 5.20    | 2.40  | 0.30  | 0.90          | 1.70        | —     |
| Hangzhou (2009) <sup>e</sup>  | 57.00           | 15.00 | 3.00    | 8.00  | 3.00  | 2.00          | 2.00        | 4     |
| Qingdao (1998) <sup>f</sup>   | 42.20           | 4.00  | 11.20   | 2.20  | 1.10  | 3.20          | —           | —     |
| Tibet (2009) <sup>g</sup>     | 72.00           | 6.00  | 12.00   | —     | 1.00  | 7.00          | —           | —     |
| Ningbo (1998) <sup>f</sup>    | 53.70           | 5.40  | 7.90    | 2.40  | 1.00  | 3.00          | 1.10        | —     |
| Guanghan (1998) <sup>h</sup>  | 50.70           | 8.80  | 6.10    | 0.6   | 0.2   | 0.60          | 0.20        | 32.80 |
| Chongqing (2006) <sup>i</sup> | 59.20           | 10.10 | 15.70   | 3.40  | 1.10  | 6.10          | 4.20        | —     |
| Guangzhou (1999) <sup>g</sup> | 58.10           | 6.30  | 14.50   | 2.00  | 0.60  | 4.80          | 3.10        | 9.00  |
| Shenzhen (1998) <sup>f</sup>  | 40.00           | 17.00 | 13.00   | 5.00  | 3.00  | 5.00          | —           | —     |
| Hong Kong (2009) <sup>j</sup> | 44.00           | 26.00 | 18.00   | 3.00  | 2.00  | 3.00          | 1.00        | —     |

“—” Means data absent.

<sup>a</sup> Li et al. (2009).

<sup>b</sup> Hong et al. (2006).

<sup>c</sup> Zhao et al. (2009a).

<sup>d</sup> Raninger (2009).

<sup>e</sup> Zhao et al. (2009b).

<sup>f</sup> Liu et al. (2006).

<sup>g</sup> Jiang et al. (2009).

<sup>h</sup> Hu et al. (1998).

<sup>i</sup> Yuan et al. (2006).

<sup>j</sup> Ko and Poon (2009).

### 3. Current municipal solid waste management in China

The MSW management in China is mainly the responsibility of a central authority, including the collection, transportation and disposal processes. The general diagram of MSW management system in China is shown in Figure 5. In March 2017, the central government implemented plans to have a standard system of recycling waste in 46 cities, including Suzhou, aiming to get 35% of waste to be recycled by the end of 2020.

(1) Waste collection

In the collection process, generally the waste is collected from households to collection points, and this is usually done by residents themselves or informal waste pickers. Then the process is either stored or transported to various treatment points by truck. These waste services can vary differently in different parts of the city in China. In Suzhou, there are adequate waste management services in rich communities in urban economic centers, but the same services are not available in historic districts and poorer villages in urban fringe.

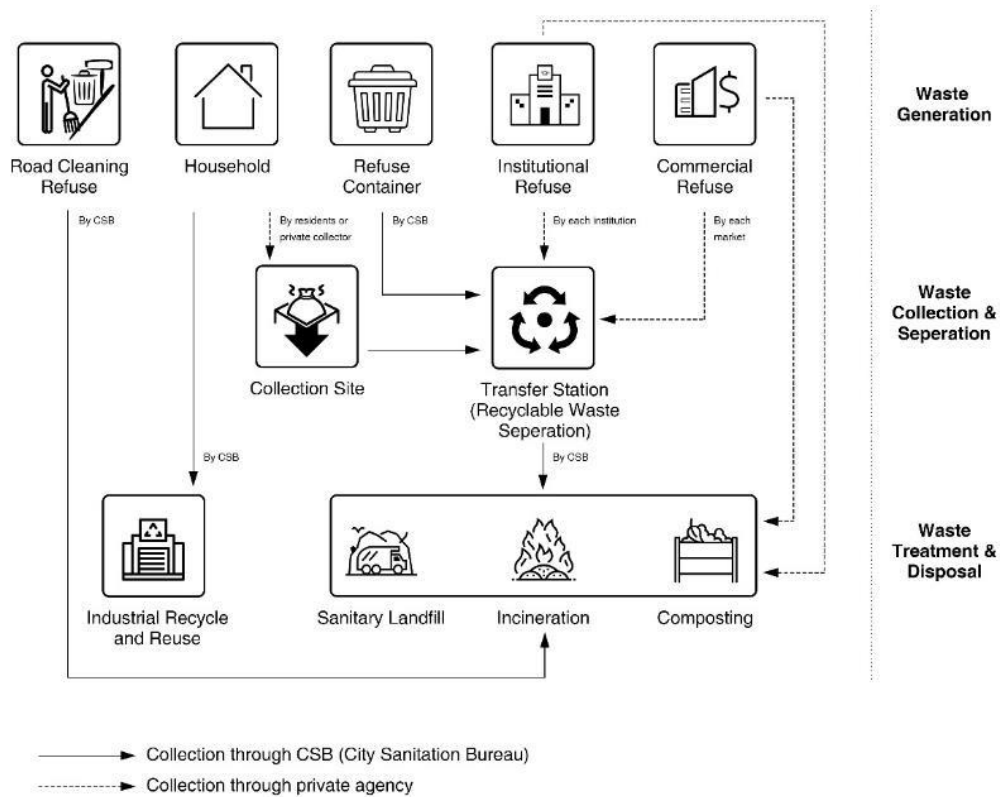


Figure 5 General diagram of municipal solid waste management system in China

In China, waste collection includes both formal and informal sectors. Unfortunately, the informal sector has more than double the number of employees. This poses many problems for formal waste management. In addition, waste collection poses a huge

threat to the health of the informal waste pickers, who do not know how polluting the poison they are exposed to. Informal collection also results in different collection rates across the city, with some places being collected three times a day and others being collected only once in several days. Overall, the efficiency of collection is higher in eastern China than in western cities.

## (2) Waste separation

In China, municipal solid waste is mostly distributed into organic, non-recyclable and recyclable waste. In the past, although there were waste separation bins on the street, few people sorted waste. Now that China has implemented a new waste sorting policy, every household has learned how to sort waste according to requirements. In addition, with the help of volunteers and cleaning staff, the waste transfer station's waste sorting work is much easier. The recyclable materials (typically are cardboards, papers, plastic bottles and woods) are usually brought by waste pickers who buy waste door to door from residents and then sell them to middle-men or local distribution center where they can get higher profit. When the Chinese government's intervention in waste collection was not much, the waste collection in various cities mainly relied on informal waste pickers to ensure smooth operation. These waste pickers have also changed the way waste management operates in China. Unlike developed countries, China's waste collection, sorting, and transportation are done by different entities. In developed countries, these processes are included in the same waste management system and managed by one entity.

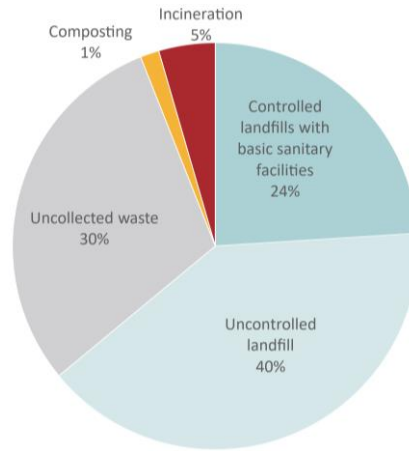


Figure 6 Disposal method for municipal solid waste in China

### (3) Waste treatment and disposal

China's waste disposal method is mainly landfill, because of its lower cost and larger waste treatment capacity. Figure 6 shows the disposal method for MSW in China. It can be seen that in addition to the largest proportion of landfills, there is still a lot of waste (about 30%) that has not been effectively collected.

At present, nearly 50% of the nearly 2000 landfills in cities and towns in China do not operate at full capacity. Of these, about half of the landfills are overloaded, which will inevitably lead to the increasing burden on the regular operations of domestic waste landfills. Figure 7 shows current landfill volume and capacity in three major provinces in China.

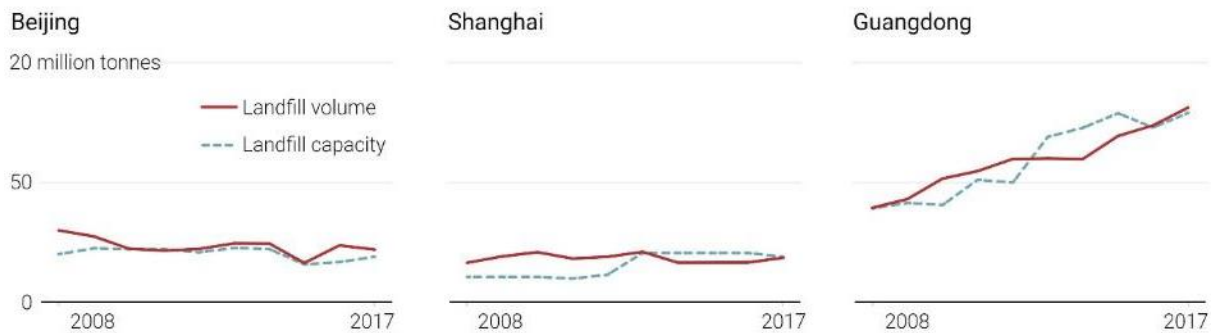


Figure 7 Landfill volume and capacity in Beijing, Shanghai and Guangdong

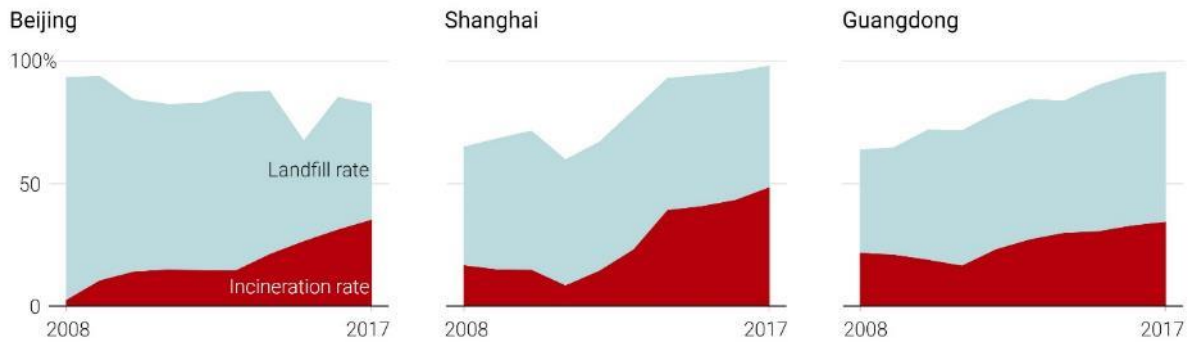


Figure 8 Landfill and incineration rate in Beijing, Shanghai and Guangdong

Waste incineration is the second largest waste disposal method in China after landfill. Compared with landfill, the advantages of incineration are: first, it reduces the land occupation; second, it avoids the pollution of land and water bodies; third, it can realize energy storage for incineration. However, the disadvantages of incineration are also obvious: first, the pollution is mainly converted into air pollution, and the scope of pollution has become wider; second, a lot of waste with recycling value has been burned by fire, causing waste of resources.

According to statistics, China's waste incineration power plant project has reached a new peak in 2019, with about 600 large, medium and small projects planned to be constructed. However, due to uneven construction levels and low waste classification, the incineration plant is almost equal to "toxic and hazardous substances". As a result, residents protested frequently. NIMBY (Not In My Backyard) has become a major problem in the site selection of China's waste incineration industry.

Since 2017, China's environmental regulatory authorities have imposed strict requirements on the monitoring and disclosure of pollution information from the waste incineration industry in order to reverse the industry's long-standing negative image in the public. These measures will be further strengthened and upgraded from

the beginning of 2020, and the waste incineration industry will face much stricter supervision from regulators and the public.

#### 4. Evolution of the formal and informal systems in China's waste management

China's formal and informal waste management systems have always been in a state of mutual restraint. (Figure 9) China's formal waste management system originated from State-run Supply and Marketing Cooperatives (SMCs) under planned economy.<sup>17</sup> At that time, in order to improve living standards, people actively collected recyclable valuable waste and exchanged daily supplies at SMCs. After the government withdrew from WM in the early 1980s, this field gradually became dominated by informal sectors. More and more low-income people earned their living by collecting waste. Later, many “waste villages” appeared on the outskirts of the cities. Most of the villagers were waste pickers, and the collected waste was piled up everywhere in the village. After entering the 20th century, as the problem of waste siege became more and more serious, the government restarted the waste management system, and continued to expel informal waste pickers to try to eliminate waste villages. Since then, many waste villages have been forced to relocate many times and struggle to survive. Now that waste management is becoming more and more formal, we urgently need to consider how to incorporate informal waste pickers into the formal waste management system.

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<sup>17</sup> “Forty years of waste collection① | How is the private waste recycling network formed”, THE PAPER, [https://m.thepaper.cn/newsDetail\\_forward\\_2200457\\_1](https://m.thepaper.cn/newsDetail_forward_2200457_1)

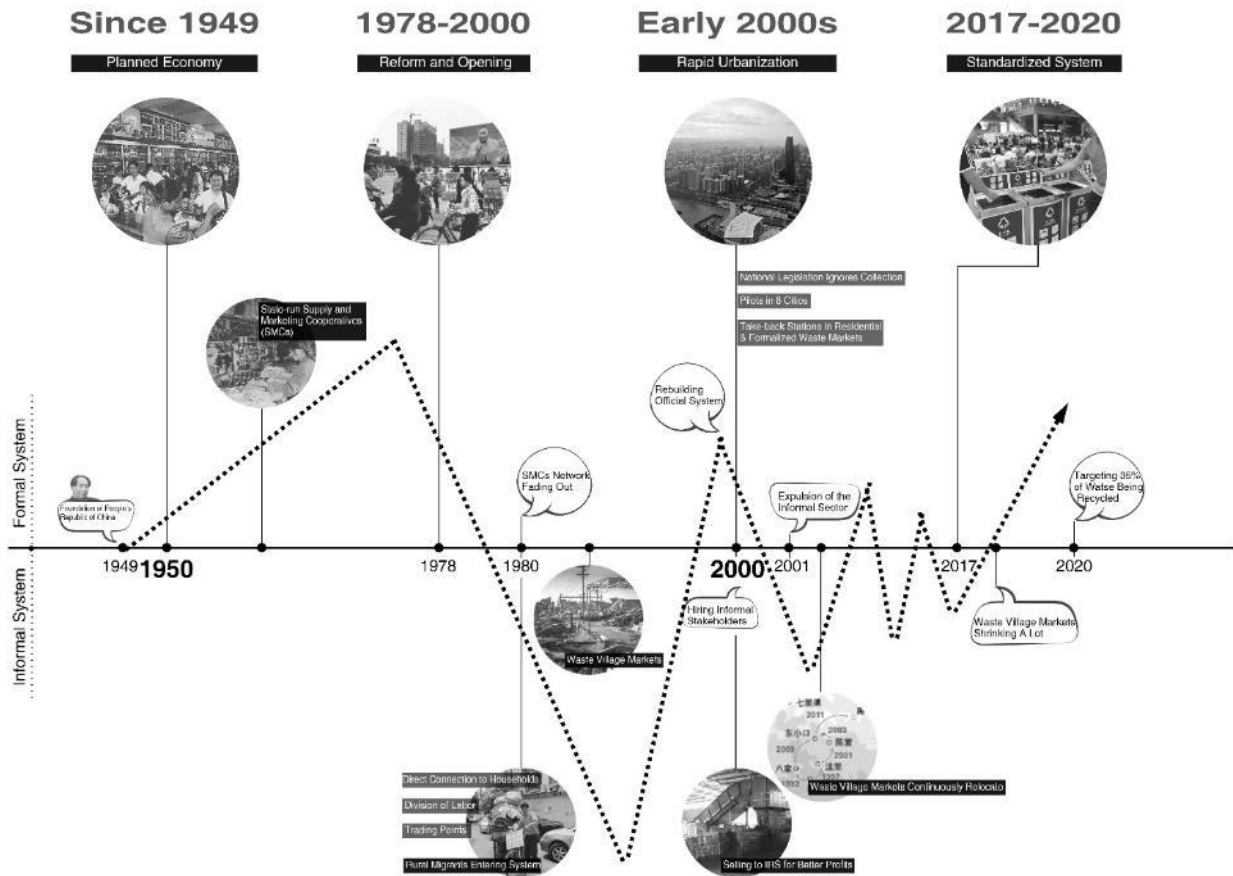


Figure 9 Evolution of formal and informal waste management system in China

## 5. Waste pickers' life in China

Waste picking is a long-established social phenomenon. Under the private exploitation system, due to natural and man-made disasters and other factors, the poor are often displaced into exiles, and those who are unable to make ends meet will also become beggars. While begging, some people will also maintain their minimum survival needs by picking up waste items discarded by others. This is the most primitive waste picking phenomenon, and these people have become the original waste pickers.



*Figure 10 Waste pickers' life in China*

Taking Suzhou as an example, in the survey, the author found that the group of waste pickers in Suzhou has obvious regional characteristics. The earlier waste pickers in Suzhou came from northern Jiangsu. They had been scavenging in Suzhou in the mid-1980s. At that time, the country's waste recycling system was still functioning. Therefore, their initial waste collection method was mobile purchases in the streets. By the mid-1990s, waste pickers from the northern Anhui region began to enter Suzhou. They formed a new group of waste pickers, and the scale of the group in Suzhou gradually expanded. Through investigation, the author found that according to the different ways of picking waste and the status of income and capital ownership, the waste pickers can be divided into three hierarchical groups with obvious hierarchical relationships:

(1) Individual pickers

As far as the whole industry is concerned, the pickers are the lowest level, the lowest income, the most unstable, and the hardest waste picking method in the entire group of waste pickers. It is the bottom of the waste picker group, accounting for about 20% of the whole group. The tools for picking up waste are a stick with a hook and a woven bag carried on the body. They walk every day between the trash bins in various urban areas of Suzhou; their average monthly income is about 300 to 400 RMB.

### (2) Mobile pickers

This group has the largest number of waste pickers. The main way for mobile scavengers to pick waste is to pull carts or tricycles throughout streets and buy waste from urban residents in various places in Suzhou. 43 of the survey samples are mobile scavengers, accounting for about 70% of the entire waste picker community. The monthly income of mobile scavengers at this level is about 800-1,000 yuan, which is a certain improvement compared to the pickers.

### (3) Fixed pickers

This part is in a higher position among the waste picker group, accounting for about 10% of the entire group. They no longer need to pull carts or tricycles all day to collect waste products. They often reach a certain agreement with residents' committee to exclusively contract the purchase of waste products in one unit or several communities, so they only need to go to their own contracted units or communities every day to purchase waste products; their income is also the highest in the entire group. Their monthly income is around 1,500-2,000 yuan. Relatively speaking, although mobile scavengers also get income mainly from acquisitions, they do not have fixed acquisition locations. They often run down a day and collect less than one pallet of goods, so their income is much lower than fixed scavengers.

## 6. Case studies

### (1) Waste treatment: Venice and Makoko

When thinking of sustainable use of waste transportation, Venice is a good example for that. Venice, Italy, as a world-famous water city, has more than tens of millions of tourists visiting Venice every year. While the arrival of a large number of tourists brings economic benefits, daily waste disposal becomes a burden and pressure on the city. According to official statistics, there are currently less than 60,000 urban residents in Venice, and the waste recycling expenditure in Venice is about 40% more than other Italian urban residents. Although barges carrying cleaning equipment can clean waste on the bottom of the canal, the machinery cannot reach many areas in the city, and urban waste disposal depends more on manual cleaning. In this case, Venice has launched a door-to-door waste collection service. Cleaners walk through the streets to collect garbage, and residents can even throw garbage directly into the waste recycling boat (Figure 11 & 12) on the canal. This on-site waste collection service not only makes the city more livable, but also greatly enhances the consciousness of tourists to sort and put waste.



*Figure 11 Barge carrying waste in Venice from Google Images*



*Figure 12 Barge picking waste in Venice from Google Images*

In addition to Venice, where people have richer life, it is also important to see how other non-wealthy countries treat waste. Makoko is the world's bigger floating slum in west Africa. People live in this slum used the surplus wood from the former sawmill to build houses. These houses look like a mess and people may wonder how they stand, but the most surprising thing about these structures is that many of them have been around for more than 40 years.<sup>18</sup> If these inferior structures can last for such a long time, then people may imagine how long they can last with enough support. The sustainable development of slums is also the sustainability of its transportation. Residents live completely on the water, using canoes to shuttle from one place to another. As a result, economic activities there are mainly fishing and smoked fish. Makoko's shortcomings are due to the lack of waste removal, such as pipelines, causing serious pollution of its domestic water. If they can use modern technology or specific landscaping methods to properly process waste, this problem can be solved.

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<sup>18</sup> "Inside Makoko: danger and ingenuity in the world's biggest slum", Guardian Logos Week, <https://www.theguardian.com/cities/2016/feb/23/makoko-lagos-danger-ingenuity-floating-slum>

For China, even though people have received education in recycling, they are not more of an example than slums. People can practice recycling, but they are still the world's top waste consumers and waste producers, ranking among the top three with the largest ecological footprint. Many Third World countries do not even have a footprint because they use so few resources in the world, and in this case, they are making greater progress.



*Figure 13 Makoko's slums from Google Images*

## (2) WtE: Amager Bakke Waste-to-Energy Plant

The Amager Bakke waste-to-energy plant designed by Bjarke Ingles Group combines waste treatment and public conveniences to create a hybrid building typology. By incorporating a public ski slope into a WtE plant, the building was upgraded from a typical industrial building to a new type, attracting and encouraging public interaction with what is generally considered to be negative. The building is located in an industrial area not far from Copenhagen's central historic district and is a popular destination for tourists and locals.

The ski slope is designed into three parts, each part is graded according to steepness, and each part provides different difficulty levels to cater to the trained skiers and beginners. There will also be a freestyle park for citizens to practice jumping and skiing skills.

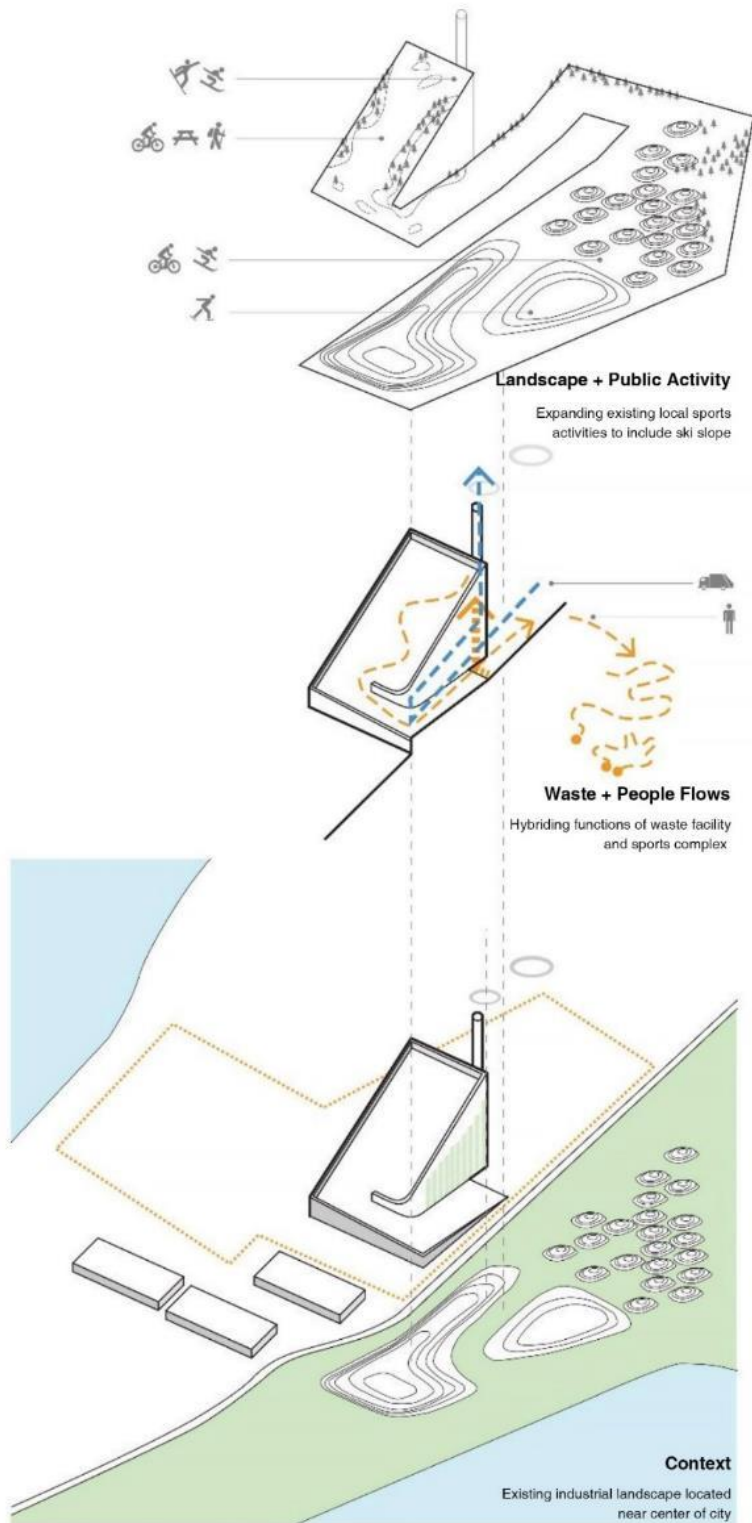


Figure 14 Amager Bakke Waste-to-Energy Plant Analysis



*Figure 15 Amager Bakke Waste-to-Energy Plant rendering from ArchDaily*



*Figure 16 Amager Bakke Waste-to-Energy Plant rendering from ArchDaily*

### (3) Sydhavyns Recycling Center

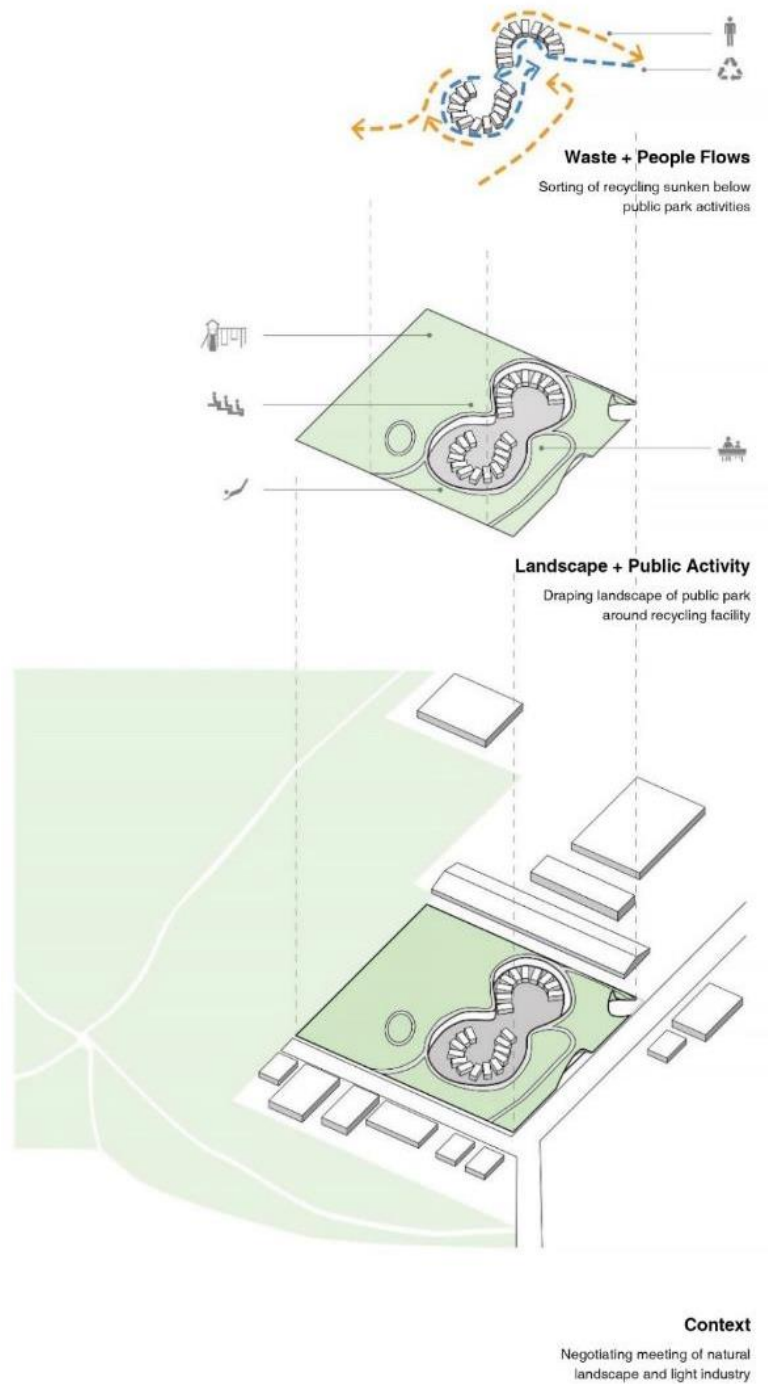


Figure 17 Sydhavyns Recycling Center analysis



Figure 18 Sydhavyns Recycling Center from BIG



Figure 19 Sydhavyns Recycling Center from BIG

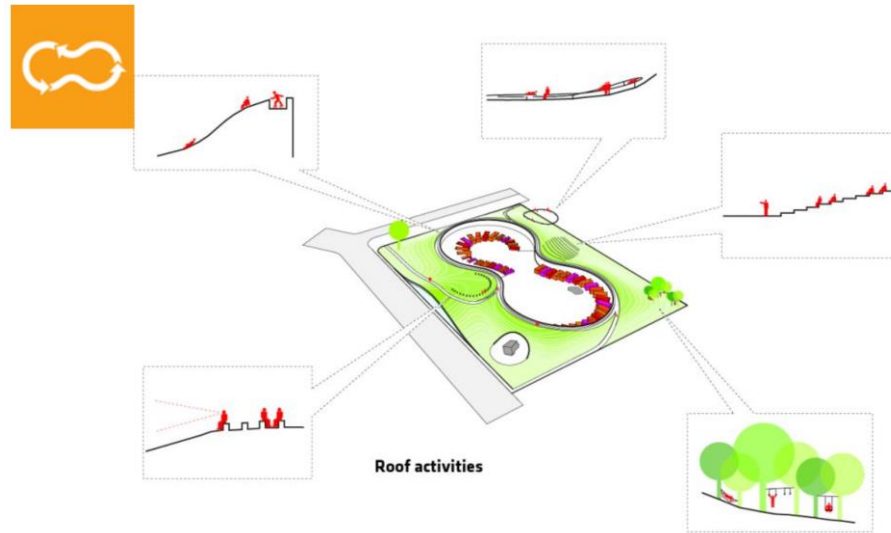


Figure 20 Sydhavyns Recycling Center from BIG

The Sydhavyns recycling center is designed by Bjarke Ingles Group. It is located in the Sydhavyns district, southwest of Copenhagen’s historic city center. The recycling center is located at the waterside of the light industrial zone, embedding itself in the landscape and connected to a large park. This design is not to separate the building from the surrounding environment, but to bury the building in the surrounding environment. As BIG said, “As a society, our investment in waste management often ends up as utilitarian facilities of concrete boxes that constitute grey areas on our city maps...What if they could become attractive and lively urban spaces in the neighbourhoods they form part of?”<sup>19</sup> The slope of the green roof provides different activities for people according to different slopes and orientations, while leaving a path at the entrance for people to observe and learn the recycling process. This fusion of buildings and landscape in the urban environment is an important change in design thinking. By recognizing that all spaces including buildings and landscapes are constructed entities in cities that often incorporate complex infrastructure

<sup>19</sup> Bjarke Ingles Group, “Sydhavyns Recycling Center,” <http://www.big.dk/#projects-gbs>

networks, it can be said that any design needs to address the overlap of buildings and landscapes.

#### (4) Inclusive public policies

Waste pickers around the world have tried many solutions for inclusion, such as large-scale mobilization, strategic alliances at the local, national and international levels, and policy and legislative struggles to gain recognition and ensure integration of their livelihoods. Organizing can take the form of membership-based organizations (MBO), such as cooperatives, associations, trade unions, community organizations, or micro-enterprises. The way that waste pickers organize and waste pickers' requirements is affected by many historical and political factors.

This part is going to discuss inclusive waste management policies in three different cities and what role waste pickers play in achieving these inclusive goals.

##### 1) Brazil

In 1993, the city Belo Horizonte in Brazil started a program aimed at combining waste pickers into municipal solid waste management system. The waste pickers' cooperative made great efforts in integrating waste pickers into formal waste management system. They integrated mainly pickers of recyclables and of debris into this system. This new model focused on promoting the separation of source waste and involving waste pickers in both the collection and sorting process.

Firstly, specific waste pickers' cooperative offers door to door waste collection of recyclables in collection areas. Secondly, people can drop recyclables at drop off point and the waste will be sorted by informal waste pickers. There is also a curbside waste collection.

In order to stimulate the enthusiasm of waste pickers, the government issued an incentive policy for this project. Waste pickers can get corresponding economic bonus according to the quantity and quality of work.

## 2) Colombia

The city Bogotá in Colombia also made efforts for waste pickers to gain recognition. The Bogotá Waste Picker Association struggled to defend waste pickers' right to work and their integration into waste management system. In 2012, the municipality has launched a plan to integrate waste pickers into the implementation of the zero-waste plan and the waste pickers in the municipal waste management system is also part of the collection, transportation and recycling process of recyclables.

## 3) India

In Pune, India, the Waste Pickers' Union reached a contract agreement with Pune Municipal Corporation in 2008 which allows union members to provide door to door waste collection services to urban residents. Workers are paid through user fees and are accountable to residents and municipalities. Waste pickers have obtained equipment and working space, received technical training, obtained the right to carry out door to door waste collection and authorized the commercialization of recyclable goods, and have the right to charge residents. Although the municipality bears the administrative costs of waste pickers, purchases equipment such as carts and gloves, and provides medical insurance, the costs are much lower than those that must be paid for private collection and disposal. This makes this policy a win-win policy.

The cases above indicate that non-governmental organizations investing in encouraging organizations between waste pickers will be valuable. In addition, as shown in the above examples, the government also plays an important role in integrating informal waste picker organizations as a partner and major player in municipal solid waste management.

## **Conclusions**

At present, China's waste collection and recycling policy is not perfect, nor can waste collection and reprocessing be performed very efficiently. This situation has greatly increased the amount of waste that needs to be landfilled, making land use more stressful. With the development of China's waste recycling policy for many years, it is now the best time to incorporate informal waste management into the formal system. The investigation of inclusive policies shows the feasibility of incorporating waste pickers into the formal system. This can not only achieve one of the goals of thesis, to allow waste pickers to gain recognition, but also greatly increase public engagement in waste collection and recycling.

With reference to the design cases, the thesis can consider using roofs or other public spaces to enhance the interaction between the public and waste collection and sorting. For waste transportation, terrain and river landscape can also be used to provide a variety of transportation options for waste pickers.

## Chapter 3 Methodology

### Site Selection and Analysis

#### 1. Site context

Suzhou, known as Wu in ancient times, is a prefecture-level city in the southeast of Jiangsu Province, the People's Republic of China. It is located in the center of the Yangtze River Delta and Taihu Plain. This historical and cultural city has enjoyed the reputation of "paradise on earth" since ancient times.<sup>20</sup> The Yangtze River and the ancient canal run north of the urban area in Suzhou. The ancient city area of Suzhou is surrounded by ancient canals, and it was rated as one of the five most beautiful urban areas in China. The site selected is Pingjiang Road Community located near the canal in the northeast of the ancient city area. The population density of the site is also very large. Suzhou has a large population of 10,721,700, with 294,078 in the ancient city area and 36,479 in Pingjiang Road Community.

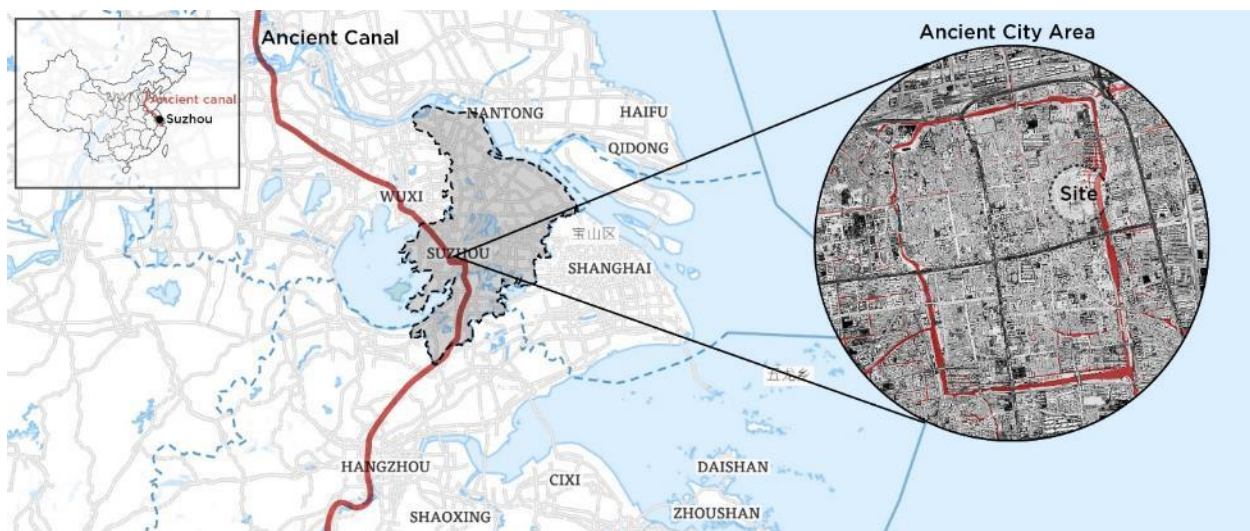
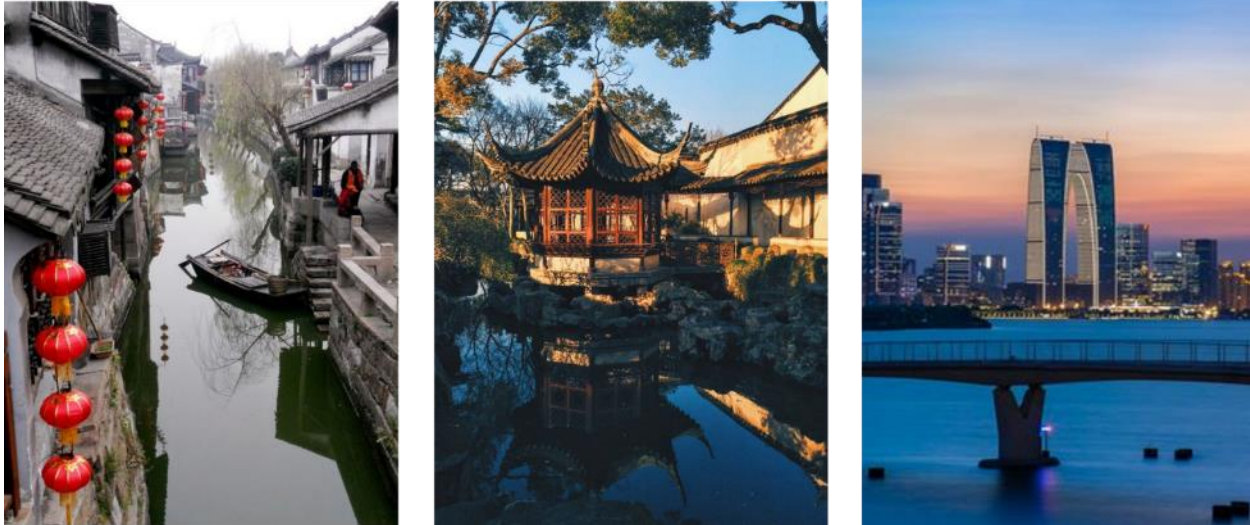


Figure 21 Suzhou overview

<sup>20</sup> Wikipedia, <https://zh.wikipedia.org/wiki/%E8%8B%8F%E5%B7%9E%E5%B8%82>

Suzhou is a famous cultural tourism city in China, famous for its numerous rivers, characteristic water town buildings, and Chinese classical gardens.



*Figure 22 Waterways, Chinese gardens and skyscrapers in Suzhou from Google Images*

## 2. Site analysis

The entire ancient city area has close water links, numerous bridges, and convenient transportation, as well as multiple parks and Chinese gardens. (Fig. 23) Suzhou Railway Station, which is located outside the canal in the north of the ancient city, is connected to the main road, providing great assistance for tourists and residents to reach the site. At the same time, ancient canals extending in all directions spread throughout the ancient city and the entire city, bringing convenient water transportation to the site. In addition to the canal and the main roads, the bridges connecting the inside and outside of the ancient city has also become the main transportation system. Chinese classical gardens are scattered throughout the ancient city area and concentrated on the east (near the canal) and north of the site. The green space on the east side of the site is linearly distributed along the topography of the canal, forming a banded landscape along the canal.

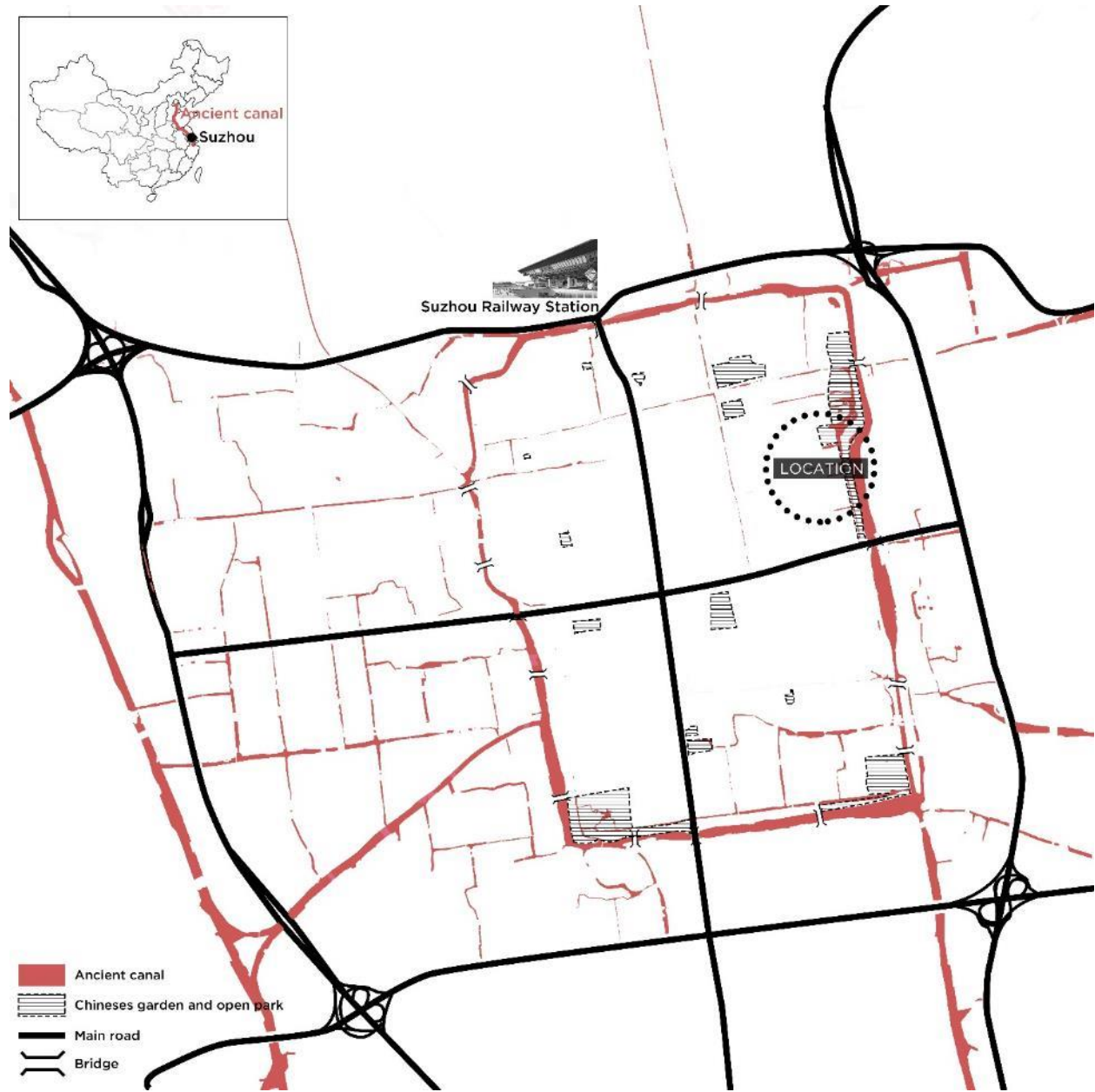


Figure 23 Waterways and main roads around the site



Figure 24 Cultural institutes and recycling points around the site

Many cultural institutions involving Suzhou’s cultural propaganda and educational institutions including Suzhou University and middle schools are scattered around the ancient city and the site. (Fig. 24) There are also several informal recycling points where waste pickers trade recyclable waste to the third party, but most of them are far away from the ancient city and the site.



Figure 25 Site context



Figure 26 [1] Traditional boat around the site



Figure 27 [2] Typical street view around the site



Figure 28 [3] Barge picking waste in the water



Figure 29 [4] Barge picking waste in the water



Figure 30 [5] Corner view of the Chinese Garden



Figure 31 [6] The new port along the site



*Figure 32 [7] The view of the canal*

The site is located in Pingjiang Road Community, and it's currently a wasteland. (Fig. 25) The south side of the site is the main road which makes transportation convenient, the east side is the ancient city wall and the public park with fitness trails which can bring a larger number of residents and tourists, the north side is a Chinese garden, and there are several schools around the site. Educational facilities surround the site can provide constant and easy information. The existing inner city canal passes through the middle, east and north of the site which also provides another way of transportation. The remaining area is mainly residential with high population density. Walking around the site, it is very common to see the traditional boats (Fig. 26) carrying tourists in canals throughout the ancient city. The typical street view has canal in the middle, an alley on one side and a wall on the other (Fig. 27). The width of the street and the canal is just in the right proportion. You can see it often that a barge is picking waste in the water to help keep the canal clean and tidy (Fig. 28 & 29). A new port under construction is along the east of the site (Fig.31). It will become another important port for tourists, and one of the important routes to the site.

## **Design Goals and Objectives**

The design part of the project is intended as an example of community that can be designed in the smaller sub-environment of the city to prove the ideal of waste management ideas discussed in Chapter 2 and establish a cradle of sustainable management system with the design of urban recycling center can be achieved. Although the project is hypothetical, it can prove that even if our waste problem sometimes seems insurmountable, changes can be made. The design aims to encourage the public and waste pickers to work together as a community and help waste pickers to gain social identity. The design seeks to tightly link public activities and waste process through the merging of architecture and landscape to create public engagement and break the physical and mental border between the public and waste, as well as the raising awareness of recycling.

## **Program**

There are four essential program components that drive the design. Based on what is discussed before, the design component of the thesis is to create a typological waste management system thinking and design thinking to improve the environment and living conditions of residents. By keeping this in mind, the four program components become waste, transportation, education and living.

The diagram below (Fig. 33) shows the general program of the entire community, the connection between the site and the community and how the site affects the community. The community recycling center can be established on the site to serve the entire community, and at the same time provide waste pickers with jobs and low-rent housing. Canals can be used as the main transportation route for waste collection. The site will become the activation point in the entire community, and the fitness trails along the canal will be connected to the main public

places and gardens in the community, so that not only the site, but the entire community will become a system suitable for tourists, residents, and waste pickers to coexist. The traffic in the whole area will not only consider the entry and exit of cars and trucks, but also the combination of the canal systems and barges. Appropriate amount of waste collection points will be distributed throughout the community to facilitate the centralized collection and transportation of waste.

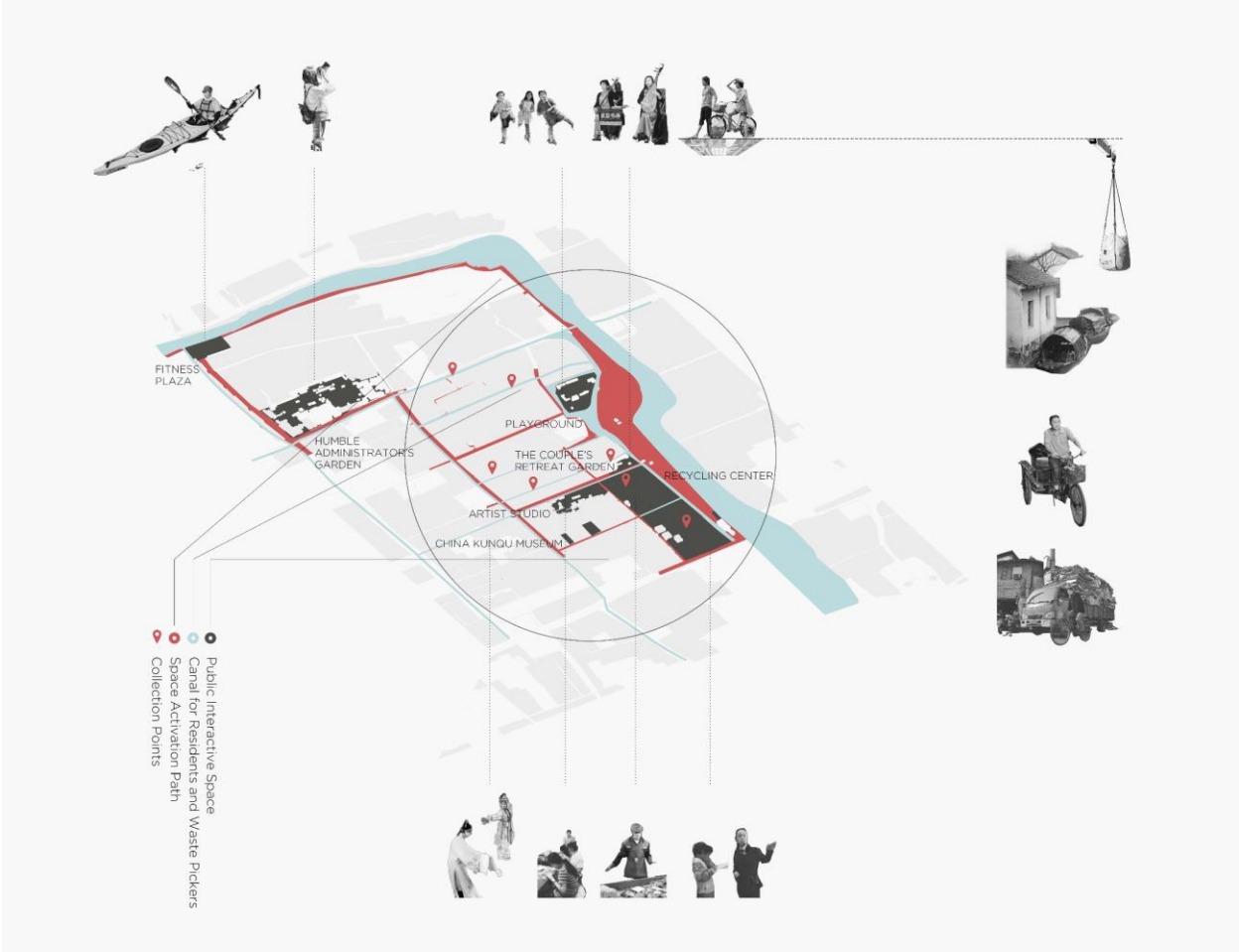


Figure 33 Urban scale program

With the ideas of waste flows, transportation, education and living achieved, this site would function as a micro-community where people can live and work sustainably. Letting residents live on the site will further nurture and strengthen the relationship between people, places and

the earth, and will attract more and more people to pay attention to the environment and recycling. The hope of this project is that with this new program, the activated space will inadvertently attract the entire community. The site will then promote relationships with the city and enrich its citizens. The site will also attract tourists to stop and stay for a while, thereby further waking up the old district.

## Chapter 4 Design Response

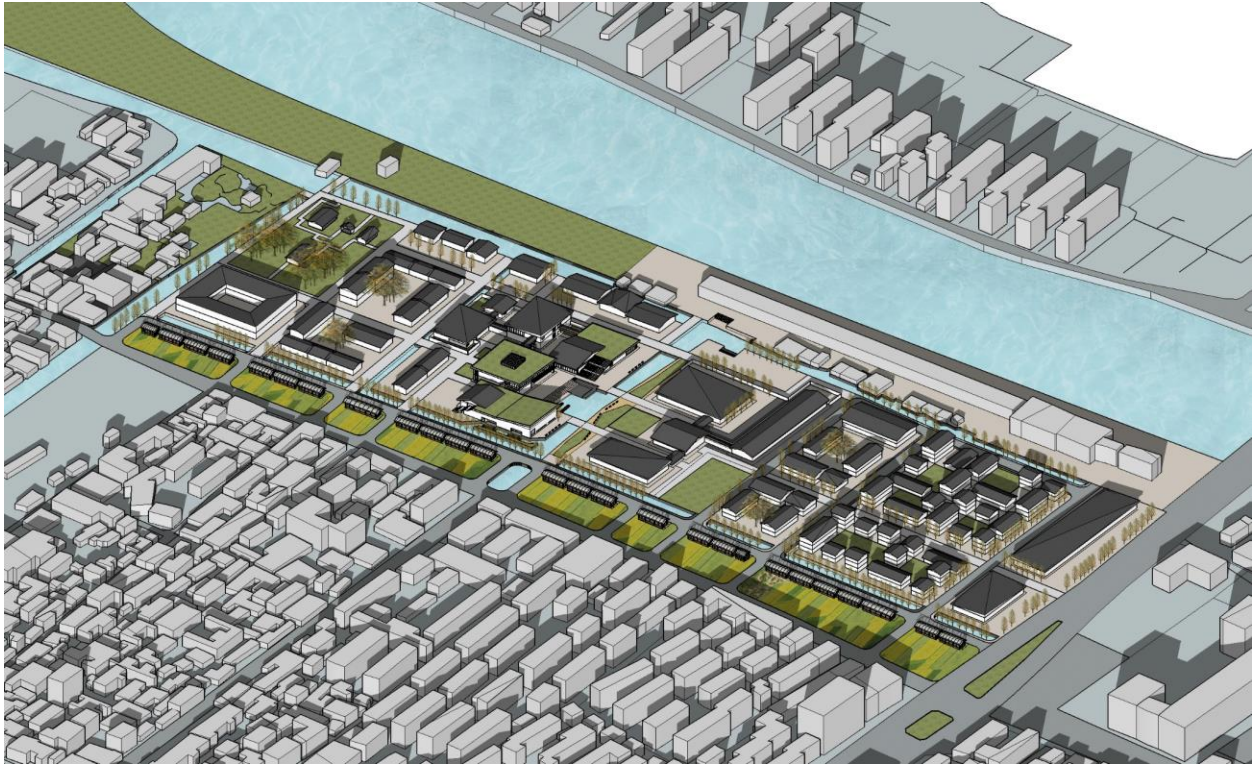


Figure 34 Axon view

### Urban Design Strategies

The urban design of this project is mainly focused on the site and its relationship with the canal and landscape zone on the east. Since the west of the site is close to the residential area, the strategy is to open the west area as a community-friendly urban agriculture. The products of urban agriculture can be sold in the food market on the site. The recycling center is in the center of the site, and the original canal divides it into north and south parts to make full use of the transportation and landscape advantages brought by the canal. Residential areas provide low rent for waste pickers who are willing to provide services to the community. The civic park in the north responds to the green belt in the east and the Chinese garden in the north, and it also

connects the north and east of the site through an open green area, attracting more tourists and citizens to stop by.

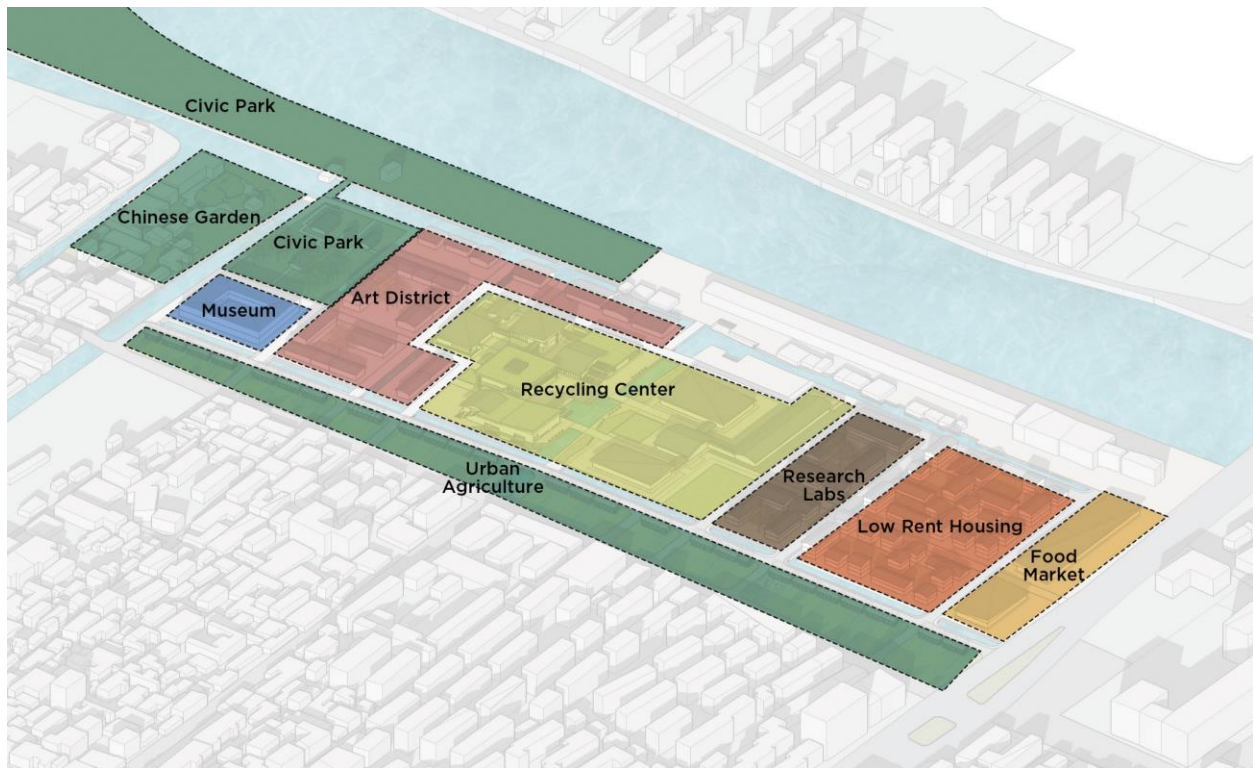


Figure 35 Land use analysis

The roads on the site are mainly divided into two different levels, the main streets and woonerf. “A woonerf is a living street, as originally implemented in the Netherlands and in Flanders, the Dutch-speaking northern portion of Belgium. Techniques include shared space, traffic calming, and low speed limits.”<sup>21</sup> There are also such streets in downtown Seattle (Fig. 37). Pedestrian own top privilege on these streets. Most of the areas of the site are pedestrian friendly walking areas. The main pedestrian street is located on the main axis of the site.

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<sup>21</sup> “Woonerf”, Wikipedia, last modified April 1, 2020, [https://en.wikipedia.org/wiki/Woonerf#:~:text=A%20woonerf%20\(Dutch%20pronunciation%3A%20%5B,calming%2C%20and%20low%20speed%20limits.](https://en.wikipedia.org/wiki/Woonerf#:~:text=A%20woonerf%20(Dutch%20pronunciation%3A%20%5B,calming%2C%20and%20low%20speed%20limits.)

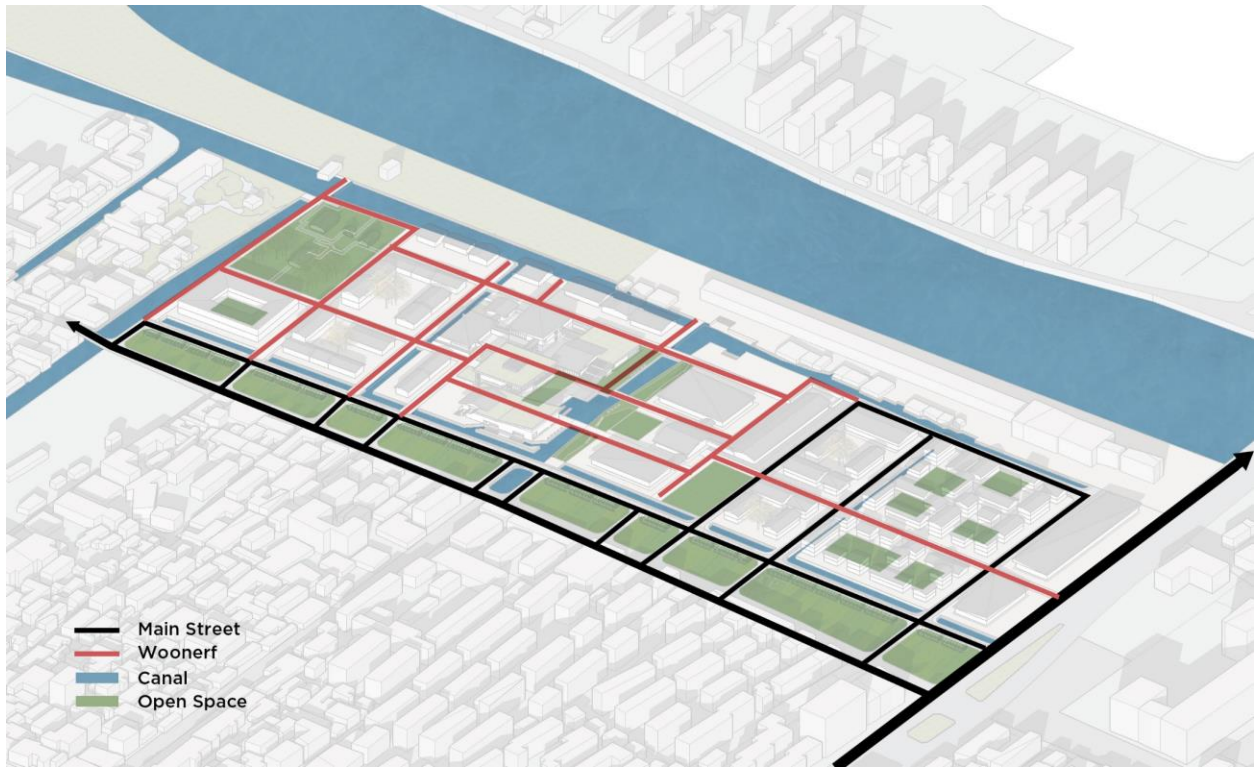


Figure 36 Road & canal system analysis



Figure 37 Woonerf in Seattle from twitter

Figure 38 shows how the barges circulate around the site. The barges loaded with collected recycling waste would come from the community to the recycling center to drop the waste for further sorting. Then the barges can either load the compacted waste after sorting to other larger manufactures in the whole city area, or the barges can dock on the port to take some rest, then continue to load waste from collection points on the site and the community next time.

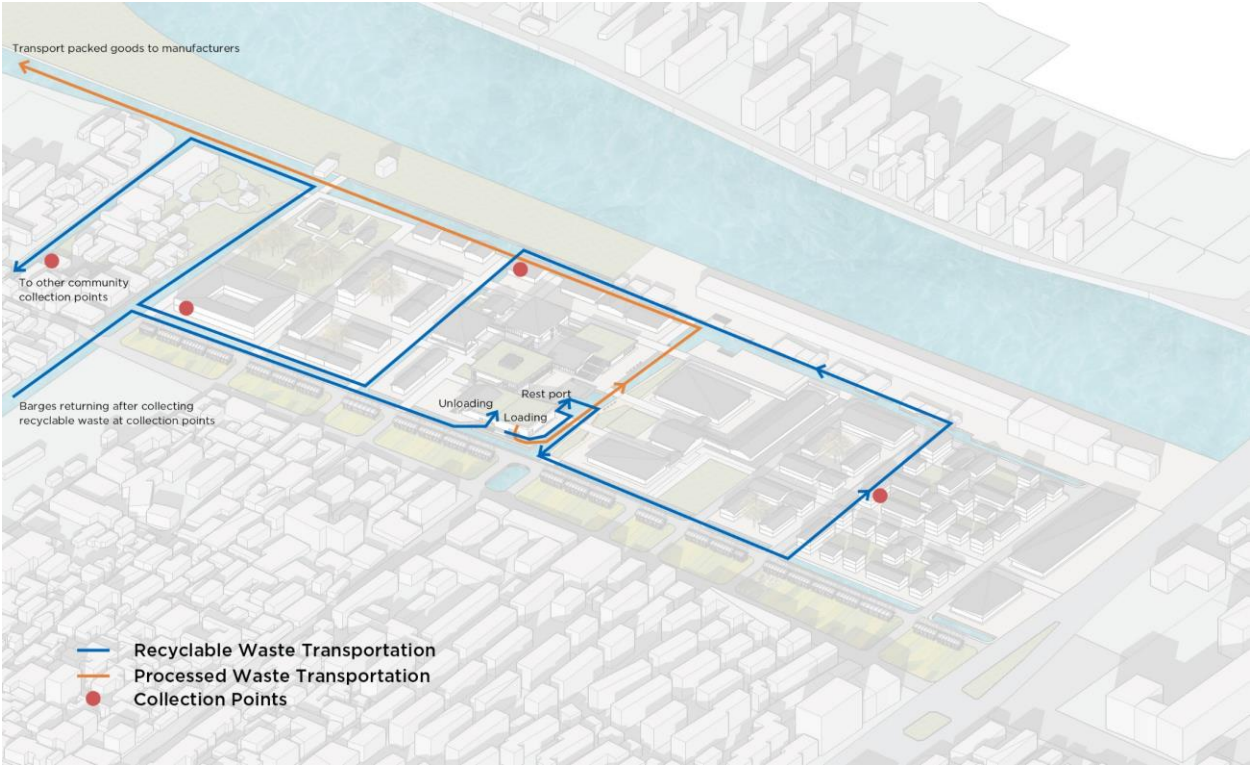


Figure 38 Waste transportation analysis

### Jobs Offered to Waste Pickers

Waste pickers' working and living are the focus problems of this thesis. The project provides a complete network (Fig. 39) to include different types of waste pickers into the formal waste management system. The project lets them gain the privilege of living in this community. Depending on the different living conditions of waste pickers, the recycling center can offer different jobs to them. For waste pickers who do not have enough transportation budget, they

can be trained to be staff in the recycling center. People who own tricycles can continue picking recyclable waste from households and transport them to the community collection points. Waste pickers who already reach certain agreement with the community can be offered with barges to transport waste from the community to the recycling center. All these jobs have bonus based on the work they do.

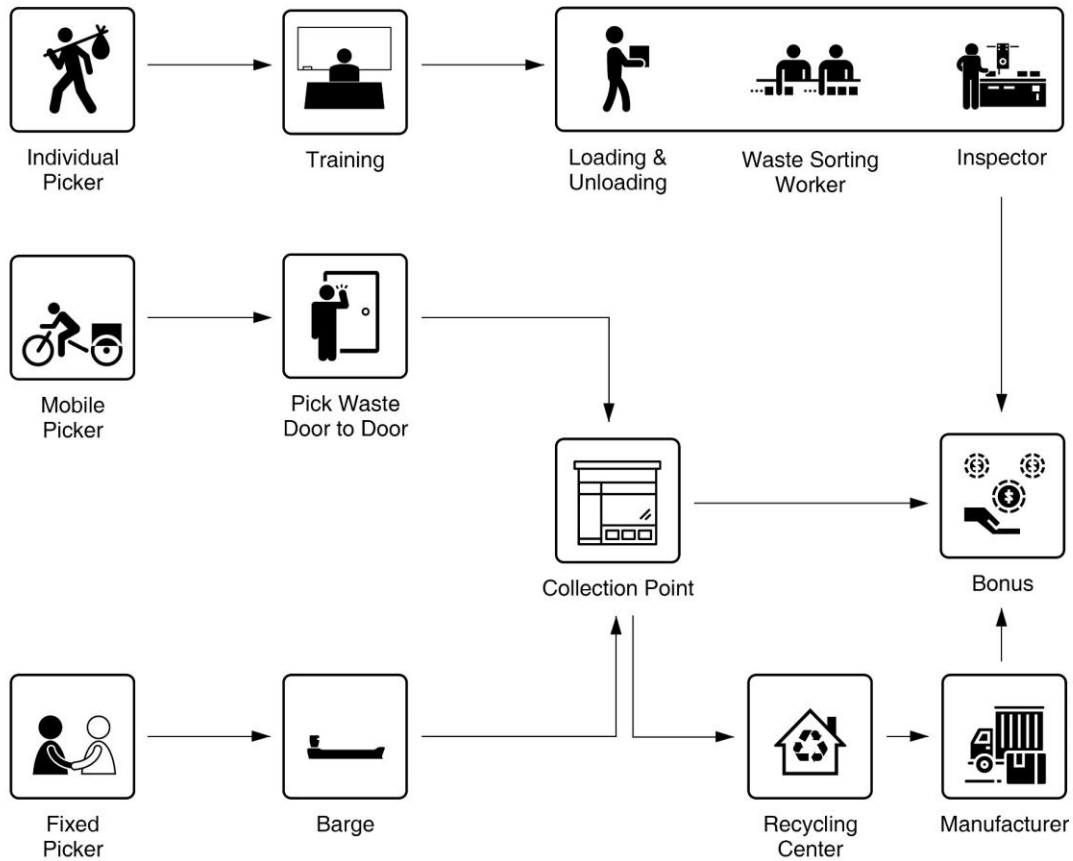
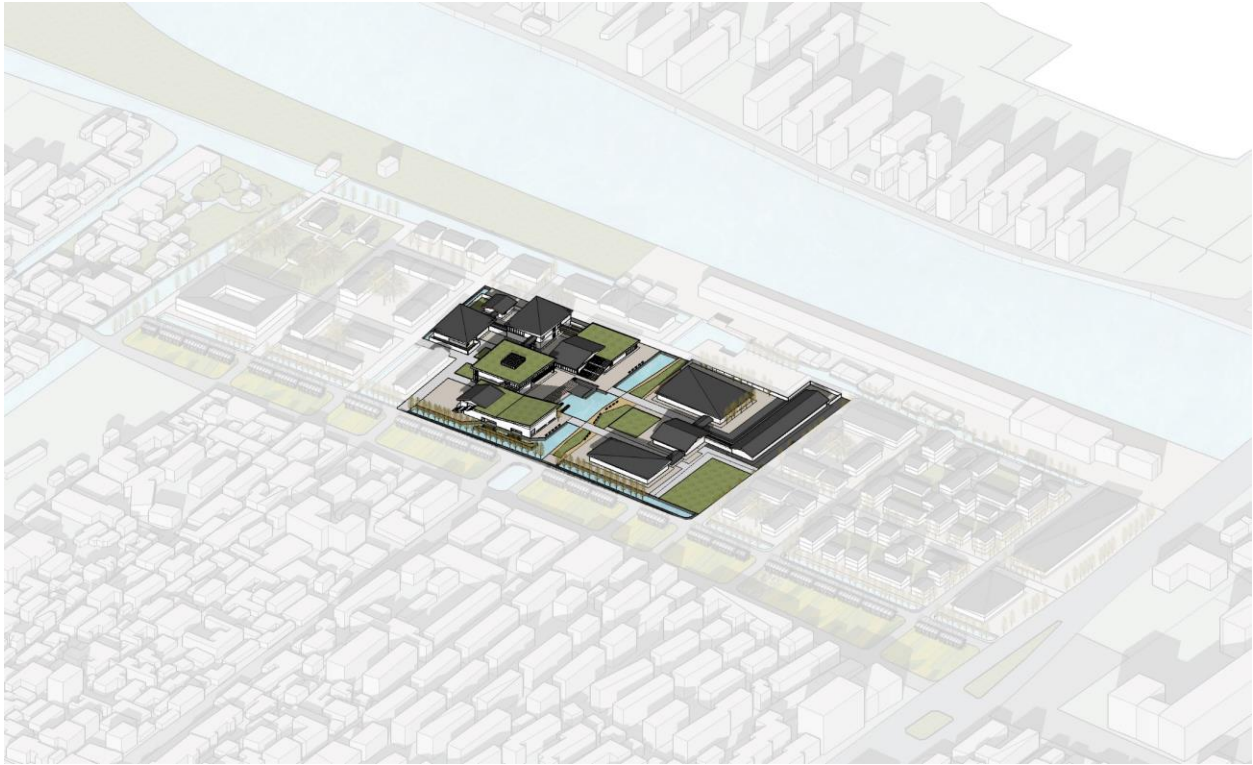


Figure 39 Jobs offered to waste pickers

### Recycling Center Design Response

The recycling center design is the main focus of the building design part of this thesis. The entire waste recycling campus is separated by a canal in the middle, but at the same time the canal, the squares and open spaces on both sides make them connected to each other.



*Figure 40 Recycling center axon view*

Figure 41 is the building use analysis of the urban recycling center. The most important waste sorting building is on the west side of the site, with two sides along the canal to transport waste and products conveniently. The wood processing factory and 3D printing are also close to the waste sorting building to let workers get recyclable materials easily. The education zone allows students to come visit and take relative lessons here, such as wood construction class, recycling class, and 3D printing class. Recreation zone including recycling workshops and art studios would be open to the public. People can generate creative products made from recycled materials at recreation zone, and these products can be taken to the flea market for further transactions. Other buildings including offices, research studios and the lecture hall where citizens can attend for meetings and events is on the south bank of the canal. The north bank of the recycling center is more open to the public, and the south bank is quieter for only residents and researchers to stay and work. This recycling center is not only a place where people can

learn recycling knowledge, but also where people can participate in all the recycling process and create their own recycled products.

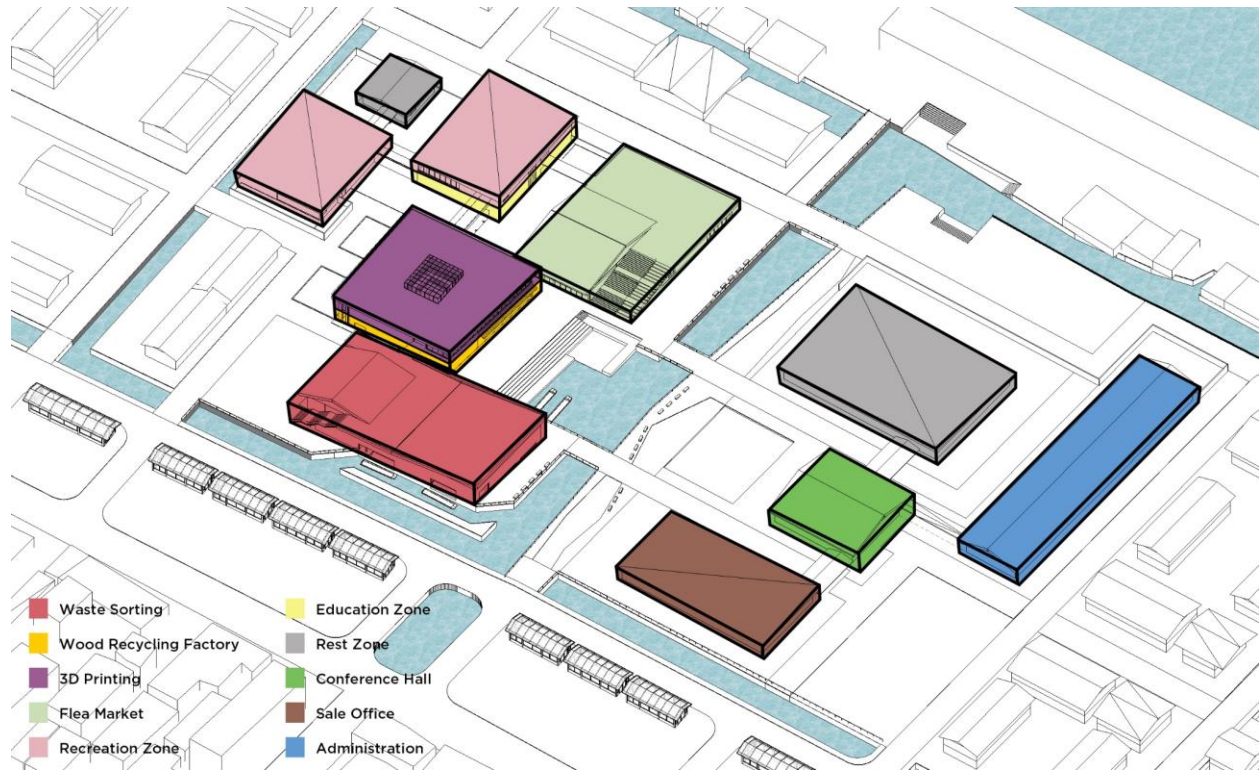


Figure 41 Building use analysis

Figure 42 is a schematic diagram of the waste sorting machine. The waste is first sorted manually to obtain large pieces of recyclable wood. The recyclable wood will be transported to the recycling wood factory through the conveyor belt. Then the materials with different compositions are separated under the action of magnetic separator. The magnetic separator consists of a large electromagnet, through which the mineral mixture can pass in a metal tank, which is separated near its outlet end. Through changing the magnetic field strength or the slope of the separation tank, it is convenient to separate different materials automatically.

The small fraction materials sorted out according to the magnetic strength are metal, plastics, glass, paper, iron, and steel. These materials will be transported to the 3D printing rooms on the second floor of the wood recycling plant as printing materials to be recycled.

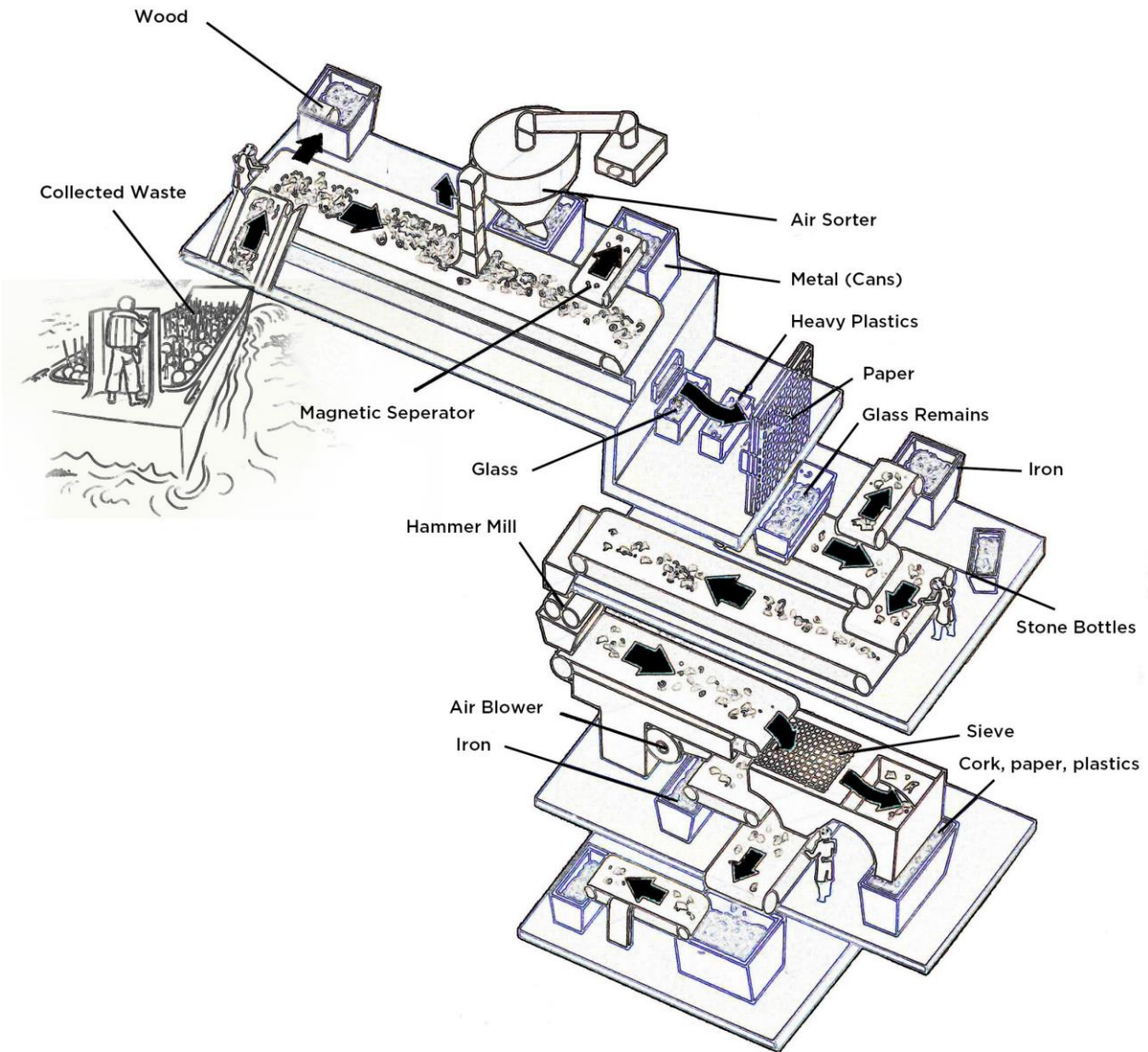


Figure 42 Waste facility

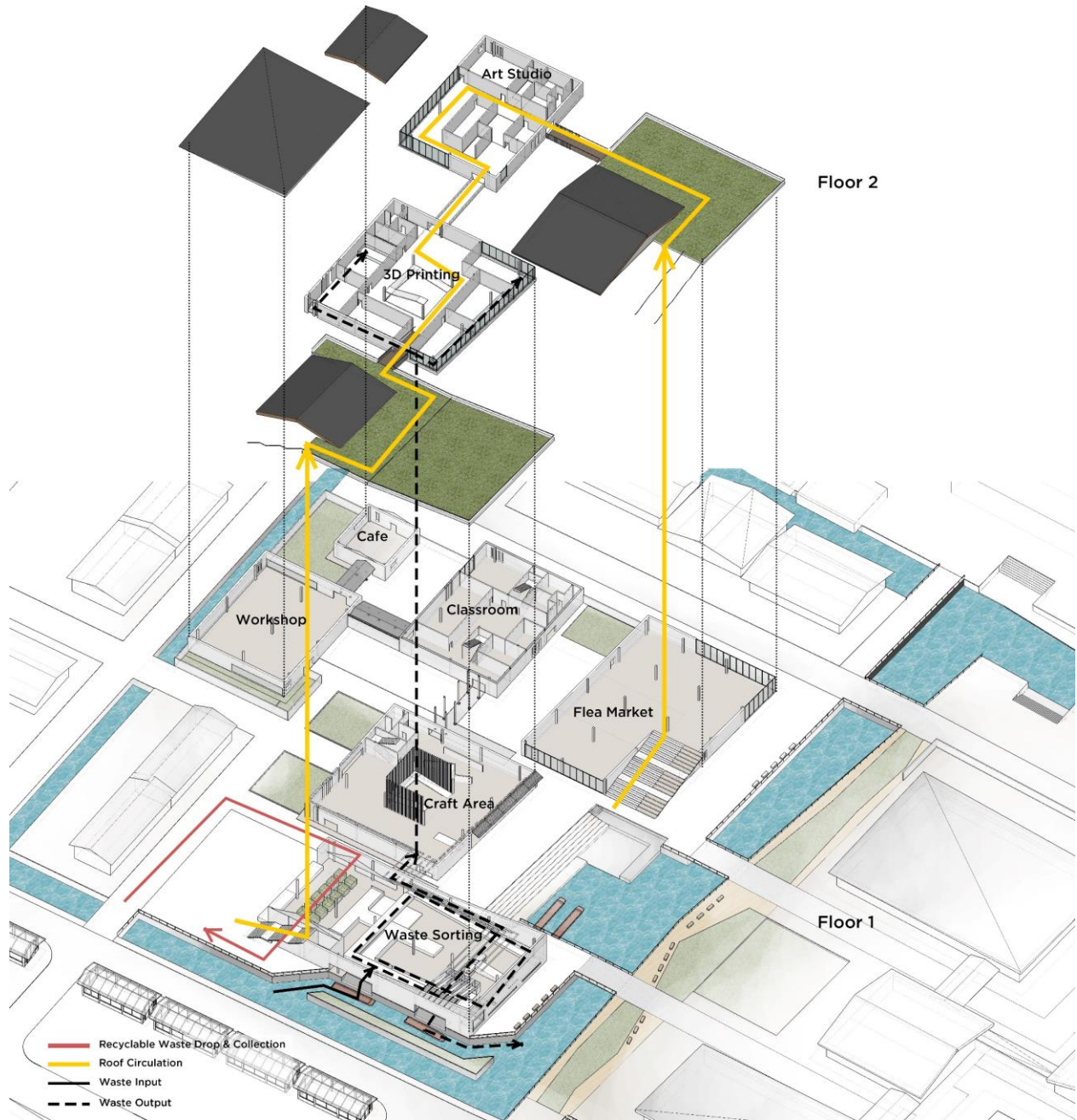


Figure 43 Circulation

The residents can easily drop recycled waste and used CDs/books when they pass by the recycling center. In addition to the circulation connecting each building through the corridor, there is another circulation on the roof of the building. People can directly enter the 3D printing

rooms and artist studios on the second floor through the green roof of waste sorting building or flea market. As an important place where citizens, tourists and students meet, the rooftop provides a variety of public activities, such as rooftop cinema (Fig. 44), rooftop farms (Fig. 45) and rooftop fitness (Fig. 46). Rooftop gardens can also be more energy efficient by providing good thermal insulation in winter and keeping cool in summer.



Figure 44 Rooftop cinema from Rooftop Cinema Club



Figure 45 Rooftop farms from Brooklyn Navy Yard



Figure 46 Rooftop fitness from SPOT YOGA

At the ground floor, there are some important waste facilities in the waste sorting building, they are shredder (to cut waste to smaller pieces), fine fraction separator, and compactor. The waste sorting building, wood recycling factory and flea market are the most important three buildings in the loop of waste recycling in this campus. They are located around the main plaza and

oriented to the core public places. The waste sorting building is close to the transportation channel of the barges on the west, which is convenient for loading and unloading. The wood recycling factory has a double-story atrium space, which is convenient for students to build and display wooden structures made from recycled wood. The entrance of the wood recycling factory is open to the plaza, which can extend the internal exhibition space to the outside, and visitors can also freely enter and exit. The flea market has outdoor steps facing the plaza and the port to guide visitors up to the roof terrace, or for people to sit on the steps to relax and watch activities. All these main buildings have entrances and viewing windows facing the public plaza. Both the 3D printing room and artist studio on the second floor can be directly connected to the outdoor roof terrace.



Figure 47 Ground floor plan



Figure 48 Second floor plan

The recycled wood would be sorted out by hand firstly, the rest of the waste would go through the shredder, some fine fraction would be separated after that, then the waste can go to the waste sorting machine to be sorted into different materials, the small fraction of these materials would be used by 3d printing, the larger size would be compacted and transported to other manufacturers.

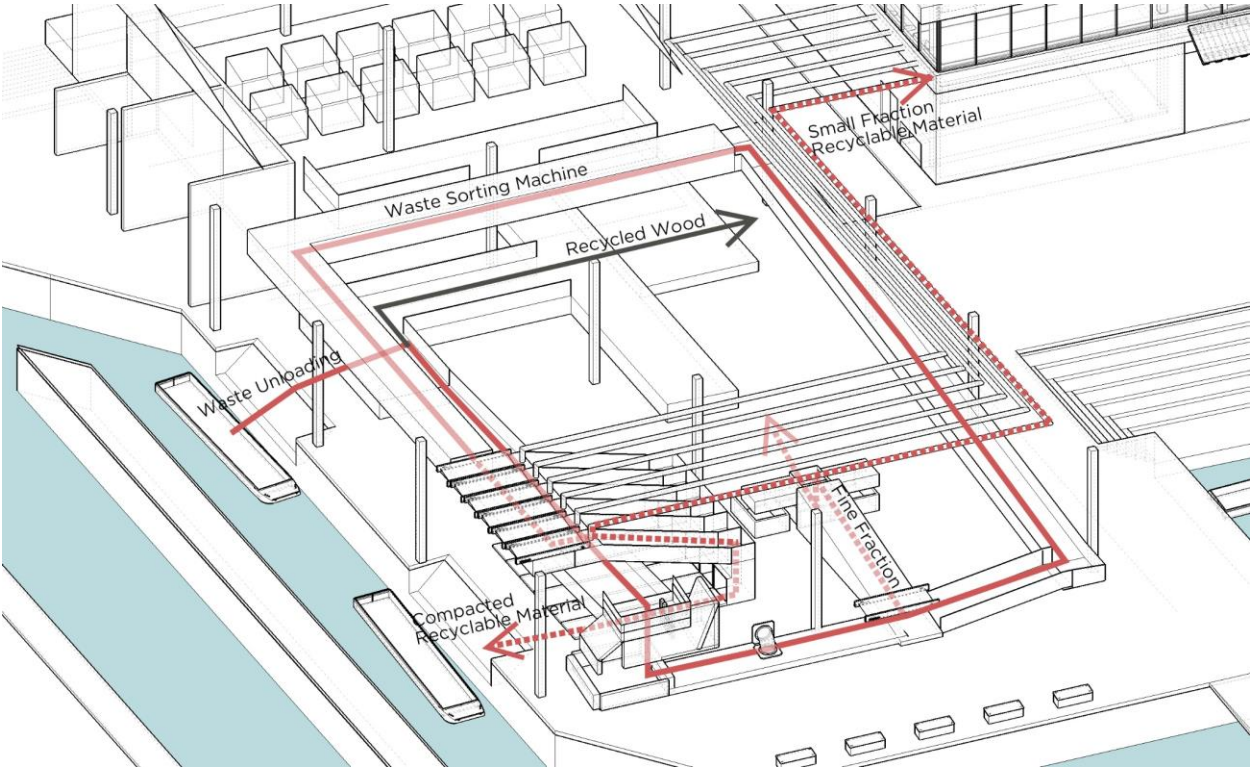


Figure 49 Waste flow

Figure 50 is the perspective standing on the bridge and looking north to the recycling center. The activities in the three main buildings can be seen through the windows and the open doors. People can gather at the central plaza to take boats, looking activities happening in the recycling center, or just sitting there. Barges carrying compressed waste, barges about to dock at the port, and boats carrying passengers will meet near the port here.



*Figure 50 Urban recycling center perspective*

Figure 51 is the bird's eye view looking to the south. People attracted by the rooftop view can freely go up to the roof. In the distance, people can see the winding roof skyline of the ancient city of Suzhou with the ancient city wall in the background.



*Figure 51 Bird's eye view perspective*

**Chapter 5 Conclusions**



*Figure 52 Site plan*

In summary, this thesis intends to find out ways to rethink relationship between people, city and the waste they generate. This thesis introduces a project prototype in a waterfront city in China which works for the community by designing a new place for public engagement with waste sorting and recycling. It solves the problem on two levels, where it contains industry, education, crafting and scientific research, all of these items are working in one circle to achieve sustainable life. This design project and the research prepared for it aim to find tools to encourage people to further discuss the potential of waste management. At the same time, the project prototype is used to activate the historic site and promote the relationship between residents and waste pickers.

This project typology could be used in other high dense waterfront communities throughout Suzhou and as well as in other cities throughout China. It promotes the awareness of waste recycling and social attention of waste pickers, which in turn promotes a harmonious relationship between people, waste and city.

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