THE APPLICATION OF SYSTEMIC DESIGN METHOD IN GREEN CAMPUS BUILDING

A Case Study of Shanghai Tongji-Huangpu School of Design and Innovation.

Candidate:
Hanlin She, Mengying Deng
s262252, s263514
Supervisor:
Pier Paolo Peruccio, Maurizio Vrenna

POLITECNICO
DI TORINO

DAD - Department of Architeture and Design
Master's Degree Thesis
Major: Systemic Design
Academic year 2020/2021

The Application of Systemic Design Method in Green Campus Building

Candidate:
Hanlin She, Mengying Deng
s262252,s263514
Supervisor:
Pier Paolo Peruccio, Maurizio Vrenna

At the begining of this paper, we wish to thank all the people without whom this thesis work would not have existed.

We thank our supervisor Professor Pier Paolo Peruccio, Doctor Maurizio Vrenna.

Special thanks go to our classmates: thanks to you, the university experience has been enriching, amusing, and full of satisfaction.

Finally, thanks to us, we companions of adventure. We trust that this thesis will be the beginning of other experiences.

INDEX

Abstract

1 INTRODUCTION

2 SYSTEMIC DESIGN THEORY AND METHODOLOGY

3 STRATEGY

4 HOLISTIC DIAGNOSIS

Abstract

A Case Study of Shanghai Tongji-Huangpu School of Design and Innovation.

Keywords

/ systemic design
/ green campus building
/ old campus
/ school waste

Since the 2000s, the ‘Green Campus’ has emerged as a popular discourse in education field for solving ecological issues. At present, the research and practice of green campus has made remarkable achievements in campus building assessment, energy utilization and so on. However, the current design research is limited to the physical space design. Traditional design idea can only provide the design strategy for the new campus, but it is relatively powerless for the sustainable development of the old campus. This paper aims to provide a new approach and a systemic perspective for the design intervention in the sustainable development of the old campus. Taking Shanghai Tongji-Huangpu School of Design and Innovation as an example, this paper studies the analysis and optimization of the sustainability of the current campus system by using the systemic design method. The author collected data by observation and interview according to different research scenarios, and calculated the ecological footprint of food, energy, water, waste and sewage by combining with the ecological footprint analysis. The results show that total amount is low, but capita ecological footprint is large. And energy, food and water are the major contributor. Ultimately, based on the results of ecological analysis and the conclusion of interview, this paper provides a systemic solution,

summarizing the common problems in green campus building and putting forward the design strategy accordingly.

The research results of this paper provide new ideas for sustainable campus design, reveal the potential causes of campus resource waste and waste generation, and provide a concrete research framework for the application of systemic design method in the field of green campus by combining the ecological footprint component method. Due to the particularity of the research object in this paper, the research results cannot fully cover all campus application scenarios, so specific studies on different campus types need to be carried out in the future to gradually improve and verify the conclusions of this paper.

1 INTRODUCTION


APARCAMENT

1.1 Background

1.1.1 Contemporary campus resources and environment

Thousands of years of human activities have profoundly changed the surface of the earth (Yu, 2016). Human beings have continuously enriched the world of man-made objects, turning natural resources into a material basis for human activities. However, many problems brought about by uncontrolled development have seriously endangered the survival of human offspring. Especially the process of industrialization and urbanization has gradually pushed the city's ecological environment into desperation. Faced with the expected growth of the urban population and the ensuing needs for clothing, food, housing, and transportation for billions of people, the urban environmental capacity will gradually reach its ceiling. And environmental problems, in recent years, like smog, energy tension, pollutant discharge, water and soil pollution are visible proofs.

In the process of transforming nature, the relationship between humans and nature has evolved from adapting to controlling nature. **We have entered the Anthropocene**, where human influence and creation have formed the same geological forces on the global scale as other previous geological periods (Ahern, 2016), enough to define the current geological era of the earth.

As the scope and intensity of human-nature interactions continue to increase, the connection between human systems and nature systems has become closer, no longer regarded as independent, but as connected and embedded entities in the interaction network, coupling in organization, space, and time(Liu et al., 2007).

Specifically, improper human practice will lead to the degradation of natural systems, and at the same time, nature's feedback on human impact will destroy human systems. For example, the greenhouse gas emissions that have increased significantly since the Industrial Revolution have destroyed the ozone layer, and subsequent natural phenomena such as global warming, extreme high-temperature weather, and forest fires have in turn caused economic losses and disasters to human society. Besides, humans also indirectly act on the natural environment through the production and use of artificial objects, unknowingly consuming the energy contained in the production and use of products during the use of artificial products. For example, people's dependence on plastic packaging greatly affects the rate of fossil fuel consumption on the planet.

Urbanization is a menacing human force. It is the process of large-scale of the population driven by the development of the manufacturing economy, transforming natural areas into urban areas, and constantly shaping the city's huge artificial system. In the process of urbanization, 60% of my country's land area has been transformed into a natural-social-economic composite artificial ecosystem centered on human activities (G. Y. Liu, Z. F.Yang, & B. Chen, 2013).

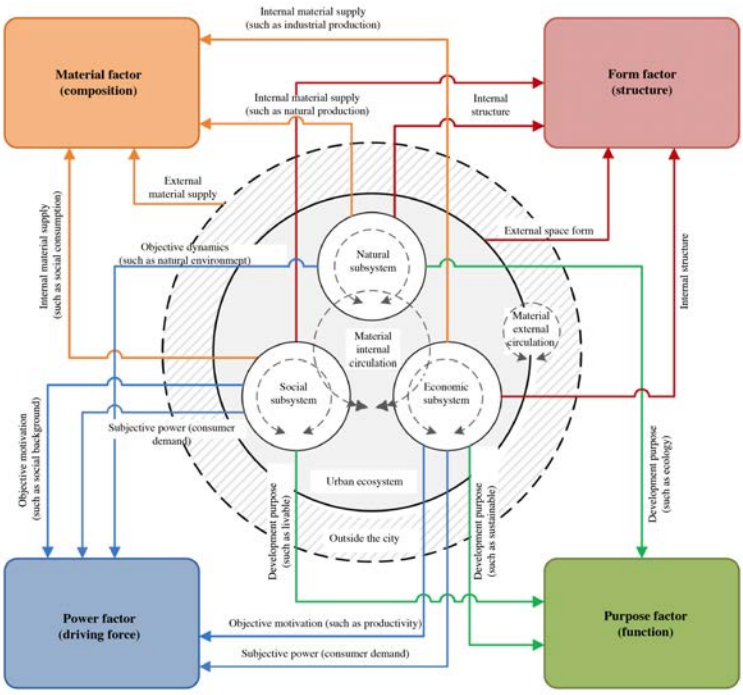


Figure 1. The four-causes-map for urban metabolism. Adapted from "A review on urban metabolism: connotation and methodology" by Y., Lu, and B., Chen, 2015, *Acta Ecologica Sinica*, 35(8), 2438-2451. http://dx.doi.org/10.5846/stxb201306091538

Humans have become the dominant factor in this system, and human activities have become an important factor affecting and controlling the energy flow, material circulation, information transmission, and system evolution in the system(S. H. Cui, F. Y. Li, Y. X. Yu, & J. Y. Lin, 2010).

At the beginning of the design of the urban system, it was not considered to imitate the model of the ecosystem to build a biosphere in which the material, energy and energy are circulated through the interaction of producers, consumers, and decomposers. Therefore, the urban system does not have a complete mechanism for the metabolism of the material cycle.

Producers, consumers and decomposers in cities are far apart in space, so the material needs to be transmit between them through the transportation as material flow. During transportation, a lot of energy will be consumed, resulting in a waste of resources and increased pollutants. This leads to the situation that obstruction of the metabolic process of the ecosystem and the wastes stuck in the environment (S. H. Cui et al., 2010).

A series of problems in the process of urbanization in my country are essentially caused by poor metabolism of urban materials (Duan, 2004). Urban material metabolism refers to metabolic processes such as material input, conversion, storage, and waste discharge in the urban system (Zhang & Yang, 2007). Y. Lu and B. Chen (2015) introduced Aristotle's 'Four Causes', named matter, form, agent, and purpose, to explain the connotation of urban system metabolism, as shown in Figure 1.

Matter is various forms of material and energy flowing inside the city, and it is the physical basis of urban metabolism. The natural, social and economic subsystems in the city continuously exchange metabolic materials during activities and constitute the inner cycle of urban metabolism. Economic activities transform natural resources and energy through processes such as acquisition, manufacturing, decomposition, and waste; the metabolic processes of social subsystems are represented as consumption and waste processes at different scales of social-community-family; nature is more responsible for The role of providing materials and decomposing waste; at the same time, the city itself will transform materials with the external environment to form an external cycle.

Form represents the prototype of things. The prototype of the city can be divided into external form and internal structure. The external form refers to the physical spatial form of the city, etc., and the internal structure refers to the internal network of metabolic activities of urban subsystems.

Agent refers to the driving force of changes in urban metabolism, that is, the fundamental cause of changes in the amount of urban material metabolism, changes in form or nature. Specifically, changes in quantity refer to the efficiency of metabolism, changes in morphology refer to changes in metabolic structure, and properties refer to metabolic quality.

The causes of metabolic changes are divided into subjective and objective. Objectively, it can be understood that external forces such as social environment and natural environment promote metabolic changes. For example, when environmental disasters hinder the normal progress of human activities, the speed of urban metabolism slows down. Subjectively, the social needs of urban people determine the changing process of the city. For example, people can adjust their consumption needs and lifestyle by environmentally friendly requirements to reduce the burden of urban metabolism and increase metabolic efficiency.

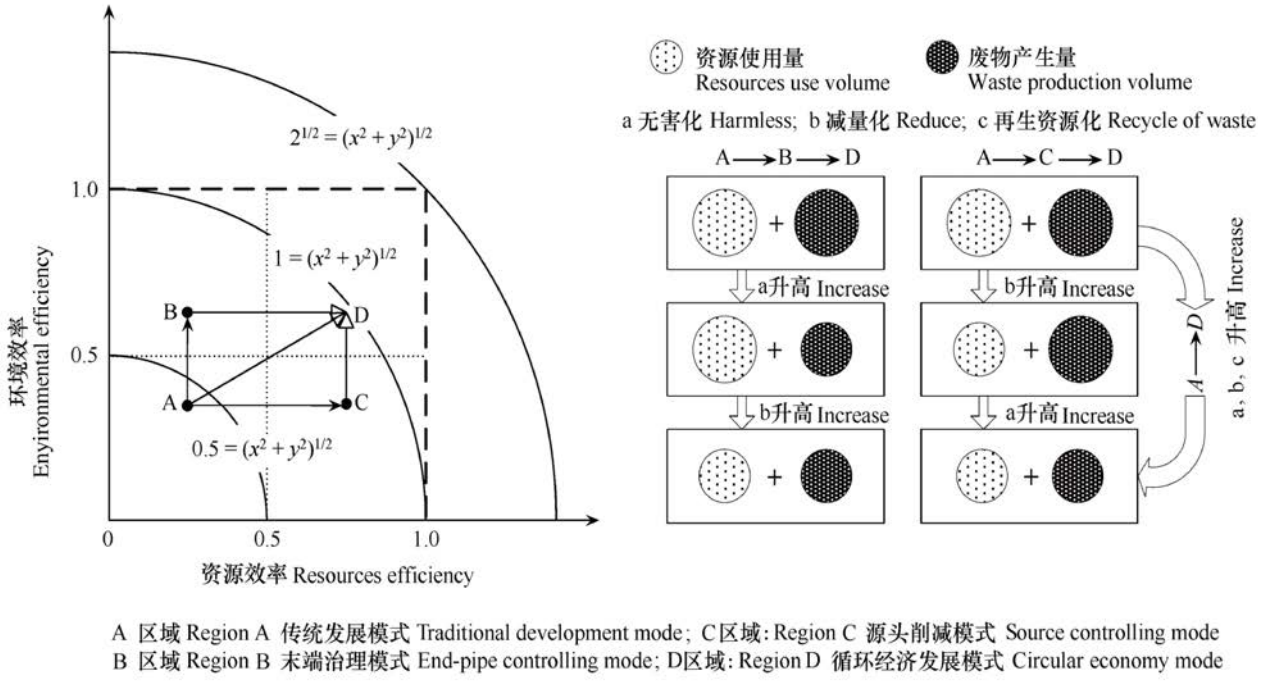
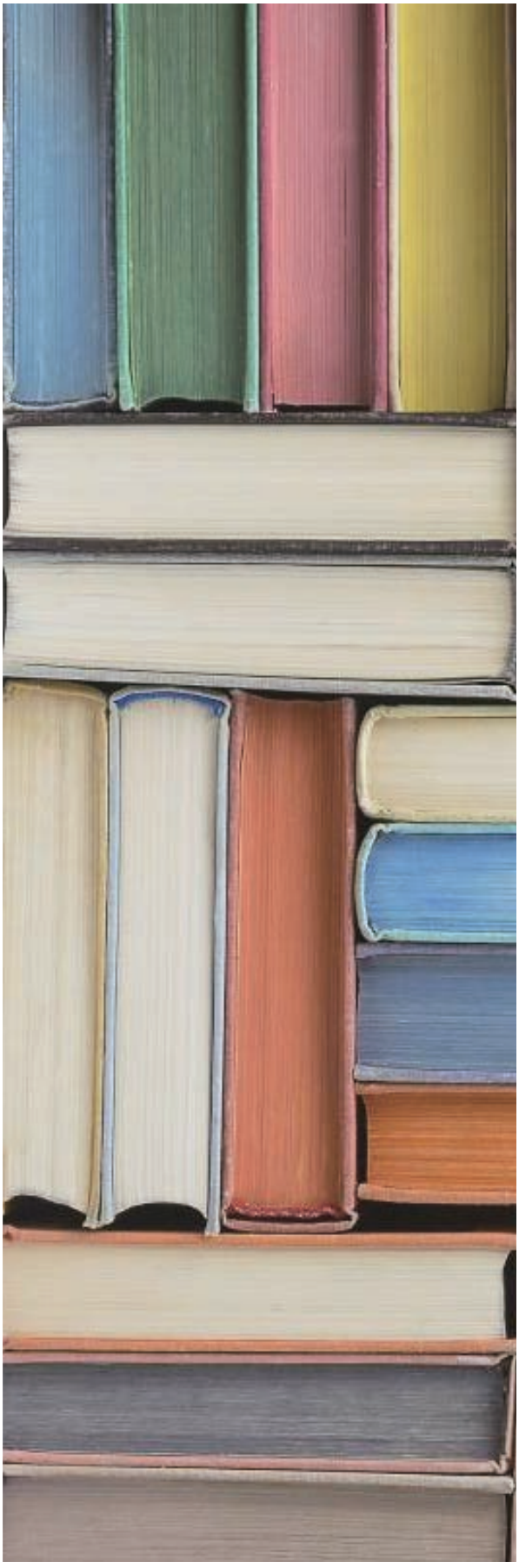


Figure 2. Measure model of eco-efficiency. Adapted from "Eco-efficiency of urban material metabolism: a case study of Shenzhen" by Y., Zhang, and Z.F., Yang, *Acta Ecologica Sinica*, 27(8), 3124-3131. Copyright 2006 by Acta Ecologica Sinica.

Purpose is the root cause of the existence of things, which can be understood as the ultimate purpose of urban development and existence. (p.2441)

The quality of urban material metabolism depends on its ecological efficiency, that is, the amount of social services provided by unit resource consumption and pollution load during urban material metabolism (Y. Zhang & Z. F. Yang, 2007). Therefore, improving the efficiency and structure of urban energy use, reducing material consumption and reducing waste emissions can improve the ecological efficiency of urban material metabolism. Figure 2 is a model for measuring the ecological efficiency of urban material metabolism. The four areas in the figure represent different development patterns of cities. Region A embodies the traditional development mode, that is, unrestrained access and utilization of natural resources by humans, and the direct discharge of waste to nature; Region B embodies the end-pipe controlling mode, which turns into the harmless treatment of waste by people It is then discharged into nature; Region C embodies the source controlling mode, that is, reducing

resources and energy consumption from the source; Region D embodies the circular economy mode, which proposes to reduce the generation of waste through source reduction and material reuse and recycling.



1.1.2 Prospect of a circular society

1. Circular Economy Concept

Since the 1860s, people have been aware of the huge shackles brought by linear development thinking to human development. Economist and ecological activist Gunter Pauli advocates applying outstanding achievements such as ecosystems to the economic system, calling on people to generate more value from existing resources. William McDonough and Michael Braungart showed readers a brand new sustainable development model of human society, calling on humans to find out the root cause of the problem. A 'cradle to cradle' circular development model to replace the current unidirectional 'cradle to grave' linear development model from growth to death.

It is against this background that the concept of circular economy pointed out that the transition from a linear economy of 'acquisition-manufacture-abandonment' to a material closed-loop economy should be accelerated. The previous process lacked a systematic vision, ignored upstream and downstream relationships, and treated each link and individual in isolation, which often led to the simple superposition of material flows, and a large number of resources were abandoned invisibly. The circular economy sees the connections within the system and builds a bridge between the materials, making some resources called 'waste' recirculate in the system. People often understand the circular economy as 'turning waste into treasure' and use waste to create a new economy.In fact, the ideal goal of the circular economy is to systematically reduce waste generation and resource consumption on a macro model. As shown in Figure 3, the circular economy advocates to minimize the energy and material quality consumed at the input end; in the process, the user reuses the items; the recyclable waste can be recycled as raw materials or The reused products are recycled into the system, and the last remaining part is allowed to enter the landfill. This series of actions can be summarized as Reduce, Reuse, and Recycle. The main actors involved in the process are resource miners, processors, consumers and waste processors(Y. Lu & B. Chen, 2015),, which play an important role in the control of each link and the communication between upstream and downstream.

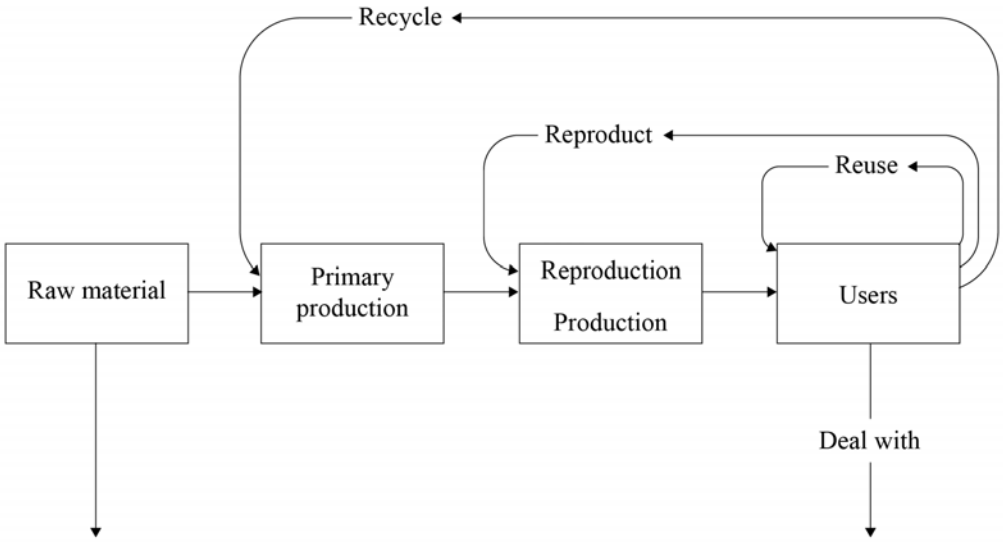


Figure 3. Material production cycle. Adapted from "The Connotation, Objectives and Strategies of Shanghai's Low-carbon growth" by D. J., Zhu, and F. Chen, 2010, *Urban Insight,* No. 2, p. 60.

2. Conception of a circular society

From the perspective of social development, the circular economy proposes 3 key ideas for forming a material loop. The first is to emphasize ecological benefits. Through the selection of energy and resource usage, hazardous substance emissions, renewable resources, etc., each node intentionally reduces the negative impact of activities on the environment. The second is to construct an 'ecological' system, which builds a symbiotic system by organizing the waste input and output relationship between enterprises. Such an eco-industrial park has been developed and formed, such as Kalundborg in Denmark. The third is to recycle and reduce wastes. In this step, the eyes are projected to a wider social scope, trying to build a corresponding closed-loop channel for waste after the consumption process. For example, Germany and Japan have issued laws and regulations on waste management. As sustainable development has become an important issue and mainstream value orientation faced by mankind, it has become a revolution in human values, lifestyles, and production methods (C. Wu, C. L. Peng, Q.Y.Wu, L. W. Shi, & B. B. Zhang, 2011). The development of human society urgently needs an ecological turn. By realizing the

closed-loop flow of social materials, the long-term contradiction between the ecological environment and economic development is resolved, and circular society is established. This is an important way and implementation form for countries to implement sustainable development strategies (D. J. Zhu, 2000).

3. Public participation in green governance

Almost all resources, energy consumption, and environmental emissions are directly caused by production and consumption activities(H. T. Wang, 2011). Residents consume a lot of substances, which is one of the main reasons for a large amount of input, precipitation, conversion, and output of urban substances(p. 76). Improper human behavior is also one of the important factors affecting the ecological environment. Studies have shown that 20% of energy consumption is caused by wrong user behavior(Krieger et al., 2007).In order to solve the sharp contradiction between urban development and limited environmental resources, and even solve the long-term resource and environmental problems, we humans must exert subjective initiative, pay attention to the impact of humanactivities on the natural environment and take active actions to change the existing production and consumption patterns.

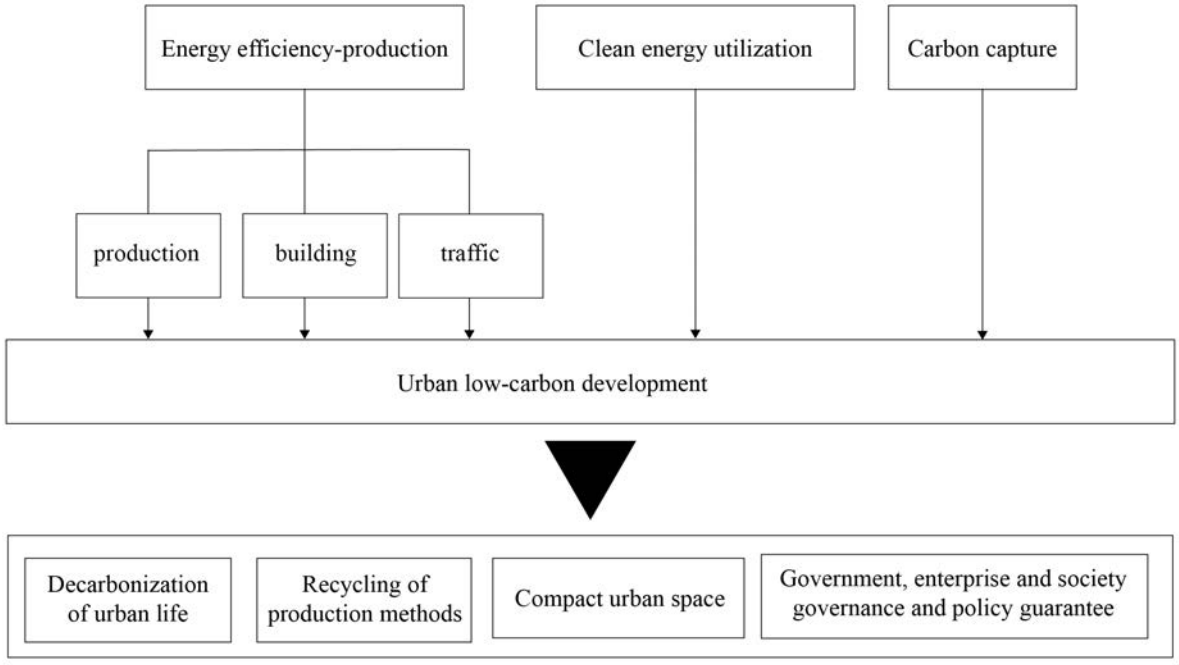
The sustainable development of cities not only requires top-down efforts of national governments and enterprises, but more importantly, this development model requires us to take collective actions different from the past(Lou, 2018). Specifically, social institutions should promote public participation and encourage social individuals to adjust their lifestyles according to the requirements of resource conservation and environmental friendliness. More specifically, each social individual needs to determine its own consumption standard within the scope of ecological carrying capacity. By controlling the growth of the urban per capita ecological footprint, the urban metabolic ecological efficiency will be improved.

1.1.3 The necessity of developing a green campus

1. The social significance of developing a green campus

Since the 18th National Congress of the Communist Party of China and China's emphasis on ecological civilization has reached a historic height. The Party Central Committee and the State Council of the People's Republic of China have put forward new requirements for addressing climate change and environmental pollution in cities. From the perspective of energy flow, the composition of low-carbon cities includes three main aspects. The first aspect is to adjust the energy input structure and increase the proportion of renewable energy in the import process of the economic process; the second aspect is to increase energy conservation and emission reduction in the three major energy consumption areas of industry, transportation and construction in the transformation process of the economic process Strength; the third aspect is to improve the carbon sink and carbon capture capacity in the output of economic processes (D. J. Zhu & F. Chen, 2010). Under the dual constraints of resources and environment, high-energy-consuming enterprises have gradually moved their industries away from cities. The carbon emission structure of cities in my country is about to develop from industry-led emissions to building-led emissions. In the future, carbon emissions from major buildings in cities will mainly come from residential and public buildings.Schools are a type of public buildings in the city. It has a high potential to achieve campus emission reduction goals by improving campus energy efficiency and improving teachers' and students' energy use behavior, and it may become the main regulation unit of the city in the future. Therefore, taking the school as an example to consider the future public building emission reduction strategy has certain social significance.

The school is the basic social unit for carrying out educational activities, and it is also a symbiotic system adjacent to society. The school's metabolic process begins with the consumption and use of materials and energy. This is a linear process of consumption-abandonment. The school's resources, energy consumption activities and waste emissions are closely related to the city and the ecological



The composition of urban carbon emissions and low-carbon action areas

Figure 4. The composition of urban carbon emissions and low-carbon action areas. Adapted from "The Connotation, Objectives and Strategies of Shanghai's Low-carbon growth" by D. J., Zhu, and F. Chen, 2010, *Urban Insight,* No. 2, p. 55.

environment. Considering the school as an organism with metabolic functions, exploring the mode of input and output of resources in the school helps to evaluate the impact of the basic social unit on the external environment and improve the ecological efficiency of campus activities. At the same time, because the campus is the basic unit of society, with a unified ownership and self-management system (Krieger et al., 2015), it has a perfect organizational structure and components, and it has a specific target group: teachers, students, and school staff. The structure of the campus system is special, and promoting the development of a green campus is beneficial to the unit regulation of the city. The sustainability of campuses can be used as a micro-mapping of

social sustainability issues, and the practice methods and research results of green campuses can be used as the engine to promote the transformation of society into a sustainable development mode. Its material resource flow mode has a basic guiding role for the social subsystem and the city as a whole, and the research scale from the school to the city through analogy will provide new ideas for related research (Y. Lu & B. Chen, 2015). In addition, the campus is a living laboratory for experiments like studying social issues and spreading sustainable ideas. It is an educational environment that fosters ecological values. The school not only has sufficient human resources, but also has extensive contacts with the government, companies, and social institutions. It has innovative capabilities in solving ecological problems.

2. Realistic problems faced by urban high schools

Nine-year Compulsory Education System is the current education systemin China. It is the education that all children of school age and adolescents must implement uniformly implemented by the state and public welfare undertaking that the state must guarantee. The implementation of nine-year compulsory education means that the school-age children andadolescents begin to receive education for nine years, that is, no tuition and miscellaneous fees are charged for the nine years from primary school to high school graduation. The state establishes a compulsory education funding guarantee mechanism to ensure the implementation of the compulsory education system.

Under the background of urbanization in China, the population is concentrated in urban areas. The rapid expansion of the urban population directly led to an increase in the number of students in urban Nine-year Compulsory Education Schools (J. H. Huang, 2014), as well as the expansion of urban schools. According to the statistics of the 'China Education Statistics Yearbook', from 1978 to mid-2008, Chinese compulsory education schools were concentrated in urban areas, and urban schools expanded from 3.7% to 20.7% (Development and Planning Department, Ministry of Education of the People's Republic of China, 2010).

Among them, high schools have the characteristics of large numbers, wide distribution, and dense population. According to the '2018 Shanghai Statistical Yearbook', the number of ordinary secondary school students in Shanghai is 679,700, and the number of secondary schools is 833, accounting for 53% of the total, which is much higher than that of ordinary primary schools and higher schools (Shanghai Bureau of Statistics, 2018). In addition, the high school campus is

a public space that integrates services and teaching activities. Due to Nine-year Compulsory Education and college entrance examination system, high school is the education stage with the most academic pressure, the most compact teaching activities, and the highest academic intensity. In this special educational environment, the material and energy flow in the high school campus have certain characteristics. With the increasing number and volume of schools, the negative problems brought about by the campus activities on the urban environment are gradually revealed (X. Zhao & T.T. Sun, 2014).

In terms of energy use, schools are the ‘large energy users’ in cities, and energy management is relatively extensive. National campus energy consumption accounts for 8% of the total energy consumption of the society (B. Gao, H.W. Tan, & Y.C. Song, 2011). The average energy consumption per student and the energy consumption per unit building area of school students in China is higher than the national per capita level and the energy consumption per unit building area of the national residents (National Bureau of Statistics of the People's Republic of China, 2008).

In addition, a large amount of campus waste also plagues campus environmental governance. Over the past year, China has pushed more than 6 billion tons of waste, and urban waste continues to grow at a rate of 8%-10% every year (Z. G. Xu, Z. Q. Yin, J. Q. Wang, J. Q. Yin, & J. F. Gao, 2011). These wastes not only occupy a lot of lands, (C. Y. Chen, 2001). but also generate greenhouse gases during landfills. According to preliminary investigations, one-third of the 668 cities in the country are surrounded by waste belts(C. Y. Chen, 2001).

According to the statistics of the ‘2017 China Education Statistics Yearbook’, there are about 513,800 schools of all types and at all levels across the country, with more than 270 million students in school (Development and Planning Department, Ministry of Education of the People's Republic of China, 2017).

Calculated on the basis of the daily output of 0.5kg of waste per capita, the total amount of campus waste generated by schools nationwide is about 1.38 million tons. The school has the characteristics of concentrated personnel and multiple functions.

The daily output of waste is large and the variety is rich. The quantity and composition of different waste in the functional area are different. Among campus wastes, resource wastes account for a relatively high proportion(X. He & Bai, 2011), with paper and paperboard accounting for the majority, including printing paper,

mixed paper, newspapers, corrugated paperboard, boxboard and paper towels (Smyth, Fredeen, & Booth, 2010).

This type of waste has use-value and can be recycled into resource waste through classification and recycling, which is conducive to the reduction of waste at the source to slow down the status quo of ‘waste siege’ and reduce the load of the waste disposal system. At the same time, the students and faculty of the school have high environmental protection knowledge and awareness, and can actively cooperate with the management of the school. In general, campus waste has great potential for classification, recycling, and comprehensive utilization(Dai et al., 2010).

1.2 Concept Definition

1.2.1 Green Campus

Since the concept of sustainability in higher education was first proposed in the Stockholm Declaration, the promotion of the concept of sustainability in the education community has gradually reached a broad consensus, and a series of action projects and derived concepts have emerged. Due to the differences in the level of social development of various countries, there is currently no uniform definition and standard for the concept of green campus in the world (J. T. He, 2009). The emphasis on developing green campuses at China and abroad varies, some focus on leading-edge green research (X. Q. Chen, 2015), some focus on the school's environmental education function (T. Y. Zhao, H. Liu, & X. Jin, 2009), and others focus on delivering sustainability to society Development philosophy, etc. (L. Cole & T. Wright, 2003).

In 2008, China's 'Guidelines for the Construction and Management of Economical Campuses in Colleges and Universities' defined the Green Campus as 'the maximum saving of resources (energy saving, water saving, material saving in its entire life cycle), Save land) protect the environment and reduce pollution, provide teachers and students with a healthy, applicable and efficient teaching and living environment, and a harmonious symbiosis with the natural environment [33].' This definition is closer to the green campus as understood in this paper Connotation, it emphasizes that the development of a green campus is a full life cycle process, and points out that its purpose is to minimize the negative impact of various activities

on the campus on human health and the ecological environment, so as to achieve the campus environment and the natural environment. Harmonious symbiosis.

In practical applications, the following concepts are often confused with green campuses, namely low-carbon campuses and sustainable campuses. The author briefly analyzes these concepts as follows:
Low-carbon campus refers to the introduction of low-carbon lifestyles in campus life to reduce carbon emissions from teaching, scientific research, production, and life on campus. Sustainable campus refers to protecting and improving the health and well-being of human beings and ecosystems, and addressing the ecological and social challenges facing humanity now and in the future. In contrast, the connotation of a green campus is more similar to a sustainable campus. Low-carbon campuses pay more attention to the campus' carbon footprint and carbon emissions and use this as a criterion for evaluating campus sustainability.

1.2.2 Green campus building

The term ‘construction’ was originally used in the field of architecture, meaning architecture, construction, construction, and manufacture. The legal construction technical classics ‘Building Method’ issued by the Northern Song Dynasty and the China Construction Academy established in the early days of the founding of China both used the term to describe the structure of buildings. As the context of use changes, the concept of word meaning is gradually expanded, and the objects created by ‘creation’ gradually change from figurative objects to abstract environments and atmospheres, and the use of vocabulary is not limited to construction projects and equipment making.

After a community development movement originated in Japan, it was named ‘building’ after it was introduced to Taiwan, that is, ‘community building’, which refers to people living in a certain geographical area in order to protect the living environment, improve the quality of life, and continue to take collective action To deal with the issues of community life that are faced together, and to solve problems while creating common life well-being (P. Hu, 2013).

Different from the traditional community planning and construction, the content and participants of community construction have changed. Professor Chiaki Miyazaki of Chiba University proposed that the topics of community building can be divided into five categories: ‘person’, ‘text’, ‘land’, ‘product’ and ‘view’, namely interpersonal atmosphere, cultural atmosphere, natural environment, production environment, and Landscape environment. It can be seen that in addition to pure creation, the soft environment that maintains the self-organized actions of community residents, such as social relations in the community and social capital of the community, also needs to be continuously managed and actively created. In this process, the designer transformed the sages into residents and transformed them into event promoters and organizers. The voluntary organization and active participation of community residents and joint creation with other members of society are regarded as a continuous driving force for the healthy development of the community(M. S. Gong, Z. Yang, B. B. Zheng, & L.

Zhang, 2019). Professor Zeng Xuzheng pointed out that ‘management’ and ‘creation’ are the original meanings of our use of the word ‘building’ rather than the traditional meaning of ‘building’ (K. L. Ding, L. L. Huang, & W. Zheng, 2013). From this we can see that the term ‘construction’ is more Rich content and meaning. First of all, the content scope of ‘creation’ is widened, which points to dynamic activities and operations. Secondly, ‘battalion’ has the meaning of operation management and seeking, reflects the continuity of activities, and emphasizes that results need to be continuously operated, organized, and managed. The emphasis on the concept of sustainability and self-organization helps to develop the thinking of ‘points’ that flow on the surface into the thinking of ‘faces’ of the system, allowing the design to intervene in the entire construction life cycle. Furthermore, ‘make’ refers to a series of actions based on human connection (B. Z. Wang, 2017). In the process of construction, everyone is the main body of activity. Through the voluntary organization and participation of individuals from the bottom up, they can prevent the design and policies of making cars behind closed doors. At present, the campus sustainable development topics mostly use the words ‘green campus building’and ‘green campus building design’. The lack of unified terminology has led designers to ambiguity in understanding concepts

in practice.

There are 3 main problems with the keywords "green campus building":

(1) the research focuses on related technical areas such as building energy conservation and environmental protection(J. Hai, 2011);

(2) the isolated subsystems and flows in the campus are viewed in isolation, and there is a lack of overall vision;

(3) the lack of The attention of campus users.

Therefore, the author uses the term ‘construction’ instead of ‘construction’ to distinguish it from the traditional green campus building, expanding the meaning of green campus design, emphasizing that the construction of green campus requires the active participation of people, and the design concerns are not limited to traditional In terms of material space, it is necessary to consider the individual ‘green’ and the overall ‘green’ in order to maintain the campus green throughout the life cycle.

From a longitudinal perspective, the full life cycle of a green campus consists of three stages: The early stage of sustainable construction focuses on the construction of campus energy-saving systems and the green design of green physical spaces. In the middle stage, each member of the campus needs to participate in the management of energy and waste. The replacement of the school building in the later stage requires urban planners to deal with old building spaces The purpose of the transformation. From a horizontal perspective, green campus building can be based on the two dimensions of the main body of the campus and the physical environment. Among them, the ‘use subject’ dimension emphasizes the user experience and feelings of students, teachers, and staff and other stakeholders, and participates in the establishment of operation and management mechanisms; the ‘material environment’ dimension includes campus architecture, energy utilization, transportation organization, The aspects of waste recycling and food health and safety emphasize the sustainable and coordinated development of the environment, society, and economy.

1.3 Literature review

The author summarized the development status and research results of green campuses at China and abroad, the purpose is to understand the research status and achievements of domestic and foreign scholars in this field and to diagnose the problems faced by the design practice of green campus in China. Using 'green campus', 'low-carbon campus', and 'sustainable campus' as keywords to search in China National Knowledge Infrastructure(CNKI), and selects the top 60 citation-related papers related to design. The practice and research results of green campuses are mainly concentrated in green campus buildings, campus energy utilization, carbon emission control, and waste management. The author summarized the current status of these subdivisions.

1.3.1 Overview of research on green campus building

1. Green Campus Building

The campus building monomer has accumulated rich experience in sustainable design. The research focuses on the use of green building technology to improve the green performance of the building. The main breakthroughs are reflected in the detailed design of space, materials, and structure. In the choice of building materials, we pay more attention to the use-value of building materials after they are abandoned, pay attention to the spatial organization of buildings,and play a role of microclimate regulation by forming an intermediary skin.For example, the Electronic Science Experiment on the

campus of the Federal Institute of Science and Technology in Zurich uses passive design methods to reduce the heating energy consumption of buildings by optimizing the physical performance of the building, introducing natural ventilation and lighting, and strengthening the insulation and airtightness around the building(L. Bao, J. Zhou, & Y. B. Ding, 2019).

In addition to the improvement of green building technology, some green building evaluation systems abroad have launched their corresponding school versions. This has played a vital role in advocating the 'green' concept of campus architecture and guiding school builders to pay attention to the sustainable development of the campus(C. Liu, 2011). BREEAM, the earliest green building evaluation system in the world, has developed its campus version, which evaluates campus buildings from the two stages of design and completion. Japan's CASBEE has not launched a special campus version, but the campus buildings are included in the evaluation scope, and more emphasis is placed on the indoor environment and service quality of the campus buildings. The US LEED for School is currently the most widely used campus building evaluation system and is used by more than 100 universities in the United States. China has also issued the 'Guidelines for Construction and Management of Economical Campuses in Colleges and Universities' and 'Green Campus Evaluation Standards' and other specifications. These green building certifications provide guidelines for campus renovation and design, but they have their own limitations. In the green campus evaluation standards of the above-mentioned countries, most of the provisions are only for single buildings on the campus and do not take into account the characteristics of the campus as a 'park' (C. Liu, 2011, p.3), so the lack of consideration for the overall 'green' campus.

2. Campus Energy Utilization

In terms of campus energy utilization, the research also focuses on the technical level. Most schools use digital platforms and sensor equipment to monitor campus energy use and consumption in real-time and reduce energy management from the source. Yale University adopts new clean technology to transform and upgrade Yale Central Power Plant (X. Q. Chen, 2015, p.1); Chinese Jiangnan University deploys 20,000 sensor monitoring points on the campus and builds a digital energy monitoring platform to monitor the energy use behavior of teachers and students on campus in real-time. Mastering various energy consumptions on campus and carrying out targeted energy-saving control has saved nearly 100 million yuan in water and electricity bills (J. Q. Song, R. Zhao,

& M. L. Zhang, 2018). There are also some studies focusing on the recovery and utilization of surplus energy, advocating turning waste into treasure. For example, the ETH Zurich uses the 'Energy Grid' system to efficiently and dynamically regulate the energy of the entire campus through the use of geothermal heat and the recovery of waste heat on campus. Supply (L. Bao, J. Zhou, & Y. B. Ding, p.26).

3. Campus carbon emission control

In terms of campus carbon emission control, China is still in its infancy, and most of the research focuses on the quantitative measurement of campus greenhouse gas emissions, and the campus low-carbon development model and emission reduction technology need to be discussed in depth. Most Scholars took the entire campus as the research object, in 2011, Z. Yao, C. C. Feng, and J. J. Kan used the ecological footprint model to calculate the ecological footprint of Peking University and compared the results with domestic and foreign campuses. Based on the calculation results, the ecological footprint reduction method was pointedly proposed. X. W. Gu et al. (2005) used the ecological footprint composition method to measure the ecological efficiency of Chinese Northeastern University and Chinese Shenyang University. The results showed that the ecological footprints of the two universities mainly came from coal, food, electricity consumption, and waste discharge. Some scholars have also carried out research on the ecological footprint of individual activities on campus, such as campus catering (B. W. Huang & B. Lu, 2016) , university office building expansion (Y. S. Wang, X. Yang, H.Yan, Y. Zhang, & Li, J. F., 2017), and campus waste collection(X. Sun, H. H. Tong , J. Niu, & Y. C. Zhao, 2011) .Some scholars also approached from different perspectives to discuss the factors that caused the changes in teachers' and students' ecological footprints. Chen Jinfu et al(J. F. Chen, X. Y. Zhu, & L. J. Ren, 2011). [47] analyzed the impact of spatial structure changes on-campus transportation carbon emissions. J. S. Cai, M. L. Chang and W. Q. Chen (2011)[48] were studying students' personal ecology. The influencing factors of footprint were analyzed, and the results showed that personal monthly disposable income and transportation were the most important influencing factors.

4. Campus waste management

The campus is a space for students, faculty and staff to study, work and live. Due to the concentration and large population of the campus, the school generates a lot of waste every day, mainly including kitchen waste, teaching waste and household waste (Y. L. Zhao, J. Yang, T. Y. Sun, & J. L. Yao, 2019). And the types and quantity

of electrical waste produced in different areas are different M. Yang et al. (2018). N. Chen, K. Chen, L. Hu, Y. Y. Shi, & H. D. Qiu, (2010) conducted an experimental analysis of the physical composition, basic combustion characteristics, elements and calorific value of campus domestic waste, and the results showed that 80% of campus domestic waste is combustible. Among them, the high water content of the kitchen waste in the canteen will affect the efficiency of waste incineration and power generation; the ash content of domestic waste is high. If not handled properly, the heavy metal elements remaining after incineration will pollute the soil and groundwater; plastics are not fully burned Will produce toxic gas dioxin.

The research on campus waste management in my country is relatively small and focuses on discussing the current status and problems of campus waste sorting and recycling. Colleges and universities generally have problems with imperfect facilities and systems and weak classification awareness. The amount of research related to campus waste disposal is obviously inadequate. The main ways of waste recycling in my country are recycling, conversion and waste-to-energy (Z. Zhang, 2003) The waste disposal methods are mainly sanitary landfill, composting and incineration.

The waste disposal methods are mainly sanitary landfill, composting and incineration. Among them, composting technology is the most environmentally friendly. Faced with the problems of reduction and resource treatment of campus waste disposal, W. L. Tong and H. M. Ma (2016) proposed new measures for the multi-level reduction of campus waste throughout the process, from the origin place to the process itself and then to the end place - these three stages at the same time reducing wastes. X. He and X. Y. Bai (2011) believed that the school could establish contact with local waste recycling enterprises to form a closed loop for resource recycling (p. 34). Y. F. Deng, L. Qiu, and D. Zhang, (2011) proposed the use of anaerobic fermentation technology to treat organic waste in campus waste for rural primary and secondary schools, and combined with a large amount of agricultural residues generated from cultivated land around the campus, to perform anaerobic digestion to produce biogas and obtain energy.

Western research on campus waste is mainly divided into 3 directions: waste management practices, waste to energy, and comprehensive solid waste management (Y. L. Zhao, J. Yang, T. Y. Sun, & J. L. Yao, 2019, p.44).Waste-to-energy refers to a solution that achieves the goal of sustainable development of benefits by recycling or reusing waste on-site and converting it into energy. Converting

waste into energy not only helps to reduce waste on campus, but also effectively eliminates greenhouse gas emissions during the transfer of campus waste. Cincinnati City University tried to produce biodiesel from catering waste oil, fuel ppapers from waste paper, and biogas from food waste(Tu, C. Zhu, and McAvoy, 2015). Ohio University uses a containerized composting system for organic waste to compost food waste(McLure, 2009). In order to achieve sustainable waste management, the United Nations University of Columbia has adopted a variety of strategies, targeting a series of materials, and following the principles of the waste management level: first reduce waste from the source, reuse materials as much as possible and recycle the remaining materials (Keniry, 1995).

1.3.2 Case studies (25 projects discussion)

Through the analysis and study of existing sustainable campus cases, this chapter provides a reference for exploring the sustainable development solutions of Chinese middle school campuses, and further determines the design scope.

The purpose of the case study was:
a) Collect sustainable solutions of existing schools.
b) Analyze the pros and cons of sustainable campus cases in practice.
c) Identify the main aspects of the campus that have sustainability issues.
d) Find cases suitable for application in Chinese middle school campuses.

According to the research goals, this paper selects 25 practical sustainability cases of domestic and abroad campuses. Since the schools that currently implement sustainable campuses are all universities, the conclusions of the case studies cannot be used as a direct basis for the sustainable development of middle school campuses in China.

1. PoliTO Sustainable School Plan
[sustainability policy]
The sustainability of the plan is about "futureness", critical and value thinking, and long-term environmental and social responsiveness.

One of PoliTO's goals is actually to increase people's awareness of their social role in cities and society as a whole, because individuals and institutions can drive change towards a more sustainable future. 5 dimensions of sustainability:

1. Energy and buildings
Pursuing energy sustainability at Politecnico di Torino means reducing and rationalizing energy use and its environmental impact on campus reality.

2. Mobility and transport
Sustainable mobility from and to the university campuses and its five metropolitan poles means to guarantee to all PoliTO's employees and users the availability of various transport modes.

3. Urban outreach
This actions field includes two fundamental focuses: a first one, towards the city and the society,and a second one, directed to PoliTO's internal community.

4. Food, water and waste
This dimension is twofold: on the food and wellness side, PoliTO is committed to promote the sustainability of the agro-food chain (energy saving, re-use of surplus) and local and traditional products and to encouraging guidelines for catering providers within the university in terms of contract and procurement (materials used). About waste management, PoliTO is committed to reduce/ rationalize waste production, thus reducing its environmental impact following the "reuse-recycle-reduction" approach. To this end, PoliTO aims to increase the efficiency of both disposals and purchases, looking towards a full closure of the life cycle of the product in a sustainable way.

4. Green procurement
Materials for the university and its employees are bought following the green public procurement guidelines, in order to respect the environment without forgetting the cost effectiveness of supply.

Pros & Cons
✓ Starting from the construction of the bottom, the basic aspects of a sustainable campus are systematically and holistically planned.

✗ The description of the plan is very ambitious. There are also many goals expected to be achieved and achieved. The theoretical foundation is sufficient but there are many practical needs, and the practical effect is difficult to guarantee.

2. MYPOLITOBOTTLE
[waste management]

Figure 5. The drinking water fountain map the project "MyPoliTObottle".
Figure 6. The bottle of project "MyPoliTObottle".
Adapted from the official website of the Project Sustainable Campus of PoliTO.

Starting from October 2018, with the installation of new indoor and outdoor drinking water points, from which it's possible to obtain supplies tangible on the environment. (Figure 5)

But the novelty does not stop here: about 4200 three-yearly freshmen of the year 2018/2019 and approximately 8000 three-yearly and masterly freshmen of the year 2019/2020 received a new water bottle (MyPoliTObottle), branded PoliTO Green Team, with which to get water during the day. The initiative has been extended to the personnel and to all Ph.D. students, instead of of the paper agenda as Christmas gift.

Pros & Cons

- Turin's original bull head water fountains, showing the city culture.
- Campus series of bottles, showing the new sustainable campus culture.
- Regional culture sustainable in the inheritance.
- Reduces the water waste.
- Reduces the use of plastic bottles.

- May not reach all teachers and students. i.e. exchange students or international students.

3. PoliTO Green Procurement
[sustainable procurement]

Figure 7. GPP magazine of the project "PoliTO Green Procurement".
Adapted from the official website of the Project Sustainable Campus of PoliTO.

Pursuing the sustainability of the Politecnico in terms of "ecological purchasing" - within the five metropolitan centers that constitute it - means purchasing material for the university and its employees following the guidelines of green public procurement (APE protocols) in order to respect the environment without forgetting the economic convenience of supplies.

The actions included in this dimension of Campus sustainability must also pursue results in terms of efficiency, effectiveness and quality. *Green Procurement Magazine* is to promote the actions of this project.

Pros & Cons

✓ Supporting recyclable and degradable teaching materials in campus consumables.
✓ Use products under EPA and CAM standards
✓ Reduce material waste and costs.
✓ Educate the staff of Green procurement

⊗ Only strategies of campus general affairs, lacks the personal procurement of teachers and students.
⊗ Difficult to measure personal procurement into the campus procurement summary, and difficult to judge whether the procurement materials meet the green and sustainable standards.

4. "M'illumino con meno" ——
PoliTO Energy and Buildings
[save energy]

Figure 8. Visual Design Plan of the project "M'illumino con meno". Adapted from the official website of the Project Sustainable Campus of PoliTO.

On the occasion of "M'illumino di meno 2017", the PoliTO Green Team launched an experiment on the use of intelligent LED lighting with the involvement of some operators in the sector.

The first results of the measurement campaigns carried out at the Living Lab, before and after the replacement surgery, show significant energy savings, highlighting the effect obtained by adding presence and light sensors. The experiment has involved some sample rooms of the Sede Centre (some offices etc.) and will provide useful indications for the planning of more extensive interventions in the university offices. The topic is current for the public administration, also in relation to the possibilities offered by the current incentives.

Pros & Cons

- ✓ Reduce energy consumption.
- ✓ Systematic management of energy input and output.
- ✓ Take control from the root.
- ✓ Energy sustainability promotion.

- ⊗ Need specialized operators and analyst for long-term systematic data collecting and monitoring.
- ⊗ The overall update and iteration of the energy consumption system requires a reasonable plan and is strongly dependent on the school's initial capital investment.
- ⊗ The reuse the replaced old system is not reflected in the design plan. Therefore, this plan is suitable for newly-built schools, and the renovation of old schools needs to consider the reuse of the eliminated old energy systems.

5. Mobility Manager (MM) —— PoliTO Mobility and Transport [green mobility]

Figure 9. Photos of the project "Mobility Manager". Adapted from the official website of the Project Sustainable Campus of PolitTO.

To pursue the sustainability of mobility – from and to the University campus and between its five metropolitan poles - means guaranteeing a freedom of movement to all its employees and, as far as possible, users: they should be out in the condition to choose among various transport modes - motorised and not – considering all restrictions, especially in terms of energy and environment, presented by today's society, besides pursuing targets of quality, safety and efficiency that must characterise modern transportation.

Pros & Cons

✓ Change transportation methods and reduce multiple energy waste in transportation activities.

✓ Reduce carbon emissions.

✓ Spreading the sustainable lifestyle, affecting and radiating citizen's thinking and infrastructure in a wider range.

✓ Campus as the center, building connections with the surrounding areas and even the entire city, to receive fundamental support.

⊗ The bicycle sharing initiative is independently operated by the Politecnico di Torino. Vehicles are easily lost and damaged, and the operation and maintenance costs are high.

Regular subscription-style public transportation. This measure is a test of participation and may be less involved

⊗ Not suitable for China. There are a lot of students in chinese campus. it will take up a lot of space if implementing shared bicycles , which is a waste of land resources.

⊗ City shared bicycles would be better for China. With the development of Internet technology, China has urban and even cross-city subscription-based bicycle sharing services, which are initiated by commercial enterprises.

6. Waste Mob —— PoliTO
[waste management]

Figure 10. Posters of the project "Waste Mob". Adapted from the official website of the Project Sustainable Campus of Politecnico di Torino.

Waste mob is a sustainable new type of activity project. It unites waste collection and marathon movement to convey the concepts of health, exercise, and sustainability. The project was initiated by the Politecnico di Torino in 2017 and was successfully held in 2017, 2018, and 2019, gradually becoming a social movement. In 2020, due to the novel coronavirus epidemic, the mode of holding will be changed from outdoor to home. Participants need to hand-craft items for secondary use at home, and post photos on Instagram, an online social platform, to participate in this event.

Pros & Cons

✓ People exercise to better health in competitive sports

✓ Communicative. Efficiently conveying the sustainability concept.

✓ Sustainable lifestyle. Connecting 'better health' concept to 'picking up waste' , is like connecting sustainable human life to sustainable nature.

✓ Connect the campus project with the community and society, so that the public can understand the value of objects.

✗ For high schools, the cost of the activity is high .

✗ The scale of the Shanghai city is large and the roads are complex, and it is difficult to hold such an event in the city.

✗ The safety of students going out requires a lot of manpower from teachers, faculty and staff. The number of faculty and staff in high schools is small, so this program is not suitable.

7. WeeeOpen —— PoliTO
[waste management]

Figure 11. Poster the project "WeeeOpen". Adapted from the official website of the Project Sustainable Campus of Politecnico di Torino.

WeeeOpen is a group of students whose goal is to recover obsolete hardware disused by the University, dismantle the wreckage and extract the components, and then install free software so that these computers can have a new life. So far, more than 82 computers have been donated to the associations and public bodies that have requested them.

In 2021, the team donated 25 desktop computers, equipped with monitors, mice, keyboards, and open source software, to the PoliTO for teaching. This donation is particularly important because the school's computer equipment was recently stolen. In cooperation with school staff, despite restrictions due to anti-COVID-19 regulations, WEEEOPEN team members took action to organize shifts so that they could enter the DiSAT laboratory and complete repairs as soon as possible, while fulfilling their commitment to the school.

Pros & Cons

✓ Students spontaneously form a hardware repair team to go deep into the school's daily affairs to help the school solve problems.

✓ It can exercise the technical ability to apply theoretical knowledge to practice, and at the same time extend the life of the hardware, which is very beneficial and sustainable.

✗ Chinese middle schools generally have greater pressure to enter higher education than universities. Under such a learning environment, it is difficult for students to form an organization spontaneously

✗ Middle school students do not have the ability to practice technology, and it is difficult to popularize this type of organization in Chinese middle schools.

8. Giretto d'Italia - Bike to Work —— PoliTO
[green mobility]

Figure 12. Photos of the project "Bike to Work". Adapted from the official website of the Project Sustainable Campus of Politecnico di Torino.

Il Giretto d'Italia is an initiative of Legambiente, VeloLove in collaboration with Euromobility: it is a proposal addressed to Italian municipalities, to Mobility Managers of organizations and companies, to associations and to all interested citizens, to promote home-work travel (bike to work) carried out exclusively by bicycle. During the 2017 edition, the PoliTO participated reaching 368 cyclists.

The following years were no less, expanding the initiative also to the headquarters of the Valentino Castle and the Polytechnic Citadel.

The cyclists who participated in the initiative participated in the extraction of a personalized #myPoliTObottle bottle, to continue to be sustainable in other daily actions too.

Pros & Cons

✓ Effectively reduce carbon emission and enable people to use their commute time to exercise in their busy daily lives.

✓ Cycling commuting is reliable and comfortable for the size of this city, because the longest journey distance of Turin by bicycle is only about 40 minutes.

⊗ It could be popularized among faculty and college students, but it is unsafe for middle school students.

9. Sustainability Weeks —— PoliTO
[sustainable awareness]

Figure 13. Posters of the project "Sustainability Weeks". Adapted from the official website of the Project Sustainable Campus of PolitTO.

Since 2016, the Politecnico di Torino holds the Sustainable Development Festival every year.

Also this year the PoliTO participates with some initiatives at the Sustainable Development Festival 2020. Organized by ASviS throughout the country with the aim of drawing attention to the Sustainable Development Goals (SDGs) of the UN Agenda 2030, as for the previous editions, the 17 days of events will offer an opportunity to reflect on sustainability issues in our country.

In the event, “Climbing for Climate” and "MovingLab" are 2 representative activities.

Pros & Cons

✓ Provides a window for everyone to understand the current climate

✓ Combining sports and sustainable activities, guiding people to experience the actual changes of climate while doing physical exercises, combining the "sense of participation" of sports and the "sense of responsibility" of improving the environment, so that people's consensus on climate change is deep in their minds Imprint, with a sense of mission.

✗ Large-scale activities require multi-stakeholders, not suitable for middle schools.

10. Residential Compost Program
—— Cornell University
[waste management]

Figure 14. Posters of the project "Residential Compost Program". Adapted from the official website of the Project Sustainable Campus of Cornell University.

A Residential Compost program in 2021 and allows certified individuals to compost personal food waste on campus by enrolling. It's quiet easy to join the program and takes less than 20 minutes.

Students, staff, and families living in on-campus housing can become Residential Composters by completing a short course which will teach people about how to follow composting rules on campus and ensure our waste stream can be effectively maintained. After completing the the Residential Composters course, student will become a certified Residential Composter. And they will gain access at the end of the course to information about how to compost in five locations on Campus, and near Collegetown.

Pros & Cons

✓ Provides specific composting training, so it effectively guide students to properly participate in waste composting.

✓ Uses the existing campus space to set up a recycling site for household food waste, which is convenient for management and maintenance.

✗ The steps increases the time cost of participation.

✗ Complicated participation process(online course in order to obtain a composter certificate) might reduce the participants.

✗ Some tourists and other outsiders might be excludedfrom sustainable actions.

11. Green Impact Competition —— the University of Sydney
[sustainable awareness]

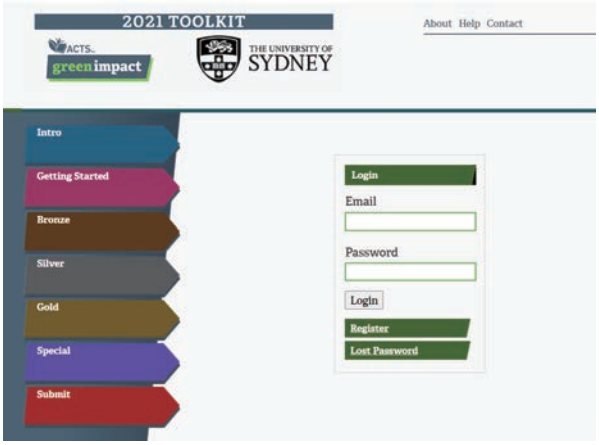


Figure 15. Picture of the project "Green Impact Competition". Adapted from the official website of the University of Sydney.

In order to get individual better involved in sustainability work, Sydney University launched a competition called Green Impact. The program runs from April to the end of September 2021. Teams can choose to make an impact in energy and emissions, waste reduction, health and wellbeing or biodiversity. No matter how many actions are completed, all teams are recognised and will win points. The actions can be completed either on campus or at home, so it doesn't matter if you are working or studying remotely.

After students registrated in green impact official website, they can login in the competition page, with checking the sustainable goals that need to be completed at each levels. The competition sets specific practical tasks based on the United Nations sustainable goals to guide students to truly transform the environmentally-unfriendly lifestyle and raise their awareness of environmental protection.

Pros & Cons

✓ A novel form of environmental protection team competitions.
✓ Promotes the continuous attention and participation of students.
✓ The green impact competition provides guidance for students from many aspects, in which covers biodiversity, energy and so on.
✓ No restrict students' behaviors in campus, and they can choose to practice in any scene.
✓ The tasks of the competition are divided according to the degree of difficulty. The gradual approach is easier for students to accept, and the task is not difficult to achieve.

✗ Tasks in the game are relatively fragmented.
✗ Some behaviors have little effect on the environmental contribution.
✗ The process lacks supervision (Students only take activities' photos), and it might be formalistic environmental protection participation, which does not really work.

12. Sustainable Waste Map —— Cornell University
[waste management]

Cornell has always supported recycling as a last resort for materials management and waste minimization. In 2019, the Campus Sustainability Office has launched a Sustainable Waste Map detailing locations on campus where Cornell community members can recycle, compost, reuse, share materials, and dispose of waste like electronic goods. Students and school staff can quickly find campus sites for waste disposal including batteries and electronics, food waste, old clothes, plastic packaging, etc. They can get the guidance of professionals to properly dispose of their discarded items, reduce the environmental pollution of waste, and recycle as much as possible.

In addition, this map also marks sites for sustainable activities on campus.Anabel's Grocery, a student-run grocery store working to combat campus food insecurity issues, compiled the list of community microwaves and fridges. By using shared kitchen appliances, Cornell can cut down on the number of individual appliances. These appliances are hard to dispose of and use a lot of water, energy, and materials to create. By sharing common resources, we can reduce our overall impact.

Pros & Cons

✓ Cornell University has developed recycling regulations to guide people in the proper disposal of waste.

✓ The school provides specific treatment methods and locations for different types of waste. For example, It sets up composting points for food waste and provide exchange or sharing space for old clothes.

✓ These initiatives help waste to be recycled.

✓ The Sustainable Waste Map is like guidelines for students to participate in recycling operations.

⊗ If the sustainability map really works, school must establish clear regulations and recycling sites for waste recycling on campus.

⊗ The school may also need to cooperate with the recycling plant for a long time, so that the waste collected by the school can be truly disposed or recycled.

13. Sustainability of Maersk Tower —— the University of Copenhagen
[sustainable building]

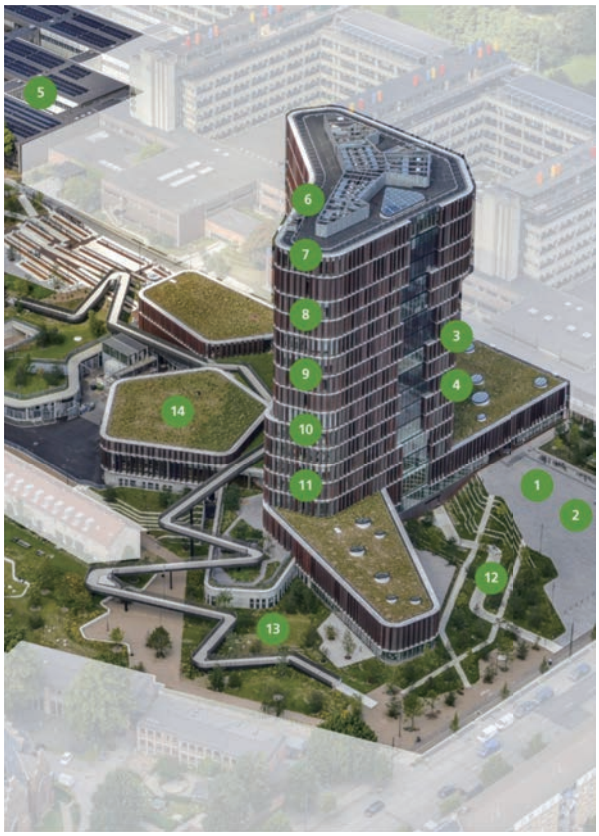


Figure 16. Design of the Maersk Tower. Adapted from the official website of the University of Copenhagen.

Apart from the equipment, freezers and ventilation systems in the laboratories, building itself also needs energy for lighting and cooling. With the objective of creating as sustainablea building as possible, a range of energy-saving solutions have been implemented in Maersk Tower.

Firstly, maersk tower equipped with extensive control systems and monitoring of heat, ventilation, cooling. Secondly, a lot of heat emited from amount of equipment and electronics at Maersk Tower requires cooling. Thirdly, the lighting at Maersk Tower consists exclusively of LED light bulbs, the most energy-efficient type of lighting. Fourthly, in connection with the construction of Maersk Tower, approximately 1,500 m2 of solar panels were installed on the roof of the Panum building. Finally, modern buildings are very wellisolated, even when their facades contain large sections of glass, as is the case at Maersk Tower. Consequentially, it is often necessary to use energy-intensive cooling to reduce the effect of the heat and light radiation from the sun and thereby ensure a good indoor climate and temperature.

Pros & Cons

The building effectively utilizes natural resources, such as rainwater and sunlight, and improves the building's own energy supply system, directly reducing electricity and water consumption.

The construction of such a sustainable building requires the support of the urban system. For example, the district cooling used by Maersk Tower requires government departments to build pipelines to transport seawater and other systems.

14. Campaign on Heating at South-City Campus —— the University of Copenhagen

[save energy]

Figure 17. Photos of the project "Campaign on heating at South-City Campus". Adapted from the official website of the University of Copenhagen.

Green Campus and the student organisations RHEA and SIMA has distributed 2000 flyers around The Municipality Hospital, KUA1&2 and in the central administration. The campaign reminds us to close the windows. During the rounds the students also closed the windows that were left open.

"Keep hot while keeping the planet cool". This sentence met employees and students coming to work in week 48 and 49. Except this message, the flyer contains 3 pieces of advice:

· **Air briefly and thoroughly**

· **Avoid leaving windows half open for a longer period.**

· **Close the door when you leave a room**

Pros & Cons

✓ Prompt everyone to close the windows to prevent the continuous loss of indoor heat.

✓ Reduce energy consumption.

✓ Encourage students to consciously protect the environment and reduce energy use all the time.

✓ Linking environmental protection with specific behaviors.

✓ Low cost and easy production,with considerable carbon emission reduction benefits.

✓High applicability and can be easily duplicated in other countries.

⊗ Only advertising slogans may not arouse everyone's willingness to save energy and reduce emissions.

⊗ No supervision, relies on the self-consciousness.

15. Aalto University
[waste management]
[food waste]

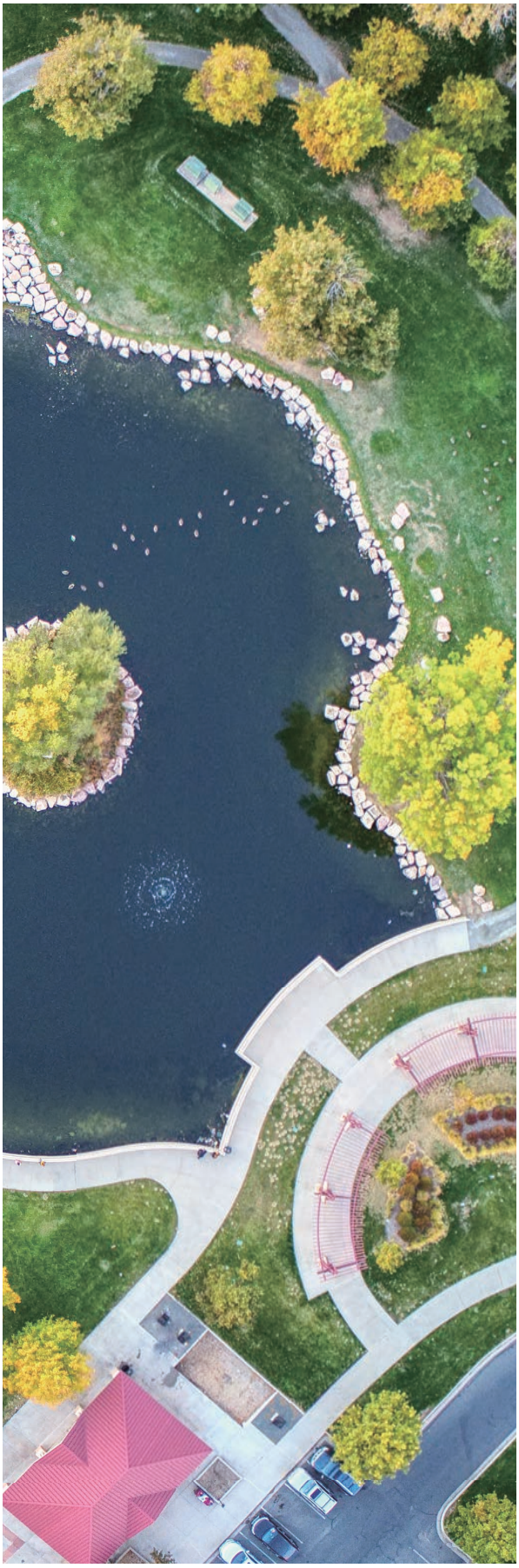
Five students at Aalto University, Finland, set up a food-sharing group that enables distribution of leftovers on campus, such as from meetings and parties, for free. They were mentored by the Aalto Ventures Program during its flagship "start-up experience" course, and started their initiative by collecting and analysing kitchen waste on campus to gain insight into what food was being thrown away. They set up the food-sharing group without any funding, and all marketing happened via word of mouth.

The founders thought the biggest barrier was encouraging the initial members to join, but now they have a growing membership of more than 1,000 people. So far, the group has prevented more than 7,000 kilograms of food from going to waste. Their tips for success are to reach out to supermarkets, restaurants and student associations on campus and ask them to share leftovers, and to regularly seek feedback from users.

Pros & Cons

✓ The food sharing group distributes free leftovers from the campus to those in need. From the end, it keeps these foods from becoming worthless, reducing the amount of waste.

⊗ Food handling and storage is a concern.



16. Go for Paperless Examinations —— The University of Malta
[save paper]

The University of Malta has reduced paper use by establishing a default of having students digitally submit assignments and research ethics applications. It has also used defaults to reduce energy consumption: the campus replaced stand-alone air conditioning units with a centralized system that has time controls and default settings to moderate temperatures.

Since January 2019, C-SUM has been working with the Office of the Registrar and with IT Services to implement a number of examinations electronically - especially multiple choice examinations - with the aim of reducing the use of paper.

The electronic examinations pilot project using WISE flow, initially planned for only a limited number of examinations, would have been held during the second semester of 2020. Through the WISEFlow platform exam papers are available electronically: students enter their replies electronically and assessments are effected electronically, completely eliminating the use of paper.

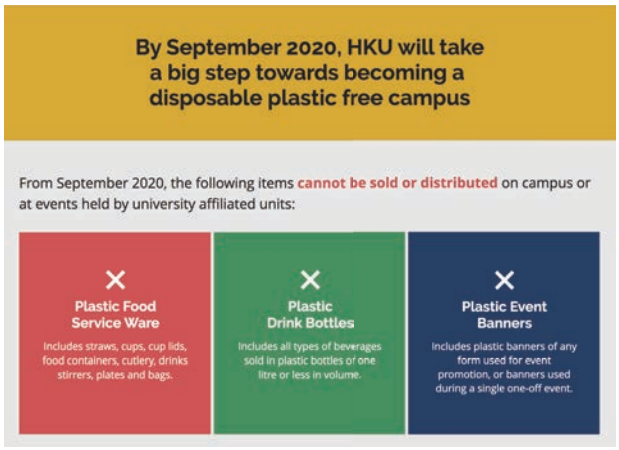
The COVID-19 emergency situation accelerated the use of electronic paperless examinations using both WISE flow and VLE Exam. The Office of the Registrar and IT Services succeeded in making this possible: a total of 142 examinations for the June 2020 session, for about 2,900 students, were held through WISEflow. VLE Exam was used for the other examinations during the June 2020 session.

Pros & Cons

✓ Reducing the paper using of huge amount of daily exam.

⊗ Requires technical support of digital examination platforms .
⊗ Some subjects' exams are highly dependent on paper, such as drawing.
⊗ Digital exams require sufficient computers and other equipment, and the requirement is a challenge for the economy of some schools.
⊗ The use of digital exams requires students' professional computer skills, which is difficult for some young students.

17. Be Part of It, Ditch Disposable.
—— The University of Hong Kong
[waste management]



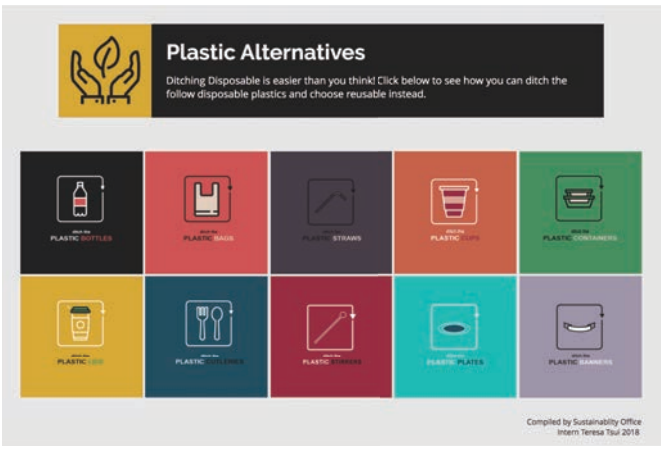


Figure 18. Principle guidelines of the project "Ditch Disposable".
Figure 19. Visual design of the project "Ditch Disposable".
Adapted from the official website of the project, https://www.ditchdisposable.hku.hk/.

Ditch Disposable is a campus-wide campaign at the University of Hong Kong to reduce plastic waste by targeting plastic disposables across campus.

The slogan of the project is 'Our campaign is encouraging everyone on campus to Ditch Disposable and and Choose Reusable!'

Plastic Free Campus Policy From September 2020, ten types of disposable single use plastics cannot be sold or distributed on campus or at events held by university affiliated units.

Pros & Cons

✓ Visual communication design (Figure 19.) expressed and spreaded the concept by visual repetition, making people think about the environmental damage of plastic products in mind and action.

✓ Greatly improve people's environmental consideration.

✓ The plastic plan is relatively easy to implement on campus.

✓ Introducing ways to change the bad habits of using plastics: ditch disposable at first, and then introduce eco-friendly plastics for special applications.

⊗ Focusing on plastics, lack of systematic design thinking of other unsustainable materials and behaviors.

18. Sustainable Canteen —— South Campus of Copenhagen University
[food waste]

The canteens at South Campus is a sort of start-up, where possible initiatives can be tested. Because the students are concerned about climate change and sustainability, they are open for innovative ideas and commited to reduce carbon footprint.

The sustainable model contains initiatives on food supply, food waste management. In order to reduce food waste, a vegan soup is cooked from leftovers and sold on the last Thursday of the month. Left-over food from the canteen is sold in the café Mødestedet, in cooperation with Too Good to Go. Coffee is cheaper if you bring your own cup – depending on the size of the cup.

Pros & Cons

☑ The campus canteen is practicing a sustainable lifestyle gradually. For example, providing vegetarian food with a lower carbon footprint, cooking soup with leftovers, encouraging the use of degradable tableware instead of disposable tableware,etc.

⊗ Some initiatives may not work in China, for example chinese canteen uses long-term tableware rather than degradable ones.

⊗ The composition and utilization value of food residue differs.

19. Construction, Operation and Management of Energy Consumption System —— Tongji University "Green Campus Plan"

[save energy]

· Solar thermal energy utilization system, electric heat storage boiler, reclaimed water treatment and reuse system, bathing sewage heat recovery and utilization system, constructed wetland water treatment system, etc. in student centralized bathroom;

· Implement energy-saving and water-saving measures, and achieve 100% non-tap water sources for campus irrigation;

· New buildings surpass the current energy-saving standards in the region and achieve building energy-saving performance design of more than 65%;

· Combined with the characteristics of the large space, the use of replacement air-conditioning ventilation, atrium composite ventilation system, etc.

· The school has also established an energy-saving supervision platform for campus facilities, focusing on strengthening the management of students' electricity and water conservation. Smart IC cards have been installed in student dormitories and centralized bathrooms, and a campus card for water and electricity payment has been implemented.

The power and water saving rates are as high as 40% and 30%, respectively. In particular, the centralized bathroom saves water, and the bathroom capacity has also been increased. Originally, one bathroom could only accommodate 1,700 people per day. Now the capacity has exceeded 4,000 people, which has been increased by 1.5 times.

Pros & Cons

✓ Effectively saving resources and funds.

✓ Fundamentally solve the energy consumption problem.

✓ Research and application at the same time.These studies are guidelines for the green campus plan.

✓ The green campus building promotes the development of disciplines. For example, the wetlands on campus is an exploration platform for related researchers to construct wetlands in central cities.

✓ From the management regulations to the specific methods, there is a scientific systemic plan, so that the school can truly achieve the goal of energy saving.

⊗ The all-in-one-card water and energy consumption system was not used for all school staff and occasions, such as the dishwashing and places in the canteen.

⊗ The cost of reforming campus construction is large, and it does not suitable for all campus types.

20. Campus Carbon Neutrality by 2050 —— Tongji University
[sustainable awareness]

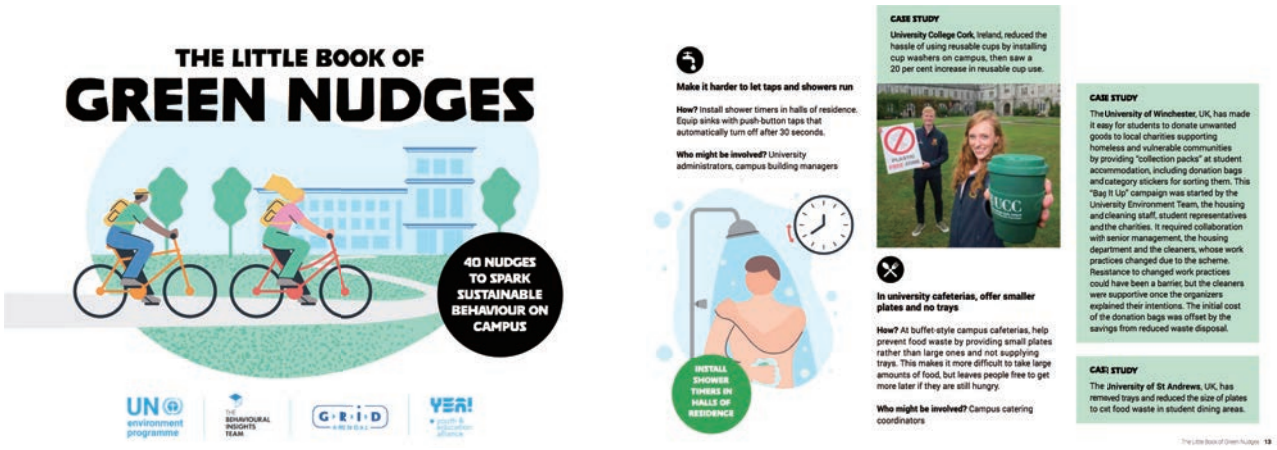


Figure 20. The english version of "The Little Book of Green Nudges". Adapted from the official website of UNEP-Tongji IESD Program.

During the China Carbon Neutral University Campus Forum held in Tongji University in Shanghai, April, 2021, 44 universities in China join the global and national ambition for carbon neutrality by releasing the Declaration on Carbon Neutrality of Chinese universities and Releases Joint Declaration Campus Carbon Neutrality by 2050.

The forum also launched the Chinese version of "The Little Book of Green Nudges". This book is a first-rate example of how the written word can be used to identify opportunities, target communities and motivate individuals to take active steps to both change their behavior and reduce their greenhouse gas emissions on campus.

Pros & Cons

✓ Summarize the efforts of different universities in sustainable design through a combination of pictures and text.

✓ Guide people to learn and change, and try to fine-tune their daily behavior.

✓ Applicapable for Middle schools.

✓ Try to get everyone involved.

✗ Does not have systemic plan in green campus building.

✗ Unsure effectivity. The 'nudges' may be forgotten after one glance.

✗ Hard to change one's behavioral habits and commercial thinking. Because environment is the greatest force that affects people on personal thinking.

21. Green Renovation of the Original Building —— Tongji University
[sustainable building]

Figure 21. Photos of Wenyuan building and the Great Hall of Tongji University. Adapted from the official website of Tongji University.

The Green Renovation of Tongji University have been unanimously praised by experts from all over the world(in the 15th Economic Conference of the "United Nations Framework Information on Climate Change" and the 5th meeting of the "Kyoto Consensus").

Example 1 Wenyuan Building

Wenyuan Building was built in 1953 and is a municipal-level protected building in Shanghai. And it was renovated in 2006.

Example 2 The Great Hall

The reonvation project adopted the open window form of the structural unit on the top of the hall. The side windows of the roof form a natural ventilation system, which can be used in spring and autumn (Figure 21).

Pros & Cons

- Save cost.
- Makes the most use of the old building and retains the original structural features.
- Comprehensive energy cycle design.
- Integrates the needs of buildings for office use.
- Scientific and highly sustainable plan.

- The systemic design of the green building is costly and has the particularity of individual cases.
- This kind of renovation may be difficult to reuse in middle school campus buildings.

22. Community Waste Sorting Activity —— Tongji University
[waste management]

Figure 22. Photos of the project "Community Waste Sorting Activity". Adapted from the china news website Sina, 29th June 2019, https://news.sina.com.cn/o/2019-06-29/doc-ihytcerm0154247.shtml

Tongji University encourages students to sort waste and recycling correctly with 'Waste-sorting Game Mach'. The game was promoted at the nearby community of the campus. And then the sorting game activity was widely spreaded in Shanghai.

Yangpu District, where the university located, is one of the first central urban areas in the city to promote waste sorting throughout the region. It is a demonstration zone for classification of domestic waste in Shanghai, and has basically established a management system for the classification collection, transportation, and disposal of domestic waste.

Pros & Cons

✓ Appropriate use of gamification design methods in the community for sustainable concept promotion can quickly and effectively increase the efficiency of communication.

✓ For children, they can quickly form a recognition of waste sorting icons and sustainable thinking.

⊗ A lot of activity related materials to be prepared, which is difficult for middle schools.

⊗ In China, the middle schools' funds are concentrated on teaching-related tasks, and there is no extra funds and materials to cooperate with communities.

23. Sponge Campus —— Duke Kunshan University, China
[save energy]

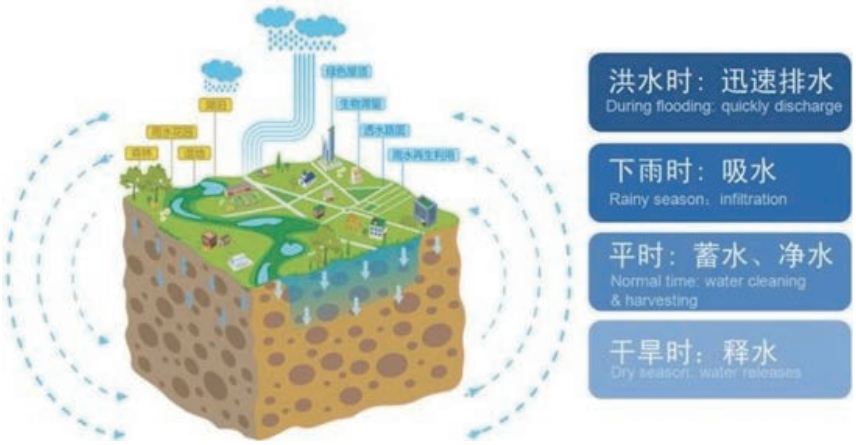


Figure 23. Photos of Duke Kunshan University.
Figure 24. Photos of the project "Sponge Campus".
Adapted from the official website of Duke Kunshan University.

The water circulation system consists of 4 complementary parts:
· The natural water point all over the campus was for rainwater collection and flow control;
· The roof garden was for rainwater infiltration;
· The underground filtration system ensures water quality;
· The irrigation system makes full use of treated rainwater for irrigation.

Since the campus started in 2014, all the irrigation has used recycled rainwater, saving about 10 tons of water per day on average. At the end of 2017, the system could meet 99% of the landscape water demand, almost eliminating the need for external water supply. 90% of water heating is powered by solar, and 65% of the food served in the cateen is from local.

Pros & Cons
✓ Integrating the sustainable campus building with local landscape.
✓ Relate the systemic plan with territory climate.
✓ Eliminates the need for external water resources.
✓ Most of the food is from local, avoiding the carbon emission and the food loss of transportation.

✗ The University is located in the suburbs, so this design might not be scalable and reusable for urban campus.

24. Zero Waste —— The University of California, , Berkeley, US
[waste management]

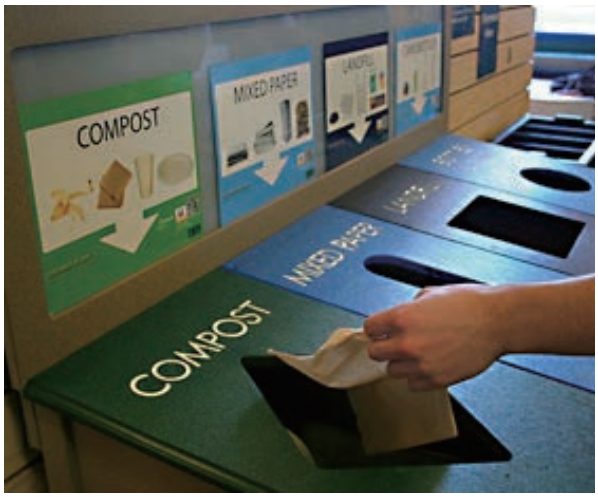


Figure 25. The custom-designed recycling bins of the project "Zero Waste". Adapted from the official website of The University of California, Berkeley.

Thirteen custom-designed recycling bins, funded through the campus's major beverage contract, are now up and running in Barrows Hall, Hearst Gym, Anthony Hall and and other campus buildings.

The bins, each manufactured from 1,550 recycled plastic milk jugs, were funded by the $15,000 annually that PepsiCo, in a 10-year contract signed in 2010, agreed to contribute to campus sustainability projects. The contract sets terms for the purchase of bottled beverages by the UC Berkeley Beverage Alliance, made up of Cal Dining, Residential and Student Service Programs, Cal Athletics, ASUC Auxiliary and Recreational Sports.

· The new bins were designed in collaboration with the manufacturer Max-R, with close attention to signage and color-coding of different waste streams – **green for compost, blue for recycling, black for landfill.**

· **Rearranging bins, hanging up new signs or using different products.** Their tip is to build relationships with others on campus, including facilities managers, dining managers, chefs, custodians and campus administrators. They found that when they shared their goals, others on campus were more likely to support them.

Pros & Cons

✓ Catched the pain point: the daily input and output are more likely to be wasted and overlooked because of the large number of people.
✓ The measures are scientific and specific, so it would be implementable;
✓ The management of food and water from the source is also very effective.

✗ Great challenge for campus waste system. Because the system is constantly inputting and outputting every day.

25. A Pan-European Campus Network as Regional Climate Innovation Engines Sustainable Campus: Launching Customer (SCLC)

[sustainability policy]

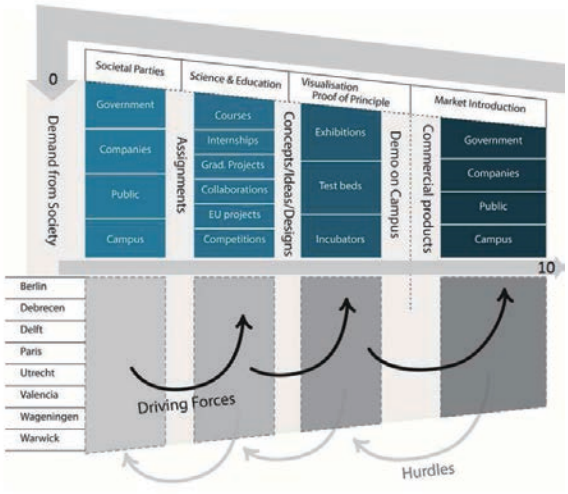


Figure 26. University's innovation funnel in the context of the SCLC project. Adapted from "Towards a Carbon Free Campus —— A Pan-European Campus Network with Focus on Technische Universität Berlin" by Kriegel. M, Münch. B, Steffan, C, and Zillich K, *Urban Design,* No. 1, p. 8-039.

Figure 26 shows the university innovation channels that the project has developed. At the head of the arrow, we introduced stage 0—showing active social needs, and stage 10—wide dissemination of a certain innovation achieved through social dissemination and adoption. The technology maturity level (TRL) has been redefined as the innovation maturity level (IRL). The intention is to dynamically mark the different innovations of different universities under this channel, so as to simplify the process of knowledge exchange between project partners.

Pros & Cons

✓ The project demonstrates the advantages of regional alliances, especially the regional joint actions of educational organizations.

✓ University campuses have all the prerequisites for creating and developing sustainable system innovation: smart minds, international network connections established with governments, companies and other scientists, sufficient space, and realization The equipment needed for innovation and the future generation of talents.

⊗ The sustainability of the project itself was not taken into consideration. The project was relatively active during 2013-2016, but now it has gradually lost its activity.

⊗ With the assistance of technology, the campus has achieved a period of sustainability, but the sustainability itself should consider the iterative sustainability of the project.

Discussion of the 25 case studies

The 25 cases selected in this chapter comes from university campuses in Europe, Asia, North America and other regions. Among many cases, this paper selected the cases that have been implemented and has great feedback as the research objects, and is committed to absorbing the effective experience of sustainable campus initiatives.

Among these initiatives, 7 research topics receive more attention, which are waste management, energy saving, sustainable building, green mobility, sustainability policy, sustainable procurement and sustainable awareness.

The key issue that raised highly concern is campus waste management. Campus is a multi-functional place that includes activities such as learning, living, entertainment, catering and so forth. Therefore, the types of waste on the campus are very complicated and the amount is huge. Many universities have adopted corresponding policies to help reduce the amount of waste discharged on campus. Cornell university dealed with food waste by launching residential compost program. Aalto university also cared about this issue, which encouraged food sharing and distributed free leftovers to those in need. The university of Malta aimed at reducing paper consumption through implementing electronic examinations.

Both Polytechnic University of Turin and the University of Hong Kong paid attention to plastic waste on campus. The former encouraged the use of water bottles instead of plastic bottles, while the latter strictly restricted the use and sale of disposable plastic products on campus. The university of California, Berkely, US and Tongji University redesigned the recycling bin to help people sort their waste correctly. Besides, several schools promoted the upcycling of old materials to eliminate waste.

Another issue is refered to energy consumption. Equipment, freezers and ventilation systems in the laboratories, buildings needs electricity for lighting and cooling. There is also a great demand for water on campus for flushing toilets, bathing and cleaning. At the same time, the University of Copenhagen also advocates reducing heat consumption,thereby reducing carbon emissions. Some schools advocate energy conservation for students, faculty and staff by organizing energy-saving theme activities.

However, more effective energy-saving solutions are still related to sustainable buildings equipped with central heating systems and ecological energy-saving technologies.

The last issue is the carbon emissions caused by transportation. Some schools advocated commuting by bike. Others supported the shared use of vehicles.

Through case studies, the author narrow down the research focus, focusing on campus waste management, energy consumption and carbon emissions from travel to facilitate a sustainable campus transition.

1.3.3 Summary of green campus design research

Since the green campus building idea came out, design has been involved in the green development of the campus from the aspect of physical space, and has researched the aspects of campus space planning, architecture and landscape. However, there is a lack of attention to the processes, services and systems in campus operations. In recent years, there have been numerous examples of sustainable campus building renewal, but these cases are focusing in one aspect of school building construction to minimize the impact of design activities on the environment. When the building design is completed, the school is in its' self-running and designers cannot influence the campus environment anymore. These designs do consider environmental factors, but the intent of the design cannot be sustained throughout the entire life cycle of the building, so it is to say that the design outcome influenced in one ‘green point’. Architecture, space and landscape design approach create a visible green environment for teachers and students, but the ‘green point’ design approach has a very limited contribution to the entire environment. If we do not change the ‘use and discard’ way of life, we will still not be able to change the course of depletion of resources and the human race towards the grave.

The booming of chinese education development, caused the nationwide campuses increasing. Building a green campus requires not only the guidance of technology and programs, but also a global perspective to solve complex systemic problems. The existing green campus planning and building, mostly tend to focus on a certain sustainable measure in the physical space environment in isolation, but ignore the resource utilization and energy consumption. Due to the lack of systematic guidance on the ideological and design, the design practice of green campuses is generally cut from a single dimension. Hai Jia of South China University of Technology(B. Gao, Tan, & Y. C. Song, 2011, p.48) based on the symbiosis idea, carried out a new interpretation of the sustainable campus architecture, and put forward the regional, era and cultural characteristics of campus architecture. The design strategy proposed by Z. Guo (2014) of Shanghai Jiao Tong University focuses on the construction of new campuses in the future and lacks attention to the

old campus environment.

Liu Chang(C. Liu, 2011, p.41) from Tsinghua University developed a building evaluation system for post-disaster reconstruction schools. Due to the vague understanding and understanding of the concept of green campus in thought, the lack of a more comprehensive and systematic design strategy inaction has caused many inconveniences to the design practice and is also the bottleneck that design needs to overcome to promote the sustainable development of the campus.

From the 'thinking' side, there is a lack of scientific interpretation of the green campus, and the understanding of the connotation of the green campus is not comprehensive. Most green campus planners believe that keeping sufficient area for campus development and adopting advanced technology and equipment have achieved ‘sustainable development’ (J. Hai, 2011, p.13). Others understand it as green education, and some even think that a green campus is an environmentally friendly campus and a green campus (C. Liu, 2011, p.2). Due to the lack of sufficient knowledge of the green campus, the existing design practice often only cuts in from a single technical level, lacking overall planning and systematic vision. The interconnected elements of the campus system are treated in isolation. This partial optimization can only play a negligible role in improving the ecological efficiency of the entire system.

From the 'practicing' side, 1) The design only intervenes in the early stage of the process and lacks consideration of the campus operation and transformation. Therefore, it has not reached the full life cycle of design participation. This has also led to the emergence of blank areas in the research object. The research is more focused on the green planning and design of the new campus in the future. The organic updating of the existing old campus environment needs to be improved and expanded on the issue of sustainable development. 2) The research focuses on the technical level, focusing on the supply side rather than the demand side. This makes some design solutions lack the consideration of the user’s perspective, so it is impossible to fundamentally change the unsustainable behavior of campus users, nor to achieve the goal of energy-saving and emission reduction. 3) Since the design object is focused on the design of the physical environment on campus, there is a lack of other forms of solutions. Therefore, the design’s persistent long-term mechanism (H. B. Liu, X. Zhou & Y. F. Liu, 2017), and the integration of creativity in the real life (C. C. Yang, 2018), usually only achieved the ‘green campus’ in some seperate point.

1.4 Objects and problems

The research scope is the green campus building design of original chinese senior high schools, and taking Shanghai Tongji-Huangpu School of Design and Innovation as an case example.

Specifically, the research content of this paper is as follows:

1) How to explore the environment problems of the old campus and the reasons for its formation?

2) What are the human factors that cause problems in the campus environment? What are the reasons that influenced sustainable behavior of campus environment?

3) How to incentivize campus users to change unsustainable behavior through design, so that they can participate in campus environmental governance in a responsible way?

4) How to improve the sustainability of the old campus by planning the material and energy flow of the old campus? How could design helps? What might be the strategy to the problem solving?

1.5 Methods and framework

The research methods are mainly literature review, field research, interviews, observation , systemic design method, life cycle assessment(LCA) with ecological footprint method.

Literature review. A method to further explore the research problems by reading, sorting, and analyzing a large number of existing relevant documents and materials. In this study, through reading the relevant literature of systemic design and green campus design, we discovered the development status and blank areas in the research field, so as to clarify the scope, object, purpose and significance of this study.

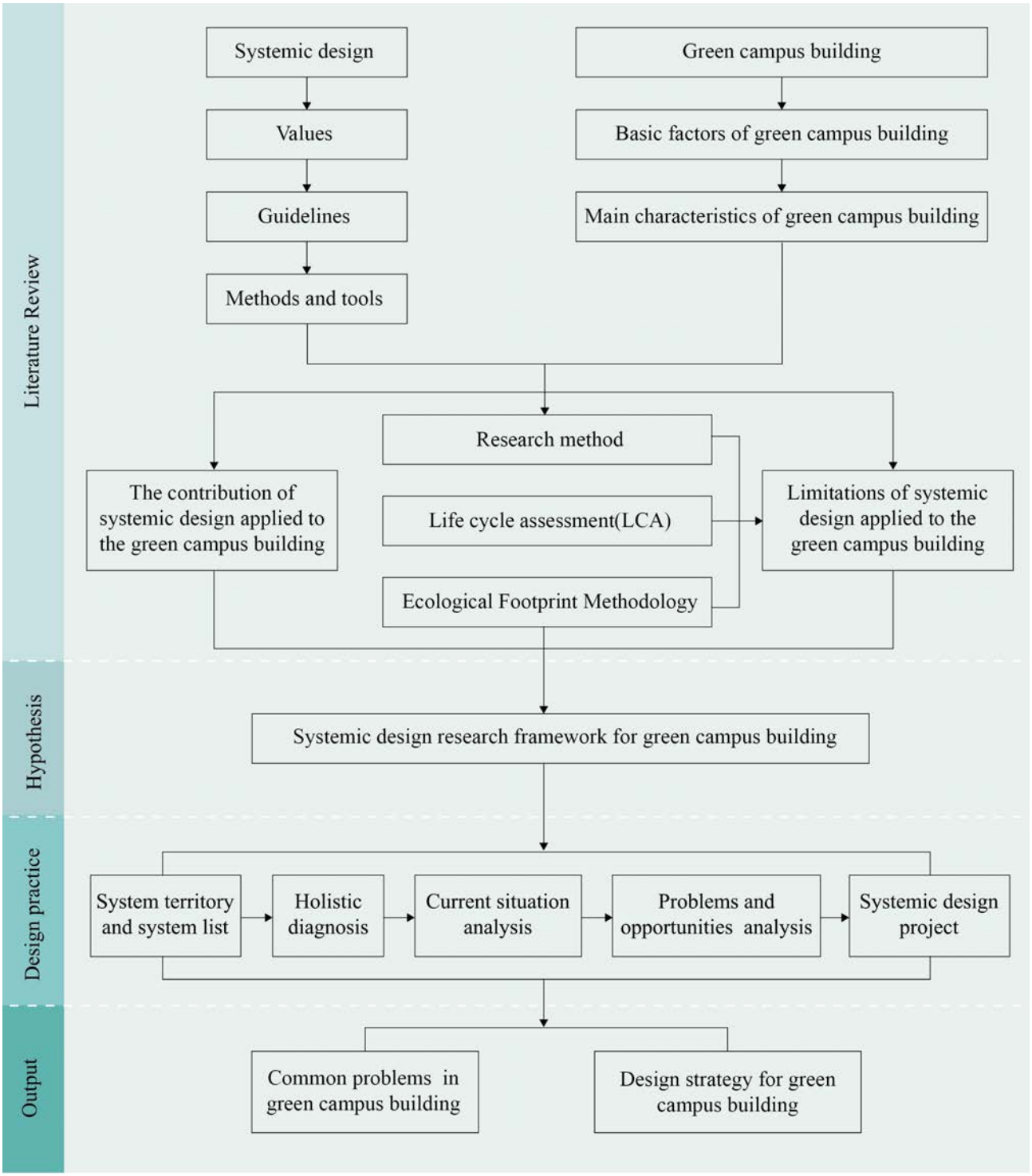


Figure 27. Research framework. Complied by the author.

Field research. It is the most direct way to build empathy with people. It helps design researcher to understand relevant behaviors and obtain first-hand raw data by entering participants' venues. Field research emphasizes observation and exploration of what is being observed. This method familiarizes users with a third perspective and often provides some hidden insights. In this comprehensive diagnosis stage, we use the method of on-the-spot investigation to collect data on campus.

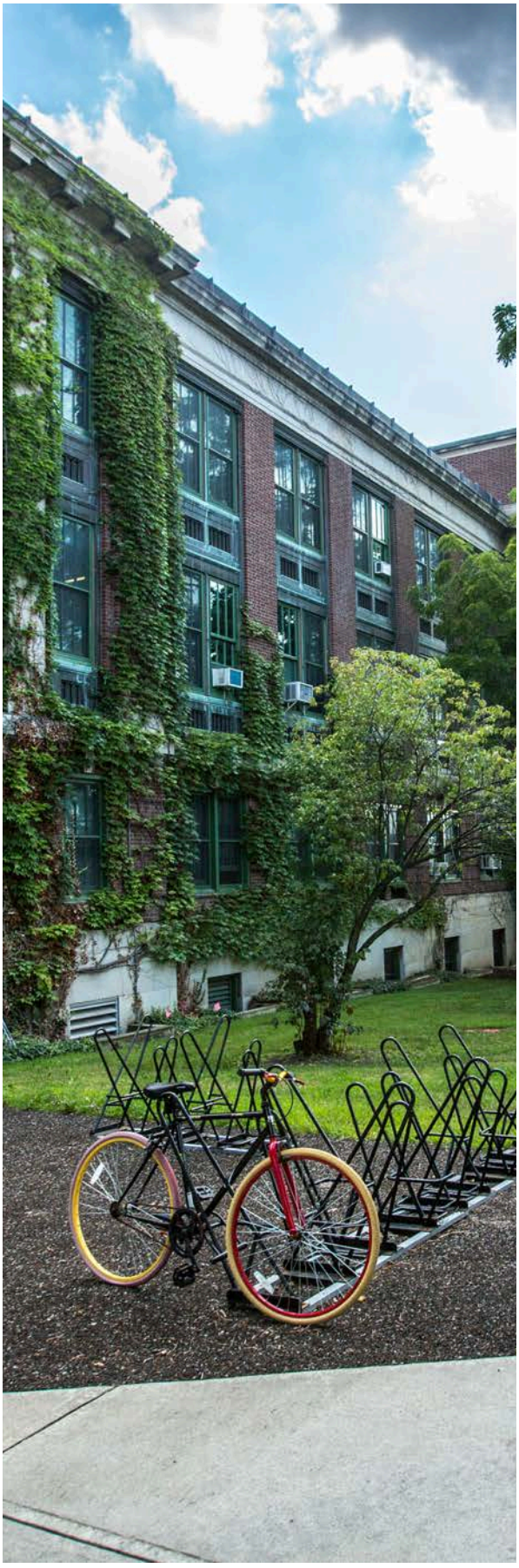
Interviews. It is a research method for the interviewer to conduct targeted conversations with the interviewee. This paper uses a semi-structured interview method to understand the process of the three types of activities on campus: 'eating', 'living', and 'learning', as well as the resources, energy and waste generated during the process, and focuses on exploring the human factors behind these consumptions.

Observation. This research method refers to a method in which authors use their own senses and auxiliary tools to directly observe the research object according to a certain research purpose and outline, so as to obtain data. In this study, observation were used to conduct fixed-point sampling observation on the waste compartments, various waste collection bins, toilets, classrooms, and kitchens on campus. Through observation, the author recorded the types of waste on the campus, monthly production, and the single energy consumption of each emission source. The author also observed the process of teaching activities and catering activities to understand the behavior of campus users in various campus activities.

Systemic design method. It is a method of the research process, and its purpose is to make the input of one subsystem into the output of another subsystem, so as to achieve 'zero emission' of the system. Specifically, it can be understood as the study of the material flow in the system. Through the analysis of the input and output of the system and its source and destination, the relationship between the material in and out at the macro level is adjusted to reduce the environmental impact. This study uses this method to explore the material input and output of Tongji-Huangpu School of Design and Innovation for the whole year of 2019, and improves the overall sustainability of the high school by reducing the environmental impact of input and output.

life cycle assessment(LCA) with ecological footprint method. It is a method to quantify the degree of the environmental impact of human activities according to the type of land area of biological productivity. This paper uses this method to calculate the ecological footprint of electricity,

gas, water, food, paper, and waste in the high school in 2019, and uses this as a quantitative basis for ecological assessment.



1.6 Purposes and significance

This paper aims to provide a new path for the sustainable design of the old campus through the use of systemic design methods. The significance of the research is reflected in both theory and practice.

In theory perspective :
1. It provides a new perspective on the sustainable development of the systemic design involved in the campus;
2. The systemic design method is applied to the scene of green campus building, and the research scope and field of the systemic design method are developed and broadened; 3. The model of green campus building is proposed, and it developed the connotation and content of green campus design;
4. Taking the old campus as the research object to make up for the blank area of research.

In practice perspective :
1. It supplements and improves the research process and methods, and provides a research framework for the application of systemic design in the campus context;
2. It has developed research assistance tools to provide support for other design authors.design, we discovered the development status and blank areas in the research field, so as to clarify the scope, object, purpose and significance of this study.

Reference

Yu, K. J. (2016). Anthropocene ecosystem and ecological restoration. Landscape design, (1), 4-9.

Ahern, J. (2016). The Anthropocene Urban Ecosystem: Its Concept, Definition, and Strategies to Support Urban Sustainability and Resilience. Landscape Architecture, 10-21.

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., Moran, E., ... & Ostrom, E. (2007). Complexity of coupled human and natural systems. science, 317(5844), 1513-1516.

Liu, G. Y., Yang, Z. F., & Chen, B. (2013). Research on urban metabolism process based on emergy analysis method——theory and method. Acta Ecologica Sinica, 33(15), 4539-4551.

Cui, S. H., Li, F. Y., Yu, Y. X., & Lin, J. Y. (2010). Theoretical Discussion on Urbanization and Sustainable Urbanization, Urban Development Research, (3), 17-21.

Duan, N. (2004). Urban material metabolism and its regulation. Environmental Science Research, 17(5), 75-77.

Zhang, Y. &Yang, Z.F. (2007). Eco-efficiency of urban material metabolism: a case study of Shenzhen. Acta Ecologica Sinica, 27(8), 3124-3131.

Lu, Y., & Chen, B. (2015). A review of urban metabolism research: connotation and methods. Acta Ecologica Sinica, 35(8), 2438-2451.

Wu, C., Peng C. L., Wu Q.Y., Shi, L.W., & Zhang B.B. (2011). Research on the construction of low-carbon life in colleges and universities——Taking the Qishan campus of Fuzhou University as an example. Environmental Education, (6), 60-62.

Zhu, D. J. (2000). From sustainable development to circular economy. World Environment, (3), 6-12.

Wang, H. T. (2011). A new approach to energy conservation and emission reduction goals-life cycle energy conservation and emission reduction evaluation method. High Technology and Industrialization, (8), 49-53.

Lou, Y. (2018). Designing interactions to counter threats to human survival. She Ji: The Journal of Design, Economics, and Innovation, 4(4), 342-354.

Zhu, D. J., & Chen, F. (2010) The connotation, goals and countermeasures of developing a low-carbon city in Shanghai. Urban Observation. (Doctoral dissertation)

Krieger, M., Munch. B., Stephen. K., Tririch, K., Lin, B. R., Zheng, X. D., Zeng, Y., & Li, S. Y. (2015) Towards a'zero carbon' campus-a focus Pan-European Campus Alliance at the Technical University of Berlin. Urban Design, (1), 8-39.

Lu, Y., & Chen, B. (2015). A review of urban metabolism research: connotation and methods. Acta Ecologica Sinica, 35(8), 2438-2451.

Huang, J. H. (2014). The cause of the problem of large class size in urban compulsory education schools and its resolution. Teaching and Management: Middle School Edition, (11), 9-10.

Development and Planning Department, Ministry of Education of the People's Republic of China. (2010). China Education Statistics Yearbook. Beijing: People's Education Press.

Shanghai Bureau of Statistics. (2018). 2018 Shanghai Statistical Yearbook. Beijing: China Statistics Press.

Zhao, X., & Sun, T. T. (2014). A preliminary study on the status quo of waste collection and recycling on university campus. Energy Environmental Protection, 28(2), 51-53.

Gao, B., Tan, H.W., & Song, Y. C. (2011). Analysis of the current situation and existing problems of energy use in campus buildings in colleges and universities——Taking a comprehensive university in the Yangtze River Delta as an example. Building Energy, (2), 41-44.

National Bureau of Statistics of the People's Republic of China. (2008). China Energy Statistics Yearbook 2008. Beijing: China Statistics Press.

Xu, Z. G., Yin, Z. Q., Wang, J. Q., Yin, J. Q., & Gao, J. F. (2011). The status quo of waste sorting and recycling on Three Gorges University campus and the establishment of recycling mechanism. Green Technology, (10), 117-119.

Cui, W. K. (2006). Discussion on the classification and recycling of campus waste and resource conservation. Science and Technology Information Development and Technology, 16(9), 233-235.

Chen, C. Y. (2001). Classification and Treatment Plan of Urban Domestic Waste. Agricultural Mechanization Research, (4), 89-92.

Development and Planning Department, Ministry of Education of the People's Republic of China. (2017). 2017 China Education Statistics Yearbook. Beijing: People's Education Press.

He, X., & Bai, X. Y. (2011). A preliminary study on the management of waste sorting and recycling in colleges and universities: Taking the Chenggong campus of Yunnan Normal University as an example. Environmental Science Guide, (2011, March), 30-34+.

Smyth, D. P., Fredeen, A. L., & Booth, A. L. (2010). Reducing solid waste in higher education: The first step towards 'greening'a university campus. Resources, Conservation and Recycling, 54(11), 1007-1016.

Dai, L., Wang, J., Cong, H. Z., Han, Y., Shao. C. J., Wang, M. Y., Feng, M. L., Zong, Q., & Dai, X. X. (2004). Discussion on the classification and recycling of campus waste and resource utilization. Urban and Rural Environmental Science and Technology of Liaoning Province, 24(6), 6-7.

He, J. T. (2009). Contemporary University Campus Planning Theory and Design Practice. Beijing: China Construction Industry Press.

Chen, X. Q. (2015). Green research supports sustainable campus——Yale University's idea and strategy for building a green university. Educational Research of Tsinghua University, (2015, June), 120-124.

Zhao, T. Y., Liu, H., & Jin, X. (2009). An analysis of effective ways for Peking

University to develop a green campus. Environmental Protection, 2009(3B), 40-42. (T. Y. Zhao, 2009).

Cole, L., & Wright, T. (2003). Assessing sustainability on Canadian University campuses: development of a campus sustainability assessment framework. Unpublished master's thesis, Royal Roads University, Victoria, BC.

Ministry of Housing and Urban-Rural Development of the People's Republic of China, Ministry of Education of the People's Republic of China. (2008). Management and technical guidelines for the construction of conservation-oriented campuses in colleges and universities, (MOHURD [2008] No. 89).

Hu, P. (2013). Japan's Theory of "Community Construction": From "Citizen Participation" to "Citizen Subject". Japanese Journal, (3), 119-134.

Gong, M. S., Yang, Z., Zheng, B. B., & Zhang, L. (2019). Co-creation mechanism and interaction in community building. Chinese Art.

Ding, K. L., Huang, L. L., & Zheng, W. (2013) An analysis of community construction in Taiwan. Journal of Zhejiang University (Science Edition), (2013, July), 716-725.

Wang, B. Z. (2017). Community x Construction: Policy Planning and Theoretical Time. Beijing: Social Sciences Literature Publishing House.

Hai, J. (2011). Research on Sustainable Campus Planning Strategy Based on Symbiosis Thought. [Doctoral dissertatio]South China University of Technology.

Bao, L., Zhou, J., & Ding Y. B. (2019). Analysis of the green campus strategy of the Science City campus of ETH Zurich. Architecture Journal, (5), 4.

Liu, C. (2011) Research on green campus evaluation system and its application in post-disaster school reconstruction., Doctoral dissertation, Tsinghua University.

Song, J. Q., Zhao, R., & Zhang, M. L. (2018). Perceived energy consumption smart supervision-exploration and practice of Jiangnan University's digital energy supervision platform construction. University Logistics Research, (2018, June), 50-54.

Yao, Z., Feng, C. C., & Kan, J. J. (2011). Research on low-carbon campus based on

the ecological footprint theory: Taking the ecological footprint of Peking University as an example. Resources Science, 33(6), 1163-1170.

Gu, X. W., Li, G. J., Wang, Q., Liu, J. X., Ding, Y., & Liu, J. Z. (2005) Eco-efficiency of Higher Education-Ecological Footprint of University Campus. Glaciology and Geocryology, 27(3), 418-425.

Huang, B. W., & Lu, B. (2016). Research on the Low-Carbon Performance of University Campus Canteens——Taking the Compass Canteen of Peking University as an Example. Journal of Peking University (Natural Science Edition), (2), 320-326.

Wang, Y. S., Yang, X., Yan, H., Zhang, Y., & Li, J. F. (2017). Building carbon emissions estimation based on the whole life cycle: Taking a campus office building renovation and expansion project in Guangzhou as an example. Journal of Engineering Management, 31(3), 19-24.

Sun, X., Tong, H. H., Niu, J., & Zhao. Y. C. (2011). Comparison of greenhouse gas emissions in the collection process of campus domestic waste. Design and Research of Nonferrous Metallurgy, 32(1), 34-36.

Chen, J. F., Zhu, X. Y., & Ren, L. J. (2011). From a low-carbon campus to a low-carbon neighborhood: Taking the campus space change of Huazhong University of Science and Technology as an example. Chinese Garden, 27(4), 74-77.

Cai, J. S., Chang, M. L., Chen, W. Q. (2011). Measurement and analysis of personal ecological footprint based on questionnaire survey——Taking Xiamen University as an example. Environmental Science and Management.

Zhao, Y. L., Yang, J., Sun, T. Y., & Yao, J. L. (2019). Research on the international academic frontier dynamics of green campus. Housing Technology, (2019. June), 40-48.

Yang, M., Xu, H. R., Guo, X. L., Han, C., Ge, S. S., & Wang, J. (2018). Research on the Countermeasures of Campus Waste Sorting Collection and Treatment from the Perspective of Green Development. Green Technology, (18), 45.

Chen, N., Chen, K., Hu, L., Shi, Y. Y., & Qiu, H. D. (2010). Classification and analysis of physical and chemical characteristics of campus domestic waste. Journal of Chongqing University of Science and Technology (Natural Science Edition), (4), 91-93.

Zhang, Z. (2003). Research on dematerialization of municipal solid waste. (Doctoral dissertation, Shanghai Fudan University).

Tong, W. L., & Ma, H. M. (2016). Research on the management and countermeasures of multi-stage waste reduction on university campuses. Logistics Engineering and Management, 38(7), 192-194.

Deng, Y. F., Qiu, L., & Zhang, D. (2011). Research progress on anaerobic digestion of organic waste in ecological campuses. Journal of Agricultural Mechanization Research, 33(8), 184-187.

]Tu, Q., Zhu, C., & McAvoy, D. C. (2015). Converting campus waste into renewable energy–A case study for the University of Cincinnati. Waste Management, 39, 258-265.

McLure, A. (2009). Composting on campus. University Business.

Keniry, J. (1995). Ecodemia: campus environmental stewardship at the turn of the 21st century: lessons in smart management from administrators, staff, and students. Natl Wildlife Federation.

Guo, Z. (2014). A Preliminary Study of Green Campus Design Strategy. (Master's thesis, Shanghai Jiao Tong University).

Liu. H. B., Zhou, X., & Liu, Y. F. (2017). A review of research on the construction of green universities in my country. Tianjin Science and Technology, (12), 28.

Yang. C. C. (2018). How to use creativity to promote the construction of a sustainable university campus——Taking Virginia Commonwealth University as an example. A Comparative Study of Cultural Innovation, (32), 92.

2 SYSTEMIC DESIGN THEORY AND METHODOLOGY


APARCAMENT

2.1 The origin of systemic design

2.1.1 Concept of system

Before talking about systemic design, we first need to define the meaning of the 'system'. A system is a grouping of parts that work together towards a common goal. (Forrester, 1971) Donella Meadows(2008) wrote in 'The Beauty of the System': 'Systems are a group of interrelated elements that are organized in a coherent way and work together to achieve a goal.' Take the digestive system as an example The elements that make up the system are teeth, enzymes, stomach and intestines. The physical flow of food and chemical signals correlate with each element. Our digestive system operates over and over again, ingesting nutrients and energy from the outside, and absorbing and excreting waste itself to help the organism continuously renew itself. The loss of one element in the system will affect the functioning of the entire system.

When the correlation disappears, the system stops. It can be seen that the three core elements that make up the system are elements, connections, and functions for the purpose. For system-level problems, the crux of these three elements needs to be found.

However, when we try to use traditional system definitions to conduct an in-depth analysis of tangible or intangible organizational and structural units, the ambiguity of the system concept itself naturally appears. Richard Buchanan(2019) discussed the potentially controversial issue in the traditional system definition, that is, does the system exist? What is systematized? How do the components work together in an organized way? And why does the system exist? Rethinking the definition of a system based on the

four modes of thinking discussed by Richard McKeown can be divided into 4 major categories. The first type is that the system may be composed of all parts under the influence of external forces. A system is an arrangement of interacting parts or bodies combined under the influence of related forces. The second type considers that human beings are autonomous and arbitrarily choose a set. A system is an exclusive combination and it is a set of units, parts, or members arranged and related to form a unity. The third definition is similar to the traditional concept. This definition comes from the identification of the problem in the phenomenon and the solution to the problem through analysis and integration. process. It believes that a system is a group of units or elements forming a whole and operating in unison to accomplish some function or purpose. This model assumes that existing problems can be systematically studied, acted on, and created. The last set of definitions considers that the system represents an assimilation pattern, and parts or elements are not considered as distinctive features of the system. On the contrary, the model emphasizes that a system is a condition for harmonious and orderly interaction. The emphasis here is on the condition, the central attribute of the whole. In other words, a system is a condition of harmonious, orderly interaction.

Luigi Bistagnino (2011) said in *Systemic Design* that the system 'is not a replica of the real world' but consists of a flexible network of relationships, among which 'people, 'Processes, materials, or equipment' exist with the conclusion of the agreement, and are also dissolved due to the termination of the agreement. The agreement provides direction and purpose for the operation of the system. In this system, the performance of the tool has an important impact on the wear and quality of the material; the methods and skills of people using the tool will also have a direct effect on the material consumption. Therefore, each element in the system can operate normally to form a joint force. This view emphasizes that the system is not a physical object, but a dynamic relationship. Human interaction plays a decisive role in maintaining the existence of this system.

Through the discussion of the connotation of the system, we must recognize the value and limitations of systems thinking for design. It can explain the complexity, internal relationships, and interdependencies that exist in our environment, but it still cannot directly derive the specific path to solve the problem. Therefore, the design needs to exert its function to define the specific action mode.

2.1.2 Systems thinking and systemic design

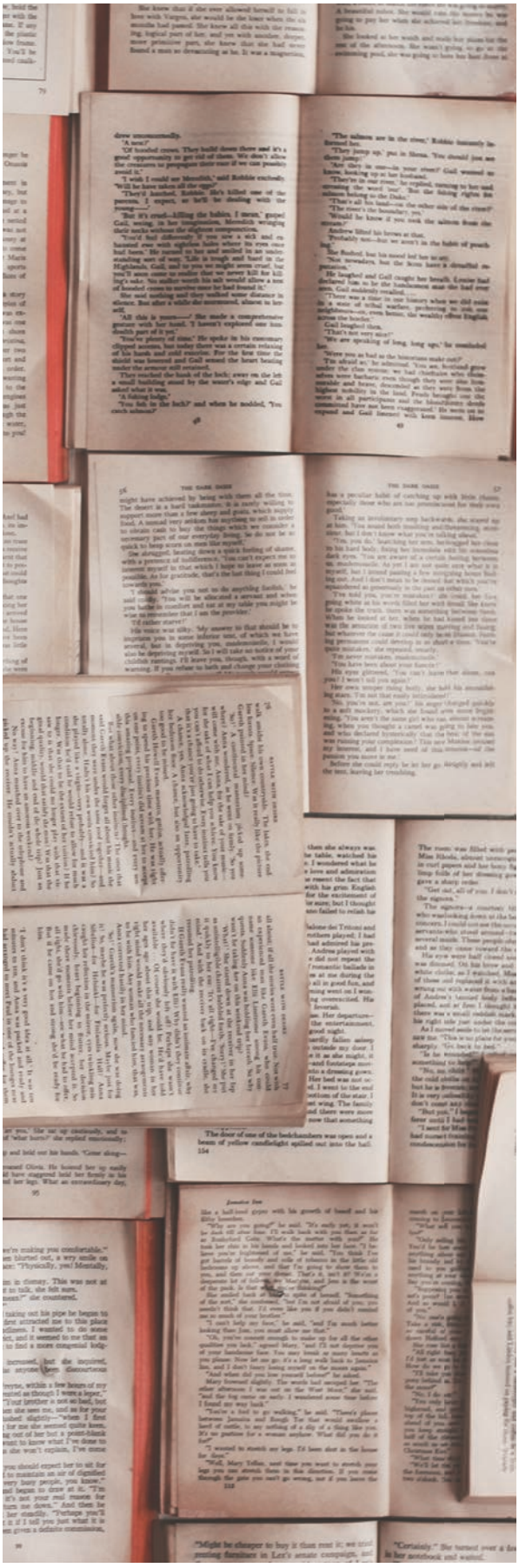
Figure 28. Global Systemic Design Academic Research Center. Adapted from Systemic design Courseware Information of Politecnico di Torino by Systemic Design Lab Politecnico di Torino.

Systems thinking advocated by systemic design is not a modern product. It has long existed in the long course of history. In ancient China, traditional chinese medicine believed that 'qi and blood are connected' and 'meridians are connected'. The organs of the human body are related, and the balance of the body needs to be regulated from the whole. In ancient Greece, Aristotle proposed the classic theory of 'the whole is greater than the sum of the parts', emphasizing that the whole system is connected by parts in a certain way, and it is not a simple pile of parts that can achieve a good operation. It can be seen that systems thinking has always been deposited in

human practice.

Systemic design is an emerging discipline that is in the early stages of development. In the context of economic globalization, resources have been over-exploited and produced as commodities and shipped to all parts of the world to satisfy people's desires and needs. Gunter Pauli, in his book *The Blue Economy: 10 years – 100 innovations – 100 million works,* explained that the sustainable opportunities of imitating nature production activities can imitate nature's metabolic principles (Pauli, 2010). In 1994, with the support of the Japanese government, he established the Zero Emissions Research Institute and Action Organization (ZERI) at the United Nations, dedicated to turning the production process into an ecological process. Systemic design came out from this background. It attempts to reshape people's mindset of treating waste and consider wastes the same as raw materials or products. And this design method provides a supportive beautiful vision: the waste will no longer be seen as a end-of-life output transporting to the landfill, but be regarded as a misplaced resource as input for another system.

Systemic design is dedicated to turning the world of man-made objects into an open circulatory system with no waste output, following the metabolism of nature.



2.2 Conceptual interpretation of systemic design

2.2.1 Vision of systemic design

The systemic design attaches importance to the relevance of the existence of all things. In the face of the current closed, linear and self-centered development concept, the symbiotic relationship between humans and nature has been severely damaged. When all systems are seeking the best resources from the outside in isolation, and completely disregarding the impact of their behavior on other systems, a bad picture appears. Resources are consumed without restraint, and will surely go from ‘cradle’ to ‘grave’. The systemic design hopes to reverse this situation. By allowing the production chains in the same area to communicate with each other, let them look around and realize that they are also part of a larger system. In cooperation, the flow of materials between the catalytic subsystems a system’s The remainder is transformed into raw materials for another system.

Systemic design is a method of rearranging design process, which follows the principles of nature to build production and energy systems to achieve zero emissions in air, water and soil. It advocates that by creating new connections between local production activities, the material and energy flows in the system are fully utilized. At the same time, a new operation mode is designed to provide a production mode that can imitate nature and have a self-circulation function for the industrial production process (Barbero, 2012). As an engine of sustainable development, it enables consumers, producers and designers to start thinking about issues such as geographical and local identity, how to reduce the environmental impact of

the entire product life cycle, and how to start from improving waste utilization Turn the output into the input (Bistagnino, 2011). The birth of systemic design provides a new way of action and entry point for the practice of sustainable design, allowing designers to intervene in environmental issues from a greater perspective. At the same time, through the material flow management of input and output, systemic design also provides a practical method for the ecological analysis of system activities, and exerts the ability to design and integrate resources to propose new strategies for the sustainable operation of the system.

2.2.2 Fundamental guidelines of systemic design

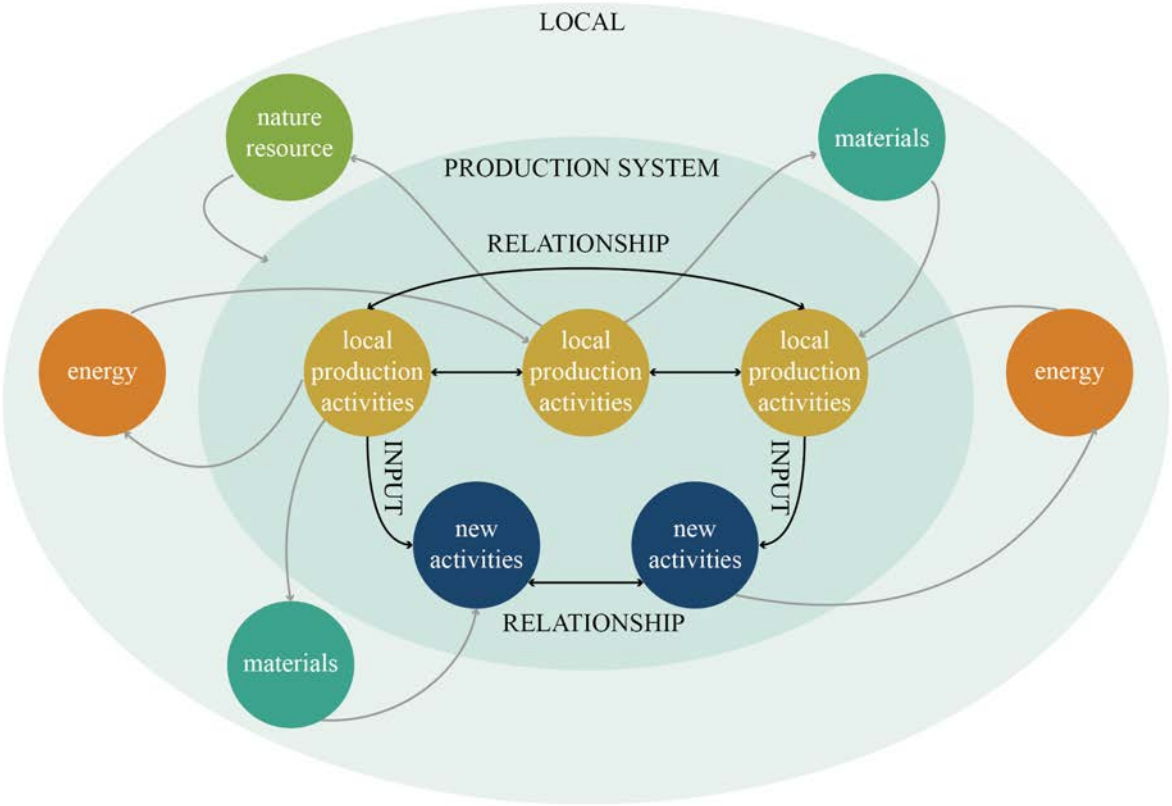


Figure 29. Systemic design method. Adapted from the original picture comes from the courseware of the Politecnico di Torino.

The theory of systemic design can be summarized into five basic guidelines:

1. The output (waste) of one system becomes the input (resource) of another system.

Metabolism in the natural world is based on the material cycle of the ecosystem. Various organisms interact with each other and between biological and non-biological environmental factors, and a continuous flow of matter and energy. However, there is a

lack of a mechanism for preserving the balance between man-made artificial systems and ecosystems, so that human activities continue to demand and consume resources to reach the natural limit. The concept of 'emissions first, governance second' encourages irresponsible production and consumption.

The systemic design emulates the way the ecosystem operates, designing ways to recycle waste, turning emissions from one system into input materials for another system, and reducing the ecological footprint and production through the material flow (throughput) in the planning process Economic flow; establishing a more effective relationship between agricultural and industrial production processes, natural systems, regions, and communities (Bistagnino, 2011).

2. The relationship constitutes the system itself, and the established relationship generates the corresponding open system.

Relevance is one of the basic elements of the system, it reveals the close connection between things. The closed, linear system cuts off the connection between itself and the outside world so that the system activities cannot obtain continuous supply, and the residual value cannot be fully utilized. Therefore, the emphasis on relevance promotes the formation of an open relationship network in the region and forms a closed-loop for the flow of matter.

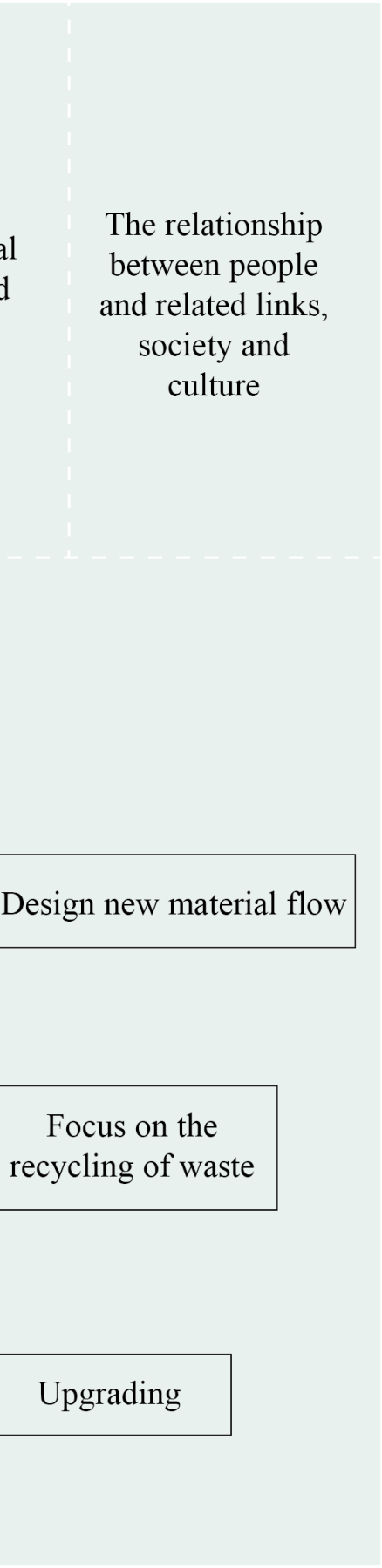
3. The open system in operation evolves together in self-sustainment and self-replication.

The open system stands on the opposite side of the closed system and attaches importance to the connection between the system and the outside world. The components of the system can develop in harmony with each other and have the ability to maintain themselves so that the existing closed system can be transformed into an open self-generated system.

4. Give priority to local resources and take action locally.

Production activities are not a linear process for businesses to use resources to manufacture products. They are also intertwined with the social, natural, cultural, and economic backgrounds in which they are located to form a complete system (Bistagnino, 2011, p.20). The development and utilization of nearby resources have promoted the long-term development of the local economy and reduced energy consumption in transportation. This approach is not to break away from the global development network, but to adapt to local conditions, place the local economy in the global network, and design a localized development strategy.

Value	The output of a system becomes the input of another system	Relationship constitutes a system, and the established relationship generates an open system	The co-evolution of operating open systems in self-shame and self-replication	Prioritize loca resources and take actions locally
Operation	Input	Process	Output	
	The source reduces the negative impact on the environment and people	Improve the efficiency of energy resource utilization		
	Strengthen local cooperation and prioritize the use of local resources	Make full use of resources		
	Design a zero-waste supply chain	Extend the life cycle of materials		



5. The relationship between people and their related environmental, social, and cultural backgrounds

Under the economics method based on fierce competition, the potential connection between man, society and nature is cut apart. Design is an activity carried out in a tightly interwoven space composed of self, society and environment (Boehnert, 2018). The design has always advocated 'people-oriented'. In the face of ecological problems, we should return to humanism, and take local social and cultural factors into consideration.

Figure 30. Principles of systemic design action.
Complied by the author.

2.3 Systemic design methods and tools

2.3.1 Methods and tools

1. 'Holistic Diagnosis' of the system

This stage mainly collects the required raw data through surveys and researches, which can be divided into field research and desk research. The data to be collected includes the quantity, quality description, source, destination and purpose of the input and output of the system activities. Flow is interpreted in the Cambridge dictionary as the movement of something in one direction. The analysis of the energy and material flow includes the analysis of all substances used in the production, exchange and consumption of goods or services. Specifically, it can be divided into 3 categories: input, output and logistics. Among them, input refers to resources such as raw materials, semi-finished products and energy entering the process. Output refers to waste, residues, surplus energy and products surplus energy and products or services produced or not used in the process. A holistic diagnosis is an analysis process. Its' main purpose is to determine the process of a system and the environment in which the system is located, to highlight the connections between system components, and to provide the necessary support for the interpretation and analysis of data.

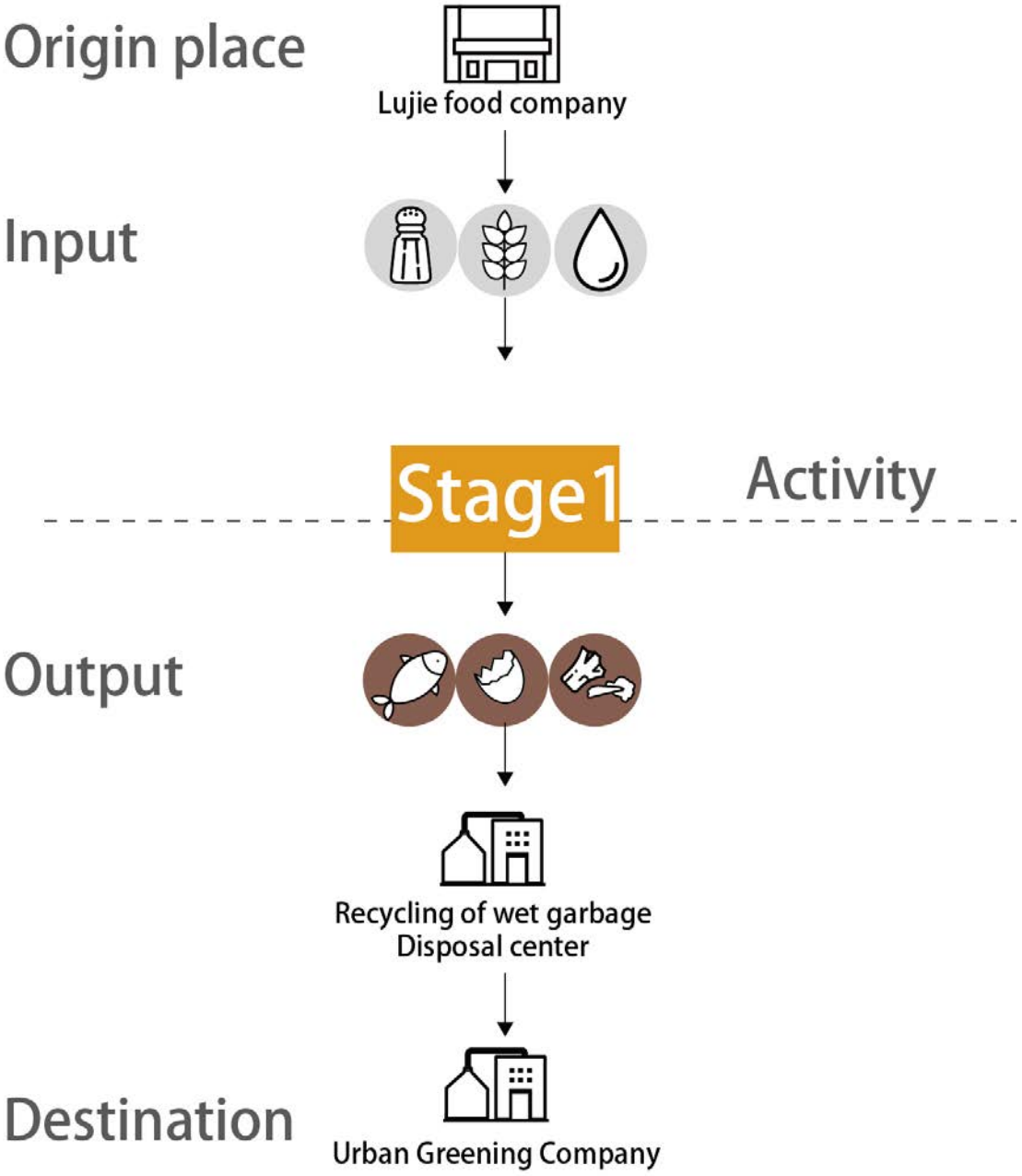
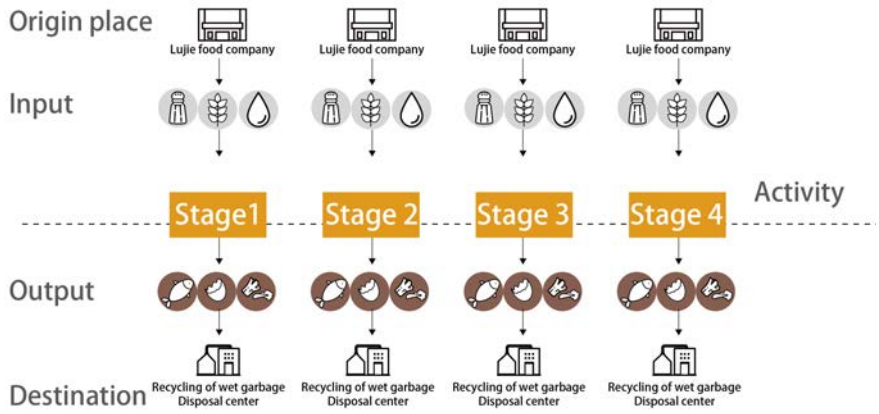
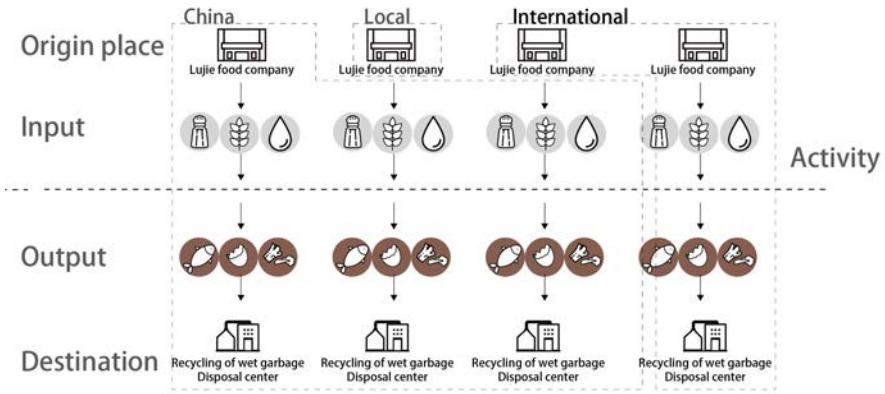


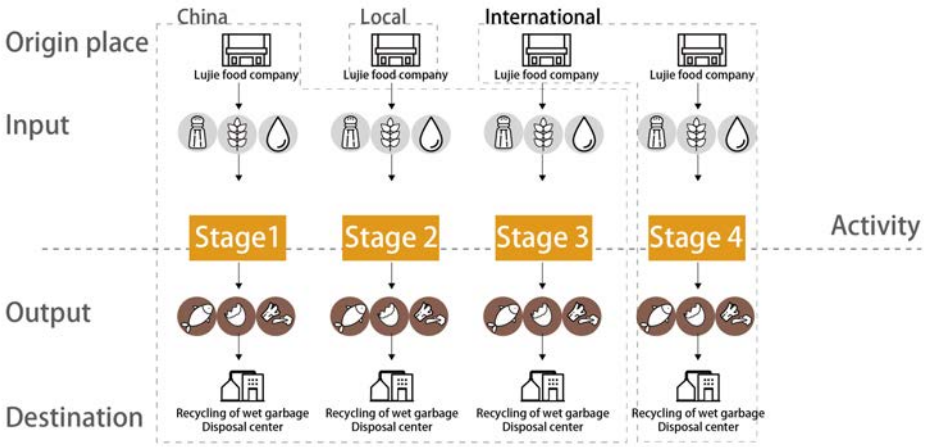
Figure 31. Contents of Holistic Diagnosis.
Adapted from the courseware of Politecnico di Torino: the author translated and redrawn.



Particular Analysis



General Analysis



Total Analysis

Figure 32. Visualization tool specification. Adapted from the courseware of Politecnico di Torino: the author translated and redrawn.

2. Analysis of current system (Analysis of Current System)

This stage requires an analysis of the collected data. The systemic design uses visualization design tools to help design teams, technicians and all stakeholders quickly understand the current status of the system. The systemic design map is mainly divided into 3 types of map layout: Particular Analysis Map, General Analysis Map and Total Analysis Map.

The maps focus on different aspects:
1. Particular Analysis Map focuses on describing the process of the system and the types, quantities, and quality characteristics of the inputs and outputs of the process, as well as the source and destination of the material, and can show the flow of material and energy at every link in the system.
2. The General Analysis Map focuses on the origin of the input and the destination of the output.
3. The Total Analysis Map is the most complex and comprehensive picture of information. The flow of matter in the process and their relationship with the region need to be presented in the same picture. This picture completely shows the process of matter from the cradle to the grave, the region and relationship.

3. Analysis of Problems/ Opportunities

Based on the visual representation of the data, the design team observes the problems in the material flow and finds alternatives. So far, system design has not proposed clear guidelines for problem analysis methods, but in the practice of using system design research methods, the design research team has explored some analytical paths. The author tried to start from the source to the end of the process node. The first step is source management analysis. In this process, it is necessary to evaluate the energy or material consumption, sustainability and source localization. The second step is process analysis. It evaluates the composition and value of waste generated in the process. It may include by-products, surpluses, surplus energy, etc. The third step is waste treatment analysis. Based on the conclusion of waste assessment, to analyze existing treatment methods, and pay attention to whether its value is repeatedly tapped and whether it is recycled.

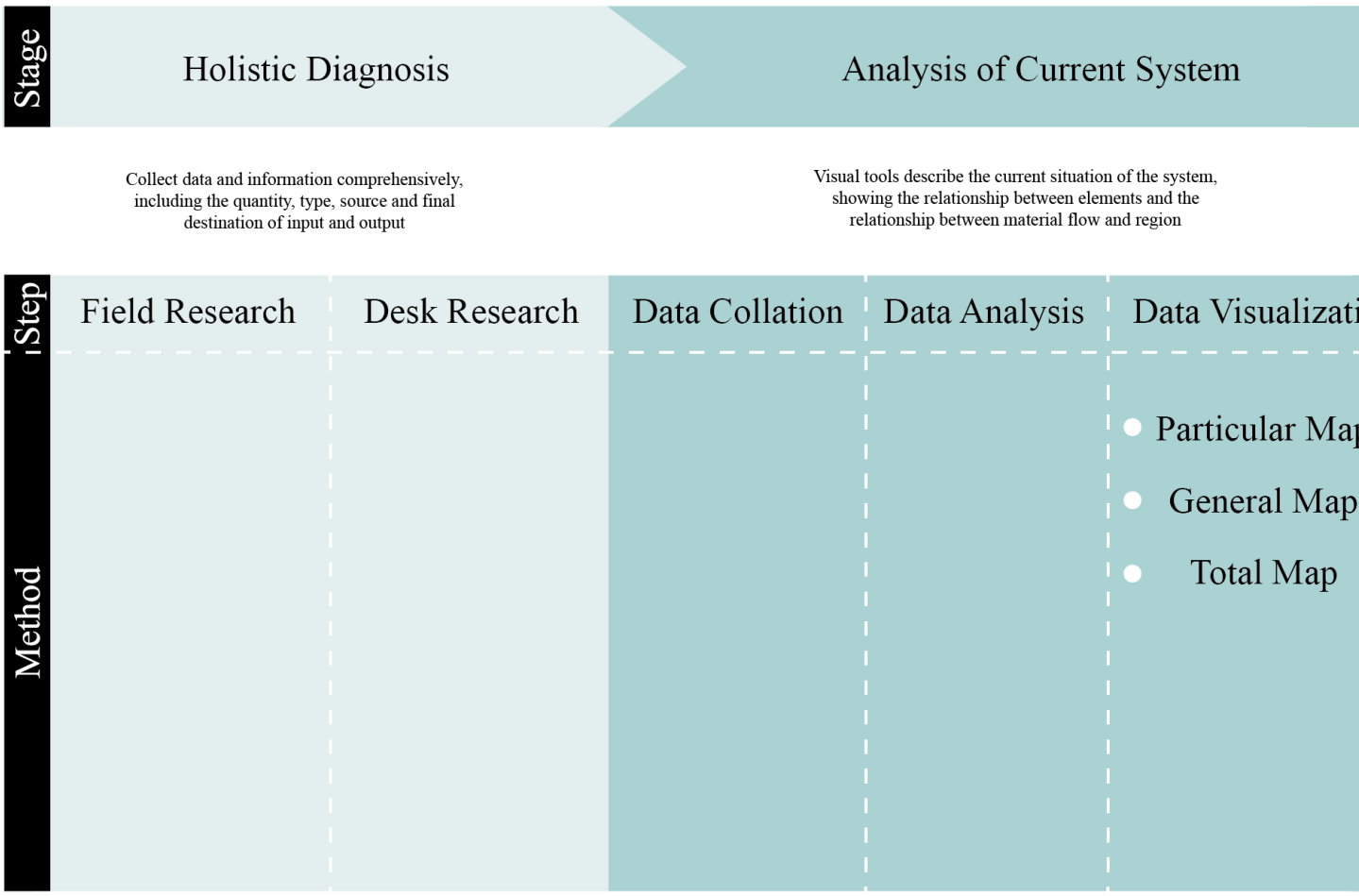


Figure 33. Steps and methods of system design. Adapted from the courseware of Politecnico di Torino: the author translated and redrawn.

4. Determine the systemic production mode (Systemic Project)

Choose alternative solutions for system optimization among alternative options, and describe the new system according to new substances and relationships, and conduct a comprehensive evaluation of the systemic solutions.

Problems / Opportunities

Analyze the problems of the existing system and find the corresponding solutions

Systemic Project

Choose highly feasible, localized, and systematic solutions among alternative options

ion	Problem Analysis	Opportunity Analysis	Systemic Project	Possibility Evaluation
p	• Problem Map	• Opportunity Map	• System Map	• Matrix Scenario • Balenced Sheet • Cash Flow • Business Plan • Outcomes • Relations to the Territory

2.4 Summary

The systemic design is mainly divided into 4 stages. The holistic diagnosis is the investigation stage. The analysis stage consists of 2 parts: system analysis, problem and opportunity analysis. Finally, there is the design and evaluation stage. This stage is composed of several design steps, some of which have clear tools to assist the design practice. The author visualized the steps of systemic design, with the current commonly used methods or tools in the visualization. As can be seen from the figure 33, most of the design tools are in the middle-end stages, and at the beginning and ending of the design process is in blank, which means no method or tool for these phases. And more than half of the tools are from the perspective of visual narration. The methods of data analysis and interpretation are not mentioned. This can easily lead to the fact that the research is processed by the subjective judgment of the researcher and lacks a solid basis for judgment.

Since system design is a design research that spans a single subject category, a large number of knowledge and tools outside the design subject are involved in the stages of design research, data collection and analysis. This is a huge challenge for the designer researcher and also increases the complexity of the design process. In addition, the object of design research is no longer a user or a specific, static object, but an abstract, complex system of motion. The role of design authors in the research process is also changing, and the objects, purposes and contents of different roles are also different. The systemic design has formed a complete set of methods, but there is no more specific explanation in the design investigation and problem analysis. Therefore, in the next chapter, I will discuss the methods and tools of systemic design applied in the process of green campus building, hoping to provide some more clear framework for the practice of related design research.

Reference

Forrester, J. (1971). Principles of Systems, Pegasus Communications. Inc., Williston, VT, USA.

Meadows, D. H. (2008). Thinking in systems: A primer. chelsea green publishing.

Buchanan, R. (2019). Systems thinking and design thinking: The search for principles in the world we are making. She Ji: The Journal of Design, Economics, and Innovation, 5(2), 85-104.

Bistagnino, L. (2011). Systemic design. Slow Food, Torino e Italy.

Pauli, G. A. (2010). The blue economy: 10 years, 100 innovations, 100 million works. Paradigm publications.

Barbero, S. (2012). SyStemic energy networkS, Vol. 1. The theory of Systemic Design applied to energy sector (Vol. 1). Lulu. com.

Boehnert, J. (2018). Design, ecology, politics: Towards the ecocene. Bloomsbury Publishing.

3 STRATEGY


APARCAMENT

3.1 Green campus building

3.1.1 Basic elements

According to the interpretation of the connotation of the green campus, the author has extracted 3 main contents contained in the green campus, which are divided into the **school people health, the ecological environment health, and the sustainable campus management**. The school people health has 2 sides of meaning. On one hand, it refers to the impact of the campus environment on human physical health. On the other hand, it involves the function of campus to perform its implicit educational function, referring to human mental health. The ecological environment health refers to the impact of human activities on the campus on the environment and the relationship between people and nature.Sustainable campus management is about the macro-control of people health and environment health, with the study of decision-making mechanism.

After the research results of the green campus related literature, the author divides the seven related research areas of the green campus according to the three main contents of the green campus. Among them, the related research on-campus health, sustainable development education and green campus building have a concern for the health of people on campus; Campus energy utilization, carbon emission control and waste management are responsible for controlling the interactive relationship between campus and ecological environment; Sustainable campus management is the last major category, master the overall idea of campus sustainable development and formulate management rules. Green campus building recognizes the values

conveyed in the concept of green campus, and only emphasizes the initiative and participation of people and the sustainability of design at the methodological level. Therefore, the basic elements of green campus building are consistent with the main content of green campus research.

3.1.2 Features of green campus building

Based on the previous explanation of the concept of green campus building, the author summarizes the characteristics of green campus building into 3 keywords: participation,continuity and intangibility.

1. Participation

The green campus building of an established school requires the initiative of campus users. As ecological emergencies repeatedly sound the horn, human beings need to change their ecological consciousness to a greater extent. Whether it is the 'not concern about oneself, hang high' mentality, or the 'Not in My Backyard' in the face of environmental dilemmas, it reflects the inertia of human beings in facing environmental problems. As an ecological creature, we are closely connected with the natural world and interdependent, but our understanding does not reflect these basic geographic and biological conditions. Therefore, we have built a very unsustainable lifestyle (Boehnert, 2018). In this complex context, the perspective of the design team's intervention should change accordingly. The local focus on the sustainability of the physical environment can only cause ripples in one place, so design urgently needs to change its mode of action and expand the scope of practice. Therefore, the author believes that the design of a green campus also needs to be cut from a systematic and global perspective. Design authors and practitioners should focus more on the intangible environment in the campus environment, and change their roles to assist and attract the campus. Active participation of users.

2. Sustainability

The traditional design process often stops in the early stage of the project and lacks intervention in the operation and use process. This is contrary to the full life cycle process design mentioned in the connotation of the green campus, resulting in the lack of sustainability of the design effect. The green campus building extends the reach of the design vertically and provides design strategies for the completed campus.

3. Intangibility

A green campus emphasizes more on the intangible environment than on the 'green' visually and physically, and the

scope of the design outcome was not only the tangible objects. Excessive resources, energy consumption and a large number of environmental emissions are almost directly caused by uncontrolled production and consumption activities (H. T. Wang, 2011). To solve the overshoot situation, it is necessary to change the existing unsustainable production and consumption patterns.

To solve the overshoot situation, it is necessary to change the existing unsustainable production and consumption patterns. A widely overlooked fact is that production and consumption activities are determined by human consciousness, actions, and decision-making. Therefore, analyzing the reasons behind behaviors that affect the environment can help provide direction for practice.

3.2 Applicability analysis

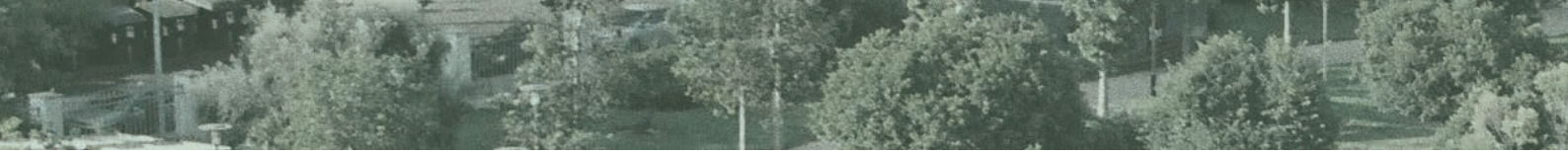
3.2.1 Feasibility analysis

Systemic design methods can solve the problem of 'visibility' of complex systems (Lou, 2018, p.347), that is, help us understand the complex environment we are in. And it could broaden and deepen the boundaries of our understanding so that we can feel and recognize the wide range of time and space background. By describing people, processes, materials, or equipment in system activities, the systemic design weaves a dense network of relationships and provides a structural reference that enables us to understand the world dimensions, describes and see ourselves location (Lou, 2018, p.343) .

In the daily activities of the campus, people consume resources on the earth indirectly or directly by consuming or using various substances or artificial objects, which affects the operation of the campus and even the urban system. However, since cities contain natural, social and other subsystems, different human activities are arranged in specific social units. Humans are far away from the natural environment, which makes it difficult for us to perceive the environmental consequences of long-distance ecological crises and individual behaviors. Systemic design uses visual language to describe the complex interaction patterns and processes in human systems and to associate them with ecosystems. Through the system map and simple and easy-to-read visual images, the ecological impact of the daily activities and routine behaviors of the participants in the system on the environment can be traced, which helps the participants of the system and the constituents to see the potential environmental issues.

Compared with data reports in the hands of ecologists and environmental engineering practitioners, the systemic design depicts unsustainable issues on campus in readable and readable language. At the same time, this approach can use the narrative nature of images to convey meaning and consensus (Zhuang & Ke, 2018). Also, this approach could help campus users to change their established thinking and acquire ecological knowledge, and construct a context of action and dialogue to inspire designers, experts and all stakeholders to pay attention to potential environmental issues on campus and stimulate them to participate.

Systems thinking included in the systemic design provides a global perspective to analyze the system. It emphasizes the potential relevance of energy resources, users, equipment, scenes, and other related elements involved in the activity, and it made us aware of the systemic consequences of our actions. Breaking established thinking and behavior patterns are not easy. An Individual's behaviors are related to an individual's judgment on the state of things, so it is hard to lead persons' life in a different way from the mainstream way of doing things, and also hard to make him willing to take active cooperative actions.



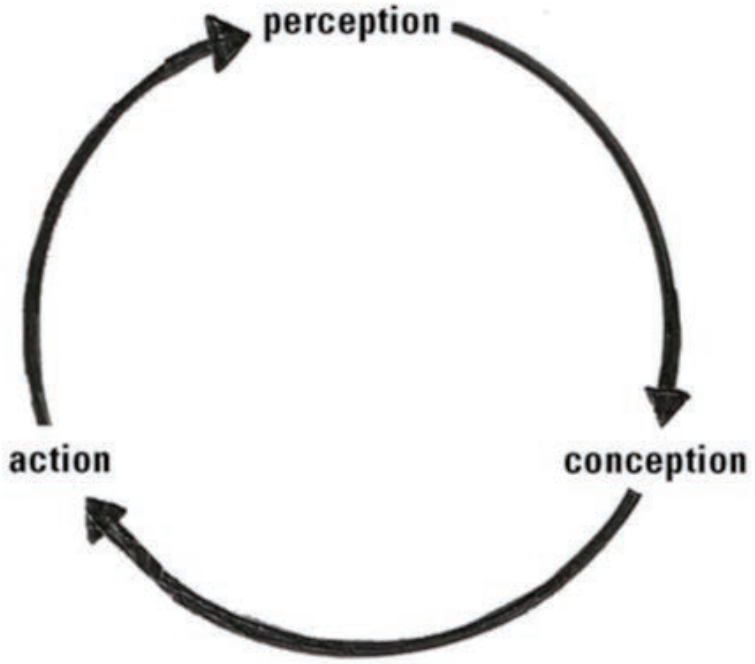


Figure 34. Perception, Conception, Action. Ecolabs. Adapted from *Design, Ecology, Politics: Towards the Ecocene*, by J. Boehnert, 2017, London: Bloomsbury Publishing. Copyright 2017 by Bloomsbury Publishing.

Systems thinking could help people in understanding the complexity of moments in the system, and help people in perceiving the variables that affect the moments (E. Manzini, 2015, p.145). The systemic design reveals the correlation between actions and results, which can clarify the factors that affect the sustainable development of the campus, help to find the crux of the sustainable problems facing the development of the green campus, and find out where is the breakthrough in the construction of the green campus by revealing the internal connections in the campus point. Recognizing the connection between personal behavior and the ecological environment helps to cultivate ecological qualities and prepares for positive action.

In addition, the systemic design method is a solution to ecological problems. It can provide concrete and actionable action plans for changing the unsustainable status quo on campus. Specifically, the systemic design's focus on resources, energy use, waste emissions, and carbon emissions is consistent with the goals of saving resources, protecting the environment, and reducing pollution

mentioned in the green campus concept. Through the analysis of the metabolism of substances at the input, process, and output of the system, the systemic design can modify the equipment, services, and interaction that cause environmental impact to ensure the reduction of the source in the campus system and the harmlessness of the process end. Compared with other ecological design methods, the systemic design is the design method of the research process. It can grasp the dynamic and periodic system rules, rather than staying at one node. Therefore, it can provide design solutions for the ecological environment in the construction of green campuses at the system level, which helps to solve another key problem - the the driving force. (Y. Lou, 2018)

As the sustainable development educator Stephen Sterling(S. Sterling, 2003)puts it, the concept has shifted from beliefs shelved in the mind to concepts that provide information and influence perceptions, behaviors, and attitudes. Once the concepts are thoroughly understood, learners will develop new ways of putting ideas into practice in daily life. As shown in Figure 34, the systemic design method is involved in the construction of green campuses, by clearly describing the complex patterns and processes of human interactions with nature, explaining the relevance, and proposing corresponding actions. This design process makes environmental issues in the system visible, understandable, and feasible to stakeholders.

3.2.2 Limitation analysis

Although the systemic design method is good at solving the problems of the ecological environment at the system level, there are still some operational problems in the application of campus scenes. It faces the following problems:

1. Difficult to collect data during the research phase.

In the investigation of systemic design, a large amount of data needs to be collected. The data is about substance input and output in each activity of the system, including the name, quantity, unit, source, destination, etc.

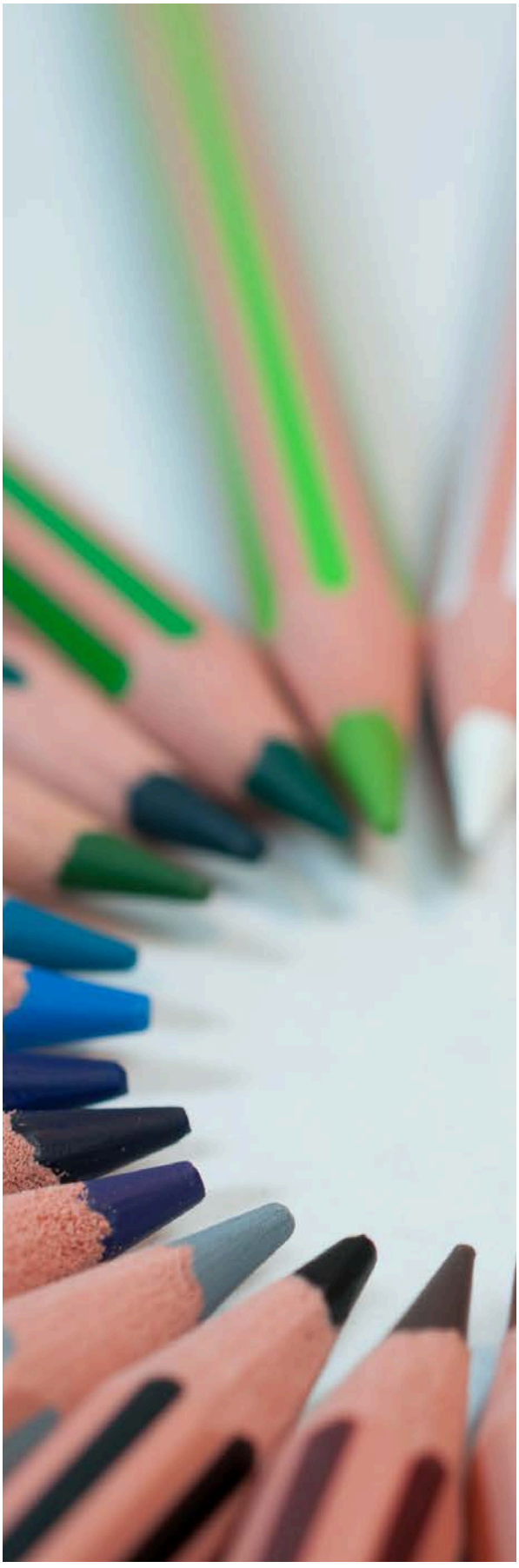
However, at the beginning of a complex system, the authors lacked sufficient understanding of the research object, so it was impossible to ensure that the data was not omitted in the survey. Because the data sources and acquisition methods are different for each research object, there are often no data or difficult to estimate. Therefore, it is necessary to specify the data collection method in different situations during the investigation phase and to clearly define the data list before the investigation.

2. Interpreting data lacks measurement standards.

Data analysis relies on subjective judgments of design authors and lacks quantitative evaluation. This cannot guarantee that the conclusion is based on accurate and objective judgment, which greatly reduces the effectiveness of the systemic design. Therefore, it is necessary to introduce criteria for evaluating the degree of sustainability in data analysis, and a comprehensive evaluation method based on the combination of qualitative analysis and quantitative analysis is required.

Through the description of the contribution and limitations of systemic design applied to green campus building, the author made an analysis and evaluation of the application of systemic design in the context of green campus building. Its solid research process has built a green campus on the campus of the established school. The solution to the ecological and environmental health problems provides a viable path, but in the face of new application scenario systemic design methods, tools and

methods need to be supplemented and adjusted during the research phase and data analysis phase. The author will mainly elaborate in the next section.



3.3 Ideas and methods

3.3.1 Ideas

Investigator	Data Clerk	Observer	Interviewer
Object	Data	Campus environment	Campus stakeholders
Type of data	Quantitative data	Pictures, videos, notes	Qualitative data
Tool	Data card	Observeration List	Interview outline
Purpose	Collect data, ensure that the data is accurate; Collect relevant information as much as possible.	Observe phenomena and potential problems; Dig out missing problems and prepare to ask for more information.	Explore the driving factors of the problem in depth and connect the phenomenon to the background environment.

Figure 35. Research methods and tools classified by design roles.
Designed by the author.

Figure 36. Research tool data card. Designed by the author.

As for the designer's role change in the process of collecting data, the author act as observer, data clerk, and interviewer, and each type of role corresponds to different research scenarios.

The first approach is that the designer acts as a data collector and clerk, inquiring, and checking the data according to the data list to ensure the accuracy of the data. When first-hand information is not available, the designer needs to collect relevant information as much as possible and find second-hand information instead.

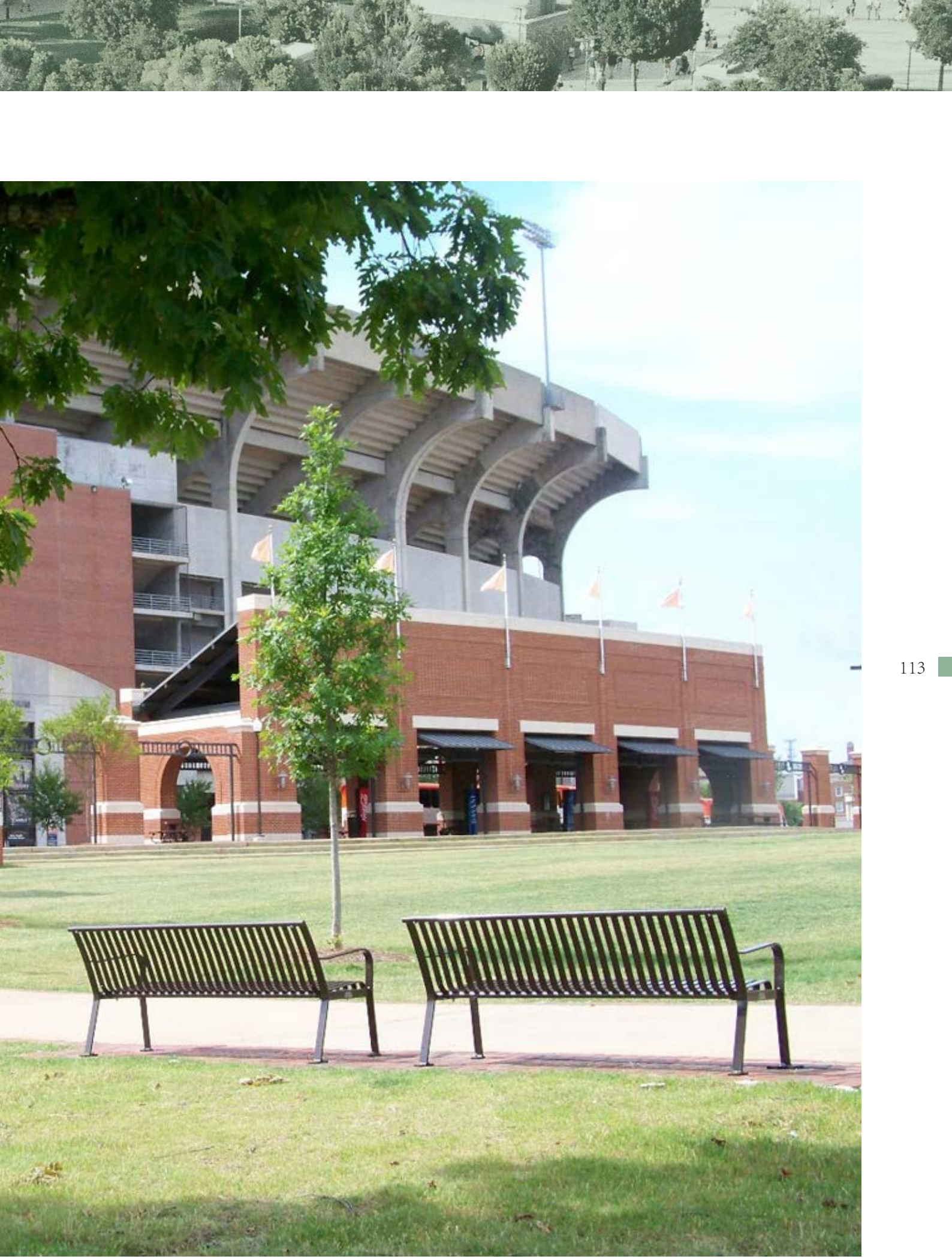
The process of data collection is the first step in systemic design and the basis of all analyses, so it needs attention. To facilitate data collection and avoid omissions, the author designed a data card as an auxiliary tool in the survey (Figure 36).

The second approach is as an observer, using the professional insight unique to the designer to discover potential problems and digging up missing information to ensure data integrity. Since the information in the interview is based on the interviewee's memories, the designer needs to dig

deeper into the research environment to find out the real situation in a way closer to campus waste. For example, trash cans of the campus and conduct the first round of data collection on the missing information.

The third approach is to gather information as interviewers in a semi-structured interview with campus stakeholders. The purpose of the interview is to understand in detail the usual activities such as procurement, preparation, use, recycling, and disposal.

The problem mainly involves the flow of system activities and the flow of material in each link. At the same time, it also needs to pay attention to the behaviors that cause waste in the process, such as ‘Why don’t you want these template papers at the end of the course?’, ‘ Did you communicate with the high school when preparing the materials?’, ‘How would you deal with some of the results that were not exhibited?’ etc.



3.3.2 Life cycle assessment method

The life cycle assessment (LCA) can be traced back to the 1969, the environmentally friendly assessment of the Coca-Cola Company's different beverage bottle packaging, which was conducted by the US Midwest Resources Institute (MRI). Since then, life cycle assessment methods have been continuously applied and developed. Authors initially focused only on the energy consumption of products, and later extended to waste emissions.

Regarding the definition of Life Cycle Assessment (LCA), the author chooses three currently representative meanings: The International Society of Environmental Toxicology and Chemistry (SETAC) is defined as: 'Life cycle assessment is an objective process that assesses the environmental load associated with a product, process, or action. It evaluates these energies and materials by identifying and quantifying the use of energy and materials and environmental emissions. The impact of material use and environmental emissions, and the assessment and implementation of environmental improvement opportunities.

The evaluation involves the entire life cycle of a product, process, or activity, including raw material extraction and processing, production, transportation and distribution, use, reuse and maintenance, Recycling, and final disposal.'

The United Nations Environment Programme (UNEP) defines Life Cycle Assessment as: '..... to evaluate the entire phase of a product system life cycle from the extraction and processing of raw materials, to product production, packaging, marketing, use, reuse, and product maintenance, Until recycling and final waste disposal-tools for environmental impact'

The definition of the International Organization for Standardization (ISO) is: 'Life Aycle Assessment is the collection and evaluation of the potential impact of all inputs and outputs on the environment of a product system's life cycle.'

Although there are different expressions and interpretations, international institutions in various countries have tended to adopt a more consistent framework and content (Q. H. Sun, N. Q. Wan, & Y. H. Fan,

2000). According to the above definition, its core can be understood as a Life Cycle Assessment to quantify and comprehensively evaluate various environmental impacts caused throughout the product life cycle. The whole life cycle of a product is from cradle to grave, which can be roughly summarized from raw material acquisition, production, transportation and distribution, use, waste disposal, recycling to final disposal. Resource consumption and environmental emissions are the two main contents of the evaluation.

LCA mainly includes 4 stages: goal and scope definition, inventory analysis, life cycle impact assessment, and interpretation.

1. Goal and Scope Definition

First of all, it is necessary to determine the goals and intentions of carrying out this research, clarify the reasons for the research, and explain the application areas of future results. Secondly, further define the research scope according to the objectives, namely product life cycle, functions and functional units, system boundaries, assumptions, constraints, etc.

2. Analysis of Inventory

Inventory analysis is the process of quantitative data collection and analysis of resources, energy consumption, and environmental emissions of products, processes, or activities throughout their life cycle stages. The core of inventory analysis is to establish input and output expressed in product systems of product functional units(H.L. Cao, 2004) . It can be divided into two steps: first, establish a life cycle model according to the definition of the system boundary, construct a system composed of product functional units, and draw a specific process flow chart (H.L. Cao, 2004, p282); Input and output in. The input resources include materials and energy, and the output is discharged into the atmosphere, water, and soil in addition to products. In addition to the recording of basic data, the source of the data needs to be marked in detail.

3. Life Cycle Impact Assessment

ISO, SETAC, and the US EPA have rated impact assessment as a 'three-step' model, the steps were classification, characterization and valuation.

4. Interpretation

The life cycle interpretation phase includes drawing main conclusions, making recommendations, and pointing out the limitations of research based on the results of life cycle assessment. In this work, the results of the life cycle assessment method are used to identify processes and hot spots that exhibit the highest environmental impact.

There are many similarities between the life cycle assessment method and the systemic design method, both of which focus on the entire life cycle process of the substance from raw material acquisition to the final disposal. Using the systemic design method alone can provide a macro analysis of the metabolism in the system. Life cycle assessment can quantify all environmental impacts from a life cycle perspective (International Organization for Standardization [ISO], 2006, p. 1) and help identify new measures to improve environmental management (Guinee et al., 2011) . However, the research process of life cycle assessment needs to involve a large amount of data and units, and the system defined in this paper is relatively complex, and the life cycle assessment method alone is not operable. Therefore, the author draws on the research ideas in the life cycle assessment method, talks about the determination of the target range and the steps of inventory analysis to integrate into the systemic design process, and provides a specific operation guide.

3.3.3 Ecological Footprint

Since there is no clear standard for measuring environmental impact in the systemic design method, design authors lack an evaluation basis when evaluating and analyzing the current status of the system. This can easily lead to subjective assumptions by design authors and affect the rationality and validity of conclusions. Besides, because it is impossible to quantify the environmental impact value, it also brings many difficulties to the identification of the influencing factors and the choice of alternatives. Therefore, in this section, the author introduces the ecological footprint component method as a measure of environmental impact.

Since the 1960s, problems such as the energy crisis and ecological destruction have caused scholars in various fields to rethink the existing development model. The limited resources of the earth and the development model of pursuing economic growth and overproduction have formed a huge contradiction. Mankind is already in a state of overshoot, and the continuously increasing demand will inevitably exceed the carrying capacity of the earth.

To ensure the endurance of the 'Spaceship', humans need to change the way they interact with nature and restrict human activities that break the ecological balance. Ecological Footprint (EP) provides a method to quantify the degree of human society's impact on the ecological environment, taking the bio-productive land area required by human activities (including resource utilization and waste discharge) as a quantitative indicator sustainability analysis. By determining 'whether human consumption currently exceeds the regeneration capacity of the biosphere, and how much it exceeds.'(Wackernagel, 1999) measures the state of the earth's bioburden to avoid overloading.

The ecological footprint of a region refers to the biologically productive land area needed to produce all the resources consumed by these populations and absorb all the waste generated by these populations(M. Wackernagel, L. Onisto, & P. A. Bello, 1997) . According to the types of land required for various resources, bio-productive land can be divided into six categories, namely fossil energy (fossil energy), arable land (arable land),

forest land (forest), pasture (pasture), built The built area and the sea area. The existing calculation methods are divided into a comprehensive method and component method. The comprehensive method is based on the macro statistics of various substances and applies to the global and national scope. The component method is suitable for the calculation of small unit objects. Its calculation steps can be summarized into 3 steps:

(1) According to the type of land occupied by each component, the quantity of each component is converted into the corresponding bio-productive land area required to provide or absorb the component.

(2) Summarize all types of land area required by all components and calculate the total area of each land type according to the formula.

(3) Multiply the equivalent factors of various types of land by the total area of the corresponding type of land and sum up to obtain the total area occupied by the land in terms of a global hectare (global hectare), that is, the ecological footprint (M. Wackernagel, L. Onisto, & P. A. Bello, 1997) .

3.4 Research framework

Based on the author's explanation of each method in this chapter, the author attempts to combine the LCA(Life Cycle Assessment) method and eco-logical footprint method into the systemic design process and provide guidance for the application in green campus construction.

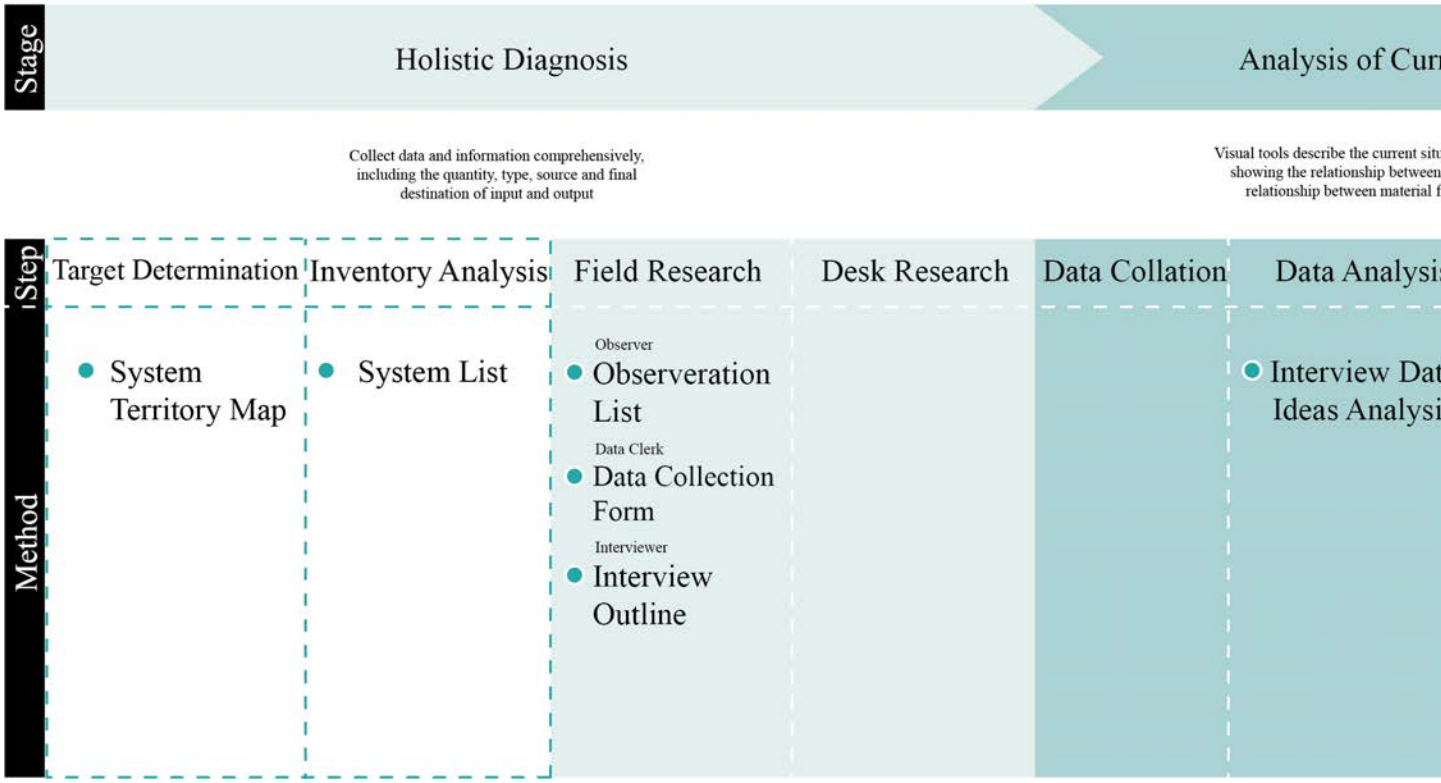


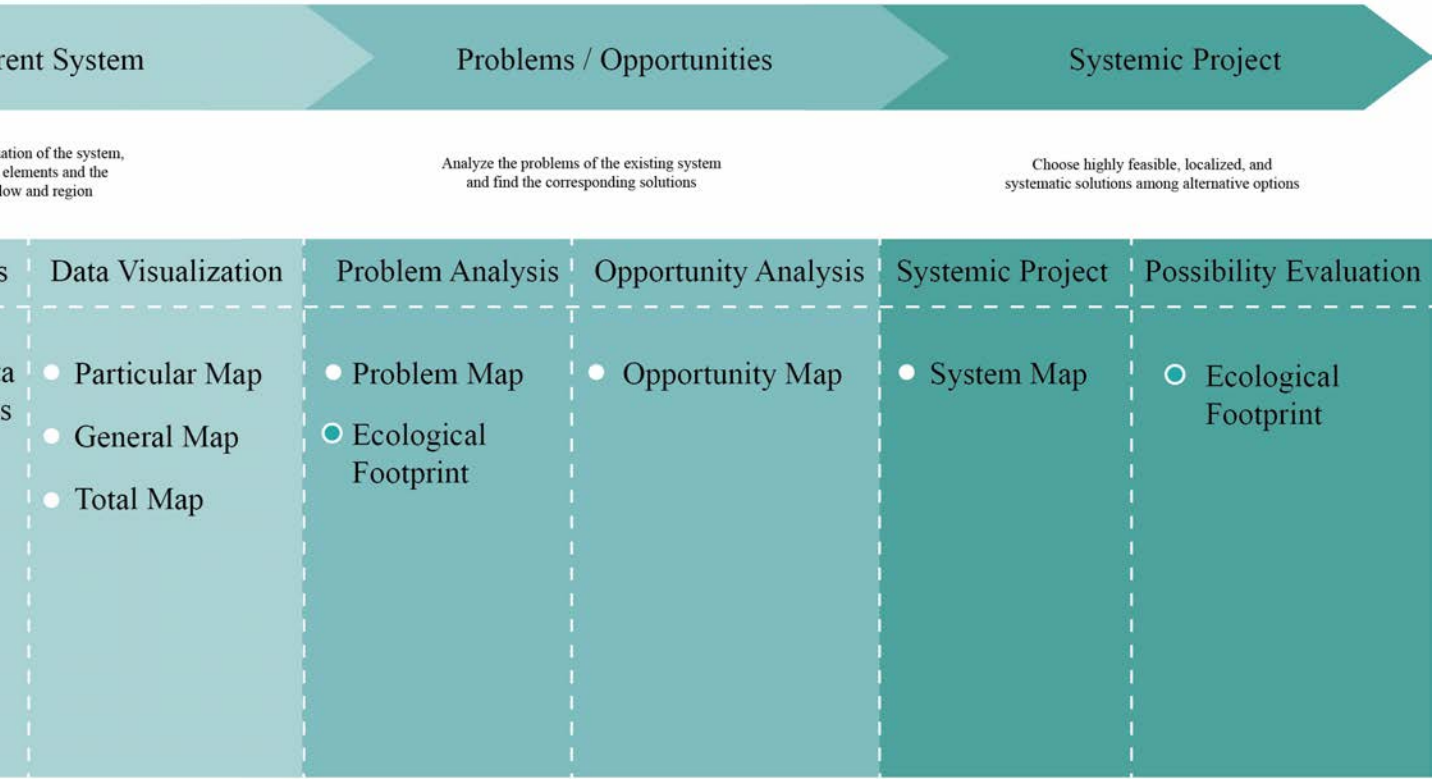
Figure 37. System design research framework for green campus building. Designed by the author.

Before carrying out the investigation, the first and second steps in the Life Cycle Assessment method need to be carried out, that is, Goal and Scope Definition and Analysis of Inventory. The purpose of these two steps is to clarify the scope of the system design investigation and data collection tasks.

When design authors participate in field research, they take multiple roles as observers, data clerks, and interviewers, to obtain quantitative and qualitative data in a comprehensive manner, observe the environment on campus, record detailed data and information, and access stakeholders.

At the analysis stage of the current system situation, except for the calculation of quantitative data, the text data collected should be analyzed by the qualitative research method.

At the stage of problems and opportunities analysis, the ecological footprint method is used to measure the substances in the list. At the stage of determining a systemic plan, designers use the system map to describe the design outcomes.



Reference

Boehnert, J. (2018). Design, ecology, politics: Towards the ecocene. Bloomsbury Publishing.

Wang, H. T. (2011). A new approach to energy conservation and emission reduction goals-life cycle energy conservation and emission reduction evaluation method. High Technology and Industrialization, (8), 49-53.

Zhuang, W. Y., & Ke, W. Y. (2018) Design and practice of digital communication platform interface based on information visualization. Communication Power Research, (10), 208.

Manzini, E. (2015). Design, when everybody designs: An introduction to design for social innovation. MIT press.

Sterling, S. (2003). Whole systems thinking as a basis for paradigm change in education. PhD paper, University of Bath.

Sun, Q. H., Wan, N. Q., & Fan Y. H. (2000). A review of foreign life cycle assessment (LCA) research . World Standardization and Quality Management, (12), 24-25.

Cao, H.L. (2004) Research on the Theory and Methods of Product Life Cycle Assessment (LCA). Journal of Southwest University for Nationalities (Humanities and Social Sciences Edition), 25(2), 281-284.

International Organization for Standardization. (2006). Environmental management: Life cycle assessment; requirements and guidelines. Geneva: ISO.

Guinee, J. B., Heijungs, R., Huppes, G., Zamagni, A., Masoni, P., Buonamici, R., ... & Rydberg, T. (2011). Life cycle assessment: past, present, and future.

Wackernagel, M. (1999). An evaluation of the ecological footprint. Ecological Economics, 31(3), 317-318.

Wackernagel, M., Onisto, L., & Bello, P. A. (1997). Ecological footprints of nations. Universidad Anahuac de Xalapa, Centro de Estudios para la Sustentabilidad.

Gu, X. W., Li, G. J., Wang, Q., Liu, J. X., Ding, Y., & Liu, J.Z. (2005). Ecological footprint in the construction of a green university. Environmental Science,(04),200-204.

4 HOLISTIC DIAGNOSIS

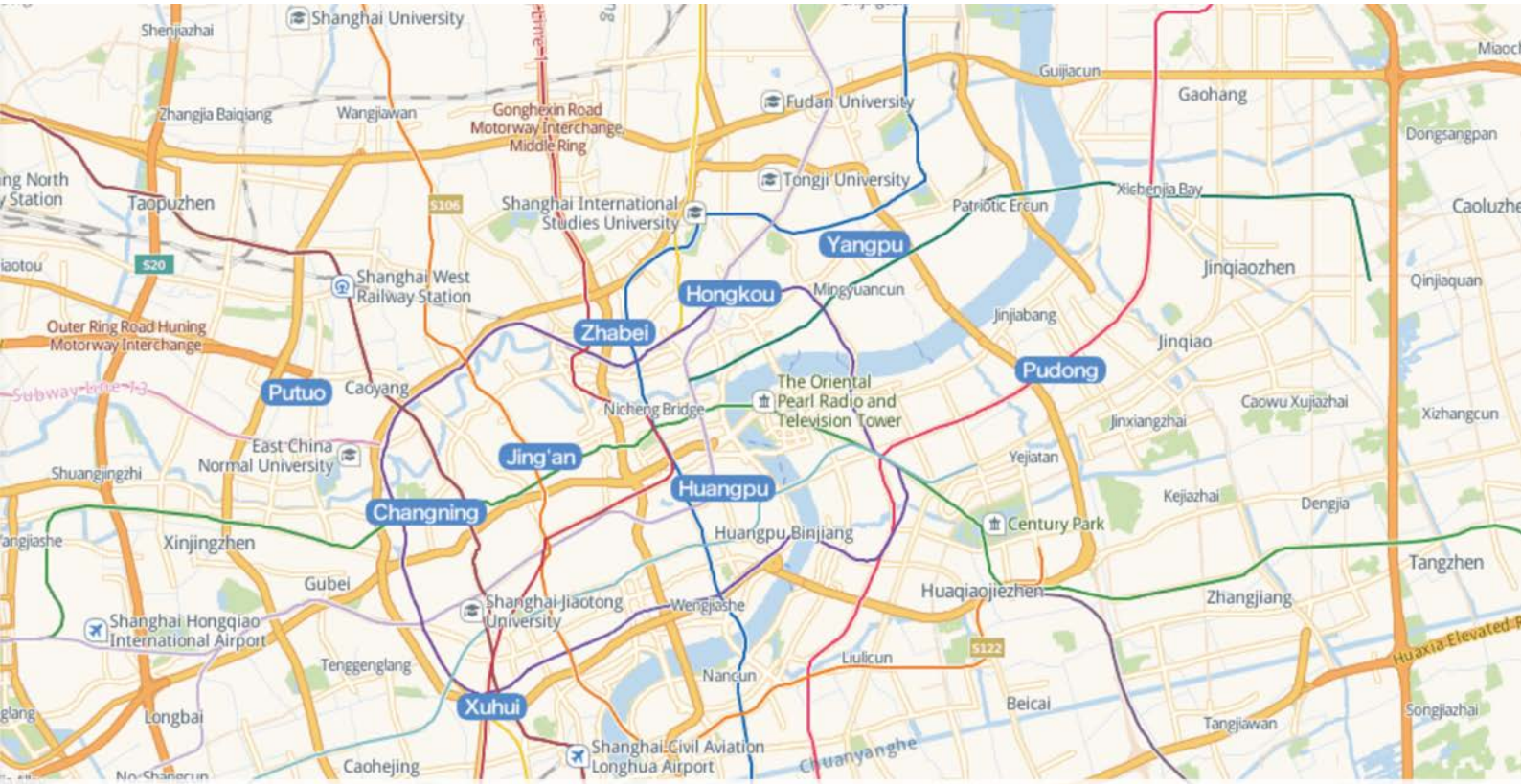

APARCAMENT

4.1 Overview of the school

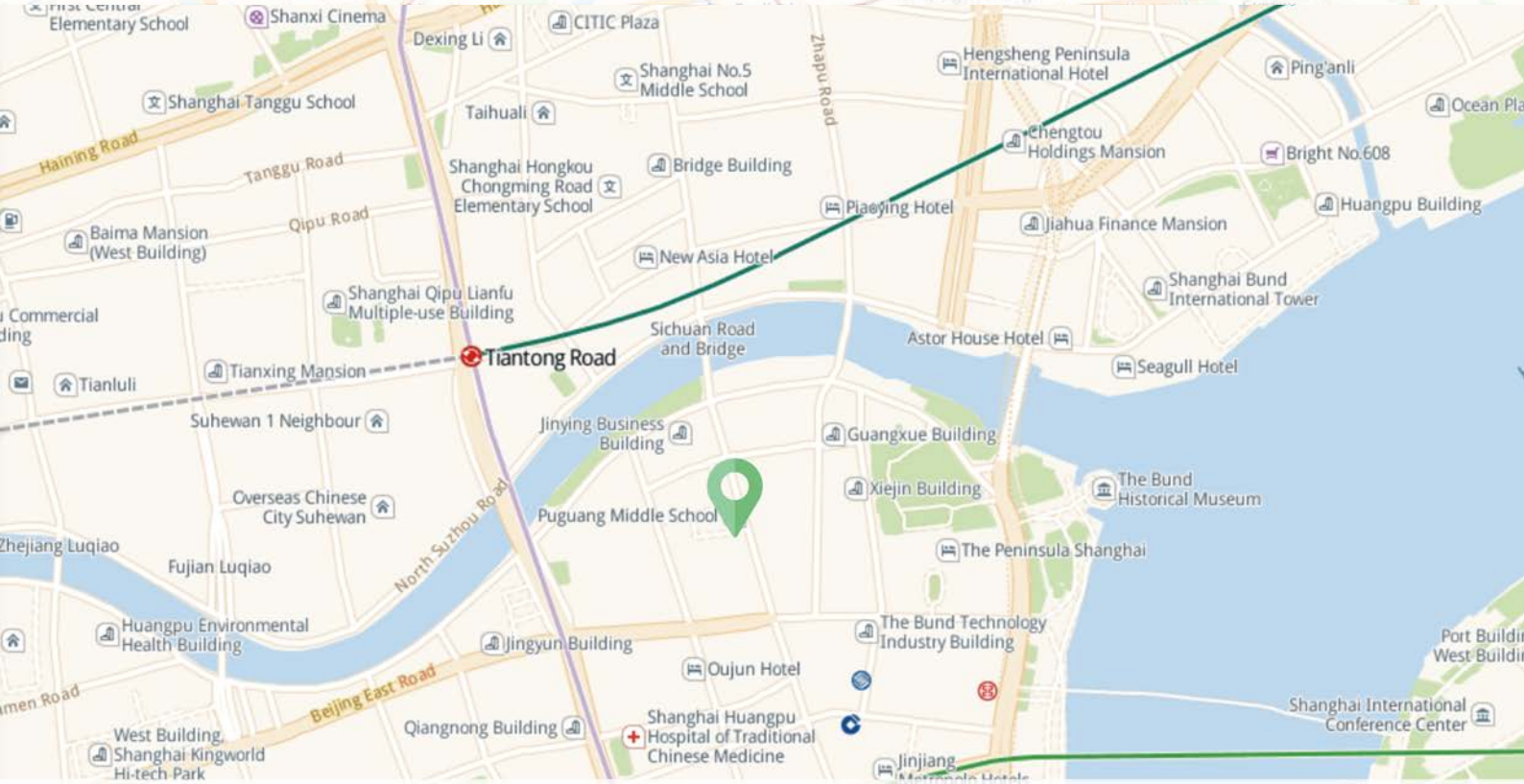
Shanghai Tongji-Huangpu School of Design and Innovation, was started as the Shanghai Youth Association Middle School established in 1901. And it was renamed Puguang Middle School, on December 18, 1951. In 2016, the Huangpu District Government and Tongji University signed a strategic cooperation framework agreement. Under this framework agreement, the Huangpu District Education Bureau established a new school campus in cooperation with the College of Design and Innovation of Tongji University, and the school officially became its current name since 2017.

The school is located at the intersection of Huangpu River and Suzhou River, with a rich cultural heritage and glorious revolutionary tradition. Many famous Chinese historical and cultural celebrities have come to the school to teach or give lectures, and many educators have written inscriptions for the school.

Over the years, the development of the school has received the attention and care of the government. The teaching building with Baroque architectural features is one of 41 "excellent historical preservation buildings" in the Bund area. (Figure 38.)



Shanghai



Tongji-Huangpu School of Design and Innovation

Figure 38. Tongji-Huangpu School of Design and Innovation. Adapted from the *Tongji university college of Design and Innovation* Official Website, by Tongji university, 2019, retrieved from https://tjdi.tongji.edu.cn/NewsDetail.do?ID=4838 Copyright 2019 by Tongji University.

Tongji-Huangpu School of Design and Innovation is a design thinking education-oriented high school, taking PBL (Problem-based Learning), suitable for design innovation education, as a teaching method. The school emphasizes the basic curriculum of knowledge output and experiential learning. And its' education platform collaborates innovative curriculum with design colleges, both domestic and abroad.

The teaching activities in the high school consist of 40% of PBL innovative courses and 60% of basic subjects. The PBL innovative curriculum advocates 'learning from practicing' and promotes the transformation of the classroom from one-way teaching to interactive learning. The teaching methods are conducted in various forms such as lectures, workshops and visits. The courses are offered by the College of Design and Innovation of Tongji University and high school teachers; Professors and teachers from Tongji

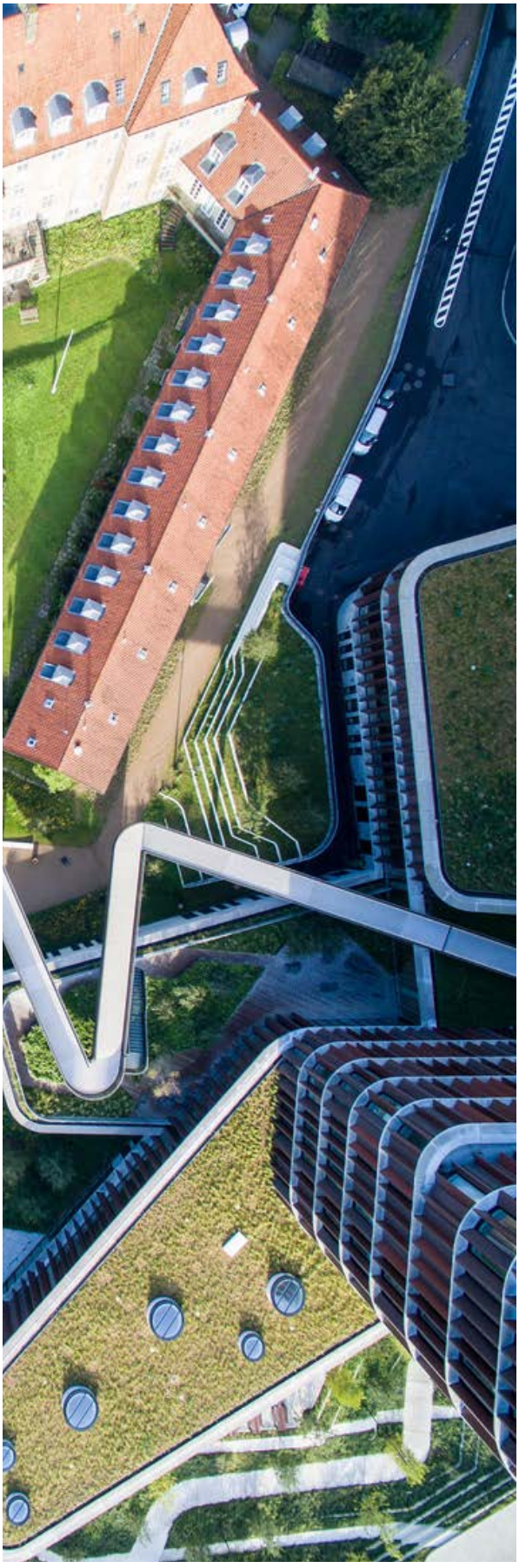
University are responsible for curriculum plan and project design. And the high school teachers are responsible for the interdisciplinary integration of knowledge highlights and providing teaching assistance.

Discussion

The courses are taught in a variety of forms, including lectures, workshops, and visits. The lecturers come from different universities or enterprises, and moves in and out of the total curriculum randomly. Due to the unstable teaching staff situation, these people are not included in this study. The curribulums and teaching methods of this school are special among Shanghai high schools, and it is a research and practice of innovative talent training model (Y. M. Zhang, 2018).

From the trend of social development and education reform, there might be a judegement that more and more high schools will change the traditional teaching ways in the future and join in innovative talent training.

4.1.1 Scope



Before the investigation plan carried out, the purpose and interviewees of the research need to be clarified. The research mainly faced the responsible personnel of various activities in high schools. In the field research stage, the author needs to have a comprehensive understanding of the campus system to build a model of the system's status quo. The investigation activities mainly focus on three purposes as follows:

1. Understand the input and output of the material and energy flow involved in each link in the basic activities of the campus. Including the place of occurrence, equipment used, participants, characteristics, name, quantity, source or destination.

2. Mining the factors that influence the unsustainable behavior of campus users.

3. Summarize design insights based on system problems.

4.1.2 Content of survey

The school is located in Huangpu District of Shanghai. As shown in Figure 39, the system boundary of the survey is defined by the property boundary of the school campus, with a construction area of 11,234.29 square meters in total, including the old campus - the east and west building of Sichuan Middle Road, and the new campus - buildings of Huqiu Road. There are around 189 permanent users on campus, including students, teachers, and administrators (catering staff, security staff and logistics staff). The research content mainly includes the input and output of the campus system throughout 2019, and their origin places and end processing. The input mainly includes energy, water and materials, of which food and teaching supplies are the main materials purchased by the school; the output mainly includes sewage and waste. The author describes the qualitative and quantitative measures of every kind of input and output in detail.

1. Substance

The substance contains three major categories, namely food, paper, and other materials, and kilograms per year (kg/year) was used as the basic unit quantity. Food and paper are categorized separately because they play a decisive role in the generation of solid waste on campus.

a) Food

The food consumption data comes from the analysis and calculation of the first-hand data. The author selects the recipes for the first working week in December as a sample and records the types and quantities of materials included in each meal of each person in the recipes, including meat, vegetables, grains, beans, and other categories, classified and summarized. And the weekly supply of various food ingredients per person was calculated finally. Considering that there are a total of 179 days of school daily time, excluding statutory holidays and weekends within a school year, about 35.8 weeks, the number of high school meals is 189, so the annual supply of various ingredients in the high school can be calculated. The snack and fruits carried by teachers and students are not considered.

b) Paper

Data on paper consumption was collected through on-site measure-

Figure 39. System list. Designed by the author.

ments and interviews.

Through literature research, we know that the waste paper is one of the main components of campus waste (X. He, & X. Y. Bai, 2011, p.30), so I included it in the system and described it in detail. Since the school lacked exact data, the relevant data was collected through sample surveys and estimates.

c) Other materials

The quantity of other materials, such as plastic packaging, cartons, and glass, is defined based on the total amount of solid waste provided by the property department for one year, and food and waste copy paper are not included.

2. Energy

The energy consumption data in the list includes the annual consumption of electricity and gas on campus. Electricity is expressed in units of kilowatt-hours per year (k·Wh/year), and gas is expressed in years (m3/year). All data comes from secondary school finance Documents provided by the Ministry.

3. Water

Although water can be classified as

material, it is regarded as an important resource for human survival, so I separately classify it as one category. Water consumption is expressed in m3/year (m3/year). Monthly water consumption and water fees in 2019 are provided directly by the school finance department.

4. Waste

Waste as a type of output,includes many kinds of wastes, such as glass, organic matter, packaging, paper, etc. At Shanghai, the wastes were divided into four categories: Residual Waste, Household Food Waste, Recyclable Waste, Hazardous Waste. In the school, glass, paper, plastic, and food waste were wastes with the most large quantity, so the research focuses on them. Their data were collected by the author based on the analysis and estimation of internal documents provided by the person in charge of property management.

5. Sewage

Sewage mainly generated by water consumed in the water supply network. According to the interview with the person in charge of property management, the input and output of water are closely related. Since teachers and students in the school mainly drink bottle water, almost 95% of the campus water is directly discharged into sewage pipes as sewage.

4.1.3 Research Methods

The purpose of the investigation is to understand the input and output modes of the material and energy in each link of the school's basic activities, and to explore the potential causes of the participants' unsustainable behavior in the activities. Based on the field research proposed in Chapter 3, the author uses a variety of methods to collect data, including semi-structured interviews, participant observation, event sampling methodology, and in-depth interviews.

The author acted as a statistician and conducts semi-structured interviews according to interview check list, with the person in charge, to collect energy and materials used in campus activities. For example, ask 'What is the electricity consumption of the school in 2019?', 'How many barrels of household food waste per day? How much is each barrel?' etc. Through inquiries, the author directly obtains the energy consumption and water consumption documents for the year of 2019 from the finance department of the high school and obtains the daily waste bin waste statistical data from the logistics department. The data collected in this process is unified into first-hand data, which has the characteristics of accuracy, specificity, and quantification, and is also the data closest to the actual situation. When first-hand data is not available, the inquiry turns to a detailed description of the daily situation, for example, 'What is the process of washing vegetables?', 'How is the purchase of ingredients carried out?'. These descriptions can provide some clues for estimating the amount of consumption. For example, 'The daily supplies of the canteen are based on the number of people in the school, and each ingredient in each dish has a quantitative regulation'. Therefore, knowing the quota of each ingredient in the canteen's daily menu and the number of people to eat can calculate the daily supply of ingredients in high school. After obtaining accurate or estimable data, it is also necessary to investigate the source and destination, such as 'Who are you going to deal with frying waste oil?', 'Where are the teaching materials purchased from?'.

After roughly collecting the data, the author found that the data obtained in the semi-structured interviews only get the actual quantitative information. Due to the fact that the data is out of the specific context, the authors'

understanding of the activation process, energy-using unit, and user behavior are still vague, so that they cannot have comprehensive and in-depth insights. Therefore, as the observer, the author conducts participant observation on the stakeholders of various activities, that is, the authors accompany the participants on a natural outing, and actively explore the subjects' experience and interaction with them through questions, listening and observation. Experience and practice when interacting with physical and social environments (Duedahl & Stilling Blichfeldt, 2020).

The author participates in the daily catering, life, and teaching activities on campus, and mines the real situation missed by the interviewees through observation and semi-structured interviews. Through on-site observations, the authors found that the interviewees missed and unaware of the waste of resources in the interviews, and found the reasons through inquirying. The specific findings will be described in detail in the analysis section. Subsequently, the authors conducted field sampling observations in different areas of the campus many times, on the catering-related areas, teaching areas, and waste management areas. In terms of catering activities, the author has repeatedly sampled and observed the kitchen waste bin after the initial processing of the kitchen, the swill

Figure 40. Interview with Manager Zhang of the Food Service Department. Photographed by the author.

bucket after the meal, and the process of cooking food in the kitchen; In terms of teaching activities, the author has repeatedly observed the waste in the classroom, the use of materials in the classroom, the waste after the class; In terms of campus waste management, the author has repeatedly observed the campus trash cans, waste compartments, and recyclable waste rooms. Photographed the real situation and record relevant data during the observation process, and conduct interviews with relevant persons in charge of the campus on the information gained during the observation.

After the investigation of the first two methods, there is a preliminary understanding of the types and quantities of material inputs and outputs in the campus system. Interview as the most common qualitative research method, the process naturally emerges. Authors

may change and refine research questions and will have a deeper understanding of ‘what to ask’ and ‘who to ask’ based on their own (Creswell John, 2007).

The purpose of the in-depth interview is to pay attention to the behavior and ideas of campus stakeholders in the process, understand their attitudes and understanding of the material, energy use and waste generated in the activities. To make sure the current sustainability status of the campus, and to know their real behaviors with motivation or reason. For example, why not recycle these papers, why is it no need for a reuse, etc. They are the main performers of system activities, by understanding the influencing factors behind their actions, it is helpful for authors to provide design solutions for transforming participants’ actions.

4.2 Catering system

After on-site observation, the author made a detailed record of the activity process in the high school catering system, including the raw materials used in each activity, the energy consumption and the waste discharged, and the source, transportation, and waste management and destination of the raw materials

One by one statistics, draw the Particular Map (Figure 46) at the end of this chapter 4.2. As shown in Figure 46, the daily activities of the kitchen system will go through the six steps of procurement, cleaning and cutting, processing, dining, food waste processing, and cleaning. Each activity is accompanied by the material flow. The raw materials are transported to the back kitchen of the school. After cleaning and removing some parts that are damaged or inedible, they are cooked at a high temperature and presented to the dining table. Some skin shells that exist after eating It is discarded together with food debris into a household food waste collection bin, which is collected and treated by the waste recycling plant.

The quality and quantity of raw materials have changed in a series of activities. The flow of substances and energy in the system can be divided into 3 stages: input, process, and output, corresponding to the procurement, production, and post-processing of raw materials, energy, and other substances.

3.3.1 Supplier of catering system

Purchasing is the first step in introducing raw materials into the system. To control the original source, quality and quantity of raw materials not only helps the campus catering service system to perform quality

Figure 41. Daily lunch in middle school. Photographed by the author.

management from the input, but also reduces the generation of system output. Through interviews with manager Zhang of the catering department, the author collected matters related to the procurement of raw materials in the catering department of the high school. The purchase of ingredients in the canteen is managed by Shanghai Lvjie Industrial Co., Ltd.(so called Lvjie Industrial Company), and all raw materials are dispatched by the company from the headquarters to the branch regularly. Among them, seasonings such as oil, salt, sauce and vinegar, and materials that are easy to store for a long time, such as rice, are distributed about once a week, and the rest of the ingredients need to be purchased once a day.

The supply of ingredients is rationed according to the total number of

students in the high school. The ingredients of each dish are quantified to the individual, and the average food intake per person is about 500g per meal. According to the menu provided by the catering department of the high school, the author found that the daily menu of the high school consisted of 2 meat dishes, 2 vegetable dishes, 1 staple food, and 1 soup. The author uses the menu of the week from December 2 to 6 as a sample and the types of raw materials that were on the menu of this week to make statistics.

Livestock products are mainly chicken, pork, duck, fish, eggs. Chicken is the main supply of livestock products, the average consumption of 330g per person per week; agricultural products are mainly divided into staple food, miscellaneous grains, vegetables and beans. Fresh vegetables consume much more than the other kind of agricultural products. The average person consumes 885 g per week. Since the weekly recipe changes less frequency in the cafeteria, it is assumed that the data of this sample is the average of the ingredients provided by the cafeteria per person per week within the available time of a school year. The available time in the high school year is 179 days, which is about 35.8 weeks, and the number of people dining in the cafeteria is 189. On average, the cafeteria needs to supply 5961kg of livestock products, 11876kg of agricultural products, and 3383.1kg of water resources.

4.2.2 Cooking process

If the campus catering system is regarded as a food production processing plant, then the process of supplying cooked food in the cafeteria is the production line of the factory. In the processing phase, the processing technology, production efficiency, and resource utilization methods are closely related to the corporate resource consumption.

1. Cleaning and cutting

Through interviews and observations, the author recorded the methods and times of cleaning various food raw materials in the kitchen. In this step, the cafeteria distinguishes the areas and methods of washing meat and vegetables. Vegetables need to be washed three times. The cleaning method is to put them in a vegetable pond filled with water and soak for 10 minutes and put 20-50 g salt for the first time to remove residual pesticides. The meat is cleaned by rinsing. Rinse briefly with running water for 5 minutes and then blanching with hot water for 3 minutes. In comparison, vegetables are washed more often than meat. Because fresh vegetables often contain pesticides, insects, and soil, multiple piles of washing are required to ensure that there are no agricultural and magazine residues. The meat is all processed semi-finished products, the processing steps are more simplified, and zero waste can be basically achieved during the preparation process.

The author made accurate measurements of the canteen pool. The size of the vegetable pond is 100 cm × 80 cm × 40 cm, and the volume is 0.32 cubic meters. The height of the water level line is 35 cm. Therefore, the water consumption for storing one pool of water at a time is 0.28 cubic meters, and the amount of water required for washing one vegetable is 0.84 cubic meters. According to the 'Code for Design of Building Water Supply and Drainage' (Ministry of Housing and Urban-Rural Development [MOHURD], 2019, GB50015-2019), the flow rate of the kitchen faucet is 0.2 L/s, and it takes 5 minutes to clean the meat. The kitchen needs to wash 0.06 cubic meters of each type of meat. The canteen needs to wash two kinds of vegetables and two kinds of meat every day. A total of 1.8 cubic meters of tap water is needed to clean the ingredients every day, and 322.2 cubic meters are needed throughout the year.

In addition, some wastes are generated

Figure 42. Kitchen cleaning pool. Photographed by the author.

in this process, mainly vegetable roots, vegetable leaves, live fish scales, and fish intestines. Because the meat selection is processed meat products, no waste is generated. The energy consumption in the process is mainly water resources. According to a sample observation by the author, about a quarter of barrels of food waste are generated every day, and each barrel of food waste is about 15 kg. Therefore, the daily discarded ingredients in the high school canteen are 3.75kg, and the rate of fresh vegetables is 10%.

2. Processing and production

The raw materials in the process basically enter the dishes and they are consumed by teachers and students. The old oil used for frying food is reused and collected in a waste oil barrel. The canteen will deliver waste

Figure 43. Cooking lunch. Photographed by the author.

oil to Shanghai Changjing Oil and Fats Co., Ltd. twice a month, which produces an average of 12.75kg of frying waste oil per month. In the process of packaging food, the kitchen will keep one copy of each daily dish in the sample box and put it in the refrigerator. After 24 hours of storage, it will be discarded as kitchen waste. The purpose of keeping the sample box is to find evidence that can be traced back to after the teachers and students feel uncomfortable due to food. According to the author's statistics, about 17 boxes of leftover food are discarded as household food waste every day. Each box of food is about 350g, so the food in the sample box that is discarded daily is about 5.95 kg.

The author found through an interview with Manager Zhang, the person in charge of catering, that there is an

example of soup in the daily menu of the high school. The daily supply of the kitchen is proportional to the number of heads of the school, and the corresponding personal supply of various dishes is strictly prescribed. In other words, there are 189 students and staff in the school, and the dishes served in the kitchen every day are the individual supply corresponding to thedish multiplied by 189 servings. According to the regulations, the cafeteria supplies 100g of soup per person per day to the high school, so the kitchen needs to use 18900g of water per day, that is, 0.0189 cubic meters of water. (Because the mass is equal to the density times the volume and the density of the water is 1g/ml, it is found that 18.9 liters of water are needed per day, and 1 liter is equal to 0.001 cubic meters.) The number of kitchen meals in a school year is 179 days, so 3.3831 cubic meters a year.

3. Dining

Figure 44. Post-meal waste collection. Photographed by the author.

Figure 45. Tableware cleaning. Photographed by the author.

There are 3 types of substances that need to be processed during the meal process, which are greased tableware, swill feet, and disposable paper towels. The first type of tableware is sent to the kitchen cleaning area for soaking and washing. The second type is waste collected by the canteen gandsent to the cleaning place. The swill foot is about 75kg per barrel. According to the statistics of the waste compartment, about half a barrel of kitchen waste is generated daily, weighing about 37.5kg. It consists of kitchen waste, leftover food, and swill feet. According to the calculation in the previous paragraph, it can be concluded that the daily swill is 27.8kg. The third type was thrown into the residual waste collection box. Therefore, the wastes generated in this process are mainly leftovers and paper

towels.

4. Cleaning

The canteen has six reservoirs for washing dishes. Use lye and detergent. And there are strict requirements and operating specifications for the cleaning process. There are 6 steps in the process of cleaning and disinfecting tableware. The first step is to scrape the debris from the tableware and tools. The second step is immersion, soaking the tableware in alkaline water at a temperature above 60 degrees for 5 to 10 minutes. The third step is cleaning, washing the front and back of the tableware in hot water with detergent. The fourth step is rinsing, rinsing each tableware twice, which takes 30 minutes. The fifth step is the humid heat disinfection. After the water boils, steam the tableware with steam for 20-30 minutes. The sixth step is cleaning. Place the sterilized tableware in the cleaning cabinet and the cleaning room. The size of the cleaning tank is the same as the size of the vegetable pools mentioned above. Therefore, the water consumption for storing one pool of water at a time is 0.28 cubic meters. The entire cleaning process needs to store 4 times of water, the water storage capacity is 1.12 cubic meters. According to the calculation method of tap water flow, the rinsing step consumes 0.36 cubic meters of tap water. Therefore, the amount of water consumed in the cleaning process is about 1.48 cubic meters, and the annual clean water consumption is 264.92 cubic meters.

4.2.3 Waste management

The waste generated by the high school catering activities is mainly divided into 3 categories. The first category is kitchen waste, which refers to the food processing waste produced in the kitchen during the cleaning and cutting stage. The second category is the swill feet produced by meals, which are mainly composed of protein, starch, and animal fat, and have the characteristics of high water content, high oil and salt content and easy corruption. The third category is the waste grease produced by the kitchen for frying food.

Kitchen waste mainly comes from the preparation stage of raw materials, including vegetable roots, discarded vegetable leaves, eggshells, carrot skins, etc. Abandoned vegetable leaves mainly come from fresh vegetables. Quick-frozen vegetables, watered vegetables, and pickled vegetables do not produce waste vegetable leaves. According to the statistics of the school cleaning department, the school canteen produces half a barrel of kitchen waste every day, which is composed of a quarter of food waste, a quarter of swills, and waste food in a sample box. These three types of food waste are eventually collected in a household food waste can and sent to the cleaning place. Every day, Shanghai Shangcheng Environmental Sanitation Transportation Co., Ltd. will use a waste truck to pull it away and send it to a waste treatment plant for disposal.

Because the composition of the three food wastes is different, with different density and weight, according to the author's previous records and calculations, it can be concluded that the daily kitchen waste generated by the canteen is equal to 3.75kg of kitchen waste plus 27.8kg of swill feet plus retained samples The box of waste food is 5.95kg, a total of 37.5 kg. The oil used for frying is collected in oil drums and reused once, and then collected in waste oil drums. The canteen will deliver the waste oil to Shanghai Changjing Oil & Fats Co., Ltd. twice a month, producing an average of 12.75kg of waste oil for frying per month.

Particular Map: Catering system

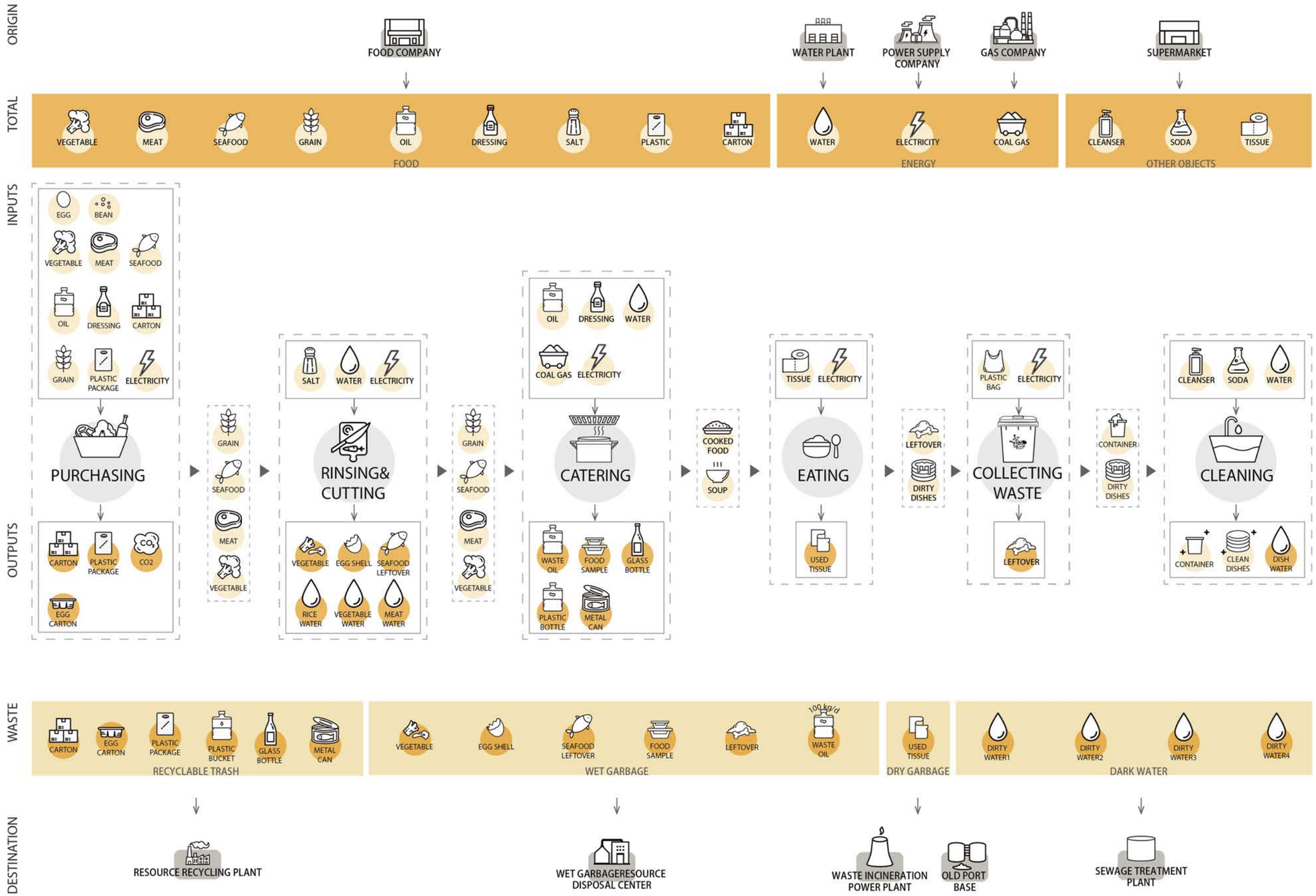


Figure 46. Catering system particular map. Designed by the author.

4.3 Water and energy system

Through field researches, the author observed and summarized the school's energy consumption types, energy consumption related activities, and related emission sources. Types of energy include electricity and artificial gas. Electricity is mainly used for lighting, heating, cooling, and equipment in buildings, and the relevant emission sources are fluorescent lamps, air conditioners, refrigerators, office equipment, and teaching equipment in buildings. The artificial gas is mainly used for kitchen cooking activities after the canteen, and the emission source is the kitchen stove. The author obtains the monthly usage and cost of electricity and gas in the Finance Department of the high school in 2019. According to statistics, the total electricity consumption of the high school for the year was 109,984 kWh, and the total gas consumption was 6061 cubic meters.

Through field observations and interviews with property management staff, the author summarizes the four main activities of campus water use, which are toilet flushing, washing, cleaning, and kitchen water use. The first three activities occurred in the bathroom, and the last activity occurred in the kitchen. Related sources of discharge are faucets and toilets.

From the previous systemic description of the high school catering activities, the water consumption flow in the process can be clearly presented. Kitchen water mainly comes from preliminary processing, preparation, and cleaning steps. Since the school has installed water dispensers and water purifiers, students, teachers, and faculty members do not use tap water supplied by urban waterworks for their daily drinking water. In the four activities of campus water use, only a little of the kitchen water used for cooking tap water has not been discharged as sewage into the sewage plant. Therefore, it can be assumed that the amount of sewage discharged from the high school to the sewage plant is equal to the water supply of the urban water supply plant minus

the amount of tap water used for cooking in the kitchen. The data from the Finance Department of the high school and the previously estimated kitchen water consumption, shown that the amount of sewage discharged by the high school in one year is about 6363.6169 cubic meters.

4.4 Teaching system

Due to the rich types of teaching activities in the high school and the large number of participants involved, the author interviewed the PBL principals, basic class teachers and PBL participants of Tongji-Huangpu School of Design and Innovation, and used the media animation PBL course as a case to detail the process and material flow.

4.4.1 Current teaching system

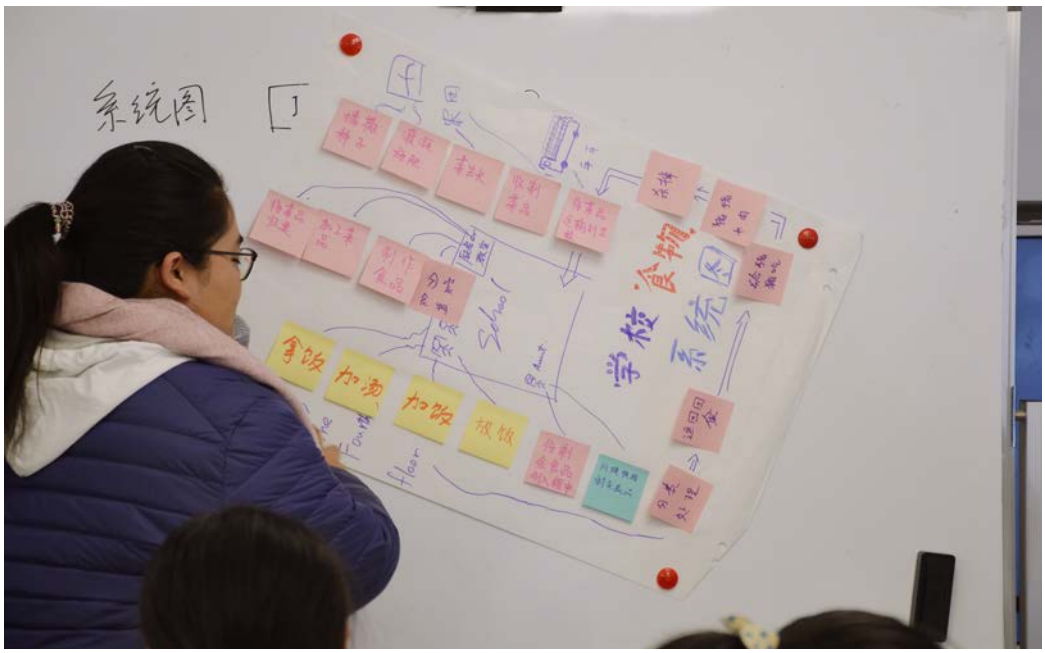


Figure 47. ‘THEY’ module roadshow. Photographed by the author.

1. PBL course (Project Based Learning courses)

The author interviewed the person in charge of the THEY module of the PBL course. The interview collected a summary of the 2017 PBL course in the teaching process, teaching materials, teaching output, achievement management and disposal. Innovative courses are carried out in four modules within a school year, and two modules are taught every semester.

The courses are conducted in various forms, including lectures, workshops, visits, and debates. The whole course needs to go through three processes: preparation, teaching, roadshow and evaluation. Fewer materials are used in lesson preparation, and most teachers use paperless office forms. In the remaining two flows, paper products are the main consumption. Most teaching flows in the PBL curriculum require students to 'do' high schools in groups. This means that a lot of hands-on production is involved in the teaching, which requires the use of specific materials and tools required for the course. During the teaching process, PBL teachers mainly provide students with some paper materials and brochures to assist students in group activities, and the rest of the materials are provided by the teacher or school. The Chinese Academy of Sciences prepares a material box for each class and adopts the team leader responsibility system for material management. The materials usually kept inside the material box are scissors, colored pens, whiteboard pens, sticky notes, solid glue, paper tape, etc. Color cardboard, copy paper, cardboard, foam board are provided according to the needs of the course. In the PBL course, students' group activity results are displayed in the form of exhibition boards and public roadshows. The display board is the most commonly used form of presentation in the PBL course session report. The materials used are mostly A0 size paper and cardboard. In the process of making the display board, you also need to use tools such as colored pens and sticky notes. Some of these paper student achievements are displayed in the campus indoor space, and most of them will be processed after being electronically archived.

The author takes Prof. Wu's media animation PBL course as an example and has an in-depth understanding of the teaching process, material input, and waste output. The media stop motion animation PBL course lasts for one month and has 180 lessons per week, for a total of 5 lessons. The course consists of lectures and workshops. In this course, students need to participate in two workshops, namely the stop-motion animation production workshop and the campus promotional film shooting workshop. 30 students are divided into 5 groups with 6 students in each group. The teaching aids of the workshop are

Figure 48. Media Animation PBL Workshop Discussion. Photographed by the author.

provided by the teaching team. They prepare 8 pieces of A0 size template paper for video positioning, 1 box of marker pens, 2 scissors, 1 mobile phone holder and 1 Bluetooth wireless shutter for each group of students. These props are the basic materials for students to shoot stop motion animation videos. To help students express their ideas smoothly and determine the shooting lens, the teaching design team printed 10 sheets of A4 size printing paper for each group of students to provide students with a frame template for drawing storyboards. Besides, the team printed 10 A4-sized tutorial materials for each group of students to guide the group's shooting work. According to the teaching requirements, the five groups of students received some stationery with strong plasticity as props for shooting stop motion animations, including paper clips, chalk, rubber, sticky notes, and pushpins. They can arbitrarily deform, bend, fold, combine, or arrange this stationery.

In the workshop, the materials used by the students have been deformed to varying degrees. Paper clips are bent and twisted, chalk is crushed into

Figure 49. 3D printing workshop classroom teaching materials. Photographed by the author.

powder or cut into small pieces, rubber is cut into large and small blocks, and notepaper is repeatedly folded. According to the course assistant's memory, the storyboard template paper distributed was not favored by students. People often started shooting directly instead of drawing a draft of the mirror, so most of the template paper was not used and then discarded. The high quality printed paper as teaching materials have not been recycled by the staff. After the course, the teaching staff will choose to recycle materials with a relatively long use period and relatively high value, such as markers, scissors, mobile phone holders, and bluetooth wireless shutters. Some unused paper clips, push pins and other teaching props will be selectively recovered by the team and idle. Since the final result of the workshop is a video, the materials used by the students have not been converted into activities. Therefore, these used papers and deformed stationery have not been recycled and become wastes.

The author found that the paper teaching aids or paper aids distributed in the workshop were not recovered by

the staff. The teaching staff processed the paper materials into smaller pieces, for the course demanded available size. The paper used by students is also has different degrees of wear and tear, which results in poor paper recycling. These factors have led the unrecyclable paper materials and teaching staff unawareness of recycling.

The author has calculated that the paper used but has not been recycled in this PBL curriculum workshop. The total number of waste paper is 140, including 100 A4 papers and 40 A3 papers. The author finds that when students' final project outcomes displayed digitally without any paper document, neither students nor teachers was awared of recycling and paper materials management, whether the paper have been used or not. Therefore, in this case, the amount of waste paper in teaching activities is higher than the origin demand.

Particular Map: Teaching System

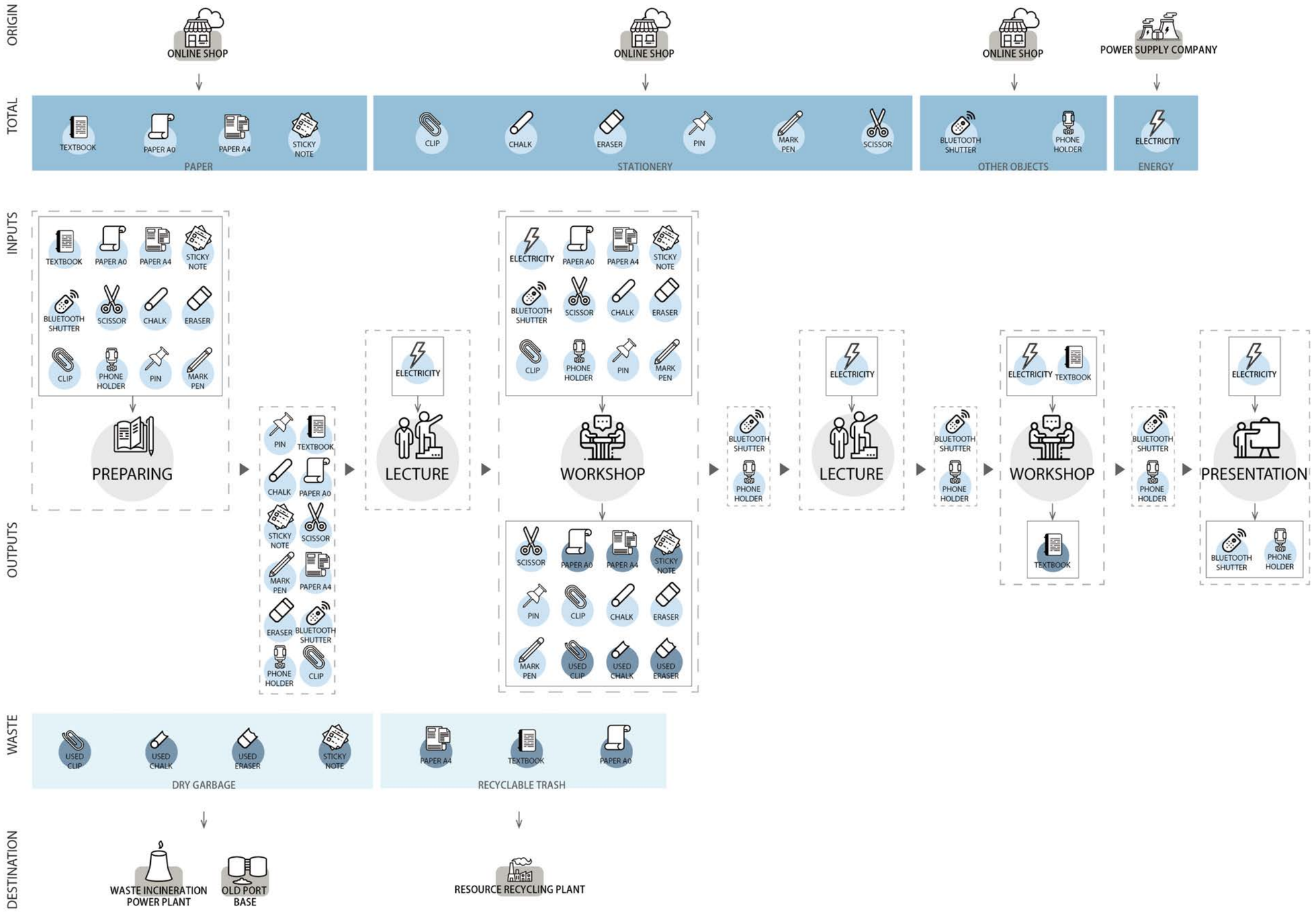


Figure 50. Teaching system particular map. Designed by the author.

2. Basic course

The author conducted interviews with the basic course teachers. The interview content was the teaching activities of the basic course and the materials used. There are three main activities in the basic course of the high school: teaching, examination and research learning. In each activity, students have produced corresponding learning outcomes. Teachers provide supporting materials, assess the quality of learning and manage teaching results throughout the teaching process.

Most of the high school basic course teachers will prepare teaching plans according to the progress of the class students. The teaching plans record the main knowledge highlights and key memory knowledge in paper, and they are distributed to students as supplementary material for a better learning. Due to the low self-management consciousness of high school students, neglecting the storage of individual paper materials, these unbound papers are easily lost or discarded into waste paper.

The school has prepared an academic year document profile, in paper printed, for all students in the second grade in the high school. The outcomes of the PBL project that students participated in in the first academic year are included in the document profile, such as post-course self summary paper writings, the design work pictures, research report, etc. The academic year outcomes' file contains about 245 A4-size piceces of papers, and they are collected together in a cabinet. It is convenient for students to see their heavy gains during the year at the end of the semester. At the same time, it is easy for students to review their performance and evaluate their performance management. Documents in papers could provide students with a sense of ritual and satisfaction. However, with the short-term pleasure, there might be hidden long-term problems. Firstly, it consumes a lot of paper and takes up space, which is not easy to store and carry. Secondly, the paper may also be left idle. How to reduce the waste in student achievement management, while ensuring the student experience?

Through the investigation of energy use, material use and wastes situation, the author found that the campus teaching system, with teaching activities as the core, is special in resources use and waste disposal. The use of resources in teaching activities often prioritizes the needs of teaching, focusing on class effects and the quality of teaching, so the sustainability of the process is easily overlooked. When carrying out teaching activities, few people will consider the environmental impact of the activity. The short-term feature of the activity makes people lack of awareness about the process details.

When with laziness thinking and short-sighted behaviors, people easily accept the unsustainable solution (Bistagnino, 2011, p.166). Even if individual participants consciously intervene in unsustainable behavior in the link, it is difficult to transform the current habitual way from the system level.

Therefore, we must have a new sight to the design, execution, management, and closing activities in teaching process, reshape the ecological consensus that humanity has lost, and re-understand what is complexity and what is the interconnection between activities and life systems (Bistagnino, 2011, p.183). The waste production in campus teaching areas is large and the types are concentrated. The waste generated by teaching buildings and office buildings is the most recoverable(X. Zhao & T. T. Sun, 2014, p.52). The recycling of recyclable resources in these two areas can greatly reduce the school's waste transportation and management (W. T. Wu, C. S. Qing, & S. C. Peng, 2005).

4.5 Living system

School waste has been collected and managed by the cleaning staff. The collection of waste is included in the daily cleaning work. The waste collected in this process is mainly residual waste, and most of the waste is generated in the daily life of the campus. There is also a part of the collection work decided by the other person in charge of the campus. The campus catering system regularly produce food ingredient packaging, including cartons, pulp egg trays, metal cans, plastic bottles, glass bottles, etc. These wastes have recyclable value, so they are stored in the waste collection room and processed once a month. In addition, teachers will occasionally produce some books or takeaway packagings, such as cartons, courier boxes, and pure water buckets.

Through three event sampling of campus waste compartments, the author recorded the composition of recyclable waste in detail, mainly including cartons, magazines, books, plastic bottles and plastic barrels, food packaging, waste paper, metal cans,

Figure 51. Recyclable waste compartment. Photographed by the author.

glass bottles, egg container made of paper pulp. Most of the recyclable waste is sorted into the recyclable waste compartment by the cleaning staff. And at the end of the semester, they will sell this recyclable waste to the person who makes a living on collecting the waste.

The author collected data on waste in the teaching area of the middle school waste compartment for four months from September to December 19 and found that 129 barrels of residual waste, 55.1 barrels of household food waste, and 128.5 barrels of recyclable waste were generated within 4 months of high school. The output of residual waste is the largest and the least valuable among them. It basically consists of shredded paper and paper towels. Household food waste includes food waste collected by the catering system and litter and peels collected by the cleaning system that is easily decomposed by microorganisms. Hazardous waste mainly includes bottles, medicine bottles, chemical experiment broken utensils, waste fluorescent tubes, keyboards, etc. In

the interview with campus manager Jin, I learned that a large amount of waste is generated during the special period of school opening and vacation. For example, at the beginning of a semester, the number of cartons for shipping new books will increase. And during the graduation season, the number of books and papers discarded by students will be surge. And every school year, the school will have dozens of boxes of extra publications and new books piled up in the office of the waste room administrator, waiting to be donated.

Particular Map: Living System

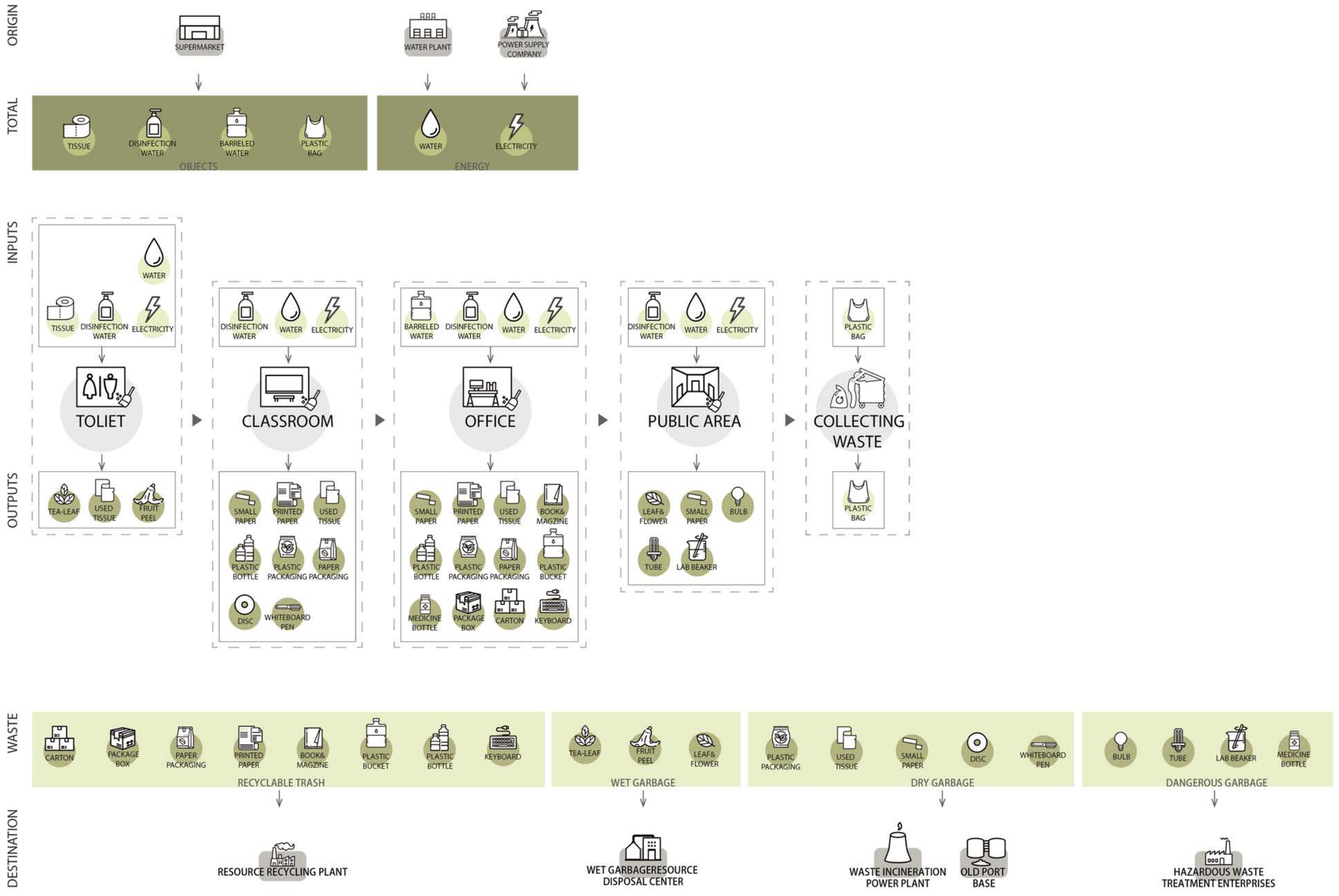


Figure 52. Living system particular map. Designed by the author.

4.6 Summary of current system

After investigation, the author found that the energy and material consumption units on campus are mainly catering areas, teaching areas, and living areas. Among them, the teaching area is the main source of residual waste. There are the most abundant types of waste in the living area. The materials purchased in the canteen and teaching area will be accompanied by a large amount of outer packaging. These packaging, including plastic, glass, and paper, will eventually be collected in the recyclable waste collection room in the living area. Household food waste mainly comes from organic matter in the dining area and green vegetation in the living area.

Among the waste generated on campus, the amount of residual waste is much higher than other types of waste. This is due to the limited types of recyclable waste. Most of the products that enter the system no longer have recyclable value and become residual waste after use and some materials lose their recyclable value due to human wear and tear.

Genral Map

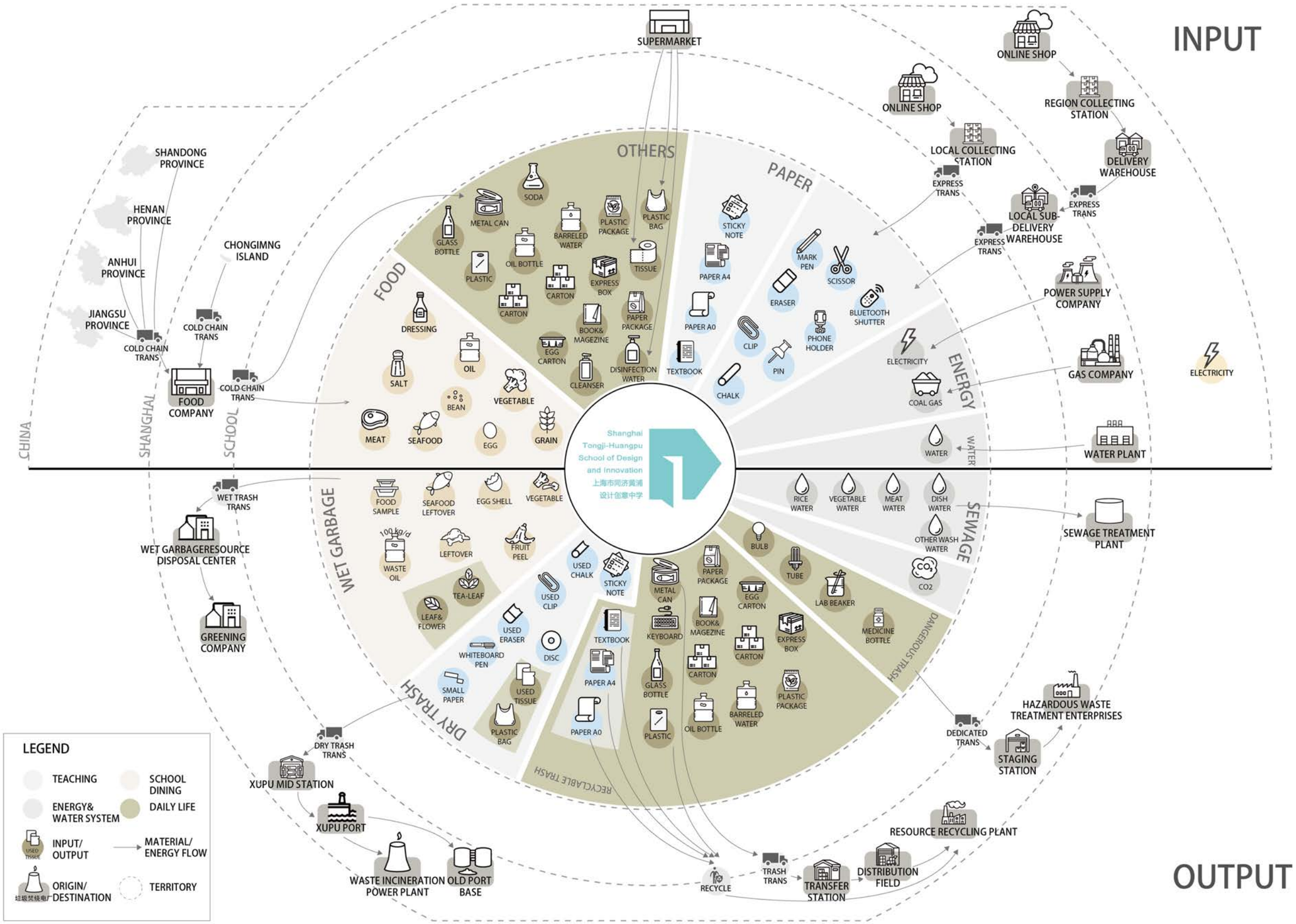


Figure 53. General Map of the campus system. Designed by the author.

For example, the recycling of paper products imposes strict requirements on the integrity of the material itself, and shredded paper and notepaper are treated as residual waste. In addition, due to the old house, the high school will produce a small number of waste lamps every month. These lamps and damaged laboratory utensils and medicines are classified as hazardous waste.

The waste generated by the school will eventually be returned to Shanghai's waste disposal system:

· Household food waste is sent to compost as a nutrient for urban greening;

· Part of the recyclable waste is recovered by special personnel at the waste station, and the other part is cleared and transported by special vehicles to the collection and distribution plant and then transported to different recycling factories;

· Hazardous waste is also transported by special vehicles to hazardous waste treatment Enterprises;

· Residual Waste is sent to the Laogang Waste Treatment Base for incineration and power generation, and the residue after incineration is buried on site.

· Most of the waste on the campus can be treated in a resourceful manner and has the characteristics of concentrated output and fixed categories. If we strengthen classification and recycling and establish corresponding closed-loop channels for waste on campus, this will reduce the burden on the city's waste system.

Total Map

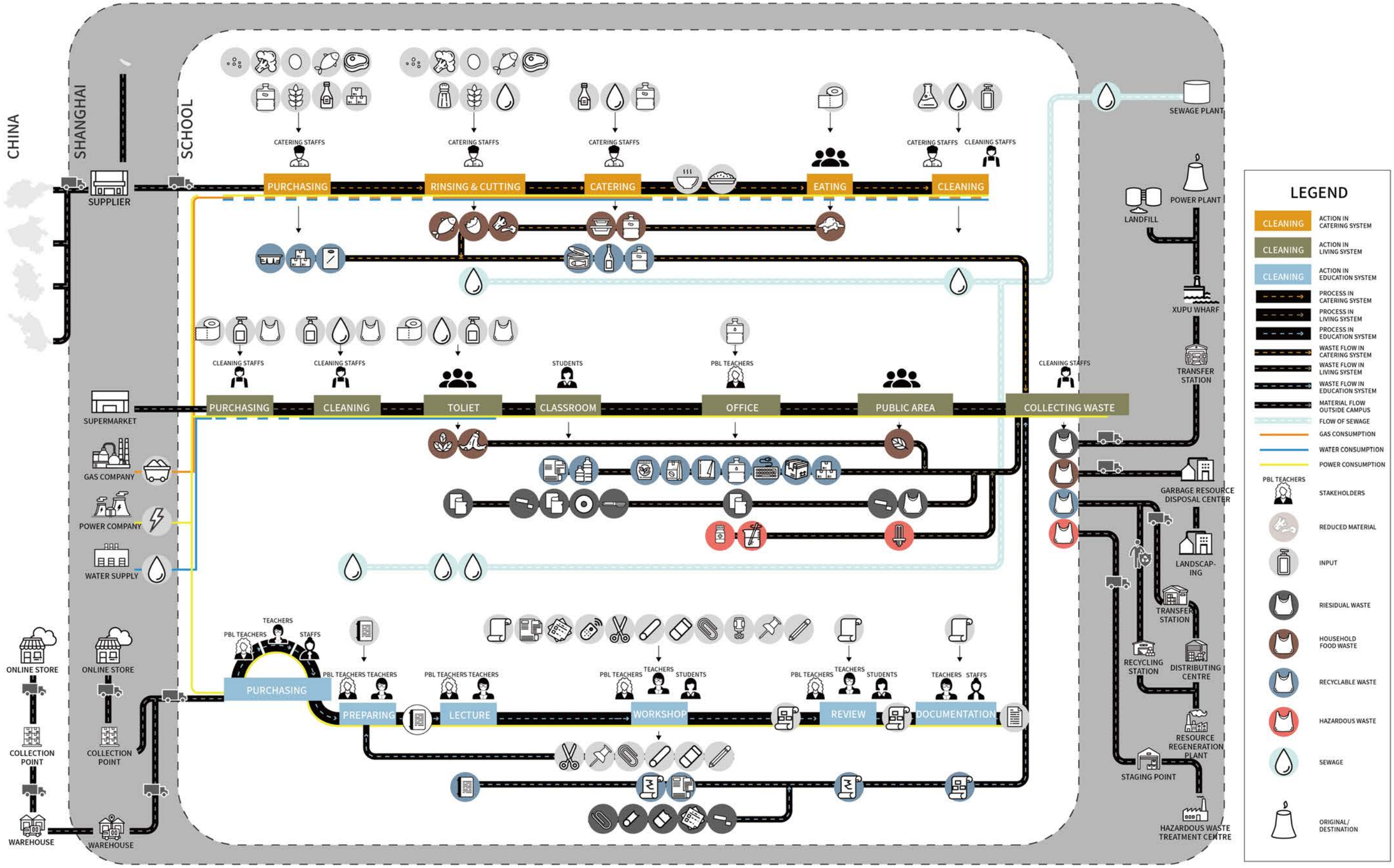


Figure 54. Total Map of the campus system. Designed by the author.

4.7 In-depth interview

4.7.1 Stakeholder interviews

In order to optimize the process of campus activities and adapt it to the limited 'metabolic' capacity of the city, we need to clarify the causal relationship between system participants, activities and their environmental results throughout the entire activity cycle. The environmental results are mainly determined by the amount of substances, energy and waste discharged during the activities. In short, it is to define a relational system to explore the causal relationship between human activities and various elements in the operation of the system.

The theme of this interview is the obstacles for sustainable action of the main user groups on campus. To ensure the scientificity of the research results, the author conducts in-depth interviews with the main persons in charge of catering, daily living, and teaching activities to find out what the hidden reasons of unsustainable behaviors. The author asked the interviewees to describe the process of their daily work and asked them to describe in detail the specific practices, materials used, and waste output of each activity. Based on this, we deliberately explore the causes of behavior, constraints and their own views on campus energy saving and emission reduction.

4.7.2 Interpretation of interview information

The author adopts a grounded theory method to collect raw materials on related topics through semi-structured interviews in a natural environment. Through open coding, spindle coding and selective coding, the text is systematically summarized and condensed to conceptualize and categorize the text, establish the relationship between each concept and category and form a theoretical framework.

1. Open coding analysis

First, the author transcribed the interview recording in Microsoft Word, read through the full text and focused on the quotations that affect energy, material use and waste generation during campus activities.

And to understand the deep meaning contained in the discourse to form the initial concept in terms of context, represented by the code n-n, the first n is the interview number, and the second n is the coding sequence number; through careful study of the four interview texts word by word, The content was preliminary conceptualized, and 91 open codes were finally identified. The research purpose of the interview is to explore the factors behind the campus activities that lead to the problems of low energy, material utilization efficiency and excessive waste generation. Therefore, the author screens 91 codes according to the research purpose and removes 13 concepts that do not match it.

Through continuous comparison, the author categorizes the approximate codes, that is, continuously discovers the relationship between the conceptual categories, and uses a vocabulary that can generalize to generalize the different categories, represented by the code An.

In the end, the author summarizes 12 categories, including personal responsibility, upper-level intervention, special factors, information exchange, environmental restrictions, lack of hardware, habitual preference, satisfaction, emotional care, attention to quality, utility priority and irregular behavior.

Examples of open coding text

A: Do you have a receipt for the monthly waste fee?
J: Then you have to ask about the school's general affairs, which comes on a quarterly basis. (1-22 someone is responsible)
A: Will there be more waste than usual at the end of each semester, after the exam or after the activity? how many?
J: There will be more during the summer vacation. We will clean up every classroom, and there will be more residual waste. During the holidays, there are more than one time. (1-23 Special period) After all, there is a lot of paper, and the cleaning is usually 1-2 hours.
J: Let me show you (toilet room). The roll paper is placed in the women's toilet, because boys need leather. Sometimes they are just thrown away. Girls won't. Boys are very leathery, unlike little girls. (1-24 Differences in behavior)
A: Is there hot water here?
J: Yes, I used this electric heater to heat it. This one was removed from the old campus. (1-25 Reuse)
A: Excuse me, the drinking water, flushing water and hand washing water in our school are all the water here, right?
J: Yes, they basically drink the water from the drinking fountain. (1-26 focus on quality)
A: Did the school not try to purchase reclaimed water recycling equipment to use the reusable water for toilet flushing?
J: No.
A: The water was drained from the sewer in the end, just as we usually do.
J: Yes, just like at home, we don't need more water for the second time. We just use it once. (1-27 pay attention to safety)

Table 1. Examples of open coding text. Compiled by the author.

2. Spindle coding analysis

Spindle coding is a process of further analysis of the generics summarized in the concept of initialization. The purpose is to clarify the interrelationship between conceptual categories and to connect approximate codes through continuous comparison to determine the main categories. In this process, the author produced new

Initial concept group	Subgenus An	Main category Bn
Cooperate with professional departments, assign full-time personnel responsibility, special storage, special personnel responsibility, lack of special personnel management, lack of management of purchasing materials, lack of specialized personnel participation, responsibility management, and sales of waste products	A1 Permanent staff is responsible	B1 Organization Management
Upper management, upper education, teacher management, teacher manage-ment, teacher management, dependent teacher management, dependent teacher management	A2 Upper Intervention	
Special period, special event, special period, national requirements, many people and many things, time	A3 Special factors	B2 Unknown factors
Information asymmetry, ignorance of the school situation, unclear, inquiries in advance	A4 Information exchange	
Construction year, limited space, bulk purchase	A5 environmental restric-tions	B3 Objective conditions
Tools are not easy to use, efficient hardware, lack of hardware, media to induce behavior, difficult to manage	A6 Hardware is missing	
Lack of awareness of recording, coordination of tasks, and cooperation methods	A7 Habitual Preference	B4 Inertial thinking
More is better than less, ensure sufficient materials, ensure sufficient materials, more important	A8 Satisfaction	
A sense of ritual, exclusiveness, gifts, personal customization, special customization	A9 Emotional care	
Pay attention to beauty, safety first, pay attention to quality, pay attention to safety, classroom effects, worry about errors, and ensure classroom effects	A10 Values quality	B5 Core value
Efficiency priority, price considerations, convenient operation, poor sense of use, being used, usefulness, recycling standards, do not want to recycle, recycling standards, rapid expression tools, teaching aids, material defor-mation, material waste, difficult operation	A11 Utility first	
Student behavior, students not using, student attitude, inconvenience in sorting, students naughty, too little material, too much material, personal ability, behavior difference, personal man-agement ability, sorting ability	A12 Irregular Behavior	B6 Invalid participation

Table 2. Spindle coding. Compiled by the author.

viewpoints and ideas and modified and added coding. Through the use of causal relationships, phenomena, situations, intermediary conditions, actions/interactive strategies, and structures as typical models, the categories of open coding are connected. Finally, six main categories of organizational management, unknown factors, objective conditions, inertial thinking, core values, and invalid participation are formed, which are denoted by B1, B2, B3, B4, B5, and B6.

Causal conditions - Objective conditions. The physical environment of the old campus and the restrictions on hardware equipment restrict how various activities of the campus are carried out. Campus users lack the favorable conditions for the change of actions so that they cause obstacles to the energy-saving and emission reduction of the campus. For example, the implementation of paperless teaching has been hindered by the lack of alternative media that assist students in real-time participation and feedback in the teaching process.

Phenomenon - Unknown factors. In the course of carrying out campus activities, the uncertainties brought by the external and internal unknown environments lead to decision barriers, the individual's ability to cope decreases, and judgment is insufficient.

Context - The attribute of action conditions-core values. Some mainstream value judgments in the education environment affect the effectiveness of campus workers and user groups in building a green campus. It is mainly reflected in the value needs of students and teachers for satisfaction, emotion, quality, and effectiveness that determine their behavior choices in the face of the contradiction between campus activities and environmental impact. For example, teachers focus on teaching activities and believe that the materials used in the teaching process are necessary to serve the classroom effect. From the perspective of classroom developers, the cost of materials, and consumables that are beneficial to teaching is often not taken into consideration by those who prepare materials. When the value of activities leads to teaching achievements, the environmental impact factors in the process are often ignored. To meet the needs of teaching quality, some materials have been worn, discarded, and left unused as test tools. For example, 'I think the chalk is a bit wasteful. They will cut into small pieces or make powder, which is a (for) shooting effect.

Intermediary conditions - That is, those conditions that promote or hinder the actions of actors-organizational management. The sustainable development of the campus depends on high-intensity upper

management, which requires professional technical support and a full-time system guarantee.

Action/interaction strategy - Inertial thinking. In the process, the campus user group tends to choose the most familiar way of doing things, hindering the transformation of the campus' sustainable model. This mindset makes it difficult for people's behavior to undergo substantial changes in the face of low-intensity campus environmental protection requirements; when the upper level gives a powerful intervention policy, people still try to narrow the scope of uncomfortable areas and passively accept the new rules.

Result - invalid participation. The individual behaviors of campus users are often lack of standardization, which artificially causes unnecessary waste of resources. For example, improper use behavior, management and conception ability, operation level, etc. will lead to low resource utilization.

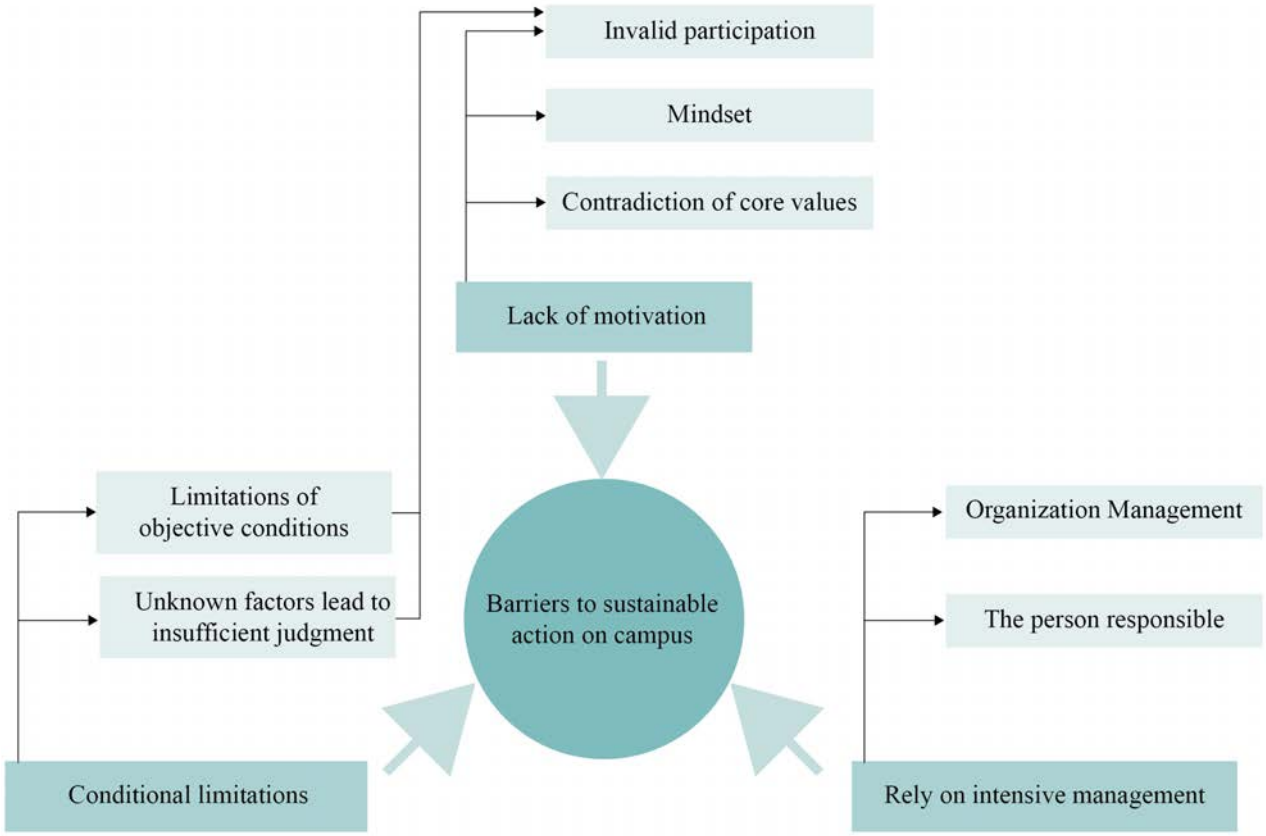


Figure 55. Sustainable mobility barriers in middle school campuses. Complied by the author.

3. Selective coding analysis

The selective encoding stage is the encoding after the main axis encoding. The main category formed by the main axis encoding needs to be systematically analyzed, compared and debugged again, and a core category (core category) is excavated from all categories. It is the key word obtained after condensing all the analysis results, which can explain the connotation of the entire study and develop a story line, that is, the typical relationship structure between categories.

Obstacles to sustainable action on the campus of secondary schools refer to the factors that affect the occurrence of unsustainable behaviors of campus users. They mainly come from lack of mobility, lack of conditions, and dependence on high-intensity management. The limitation of

objective conditions and unknown factors greatly affect the participation degree and participation effect of campus users. Personally, contradictions of core values, mind-sets, and the ineffectiveness of participation are the root causes that prevent effective participation in sustainable behavior, and directly affect the quality of action. Reliance on organization and upper management is also a reason for individuals' lack of positive action.

4.8 Summary

This chapter specifically elaborates the method and path of the investigation activities carried out for Tongji-Huangpu School of Design and Innovation. By using the systemic design method, the author collected the data related to the material and energy flow involved in the various activities of the system, and constructed a system model of the status of material energy metabolism in the high school campus; the system map describes the campus users, behavior activities, material energy, city and The inherent connection between the natural environment reveals the patterns and processes involved in the interaction of campus human activities and natural systems; macroscopically, it helps to clearly identify the most consumed substances, energy, and major waste in the campus system; microscopically , it can grasp the important units and specific flows of energy-consuming materials, help authors further insight into system problems and determine design goals. These works answer the question of what the high school campus system is. On the other hand, the author uses qualitative research methods to explore the main users of the campus system, and to clarify the status quo of his behavior and obstacles to his actions, which is a key part of achieving a sustainable transformation of campus life. Through in-depth interviews with stakeholders, the author deliberately tapped the constraints of sustainable actions of key users on campus, and found breakthroughs in providing design solutions that encourage sustainable individual behavior.

A case study based on the model of the Tongji-Huangpu School of Design and Innovation System Status helps to abstract and derive a common model of the general campus environmental impact (see Figure 33). Based on the basic activities existing in the campus and related materials and wastes in the activities, the general content and structural relationship of the green campus can be basically framed. The variables existing in this model are

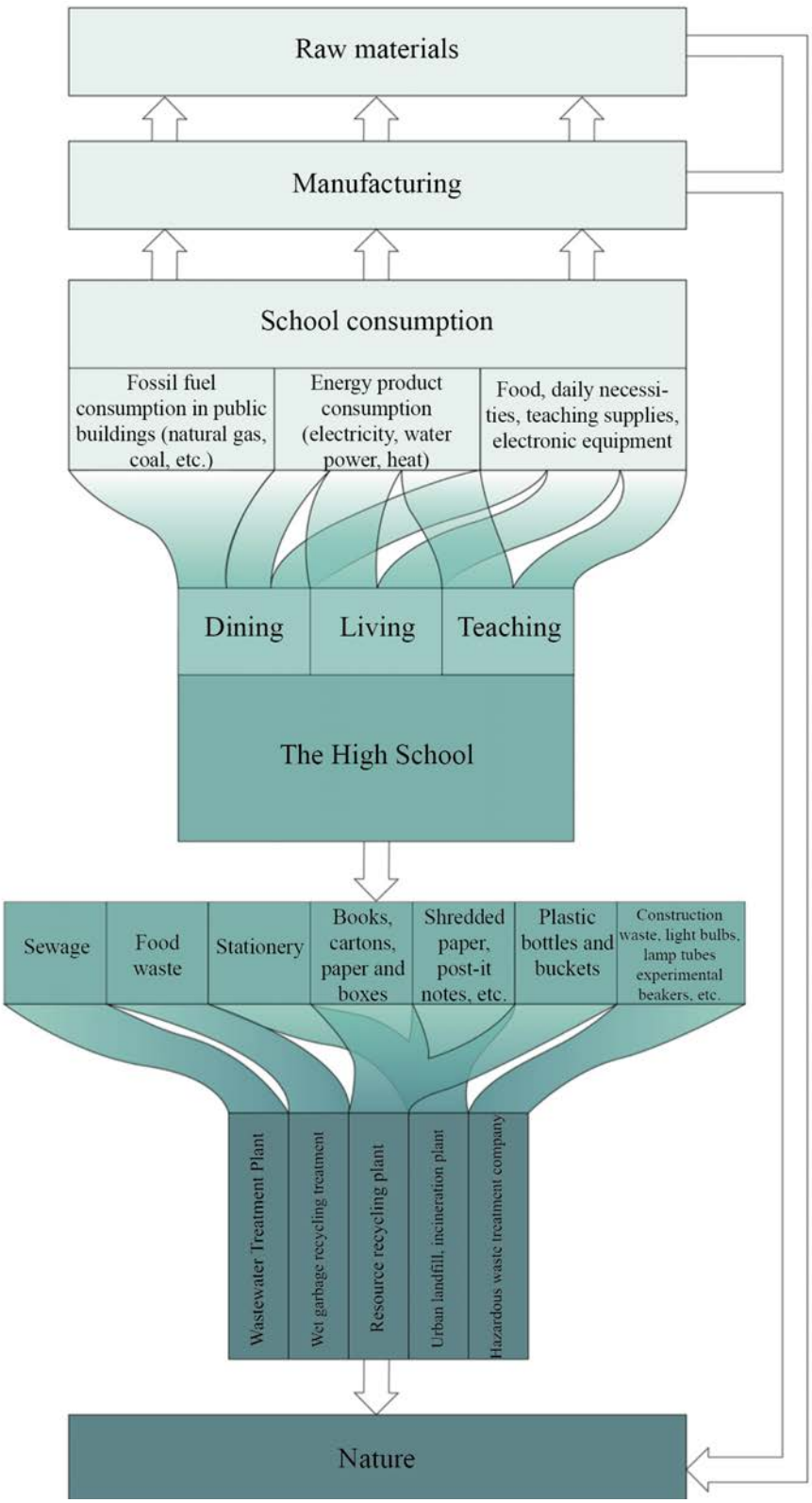


Figure 56. Campus environmental impact model. Complied by the author.

campus consumption type and proportion, waste type and proportion, urban waste sorting and treatment system. These variables may be determined specifically by the campus situation, teaching plans and education model, school students' age, population area, city culture background or other factors. However, the structural relationship between campus consumption types, campus activities, campus waste types and waste destinations constructed by this model can provide a basic logical framework for different types of green campus research. In addition, the system of sustainable action obstacles in the high school based on theoretical methods helps authors understand the deeper reasons why campus sustainable activities are difficult to carry out or continue, and facilitate the comparison of similar types of research.

Reference

Zhang, Y. M. (2018) A Preliminary Study on the Cultivation Model of Innovative Talents Oriented by Design Thinking——Taking Tongji- Huangpu School of Design and Innovation in Shanghai as an example. Innovative Talent Education, (2), 10.

Duedahl, E., & Stilling Blichfeldt, B. (2020). To walk the talk of go-along methods: navigating the unknown terrains of being-along. Scandinavian Journal of Hospitality and Tourism, 1-21.

Creswell John, W. (2007). Qualitative inquiry and research design: Choosing among five approaches. Lincoln: Sage Publications.

Ministry of Housing and Urban-Rural Development of the People's Republic of China, State Administration of Quality Supervision, Inspection and Epidemic Situation of the People's Republic of China. (2019). GB50015-2019 Building Water Supply and Drainage Design Standard. China Planning Press.

Wu, W. T., Qing, C. S., & Peng, S. C. (2005). Investigation and analysis of the status quo of domestic waste on campus of Hefei University of Technology. Journal of Hefei University of Technology (Natural Science Edition), 28(11), 1424-1426.

5 PROBLEMS AND OPPORTUNITIES


APPARCAMENT

5.1 Ecological assessment

This section mainly measures the ecological footprint of the materials in the list within the boundary of the system and determines the sustainability of the material flow in system by measuring the relationship between the demand of the campus system and the ecological supply.

5.1.1 Ecological analysis of food

Projects	Data source and description
Annual food consumption in middle school canteens	The data comes from the responsible department of the canteen. Using the amount of ingredients in a week as a sample, estimate the amount of ingredients consumed during the available time in a school year
Types of Food Consumption in Middle School Canteens	The data comes from the responsible department of the canteen, and the quantity of ingredients in a week is used as a sample to estimate the types of ingredients consumed during the available time in a school year
Number of people in the canteen	189 people
Dining days in the canteen in a school year	179 days
Average productivity	2019 China Agriculture and Animal Husbandry Statistical Yearbook and World Agricultural Food Organization Statistics
Basic consumption of livestock feed	2012 China Agriculture and Animal Husbandry Statistical Yearbook
Conversion rates	Adopt the transport emission factor conversion rate announced by UK DEFRA2008; to absorb 1 ton of carbon dioxide, 0.27hm2 of forest land is required

Table 3. Food data sources and descriptions. Compiled by the author.

Due to difficulties in tracing part of the data, the following assumptions are made for different situations to facilitate calculation.

Ignore the weightlessness of ingredients in the process of making processed foods. For processed wheat products such as hamburger bread, it

	Formula	Data and parameters needed for calculation		
	The area occupied by this type of food during the year	Consumption of this type of food during the year (kg)	Average productivity of land producing this type of food (hm2)	Land type
	Af = Qf / Pf	Qf	Pf	
Chicken	1.62	2232.846	1376.9032	Arable land
Pork	15.9	1251.747	78.891267	Arable land
Duck	0.4	541.296	1335.4917	Arable land
Seafood	0.18	1630.6542	8982.00178	Arable land
Egg	0.03	304.479	9099.931	Arable land
Rice	0.34	2368.17	7026.6	Arable land
Potato	0.51	2029.86	3990.53	Arable land
Vegetables	1.79	6165.36144	3441.82882	Arable land
Beans	0.54	1014.93	1885.1	Arable land
water		3383.1		Arable land
Oil	0.37	661.818182	1780.1372	Arable land
Total	21.66	20922.44364		

Table 4. Ecological footprint of various types of food. Compiled by the author.

is assumed that the weight of the product is consistent with the weight of raw materials. In this case, there may be a possibility that the ecological footprint of the processed product is slightly lower than the actual size.

Assumption of production. Due to

the different origins of ingredients, this study only calculated the cold chain transportation distance from Lvjie Industrial Company to Tongji Huangpu Design and Creative High school. This assumption may cause the carbon emission value of transportation to be lower than the actual value, but it still has significance for the comparison of the ecological footprint of food.

The types of land occupied by the production of various types of food materials are different. The land occupation category of cattle and sheep (milk) products is pasture; the land occupation category of pigs, poultry, grains, eggs, sugar and vegetables is cultivated land; fish The land occupation category is territorial waters.

The author classifies food in order according to the type of land occupation, categorizing cereals, vegetables, potatoes, beans, oils as agricultural products, meat and eggs as livestock products, and fish as aquatic products.

The ecological footprint of food consumption includes the area of arable land required to produce, raw materials, and the area of energy required for CO2 emissions during transportation. The land area required for each food ingredient is equal to the total annual consumption of food ingredients divided by the output per unit area of food ingredients. The area of energy required for each food ingredient is equal to the average consumption of each food ingredient multiplied by the transportation distance multiplied by the transportation emission factor conversion rate times the energy conversion rate. The author calculates the ecological footprint of various food ingredients, and the results are shown in Table 4.

The footprint of livestock products as a whole is higher than that of agricultural products and seafood, and pork is the raw material with the largest ecological footprint. Since the amount of vegetables consumed in the cafeteria accounts for 34% of the total consumption of ingredients, the ecological footprint of vegetables is also much higher than the rest of the ingredients, ranking second, followed by chicken.

5.1.2 Ecological analysis of paper using

According to the interview data, paper as a material is an important medium for transmitting information in the teaching and office process in high school. The paper-using units of the school include the office department and the teaching department. Because the data is difficult to count, the author makes assumptions about the paper consumption in the high school teaching process based on some of the data obtained to estimate the amount of paper used in the basic courses and PBL courses throughout the year. Due to the special flows such as office paper and exams, which are included in the total amount, the current ecological footprint of campus paper obtained by the author is much smaller than the actual consumption. The amount of paper used by the high school in 2019 is about 0.97 tons and an average of 4 cubic meters of wood per ton of paper (http://www.papercn.net/). The average wood productivity of the woodland is 1.99 cubic meters, and the ecological footprint of the secondary school paper is 0.97 hm2.

5.1.3 Ecological analysis of energy and water

The impact of energy consumption on the ecological environment is mainly manifested in the greenhouse effect caused by CO2 emissions. To offset this impact, sufficient forest land is needed to absorb CO2 (M. Wackernagel, L. Onisto, & P. A. Bello, 1997, p.201). In order to distinguish it from the rest of the productive forest land, this part of the forest land specifically used for absorbing CO2 is called ‘fossil energy land’ as the type of land occupation for energy consumption. The main energy consumption of the high school is artificial gas and electricity.

The area of fossil energy required for electricity consumption during the year, that is, the ecological footprint of electricity consumption during the year, is equal to the consumption of electricity during the year multiplied by the CO2 emissions per unit of power generated by ordinary thermal power plants divided by the average

productivity of fossil energy sources. The total electricity consumption of the middle and high school in 2019 is 109,984 kWh. According to the data of ‘ China Electricity Industry Annual Development Report 2019’ (China Electricity Council, 2018) , the carbon dioxide emission per unit of thermal power generation is about 841 g/kWh, and 480.98 hm2 is calculated according to the formula.

An average of 10,000 cubic meters of artificial gas needs to consume 5.4286 tons of standard coal. The amount of artificial gas used in the high school is 6061 cubic meters throughout the year, and the coal consumed by gas for the whole year is about 3.1 tons. The average burning rate of coal-fired boilers is 80%, which can be calculated according to the ecological footprint formula of coal consumption. The ecological footprint of coal consumption in high schools throughout the year is about 1.27 hm2.

According to statistics, the running water consumption of high schools in 2019 is 6,367 cubic meters, and the running water price in Shanghai during the same period is 3.65 yuan/ cubic meter. The electricity price for non-residential users is less than 1 kilovolt when the electricity price is 0.641 yuan/kwh. Since the price of water is one-fourth of the electricity cost, it is converted into a unit of electricity consumption of 1.4235569 kWh/m3, which means that for every 1 m3 of water supplied, about 1.4 kWh of electricity is consumed, so the total water supply uses electricity The amount is 9063.787051 kWh. According to the formula of electricity consumption, the ecological footprint of water supply is about 40 hm2. Assuming that the annual sewage discharge in high school is the annual water consumption minus the consumption of 6363.6 cubic meters, and the non-residential sewage treatment fee in Shanghai during the same period is 2.24 yuan per cubic meter. Similarly, the ecological footprint of secondary school sewage treatment is 24.3 hm2.

5.1.4 Ecological analysis of waste

Due to the lack of accurate data, the author only calculated the ecological footprint of some components in the waste, including glass, plastic, waste food, and paper. The annual output of these 4 types of waste is estimated by the author based on the collected second-hand data. Food waste includes kitchen waste, swill and peels in household food waste; paper contains paper, carton and pulp egg tray; plastic contains plastic oil barrels and pure water barrels. It can be seen from the comparison that the ecological footprint of paper and food waste is large, accounting for 74% and 29% of the total ecological footprint respectively.

	Footprint	Discharge amount of the i-th garbage component during the year (t)	CO2 generation rate of the i-th garbage component (t)	CH4 generation rate of the i-th garbage component (t)	GWP equivalent of CH4 wash (t)	Total amount of CO2 per unit of garbage (t)	The average amount of CO2 that can be absorbed by forest land in one year per thousand years (that is, the average increase of painter's energy land)
		Qi	qCOi 2	qCHi 4	x		Pa
Glass	0.0079344	0.04176				9.88	5.2
Plastic	0.002591733	0.02083				6.47	5.2
Swill	0.6913875	6.7125	0.0572	0.0208	23		5.2
Paper	0.230905285	0.841656723	0.1524	0.0554	23	1.4265	5.2
Total	0.932818917						5.2

Table 5. Ecological footprint of various types of waste. Compiled by the author.

5.1.5 Ecological footprint analysis

The total footprint of the high school in 2019 is about 570.3 hm2, which means that 570.3 hm2 of various bioproductive land areas are needed to support resource consumption and waste discharge activities on the campus. Since office paper and special activity paper are not included in the total paper consumption, the calculation result of the paper's ecological footprint is lower than the actual value; Residual waste, hazardous waste and some recyclable waste are not included in the calculation scope of this paper, so the waste footprint is far lower than actual data; Overall, the calculation results in this paper are conservative estimates of the actual ecological footprint.

The main components of the secondary school's ecological footprint are electricity, water, sewage, food, and paper, which account for 84.4%, 6.95%, 4.3%, 3.8%, and 0.17% of the total footprint, respectively, and the five together account for 95.32% of the total footprint. According to these types of ingredients, formulate corresponding ecological footprint reduction methods.

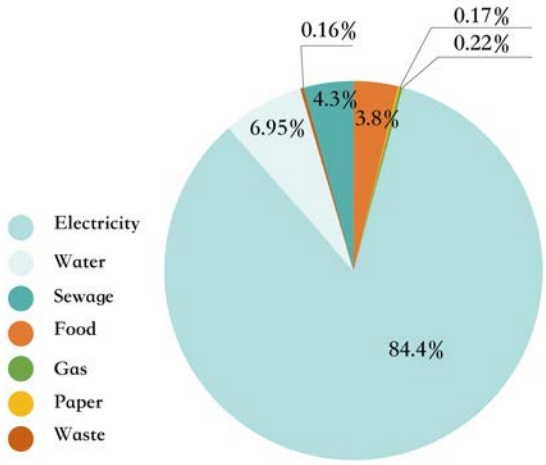


Table 6. Percentage of Ecological Footprint in Middle Schools. Compiled by the author.

Table 6 shows the characteristics of the ecological footprint of high schools:

1) The calculation results should prove the fact that the campus is regarded as the city's 'large energy user'. The largest footprint component of the high schoolis electricity and its value is much higher than the other types of footprints.

2) Campus water and sewage discharge are the second biggest factors affecting the environment, and they together account for 11.25% of the total footprint.

It can be seen that electricity, water, sewage discharge, and food and paper consumption are the main contradictions that need to be resolved in the development of a green campus. By improving these several issues, it will contribute to the significant improvement of campus ecological efficiency.

5.2 Problems

Combining the analysis of the ecological footprint component analysis and the insights gained from the design survey, the author analyzes the problems of 'eating', 'living', and 'learning' on the campus.

1. Dining system

Campus canteens have considerable carbon emissions, and food materials have varying degrees of impact on the ecological environment during production, logistics, transportation, and disposal. From the source point of view, the canteen suppliers come from Jiangsu, Shandong, and Anhui provinces, and a large number of carbon emissions will be generated during the inter-provincial long-distance transportation. At the same time, to ensure the freshness of the food, cold chain logistics technology will consume more energy. The loss of fresh vegetables in the logistics link directly affects the number of yellow leaves and rotten leaves that are artificially sorted during the initial processing. These waste food materials account for 10% of the total food waste.

The kitchen water used in the production process accounts for about 9% of the total water consumption of the high school, which is mainly used for cleaning food, cooking, and cleaning utensils. The organic load and oil content of sewage discharged from the kitchen is relatively high(D. F. Zhang, C. Wang, G. X. Ji, & Y. P. Wang, 2002), and direct discharge without treatment will pollute water resources. Kitchen waste, surplus food, and swill produced by the campus catering system are the main components of organic matter in campus waste. Kitchen waste has the characteristics of being extremely perishable, large in water content, and low in calorific value. Proper treatment can form plant nutrients through composting. However, since waste sorting has not yet begun in most parts of my country, some circumstances have caused such waste to lose its recyclable value and cause harm to the environment. Along the entire supply, production and

consumption chain of the high school canteen, food loss and waste exist in every link. The food waste in the production and consumption of high school directly leads to the amount of urban organic waste. Therefore, the catering system needs to reduce waste treatment.

2. Living system

The water use of the high school can be divided into living and dining, 91% of which is used in the living system. Except for water used in canteens, the types of water used in living areas are mainly divided into the toilet water, toilet flushing water, and clean and green water. According to the 'Design Standards for Water Supply and Drainage of Buildings' promulgated in 2019, the average daily domestic water consumption of each student in buildings in primary and secondary schools is 15 to 35 liters (Ministry of Housing and Urban-Rural Development [MOHURD], 2019, GB50015-2019, p.23). There are 180 teachers and students in secondary schools, and the prescribed annual water consumption range should be 507.5 liters to 1184.1 liters. However, except for 9% of the kitchen water, the remaining water consumption in the high school is as high as 5777.7 cubic meters, far exceeding the campus water consumption norms.It was found in the interview that the school is currently focusing on the reductionof water consumption in a single scenario. For example, the school is equipped with water-saving appliances and water-saving slogans are posted on the walls. The author has observed the use of appliances in the toilet, and the rated flow rate of the appliances is within the national standard. Therefore, the author focus problem on water-use behavior.

Through interviews, it was learned that in the daily cleaning work of the building, because the design size of the sink is too narrow, it is not enough to put down the water storage bucket. During the cleaning process, the cleaning staff can only use running water to clean utensils. The single-valve spout for the sink or sink is rated for 0.3 to 0.4 liters per second. According to the assumption of the floor space of the building, the cleaning staff needs to clean the mop 56 times, and the water needs to be replaced every time the mop is cleaned. If the water stored in the bucket is 20 liters at a time, the annual clean water consumption is 200.48 cubic meters.

Assuming that washing with running water takes 3 minutes at a time, the annual cleaning water consumption is 721.728 cubic meters, which is 3 times that of water storage cleaning. Therefore, the author believes that the design of toilet equipment affects the cleaning staff's water usage, thereby increasing school water consumption. In addition to the improper water use

behavior that caused the waste of water in the high school, due to the small scale of the high school, there is no large-scale reclaimed water recycling station, and the construction of the building drainage does not consider the secondary use of water resources. Due to the small scale of the middle school campus, there is no large-scale water recycling station, and the drainage of building buildings does not consider the secondary utilization of water resources. The total number of junior high schools and high schools in Shanghai exceeds 1,000. If they all use this kind of tap water for a long time, it will continue to aggravate the shortage of urban water resources.

3. Teaching system

The teaching system is the main unit of paper consumption. The amount of teaching paper-use in the high school is large, and the using frequency and waste discharge frequency is high. Waste paper is the preferred raw material for papermaking, with a recycling rate of up to 80%. Recycling 1 ton of paper can save 17 large trees, save 3 cubic meters of landfill space, reduce the use of soda ash by 0.24 tons, and reduce paper pollution emissions by 75% (Dai et al., 2004, p.6). After interviews and observations, the author found that the high school faced systemic problems in using paper and preparing teaching materials. In the procurement process, there are problems of poor material saving awareness, insufficient communication and lack of management. These factors cause the number of spare materials to be greater than the actual teaching needs and the occurrence of repeated purchases, thereby increasing unnecessary consumables in teaching.

In the teaching process, students' behavior is the main factor that constitutes material waste, and it is also accompanied by problems in awareness, management, and communication. Lack of awareness of moderation materials leads to unnecessary waste; Improper using habits will cause different levels of material loss and directly affect the recyclable value of the materials; Failure to plan the management of teaching materials in advance will result in teaching aids and materials designed for specific classrooms becoming useless waste materials and paper. The use of materials in the teaching process needs to be transformed through management and communication.

After the end of the teaching, because there is not enough and specific space for storage, most of the paper works that are not decorative will be photographed or saved in digital devices.

The high school does not have its document management system, and

Problem Analysis

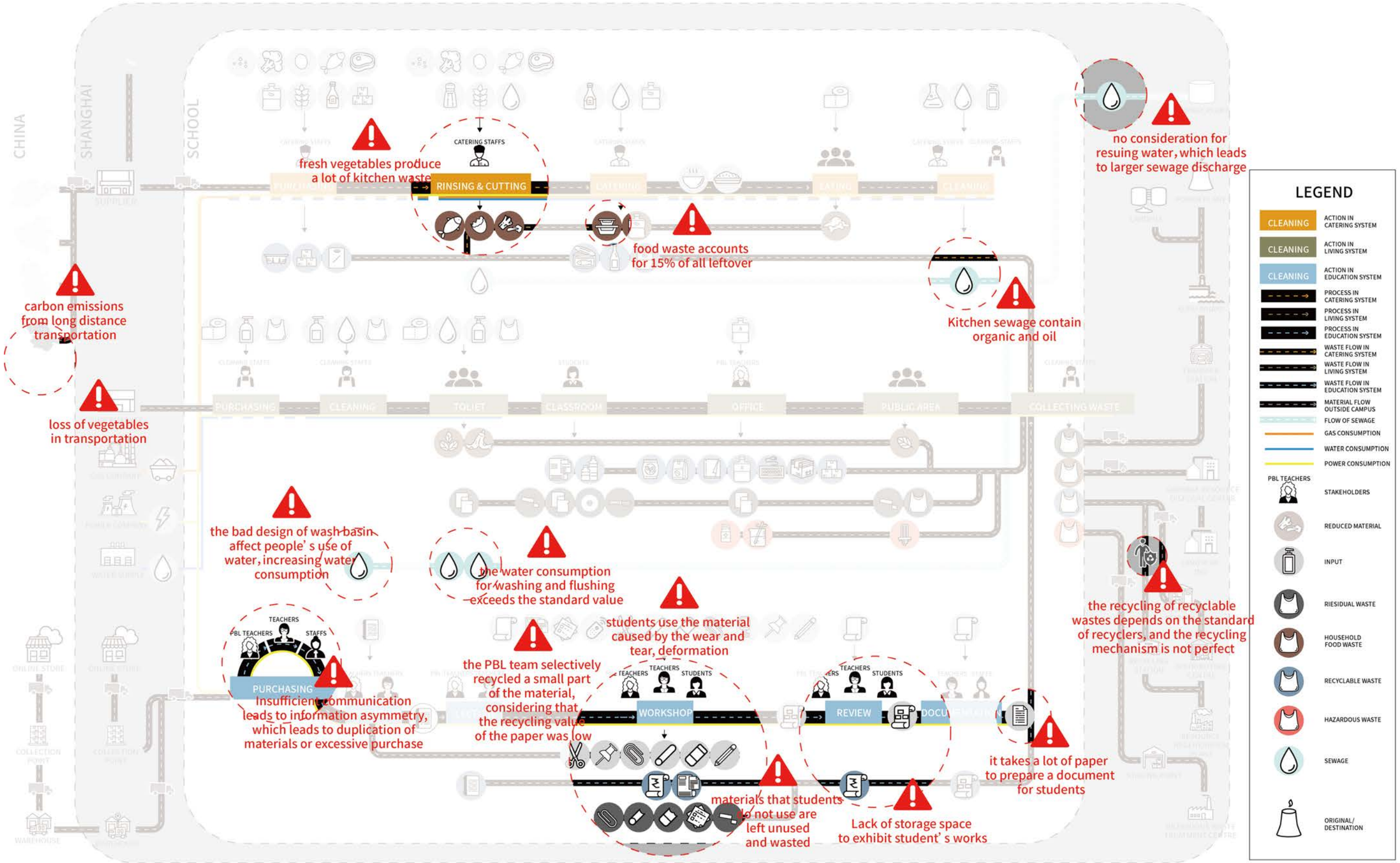


Figure 57. Analysis of problem in the campus system. Designed by the author.

a large amount of content cannot be shared with each student in real-time, which brings many problems to the management of teaching results files and affects the process experience of managers and students. The lack of a convenient and accessible virtual management platform leads to information transfer still relying on traditional paper.

5.3 Opportunities

To solve the waste problem generated by the catering system, a policy of 'Trimmed Vegetables Entering the School' can be introduced. This policy emphasizes cleaning and dividing food before transport, and this could reduce the food waste generated in transportation such as yellow leaves and roots. For the swill produced by the meal, the school ‘Clear your Plate’ activity can be implemented, calling on teachers and students to eat all the food they ordered. In order to reduce the carbon emissions from long-distance transportation, Shanghai Lvjie Industrial Development Co., Ltd. preferentially selects nearby suppliers and establishes and strengthens a series of supply chain management from storage, transportation and packaging to reduce food loss during transportation. Restrict the use of disposable packaging for storage and transportation, and try to use recyclable materials as containers. The oily sewage in the kitchen is treated and then discharged to reduce organic matter in urban sewage.

In view of the problem of excessive water consumption and drainage in the living system, water-saving appliances can be used in middle schools.

Redesign suitable water circulation system appliances, it is best to not only meet the water needs of people but also reduce water consumption from the source. In this way, reduce the total water consumption by recycling toilets and kitchen drainage as reclaimed water.

For the problem of materials used in the teaching system, strengthen the communication efficiency of stakeholders at the source to ensure that the information is accessible and searchable, for example, to provide a platform or tool for visual management of campus information.

The waste caused by human use in the teaching process takes different countermeasures according to the degree of wear and tear, such as waste material upgrading and recycling, waste paper recycling of used or unused paper, the development of electronic teaching media to reduce dependence on paper, and the use of teaching materials. Waste in the use of management methods. For the processing of paper-based teaching

achievements, more possibilities are provided in the hardware facilities, such as providing a dedicated display space, a good experience electronic achievement management tool, and generating electronic achievement archives. In addition, establish cooperation with paper mills to build a smooth and convenient resource-based channel for waste paper recycling.

Opportunity Analysis

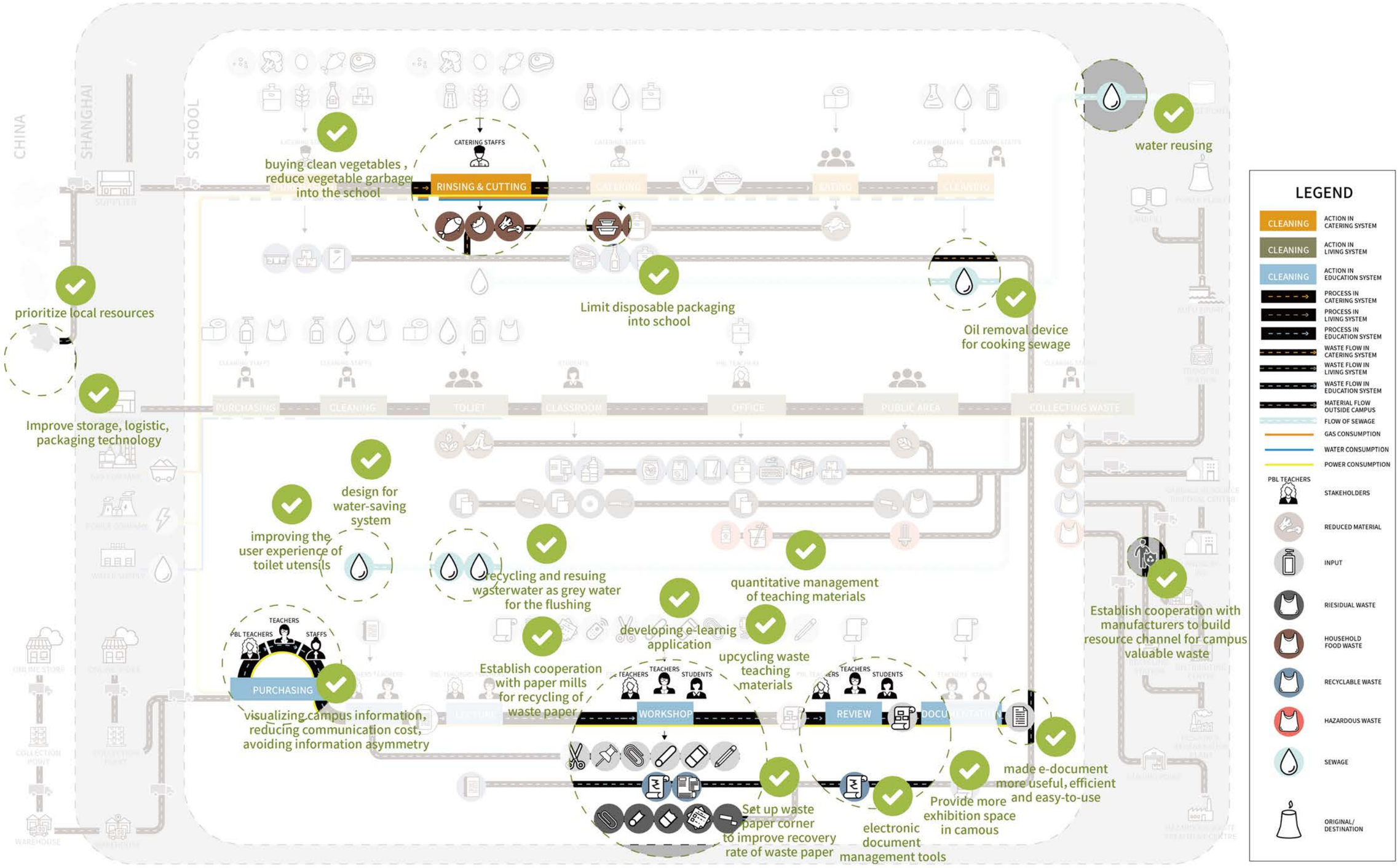


Figure 58. Analysis of opportunity in the campus system. Designed by the author.

5.4 Summary

In this chapter, the author uses the Ecological Footprint method to conduct an ecological assessment of the consumables, energy consumption, and waste emissions of various activities of the Tongji-Huangpu School of Design and Innovation to quantify its environmental impact value. Studies have shown that electricity, water, food and paper consumption, and sewage discharge have become constraints on the green campus building, and are the main contradictions that design needs to focus on and resolve. Through the case analysis of Tongji-Huangpu School of Design and Innovation, the author found that catering activities, teaching activities and living activities are the main activities that constitute the material consumption and waste discharge of the high school campus system. The metabolic materials and environmental impacts of various activities are different. The environmental impacts of catering activities are mainly reflected in the consumption of food and various types of food packaging. The waste is essentially recyclable waste that can be converted into resources by composting and other means. Rapid metabolism; teaching activities are more problematic at source reduction and end management.

At present, there are few green consumer substitutes for paper, paper products and various stationery, and because teaching is the main activity of the high school, the demand for such products is difficult to reduce. Another problem is that most of the waste generated by teaching is non-recyclable residual waste, which means that once they are abandoned, they need to enter the landfill and be disposed of by incineration or landfill. Urban land resources, soil, and air quality all serious influenced by the incineration and landfill; Daily living causes major water consumption and sewage discharge on campus, and the types of waste generated are also complex.

The case analysis discusses where the various consumer activities of the high school campus hurt the environment and draw out the key factors of the problem and the focus of the solution. The analysis results obtained by

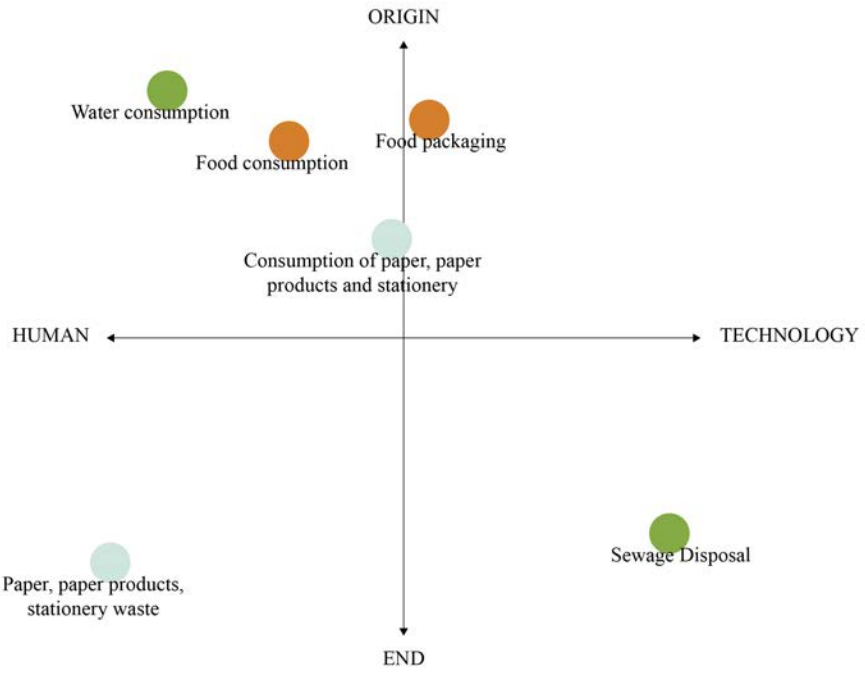


Figure 59. Campus system problems and opportunity coordinates. Designed by the author.

individual cases may not apply to all types of campus status quo, but this idea can be applied to the analysis of campus sustainability issues of different sizes, grades, and countries.

The author put the problem into a coordinates. As is shown in the following figure (Figure 59), the vertical axis according to the stage in which the influence exists, and the horizontal axis is metrics in terms of problem-solving. By placing specific questions on the campus in the coordinates, one can identify where the problem is and orient the general direction of the process. For example, if the problem occurs at the source, you can take measures such as optimizing the consumption structure and reducing the number of consumption. The horizontal axis helps to define the focus of problem solving, whether it is to use technical means to intervene or to adopt the transformation of motivating ways of action. For example, the problem of sewage discharge is a technical problem, and it is more efficient to solve it through technical means. The idea of problem analysis in this paper can be characterized by this coordinate system, as an analysis tool to define the problems of other types of schools and the perspective of problem solving.

Reference

China Electricity Council. (2018). China Electric Power Industry Annual Development Report 2019. China Market Press.

Zhang, D. F., Wang, C., Ji G. X., & Wang, Y. P. (2002). Experimental study on the treatment of kitchen sewage by SBR method. Journal of University of Shanghai for Science and Technology, 24(1), 39-42.

6 GREEN CAMPUS SYSTEMIC DESIGN PRACTICE


APPARCAMENT

6.1 Systemic project

According to the systemic design action principles summarized in Chapter 3, the author optimizes the system from the input, process and output respectively.

6.1.1 System optimization from input

1. Food

(1) Prioritize the selection of nearby ingredients to shorten the transportation distance.

Prioritize the selection of nearby resources to reduce the carbon footprint caused by food transportation. Shortening the transport distance can bring many benefits, like reduction of energy consumption, reduction of natural loss of food ingredients and increase of food supply elasticity. At the same time, the needs of the city can promote the development of suburban agriculture and form a benign interaction between the city and the countryside. The innovation of eco-agricultural technology needs to go through a long process, and reducing environmental pollution caused by food transportation is timely and feasible.

(2) Trimmed Vegetables Entering the School to reduce vegetable waste.

The process of soil-rooted green vegetables from the farm to the table has a negative effect on the urban waste disposal system and logistics transportation. Untreated rhizome leaves will turn into kitchen waste after entering the campus, and need to be transferred to an urban waste treatment plant. The one-time and ineffective transportation will waste

energy and pollute the environment. Clean vegetables refer to vegetables that have been lightly processed without silt, sundries, yellow leaves, and roots. Before entering the school, fresh vegetables complete the work of soil removal, root removal, and yellow leaf removal (Q.H. Chen & W. L. Li, 2001), which greatly reduces the vegetable wastage rate, reduces the production of school vegetable waste, and reduces the processing of food ingredients for catering staff. Through the implementation of clean vegetables into the school, it can reduce nearly 10% of campus food waste and 50% of the water used for washing vegetables.

(3) Restrict one-time food packaging into school

At present, the food packaging sent to the high school canteen is mainly cartons, metal cans, plastic barrels, glass bottles, plastic bags, most of which can be recycled. Glass bottles for packaging can be divided into disposable bottles (cosmetic bottles and medicine bottles) and reusable bottles (such as seasoning bottles, beverage bottles) that can be used multiple times(Zang, 1996). Glass bottles used for food packaging are classified in the latter category and can be recycled and reused. Cleaning and reusing of the glass bottle is more ecologically effective than breaking and making a new one.

Therefore, Lvjie Industrial Company can recycle the packaging of its supplies on the spot and use the return journey of the truck to transport these recycled materials. Through cooperation with manufacturers, logistics and warehousing services are provided to help waste packaging return to the factory, reduce the waste material recycling range, and reduce the pressure on urban waste transfer, sorting, and disposal. Because Lvjie Industrial Company is responsible for the catering services of many schools in Shanghai, it can ensure that the supply of waste packaging will not occupy the inventory for a long time, and the use of return packaging for transportation packaging does not increase logistics costs and increase the carbon footprint of transportation.

2. Water

(1) Reduction of tap water, using reclaimed water

Reuse of reclaimed water refers to the use of domestic sewage according to different water quality and usage requirements, after appropriate physical, chemical or biologicaltreatment to reach a certain standard, for reuse in ground cleaning, greeningirrigation, vehicle washing, toilet flushing, etc. At present, secondary schools do not make secondary use of campus drainage, so they have a lot of recycling space. The composition of campus drainage is simple, so it is easy to recycle and

treat it as clean water. The campus has a large drainage volume, and the drainage area and time are relatively concentrated. Excluding daily drainage, washroom and kitchen sewage are the reclaimed water sources available on campus(X. Y. Guo, Z. Y. Shen, T. Lin, & L. Kuang, 2010).

6.1.2 System optimization from process

1. Paper

(1) Design of waste collection box

Due to the clear division of campus functions, different areas have different functions, and the types and quantities of waste are also different (Z. Zhang, 2003, p.193). In the face of the particularity of waste types in different functional areas, the design and indoor layout of campus waste collection containers also need to be changed according to different use scenarios. The teaching office area is the main production area of waste paper. In this area, the placement of recycling containers according to major categories increases the difficulty of recycling waste paper. Since waste paper needs to be recycled according to the fiber composition and type, it is necessary to sort out papers of the same quality in different categories during recycling (Zang, 1996, p.26). Mixed recycling will reduce the degree of waste paper recycling.

Setting up a 'waste paper corner' in classrooms and offices to encourage the mindset and participation of paper recycling, and reduce the difficulty of waste sorting; Setting up a specific recycling area can avoid the secondary mixing of paper and other waste pollution, which could greatly improves the recycling rate of paper; By initiating this long-term campus plan, managing and guiding teachers and students to properly place after-use paper, the misoperation on paper recycle process could be reduced. Due to the complex sources of waste paper, students are mobilized to actively recycle after-use paper materials, such as draft paper, exercise books, paper templates, etc. A combination of dedicated management and multi-person participation could be more efficiently recycle waste generated by

teaching activities. Paper to take the first step towards the recycling process of 'forest resources on campus'.

2. Water

(1) Redesign of water-saving appliances

Through field research, the author observed water-saving appliances used by various sources in high school. The water-saving products used in high school are designed to reduce the amount of single-time water consumption through the 'reduction' design of the consumption process to achieve the purpose of saving water. However, this type of water-using products often has the characteristics of poor user experience and suppression of user needs. Sometimes the product intervention method is too direct, often increasing the user's frequency of use and unable to achieve the original intention of saving. For example, the excessively narrow washbasins mentioned above increase the amount of water used for building cleaning.

Therefore, in the design of campus water-saving appliances, we can not only focus on technical improvements and ignore consumer demand. In addition to the environmental awareness of the principle of reduction, it is also necessary to have a reasonable insight into the user's

Figure 60. Shigeru Ban's Square Roll Toilet Paper design. Adapted from the website: https://www.ippinka.com/blog/square-toilet-paper/

behavior and habits, provide design solutions that can guide people's consumption behavior, and subtly change the user's water usage behavior. For example, Shigeru Ban's square roll toilet paper is a subtle example of a design that guides user behavior. It breaks the conventional quadrangular cylinder core design, which causes a certain resistance to the user's paper-pulling behavior and restricts the number of paper towels in use. At the same time, this unpleasant behavior arouses users' potential environmental protection awareness, and has a positive impact on user behavior from both behavioral and psychological aspects.

(2) Campus water-saving systemic design

The water-saving system is not an independent water appliance, but a system formed by linking each link of water use (X. D. Wang, 2004). The water resources consumed in the process of recycling form a closed-loop inside the campus. 91% of water use on campus occurs in the bathroom. The toilet drainage and clean drainage can be used for toilet flushing after being collected and treated. By constructing the water circulation system inside the high school, the use of tap water can be reduced by 18%.

Pachamama, a graduate student in the Department of Ecological Design of the Polytechnic University of Turin, has designed a modular home kitchen system that uses food waste to feed the plants and the plants purify the kitchen air. By recycling the waste in each link of the kitchen and converting it into nutrients in other flows, the environmental impact in the kitchen is reduced as much as possible.

Figure 61. Pachamama.Adapted from Systemic design Courseware Information of Politecnico di Torino by Systemic Design Lab Politecnico di Torino.

6.1.3 System optimization from output

- Paper
- Establish a cooperative relationship with the paper mill

The raw material of paper is mainly plant-fibers such as wood, grass, reeds, and bamboo, so the waste paper is also called "secondary fiber". The use of secondary fiber papermaking can reduce the use of primary fiber pulp (X.Y. Wang, 2006) to protect forest resources.

At present, schools rely too much on the sorting standards of waste recycling personnel in the management of waste paper recycling, which causes some incomplete and low-priced paper to lose the opportunity of recycling, and flows to the landfill with residual waste. Chinese waste paper recycling industry has always lacked a comprehensive management mechanism, and faced the problems of insufficient recycling awareness, long supply cycles at small recycling sites, poor paper storage rooms, and low sorting expertise, etc. These problems lead to the characteristics of a low recovery rate and poor quality of waste paper in China. As the schools' waste paper recycling are following the communities, they face the same problems. However, as a "waste paper producer", the school's annual paper consumption is much larger than that of ordinary urban households. Therefore, on the issue of recycling of waste paper, schools should undertake certain social obligations to achieve responsible production and consumption. In addition, the school has dedicated staff to manage campus waste, and the average quality is higher than the current waste paper recycling practitioners.

The school has the characteristics of large paper consumption, concentrated types, and a good storage environment. If waste paper recycling management is carried out on 1747 schools in Shanghai, the source of waste paper will promote good waste paper recycling and sorting awareness, and the quantity and quality of waste paper recycling will be significantly improved.

Systemic Project

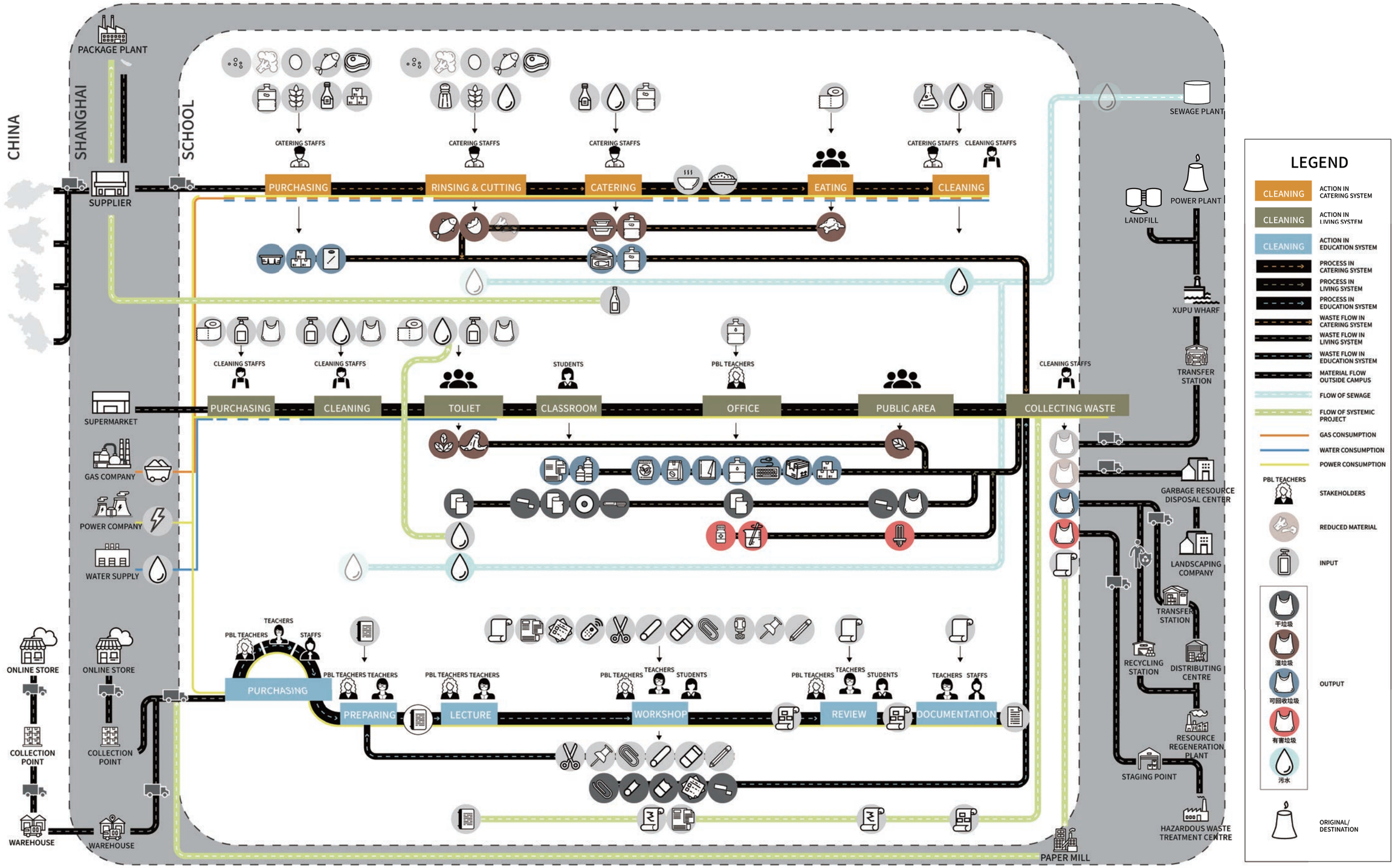


Figure 62. Systemic project map. Designed by the author.

6.2 Ecological assessment

1. Water

Most of the water consumption of high schools is consumed in public areas, and the daily water consumption for toilets, toilets and cleaning activities takes up 91% of the total water. The water footprint per capita is higher than that of Northeastern University and Peking University, which is 0.2 hm2. By redesigning the washing utensils, it is convenient for the cleaning staff to store water and clean, which can reduce 521.246 cubic meters of sewage. Assuming that the toilet drainage can just meet the water demand for toilet flushing, the total water consumption can be reduced by 40% by recycling the toilet drainage as a reclaimed water source. The cleaning of clean vegetables saves 0.16 cubic meters of tap water. The annual water consumption of the optimized system has decreased by about 52%, and fossil energy consumption due to water consumption has dropped to 20.537 hm2.

2. Sewage

Due to the reduction in water consumption, the campus's annual drainage volume has also been reduced by about 3,068 cubic meters, and the area of fossil energy consumed by sewage treatment is about 12.59 hm2.

3. Waste

The 'Trimmed Vegetables Entering the School' policy helped to reduce most of the kitchen waste, which played a positive role in reducing the amount of organic waste in the canteen, reducing 604.125 kg of food waste in one year. By carrying out the 'waste paper corner' collection activities, the recycling rate of waste paper has been increased, and the amount of mixed shredded paper in residual waste has

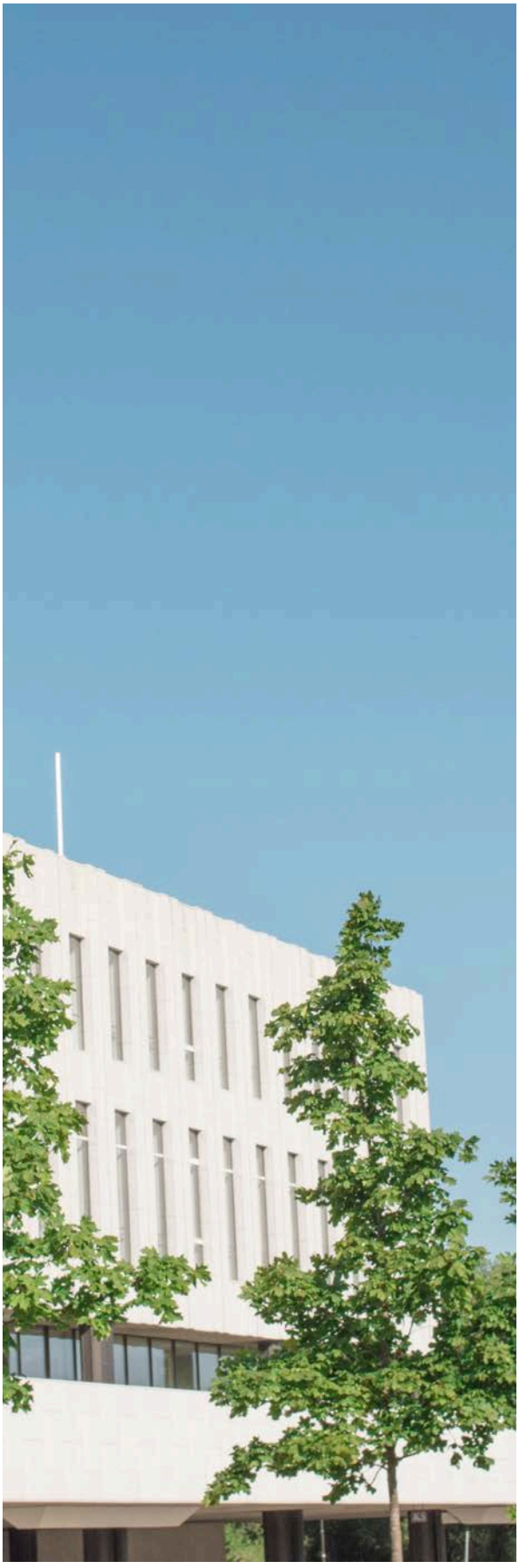
Material energy input and output within the system boundary			Current Situation		Systemic Project	
			Ecological footprint hm2	Percentage	Ecological footprint hm2	Percentage
Input	Food		21.656	3.80%	21.656	4.02%
	Paper		0.973	0.17%	0.973	0.18%
	Energy	Gas	1.27	0.22%	1.27	0.24%
		Electricity	480.982	84.40%	480.982	89.28%
	Water		39.638	6.95%	**20.537**	3.81%
Output	Waste	Glass	0.008	0.16%	0	0.13%
		Plastic	0.003		0.003	
		Swill	0.691		**0.629**	
		Paper	0.842		**0.09**	
	Sewage		24.313	4.30%	**12.59**	2.34%
	Total		570.376		**538.73**	

Table 7. Ecological footprint calculation. Compiled by the author.

been reduced.

Waste paper as a renewable resource returns to play value in the recycling system. Through the establishment of cooperation between suppliers, manufacturers and schools, the glass bottle packaging used by the school is circulated between the demand side and the supply side, reducing 41.76 kg of recyclable waste. Strengthen the recycling of waste paper from schools and other institutions and establish recycling channels with leading waste paper companies. Scientifically sorting various types of waste paper can help increase the added value and output of waste paper, reduce the proportion of waste paper in waste, and try to recycle and reuse. Through the above-mentioned approach, the total footprint of waste has dropped to 0.722 hm2.

By designing reductions at the source, improving energy use behaviors, recycling resources, and providing resource-based channels, the campus' ecological footprint in food, water, paper, and packaging waste has been improved, and the total footprint has dropped to 538.73 hm2.



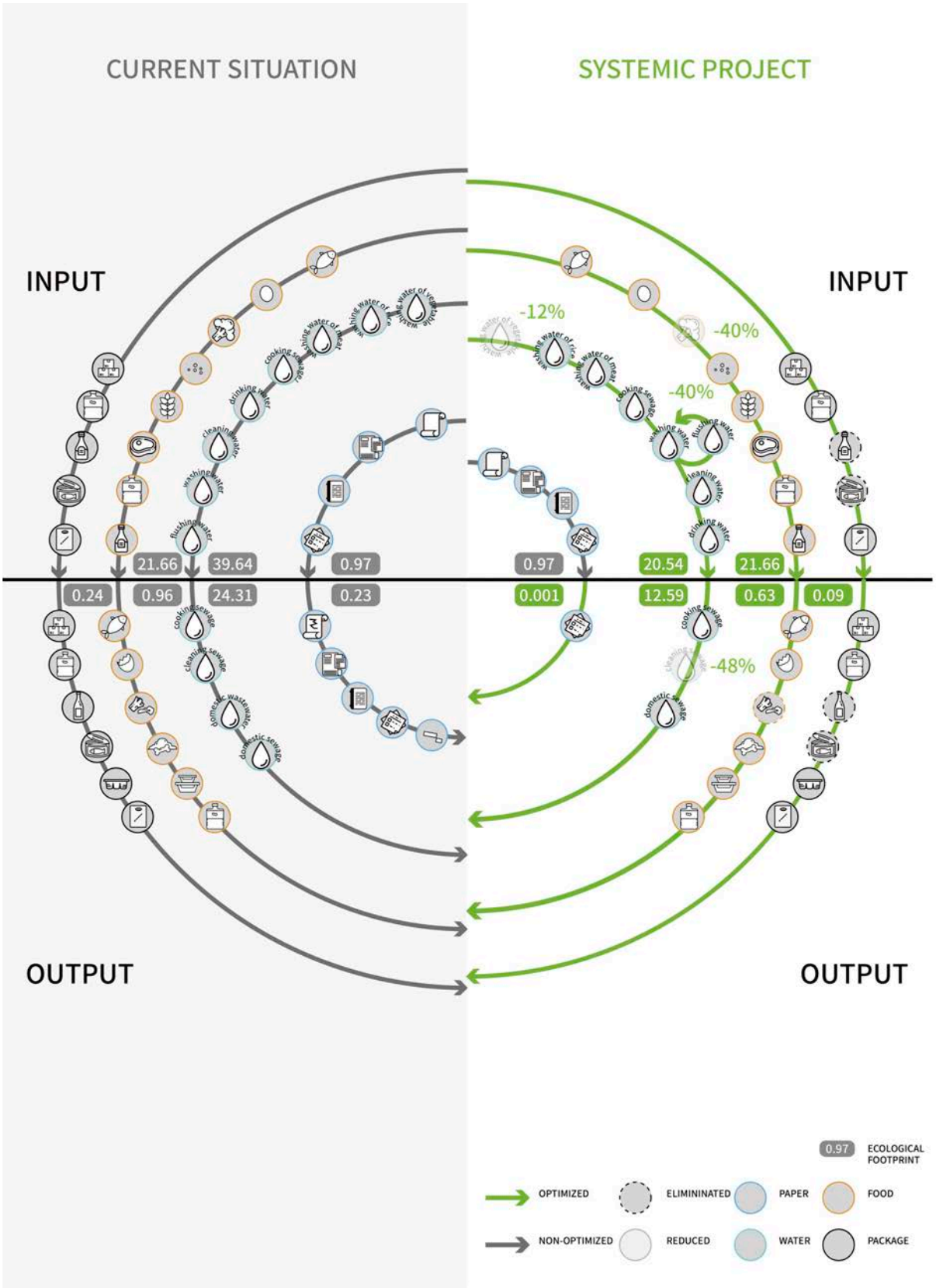


Figure 63. Comparison of ecological footprint. Designed by the author.

6.3 Discussion on the design practice

6.3.1 Common problems

In the previous analysis of the interview data, the author summarizes the common problems in the green campus building and the obstacles to sustainable behaviors on the campus. In the final analysis, campus environmental impact factors are divided into 3 categories- energy use, material use and waste discharge. Energy use includes electricity, water, and gas; Material use is mainly reflected in the consumption of teaching tools, paper, and food. Waste is the general term for the quantity of waste in daily campus activities.

Stereotypes, values that contradict sustainable values, and invalid participation lead to the lack of sustainable mobility of campus users.

On the conscious level, some core values that are contrary to the concept of environmental protection contribute to unsustainable behaviors on campus. Current research always focuses on improving consumers' environmental awareness, but the waste of resources and the generation of waste are often caused by those who understand the environmental impact of waste discharge. There is a huge hidden conflict between some consciousness in real practice, such as the understanding of efficiency, emotion, sufficiency and quality, and the goal of "zero emission". The main conflicts are:

1. Too much focus on efficiency.
By preferentially using materials with good experience and simple operation, materials with low usage rates will not be recycled, lack of long-term thinking when providing teaching materials, and only focusing on short-term use effects and other aspects.

2. Awareness related to caring will bring some extra resource consump-

tion.
For example, the teachers make additional paper documents for students as a gift at the end of the semester; the course designers carefully prepare booklets to introduce the syllabus and provide study plans in paper, for all the study curriculum; clean up the toilet stains frequently every half hour to maintain a clean and comfortable environment for use. The sufficiency of supplies is considered by most people as a thoughtful and respective approach, however, these materials that exceed requirements are easily left unused and wasted.

3. Focusing much more on 'Quality' than on 'Waste'.
Safe food, environment and teaching quality are given priority over resource waste. To guarantee the quality of life and teaching, excessive resources and energy consumption are acceptable.

On the action level, some non-standard behaviors will result in the loss of resources, idleness and excessive use, which will eventually lead to waste. The lack of external objective environment and cooperation medium is also one of the reasons that hinder positive action.

On the one hand, the lack of suitable hardware facilities will affect the efficiency and effectiveness of human-to-human and human-to-human interactions, resulting in a waste of resources. For example, the use of sinks with poor experience has increased the consumption of clean water, and the lack of an electronic collaboration platform has increased the dependence of secondary schools on paper.

On the other hand, lack of cooperation mechanism leads to insufficient management talents and low management efficiency. For example, the repeated collection and recycling of campus waste is a job with a large workload and high professional requirements. It requires the participation of teachers and students of the whole school and the cooperation of professional teams. Due to the lack of top-down management policies and no bottom-up active participation, the recycling of campus waste can only rely on passive end collection and classification. Due to the lack of multi-level management in the process, the waste recovery rate and added value will be greatly reduced. Besides, unknown factors decline people's ability to cope with things. For example, some special activities or education policies bring a lot of uncontrollable factors, and when there is insufficient information, the accuracy of decision-making will be affected and unnecessary resources will be wasted.

6.3.2 Design strategies

As the conclusion shows, the campus needs to create a good external environment to reduce the noise that disrupts sustainable behaviors. In addition, it is also possible to provide some tools, services, or systems by design to empower the behavioral changes of campus users and improve their mobility. The problem of the unsustainable campus is closely related to every campus user. Therefore, when intervening in campus scenes, sustainable design can no longer only focus on the entities that can be seen on campus, but also need to pay attention to the potential intangible content in the environment. Using design methods to change people's behaviors and lifestyles and then influence people's inertial thinking.

When designers turn their attention to the factors that affect sustainable development on the campus, we will think from a broader perspective:

1. How to design products, services, systems, and strategies to help campus users reduce the artificial loss of teaching materials?

2. How to reduce the communication cost when collaborating with staff outside the school and reduce the occurrence of information asymmetry?

3. How to meet the situation of good teaching effect and less paper usage at the same time and keep the balance?

4. How to reflect the teaching intention and teacher care without preparing excessive materials?

5. How to ensure school food safety without wasting food and energy?

Each requirement can be derived from different design practices. After categorizing, the author draws four directions of practice, as shown in Figure 64.

Problem		Demand
Awareness	Efficiency Concern Adequate Quality	How to extend the service life of teaching ma How to ensure high-quality teaching and prev How to allocate usage accurately to avoid res How to improve the efficiency of materials a
Action		How to reduce the human consumption of res How to prevent excessive use of resources? How to prevent resources from being idle?
Cooperation	Medium Approach	How to provide a medium that meets the nee efficiency in cooperation and reduce resource How to design an efficient cooperation mecha of resources in rework?
Communication		How to reduce the communication cost of int cooperation and reduce the information asym

Figure 64. Problems and design strategies in the

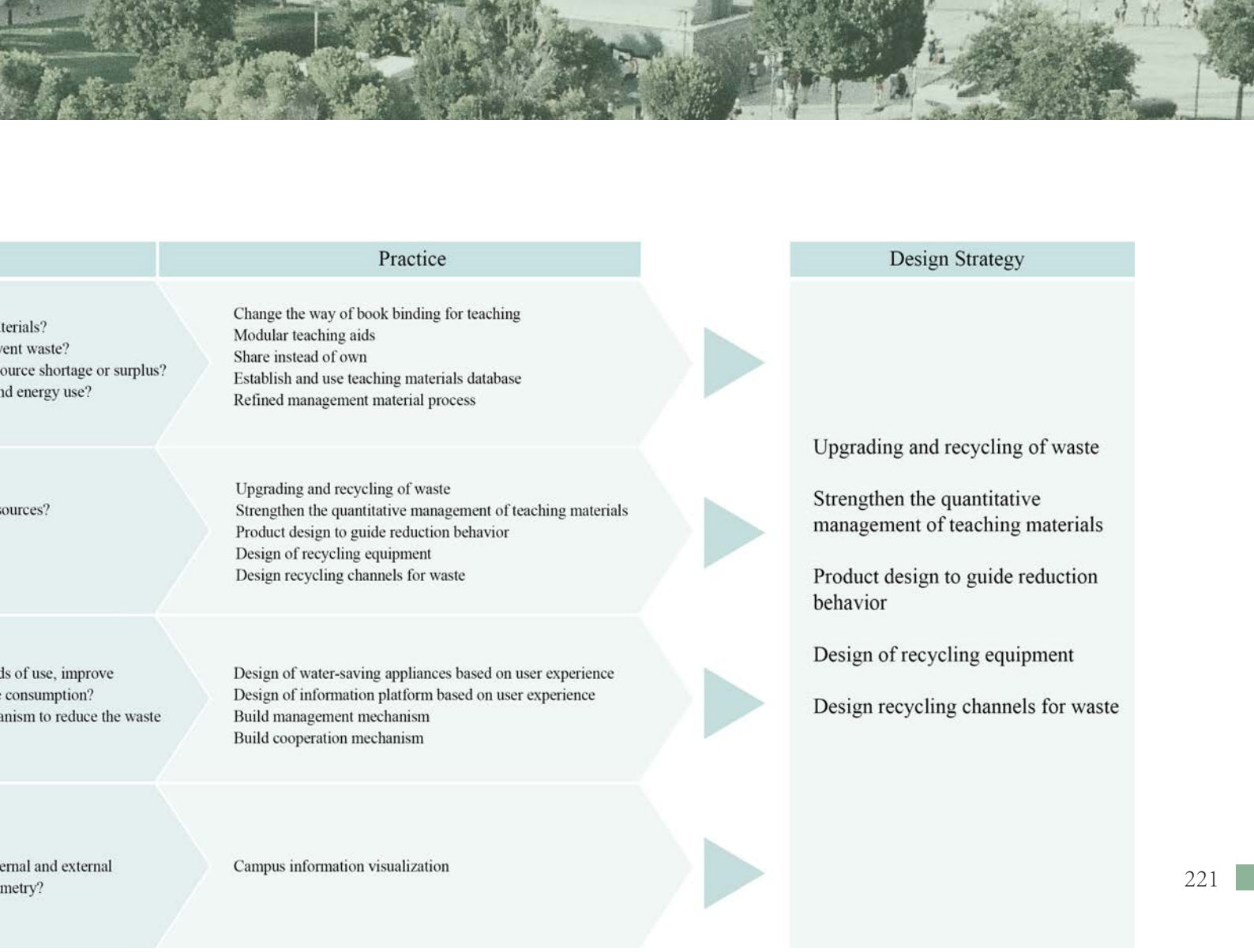
1. Source Reduction Design

Source reduction is to prevent the generation of waste from the source by restricting the potential waste entering the campus system. Waste is generated in human activities, and its value is defined by human. Therefore, it is undoubtedly a practical and effective method to study reduction from a human perspective. (H. B. Chen, C. Zhang, & Q. Pan, 2006). Service design is to help schools change the way they use products, from owning to sharing, from consuming products to consuming services; Modular design could help schools to change the relationship between teaching tools and users, and providing modular components to meet more scenarios of teaching needs. By providing new tools, services and systems, designers reduce the consumption of human activities resources and reduce the generation of waste from the source.

2. Design for guiding sustainable behavior on campus

In this complex dynamic system of school, teachers and students are active subjects, and everyone's behavior will contribute to the low environmental impact of the entire system. Every part of the whole must operate in harmony with the whole. Every participant must participate collaboratively in the process of green campus building, so that we can get a positive result of continuous improvement and improvement in the campus ecosystem(Bistagnino, 2011, p.176).

Students and faculty members need to change from "users of the campus environment" to "participants in campus affairs." The design aims to lead and promote this role change, by initiating green campus activities such as campus waste recycling activities to



green campus building. Designed by the author.

attract the participation of teachers and students, provide intellectual and action support for environmental problems on campus, and exert bottom-up power.

In addition, design can transform unsustainable practices by providing tools and products that change the way people behave. The design that guides sustainable behavior cannot be simply understood as the design of energy-saving products, but a design that can subtly guide the user's behavior and cultivate a sustainable way of thinking. Unilaterally focusing on technological innovations while ignoring the needs and experiences of campus users often fails to shape a sustainable campus lifestyle. For example, campus water-saving appliances reduce the single water consumption, but because of the poor user experience, they often increase the frequency of use by teachers and students, so it is impossible to fundamentally reduce water consumption. Therefore, the campus green design needs a reasonable insight into the user's usage behavior

and demand habits.

3. Design for recycling

When facing the already generated campus waste, users can give the waste a new using through design and explore the value and utilization of waste, and this was called Upcycling; Providing design support for recycling activities, such as Improve the experience of recycling, for example, redesign the recycling containers and recycling tools, encourage the recycling behaviors and so on; Design can also provide strategies for the management of the recycling process, optimize the three-level management system of campus waste, (Y. Yang, W. Liu, & J. G. Song, 2014) , improve the user experience of service contacts, and encourage teachers and students to participate in recycling activities

4. Closed-loop design

Waste is a misplaced resource. How to reduce the waste and loss of resources on campus and find a recycling for surplus, idle, and discarded items and resources is a topic that the design needs to pay attention to. By connecting on-campus resources and off-campus needs, recovering and redistributing remaining resources, strengthening local cooperation with communities, institutions, and businesses to build a closed-loop value chain around the campus. Through the establishment of campus alliances or academic activities, with all the stake-holders, we will jointly search for ways to recycle campus waste and experiment with the way of material recycling.

Reference

Chen, Q.H., Li, W. L. (2001). Preliminary study on the current situation and countermeasures of clean vegetables entering the city in Xiamen. Environmental Sanitation Engineering, 9(1), 29-30.

Zang, Q.M. (1996). Recycling and recycling of packaging waste in Japan. China Packaging Industry, (10), 26-27.

Guo, X. Y., Shen, Z. Y., Lin, T., & Kuang, L. (2010). Classification of water sources in colleges and universities and ranking of high quality based on AHP method. Environmental Science and Technology, (11).

Wang, X. D. (2004). Design of household water-saving products guided by the green concept. Decoration, (4), 19-19.

Wang, X.Y.(2006). Discussion on the status quo and future development direction of waste paper recycling technology. Forestry Science and Technology Information, 38(3), 110-111.

Chen, H. B., Zhang, C., & Pan, Q. (2006). Analysis of Comprehensive Benefits and Priority Status of Domestic Waste Reduction. Environmental Science and Technology, (S1), 84-86.

Yang, Y., Liu, W., & Song J. G. (2014). College students' environmental awareness and waste sorting behavior management system construction. Environmental Sanitation Engineering, 22(6), 4-6.

7 CONCLUSION AND PROSPECT


APPARCAMENT

7.1 Conclusion

At present, the relevant design research of green campus building is generally understood as the architecture design and planning of green campus. Most of the researches provided sustainable solutions for unbuilt campuses. However, lower attention has been paid to the entire campus ecosystem. In this case, we authors put forward the concept of green campus building and interprets it based on the connotation of the green campus, which enriched the cognition of design researchers in the research field of green campus construction in the future. And this paper tried to use the systemic design method to provide a sustainable development path for the existing old campus. By combing the systemic design methods and interpreting the content of green campus building, the author initially derived a design research framework for green campus building.

Operationally, the research method of systemic design is supplemented and improved in this paper. Authors worked as data clerk, observers, and interviewers, collected qualitative and quantitative data in the field research. According to the Ecological Footprint calculation of quantitative data, the results show that the consumption of electricity, water, and food, as well as the sewage during the whole process of the material from entering to discharging on the campus, have a great impact on the campus environment.

Through the coding and classification of qualitative data, the results show that the obstacles to sustainable behaviors on campus include:
1. The lack of objective campus environment and unknown factors;
2. The dependence on high-intensity management and the lack of ability to act;
3. Specifically comes from the contradiction between the core values and ecological values of campus users;
4. Set thinking and invalid participa-

tion. Based on the analysis conclusion, we summarize the problems faced by the green campus construction for the 3 types of activity: 'Catering', 'Living' and 'Teaching'. And we provide corresponding solutions and finally provide a systemetic design optimization plan for the high school. Based on the case study of Tongji-Huangpu School of Design and Innovation, the author summarizes the common problems that green campus building may encounter and proposes corresponding solutions to these problems to provide design ideas and research directions for future researchers.

1. Contribution

In terms of theory outcomes,

1) Provide practical ideas for the application of systemic design methods in the field of green campus building design, and broaden the application scope of systemic design methods.

2) Based on the traditional systemic design research process, the author built a design research framework and steps for green campus building.

3) The case analysis summarizes the environmental impact patterns of campus consumption activities and campus problem coordinates, which helps to provide a theoretical basis for other types of campus research.

In terms of practice outcomes,

1) This paper divides the different roles of design researchers in the survey and selects corresponding research methods for various survey scenarios to collect data. To solve the problem of data collection in the interview, the author designed the data card as an auxiliary tool. By providing a structured table, it helps design authors to collect data quickly and comprehensively in the survey, avoiding the omission of key information.

2) By combining the Ecological Footprint Component method, a quantitative green measurement standard is provided for the problem analysis stage in the systemic design, which avoids design authors' subjective assumptions in the analysis process and provides interdisciplinary theoretical support for the research conclusions.

2. Limitation

The systemic design method has its limitations when intervening in the green campus building problems.

1) From an ecological perspective, with material and energy flow as the research content, focusing on-campus resources and energy utilization, waste management, and carbon emission control issues. It cannot cover all the topics of green campuses, such as campus architecture, campus health, and sustainable development education.

2) The systemic design method lacks the focus on user research and does not provide design methods and tools to incentivize campus users to participate together.

The green campus is a big proposition. The research object is influenced by variables such as education level, school type, management model, cultural background, and overall scale. The author takes the Tongji-Huangpu School of Design and Innovation as an example. The research object itself has certain specificities. Therefore, the conclusion of this study cannot summarize the specific scenes of all campuses, so more specific studies of different types of campuses may be needed in the future to gradually improve the green. The theoretical framework of campus as a major proposition.

This research has deficiencies in the research plan.

1) In terms of data collection, the author has a large error in the statistics of paper consumption, neglecting administrative and office paper, so the ecological footprint of the paper differs greatly from the actual situation.

2) In the interview, the sample size is not enough, and it is not enough to reach the theoretical saturation; the choice of the object, the author did not organize in-depth interviews with the educational affairs responsible for the purchase of teaching materials, so there are many omissions in the statistics of teaching materials, This will affect the accuracy of the material flow analysis of the entire campus system.

3) There are flaws in the operation of empirical tools. For example, the author only used photo recording when observing the waste compartment, and did not conduct a deeper interview on the source and treatment of the observed waste, resulting in a lack of depth in the collected data. And disconnected from its existing scenes, affecting the author to obtain a more comprehensive and in-depth insight.

4) In terms of testing, only the ecological footprint component method is used for quantification, without considering the user's real feedback.

The theoretical deficiencies of this study:

(1) Due to the general problems summarized in this paper and the proposed design, the strategy is based on a theoretical reflection on the practice of a single project, and the results need to be improved and verified.

(2) The design framework for green campus building proposed in this paper also needs feedback and improvement in the practice of other design researchers.

3) The thinking in concept of green campus building is not deep enough, and it is slightly weak due to the lack of support from existing cases and theoretical models.

7.2 Discussion

This research discusses all resources, energy consumption, and waste discharge of the entire campus. Each problem is worthy of more in-depth research, such as food waste, water-use behavior, and paper consumption. In the future, authors could focus on the problems and incentives of a certain type of substance in the procurement, use, and disposal process and provide specific solutions through different design methods, such as experiential product design of water-saving appliances, campus water circulation systemic design, campus material management service design, etc. In the test phase, researchers can design collaboratively with stakeholders in the form of workshops, and use the visual tools in the systemic design method to assist the communication of multi-party participation.

Reference

Ahern, J. (2016). The Anthropocene Urban Ecosystem: Its Concept, Definition, and Strategies to Support Urban Sustainability and Resilience. Landscape Architecture, 10-21.

Bao, L., Zhou, J., & Ding Y. B. (2019). Analysis of the green campus strategy of the Science City campus of ETH Zurich. Architecture Journal, (5), 4.

Barbero, S. (2012). SyStemic energy networkS, Vol. 1. The theory of Systemic Design applied to energy sector (Vol. 1). Lulu. com.

Boehnert, J. (2018). Design, ecology, politics: Towards the ecocene. Bloomsbury Publishing.

Buchanan, R. (2019). Systems thinking and design thinking: The search for principles in the world we are making. She Ji: The Journal of Design, Economics, and Innovation, 5(2), 85-104.

Bistagnino, L. (2011). Systemic design. Slow Food, Torino e Italy.

Cai, J. S., Chang, M. L., Chen, W. Q. (2011). Measurement and analysis of personal ecological footprint based on questionnaire survey——Taking Xiamen University as an example. Environmental Science and Management.

Cao, H.L. (2004) Research on the Theory and Methods of Product Life Cycle Assessment (LCA). Journal of Southwest University for Nationalities (Humanities and Social Sciences Edition), 25(2), 281-284.

Chen, C. Y. (2001). Classification and Treatment Plan of Urban Domestic Waste. Agricultural Mechanization Research, (4), 89-92.

Chen, H. B., Zhang, C., & Pan, Q. (2006). Analysis of Comprehensive Benefits and Priority Status of Domestic Waste Reduction. Environmental Science and Technology, (S1), 84-86.

Chen, J. F., Zhu, X. Y., & Ren, L. J. (2011). From a low-carbon campus to a low-carbon neighborhood: Taking the campus space change of Huazhong University of Science and Technology as an example. Chinese Garden, 27(4), 74-77.

Chen, N., Chen, K., Hu, L., Shi, Y. Y., & Qiu, H. D. (2010). Classification and analysis of physical and chemical characteristics of campus domestic waste. Journal of Chongqing University of Science and Technology (Natural Science Edition), (4), 91-93.

Chen, Q.H., Li, W. L. (2001). Preliminary study on the current situation and countermeasures of clean vegetables entering the city in Xiamen. Environmental Sanitation Engineering, 9(1), 29-30.

Chen, X. Q. (2015). Green research supports sustainable campus——Yale University's idea and strategy for building a green university. Educational Research of Tsinghua University, (2015, June), 120-124.

China Electricity Council. (2018). China Electric Power Industry Annual Development Report 2019. China Market Press.

Cui, W. K. (2006). Discussion on the classification and recycling of campus waste and resource conservation. Science and Technology Information Development and Technology, 16(9), 233-235.

Cui, S. H., Li, F. Y., Yu, Y. X., & Lin, J. Y. (2010). Theoretical Discussion on Urbanization and Sustainable Urbanization, Urban Development Research, (3), 17-21.

Cole, L., & Wright, T. (2003). Assessing sustainability on Canadian University campuses: development of a campus sustainability assessment framework.

Unpublished master's thesis, Royal Roads University, Victoria, BC.

Creswell John, W. (2007). Qualitative inquiry and research design: Choosing among five approaches. Lincoln: Sage Publications.

Dai, L., Wang, J., Cong, H. Z., Han, Y., Shao. C. J., Wang, M. Y., Feng, M. L., Zong, Q., & Dai, X. X. (2004). Discussion on the classification and recycling of campus waste and resource utilization. Urban and Rural Environmental Science and Technology of Liaoning Province, 24(6), 6-7.

Deng, Y. F., Qiu, L., & Zhang, D. (2011). Research progress on anaerobic digestion of organic waste in ecological campuses. Journal of Agricultural Mechanization Research, 33(8), 184-187.

Development and Planning Department, Ministry of Education of the People's Republic of China. (2010). China Education Statistics Yearbook. Beijing: People's Education Press.

Development and Planning Department, Ministry of Education of the People's Republic of China. (2017). 2017 China Education Statistics Yearbook. Beijing: People's Education Press.

Ding, K. L., Huang, L. L., & Zheng, W. (2013) An analysis of community construction in Taiwan. Journal of Zhejiang University (Science Edition), (2013, July), 716-725.

Duan, N. (2004). Urban material metabolism and its regulation. Environmental Science Research, 17(5), 75-77.

Duedahl, E., & Stilling Blichfeldt, B. (2020). To walk the talk of go-along methods: navigating the unknown terrains of being-along. Scandinavian Journal of Hospitality and Tourism, 1-21.

Forrester, J. (1971). Principles of Systems, Pegasus Communications. Inc., Williston, VT, USA.

Gao, B., Tan, H.W., & Song, Y. C. (2011). Analysis of the current situation and existing problems of energy use in campus buildings in colleges and universities——Taking a comprehensive university in the Yangtze River Delta as an example. Building Energy, (2), 41-44.

Gong, M. S., Yang, Z., Zheng, B. B., & Zhang, L. (2019). Co-creation mechanism and interaction in community building. Chinese Art.

Gu, X. W., Li, G. J., Wang, Q., Liu, J. X., Ding, Y., & Liu, J. Z. (2005) Eco-efficiency of Higher Education-Ecological Footprint of University Campus. Glaciology and Geocryology, 27(3), 418-425.

Guinee, J. B., Heijungs, R., Huppes, G., Zamagni, A., Masoni, P., Buonamici, R., ... & Rydberg, T. (2011). Life cycle assessment: past, present, and future.

Hai, J. (2011). Research on Sustainable Campus Planning Strategy Based on Symbiosis Thought. Doctoral dissertatio, South China University of Technology.

He, J. T. (2009). Contemporary University Campus Planning Theory and Design Practice. Beijing: China Construction Industry Press.

He, X., & Bai, X. Y. (2011). A preliminary study on the management of waste sorting and recycling in colleges and universities: Taking the Chenggong campus of Yunnan Normal University as an example. Environmental Science Guide, (2011, March), 30-34+.

Hu, P. (2013). Japan's Theory of "Community Construction": From "Citizen Participation" to "Citizen Subject". Japanese Journal, (3), 119-134.

Huang, B. W., & Lu, B. (2016). Research on the Low-Carbon Performance of University Campus Canteens——Taking the Compass Canteen of Peking University as an Example. Journal of Peking University (Natural Science Edition), (2), 320-326.

International Organization for Standardization. (2006). Environmental management: Life cycle assessment; requirements and guidelines. Geneva: ISO.

Gu, X. W., Li, G. J., Wang, Q., Liu, J. X., Ding, Y., & Liu, J.Z. (2005). Ecological footprint in the construction of a green university. Environmental Science,(04),200-204.

Guo, X. Y., Shen, Z. Y., Lin, T., & Kuang, L. (2010). Classification of water sources in colleges and universities and ranking of high quality based on AHP method. Environmental Science and Technology(11).

Guo, Z. (2014). A Preliminary Study of Green Campus Design Strategy. (Master's thesis, Shanghai Jiao Tong University).

Huang, J. H. (2014). The cause of the problem of large class size in urban compulsory education schools and its resolution. Teaching and Management: Middle School Edition, (11), 9-10.

Keniry, J. (1995). Ecodemia: campus environmental stewardship at the turn of the 21st century: lessons in smart management from administrators, staff, and students. Natl Wildlife Federation.

Krieger, M., Munch. B., Stephen. K., Tririch, K., Lin, B. R., Zheng, X. D., Zeng, Y., & Li, S. Y. (2015) Towards a'zero carbon' campus-a focus Pan-European Campus Alliance at the Technical University of Berlin. Urban Design, (1), 8-39.

Liu, C. (2011) Research on green campus evaluation system and its application in post-disaster school reconstruction. Doctoral dissertation, Tsinghua University.

Liu. H. B., Zhou, X., & Liu, Y. F. (2017). A review of research on the construction of green universities in my country. Tianjin Science and Technology, (12), 28.

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., Moran, E., ... & Ostrom, E. (2007). Complexity of coupled human and natural systems. science, 317(5844), 1513-1516.

Liu, G. Y., Yang, Z. F., & Chen, B. (2013). Research on urban metabolism process based on emergy analysis method——theory and method. Acta Ecologica Sinica, 33(15), 4539-4551.

Lou, Y. (2018). Designing interactions to counter threats to human survival. She Ji: The Journal of Design, Economics, and Innovation, 4(4), 342-354.

Lu, Y., & Chen, B. (2015). A review of urban metabolism research: connotation and methods. Acta Ecologica Sinica, 35(8), 2438-2451.

Manzini, E. (2015). Design, when everybody designs: An introduction to design for social innovation. MIT press.

McLure, A. (2009). Composting on campus. University Business.

Meadows, D. H. (2008). Thinking in systems: A primer. chelsea green publishing.

Ministry of Housing and Urban-Rural Development of the People's Republic of China, Ministry of Education of the People's Republic of China. (2008). Management and technical guidelines for the construction of conservation-oriented campuses in colleges and universities, (MOHURD [2008] No. 89).

Ministry of Housing and Urban-Rural Development of the People's Republic of China, State Administration of Quality Supervision, Inspection and Epidemic Situation of the People's Republic of China. (2019). GB50015-2019 Building Water Supply and Drainage Design Standard. China Planning Press.

National Bureau of Statistics of the People's Republic of China. (2008). China Energy Statistics Yearbook 2008. Beijing: China Statistics Press.

Pauli, G. A. (2010). The blue economy: 10 years, 100 innovations, 100 million works. Paradigm publications.

Shanghai Bureau of Statistics. (2018). 2018 Shanghai Statistical Yearbook. Beijing: China Statistics Press.

Smyth, D. P., Fredeen, A. L., & Booth, A. L. (2010). Reducing solid waste in higher education: The first step towards ‘greening’a university campus. Resources, Conservation and Recycling, 54(11), 1007-1016.

Song, J. Q., Zhao, R., & Zhang, M. L. (2018). Perceived energy consumption smart supervision-exploration and practice of Jiangnan University's digital energy supervision platform construction. University Logistics Research, (2018, June), 50-54.

Sterling, S. (2003). Whole systems thinking as a basis for paradigm change in education. PhD paper, University of Bath.

Sun, Q. H., Wan, N. Q., & Fan Y. H. (2000). A review of foreign life cycle assessment (LCA) research . World Standardization and Quality Management, (12), 24-25.

Sun, X., Tong, H. H., Niu, J., & Zhao. Y. C. (2011). Comparison of greenhouse gas emissions in the collection process of campus domestic waste. Design and Research of Nonferrous Metallurgy, 32(1), 34-36.

Tong, W. L., & Ma, H. M. (2016). Research on the management and countermeasures of multi-stage waste reduction on university campuses. Logistics Engineering and Management, 38(7), 192-194.

Tu, Q., Zhu, C., & McAvoy, D. C. (2015). Converting campus waste into renewable energy–A case study for the University of Cincinnati. Waste Management, 39, 258-265.

Wackernagel, M. (1999). An evaluation of the ecological footprint. Ecological Economics, 31(3), 317-318.

Wackernagel, M., Onisto, L., & Bello, P. A. (1997). Ecological footprints of nations. Universidad Anahuac de Xalapa, Centro de Estudios para la Sustentabilidad.

Wang, B. Z. (2017). Community x Construction: Policy Planning and Theoretical Time. Beijing: Social Sciences Literature Publishing House.

Wang, H. T. (2011). A new approach to energy conservation and emission reduction goals-life cycle energy conservation and emission reduction evaluation method. High Technology and Industrialization, (8), 49-53.

Wang, X. D. (2004). Design of household water-saving products guided by the green concept. Decoration, (4), 19-19.

Wang, X.Y.(2006). Discussion on the status quo and future development direction of waste paper recycling technology. Forestry Science and Technology Information, 38(3), 110-111.

Wang, Y. S., Yang, X., Yan, H., Zhang, Y., & Li, J. F. (2017). Building carbon emissions estimation based on the whole life cycle: Taking a campus office building renovation and expansion project in Guangzhou as an example. Journal of Engineering Management, 31(3), 19-24.

Wu, C., Peng C. L., Wu Q.Y., Shi, L.W., & Zhang, B.B. (2011). Research on the construction of low-carbon life in colleges and universities——Taking the Qishan campus of Fuzhou University as an example. Environmental Education, (6), 60-62.

Wu, W. T., Qing, C. S., Peng, S. C. (2005). Investigation and analysis of the status quo of domestic waste on campus of Hefei University of Technology. Journal of Hefei University of Technology (Natural Science Edition), 28(11), 1424-1426.

Xu, Z. G., Yin, Z. Q., Wang, J. Q., Yin, J. Q., & Gao, J. F. (2011). The status quo of waste sorting and recycling on Three Gorges University campus and the establishment of recycling mechanism. Green Technology, (10), 117-119.

Yang. C. C. (2018). How to use creativity to promote the construction of a sustainable university campus——Taking Virginia Commonwealth University as an example. A Comparative Study of Cultural Innovation, (32), 92.

Yang, M., Xu, H. R., Guo, X. L., Han, C., Ge, S. S., & Wang, J. (2018). Research on the Countermeasures of Campus Waste Sorting Collection and Treatment from the Perspective of Green Development. Green Technology, (18), 45.

Yang, Y., Liu, W., & Song J. G. (2014). College students' environmental awareness and waste sorting behavior management system construction. Environmental Sanitation Engineering, 22(6), 4-6.

Yao, Z., Feng, C. C., & Kan, J. J. (2011). Research on low-carbon campus based on the ecological footprint theory: Taking the ecological footprint of Peking University as an example. Resources Science, 33(6), 1163-1170.

Yu, K. J. (2016). Anthropocene ecosystem and ecological restoration. Landscape design, (1), 4-9.

Zang, Q.M. (1996). Recycling and recycling of packaging waste in Japan. China Packaging Industry, (10), 26-27.

Zhang, D. F., Wang, C., Ji G. X., & Wang, Y. P. (2002). Experimental study on the treatment of kitchen sewage by SBR method. Journal of University of Shanghai for Science and Technology, 24(1), 39-42.

Zhang, Y. &Yang, Z.F. (2007). Eco-efficiency of urban material metabolism: a case study of Shenzhen. Acta Ecologica Sinica, 27(8), 3124-3131.

Zhang, Z. (2003). Research on dematerialization of municipal solid waste. (Doctoral dissertation, Shanghai Fudan University).

Zhang, Y. M. (2018) A Preliminary Study on the Cultivation Model of Innovative Talents Oriented by Design Thinking——Taking Tongji- Huangpu School of Design and Innovation in Shanghai as an example. Innovative Talent Education, (2), 10.

Zhao, Y. L., Yang, J., Sun, T. Y., & Yao, J. L. (2019). Research on the international academic frontier dynamics of green campus. Housing Technology, (2019. June), 40-48.

Zhao, X., & Sun, T. T. (2014). A preliminary study on the status quo of waste collection and recycling on university campus. Energy Environmental Protection, 28(2), 51-53.

Zhao, T. Y., Liu, H., & Jin, X. (2009). An analysis of effective ways for Peking University to develop a green campus. Environmental Protection, 2009(3B), 40-42.

Zhu, D. J. (2000). From sustainable development to circular economy. World Environment, (3), 6-12.

Zhu, D. J., & Chen, F. (2010) The connotation, goals and countermeasures of developing a low-carbon city in Shanghai. Urban Observation. (Doctoral dissertation)

Zhuang, W. Y., & Ke, W. Y. (2018) Design and practice of digital communication platform interface based on information visualization. Communication Power Research, (10), 208.

Appendix

Interview with Manager Mrs. Jin of the Property Management Department
A- The interviewer J- The Manager, Mrs. Jin.

A: Hello, we are University students and would like to interview you in the situation of school waste. What position do you undertake at school?
J: I am responsible for the property and I'm the manager.
A: How long have you worked here?
J: I have worked in this school since 2004.
A: Could you please introduce the daily workflow.
J: In the morning, the cleaning staff at the Huqiu campus area cleaned the campus from 6:30 to 7:30, collected the residual waste, and transported it to the Sichuan Road campus area. The school pay for the service of a professional waste recycling company, (1-1 cooperate with professional departments) and charge for one year. The company comes twice a day. The company collects the residual waste of the previous day in the morning, and the household food waste from the canteen in the afternoon. (1-2 regular recycling) Because we are newly renovated here, there is no broken light tube, bulb, or battery, which are always being discharged in the old campus area. (1-3 old and new buildings)
A: Yes, I just saw the used lamps there.
J: Yes, there were some broken lamps. When we changed the lamps, we always record the number of used lamps. (1-4 records)
A: OK. Can you show us the waste place?
J: Ok. In the Huqiu Road area, there is mainly dry and household food waste. 2 residual waste bags discharged at noon and a half barrel of household food waste a day.
A: Is there any document before September?
J: We did not have this waste recording list before September. We got the recording list on September 1st and we started sorting from that. Before the recording list exists, we divided wastes into categories without records, and they were called to get rid of as much waste as possible. (1-5 lack of record awareness)

A: Do you feel any changes in workload after you have this list paper?
J: I think there is nothing uncomfortable in this way (recording data). This is a trivial matter. Remember what you have. Keep the trash bin out. Take it in and remember it. How much residual waste there is. Household food waste. (1-06 with the task)
A: Does anyone take this paper away regularly?
J: No, it's just a record for us to check.
A: From September, Shanghai started to carry out waste sorting. Do you think there is any change in the daily work of waste collection?
J: Before the sorting waste policy, we have already sorted the carbage. (1-07 Classification awareness) For example, the batteries were thrown out in some places. As for me, the waste electronics were separately placed in plastic buckets, wrapped up separately, and taken away by the waste collectors.
A: At that time, how did you classify it? For example, some valuable items like metal, batteries, paper, etc., you think are valuable, so they will be recycled to the waste collectors. Do you still take this approach now?
J: Some people who recycle have collected it, and the recycled items are specially collected by someone. (1-08 handed over to full-time staff responsible)
A: So now the person who recycles has changed. And you change from giving waste to the single collecting person to the full-time staff, right?
J: Yes.
A: What's the name of the company you contact?
J: Actually, I don't know. Anyway, it was the people from the waste station who came to collect it.
A: After you collect it from the trash bins all over the school, do you see any wrong sorting and need to sort it again?
J: When we collect waste, we will sort it out one by one. We usually take a look, if they throw it wrong, then we will change it in time. (1-09 Professionalism)
A: Will this workload be relatively large?
J: I think it's ok. When students are in the class, we will go to each floor to collect the waste in time.
A: Students also need to participate at now, not just the staff. Would you please comment on the students' waste sorting situation?
J: Let me tell you, it is like this. It must be uncomfortable at the beginning. After school meetings, again and again, day and day, the teachers help the students to build a sense of classification and told them it would be better than without any classification. (1-10 Upper-level education) There were mistakes at the beginning because of unfamiliar, such as residual waste and household food waste were thrown wrong. But now basically there is none of this kind of mistake, and both students and teachers are very responsible. When we working staff sorted the wastes, we

were very tired but now we things getting better. The principal and general affairs all have meetings with the students and teachers to talk, and it is effective talking, which is pretty good.
A: After starting waste sorting, do you think there are some kinds(categories) of wastes waste a lot in the school?
J: A lot of residual wastes.
A: What does the residual waste have?
J: Shredded paper. And there are all kinds of milk boxes and packages.
A: Can a student order takeaway at school? Can they take food to the school?
J: It seems that food is not allowed in schools. Because the food in our cafeteria is safe and delicious, basically they eat food in school canteen or home.
A: What about the battery you just mentioned? Is it the battery in the air conditioner remote control? There will be more, right?
J: yes, there are so many. Disposable batteries are not hazardous waste, but residual waste. That kind of charged battery is harmful.
A: lithium battery.
J: Yes. In the beginning, I also regarded disposable batteries as hazardous waste. Later, someone from the Street Office came to tell me that it was not hazardous waste. (1-11 Correct the wrong behavior in time) So now we throw it away (as dry trash). Rechargeable batteries are rare in our school.
J: Now there are fewer people in school and less residual waste. We now (residual waste) generally have one bucket a day and half a bucket for household food waste. The half household food waste bucket includes the canteen waste and dead flowers and leaves from the teacher's office and school planting.
A: In teaching activities, you may often use sticky notes and large cardboard to display, and some will use 3D printers. Do you have these courses during the cleaning process?
J: Yes, we will recycle them.
A: What is the main area of the trash can?
J: Toilet and teaching area.
A: Is the waste in the toilet mainly paper? Will you put it in the residual waste?
J: Yes, it is mainly the paper towel. We will tie it up separately. We will tie up the paper in the bathroom separately, which is considered residual waste. Because the dry trash looks ugly, it is tied up and placed in a bucket. (1-12 Pay attention to beauty)
A: When does your work start?
J: There are aunts working at 5:30 and 6:00. Before the students come, the floors and toilets should be cleaned up and the waste is cleaned up. To sum up, everything is clean before they come.
A: How many cleaning people are there?

J: There is 8 cleaning staff in total, plus 5 over there in Sichuan Road campus and 3 in Huqiu Road campus. We come and clean every day. Each of us is responsible for one floor, including classrooms, offices, toilets, and corridor floors.
A: What is the working process every day?
J: Every morning, we clean the toilet first, collect toilet paper, clean the toilet, washbasin, and faucet; the next step is to disinfect with disinfectant, and then mop the floor. We mop from the inside of the classroom to the corridor floor, and stairs, and finally down to the lobby.
A: During the cleaning process in the morning, will the trash be packed and the trash bin cleaned?
J: Yes, pick up all the waste bags in the trash can and replace them. After the floor was cleaned, the residual waste was taken down. Before 7 o'clock, the staff will check if there is any paper in the bathroom. The staff will clean the toilet again when the students are in class.
A: Before leaving work, will the same work be done again just like in the morning?
J: The same. They are going to check the area they are responsible for.
A: So the large area cleaning is morning, noon and afternoon?
J: We clean the large area in the morning, but not in the afternoon. Because when we are doing things, some students will slip and fall when walking around. We must ensure that the ground is dry when the students are there. This is done when the students are in class, and we will see the unclean place outside of the classroom. (1-13 Safety first)
A: Are you responsible for the purchase of disinfection? Where did you buy it? How often do you buy it?
J: I am in charge of it, and I bought it in the supermarket 2 boxes at a time.
A: How much water does a cleaning person use each time when cleaning?
J: We don’t have a bucket here, just put the rag and mop in running water and wash then. The mop-washing pool here can’t fit a bucket, so it’s not easy to use, so we just flush it directly, like the bucket on Sichuan Road campus area. (1-13 Tools are not easy to use)
A: What is the composition of residual waste?
J: The mess of shredded paper and nothing to sell are all divided into residual waste.
A: Are there any special activities that will generate special waste?
J: Usually the teacher takes it out for us separately. Students will not throw it away. And we cleaning staff sell them. (1-14 Teacher Management)
A: So a lot of materials like those generated in the teaching, which the teacher will give to you after they don't need it?
J: Just tell us to take it away.
A: Are the papers the teacher gave you A4 papers that may have been used in class?
J: Yes, all of them are used paper. Some teachers are very economical. They usually

use the other side of the one-side used paper. They will give us the paper after they fully used it. (1-15 Save paper)
A: How do you deal with those papers?
J: Sell it to others, sell it to people who recycle.
A: Are the post-it notes sold?
J: You can't sell this, but I asked them to pick it up. There is no way to pick up small pieces of shredded paper. (1-16 Sorting is inconvenient)
A: We just interviewed Manager Zhang from the school kitchen. He mentioned that there will be many cartons and plastic bags delivered in the kitchen. Like school teaching, there will be cartons and express boxes for books. How do you deal with them?
J: The boxes from Mr. Zhang were sent here. We sold them as well. (1-17 Selling waste products) If a paper like you said can be recycled, we will put it in the recyclable trash, and if it cannot be recycled, it will be put in the dry trash.
A: So these courier boxes are collected by people who collect waste products?
J: Yes, I'll take you to see it in a while, it's just that much in a month anyway. We have another (space) for collecting, and we deal with the waste collection once a month. Bottles, paper, cartons, and messy things are handled in this way. (1-18 special storage)
A: Well, I would like to ask you, during your work for so many years, did the senior high school graduates have a lot of books? Will they take them away or put them in the school?
J: Some students are brought back, and some students don't need them, so the teacher tells us to take them away. (1-19 Teacher Management)
A: Is there a lot of books when you graduate?
J: Right.
A: Are they usually workbooks and textbooks?
J: Homework, books.
A: You also collect them and sell them to waste collectors?
J: yes yes yes.
A: How much quantity?
J: Like in 2004, there were about 1,000 students. At that time, there were many students and a lot of books. (1-20 people and many things) During the summer vacation, it is always 200-300 jin, which is not so much now. Just like these (boxes) I brought here from the old school library, these books will definitely be donated next year, and a box of these magazines is at least about 40 kilograms.
A: So the waste (the amount) is still related to the number of people?
J: If there are a lot of people, there must be a lot of types of scraps. There was a lot of rubbish back then.
A: What do you think is so much waste in school?

J: In the early days, students throw a lot of Coke bottles. There are fewer now and they no longer bring snacks that much. (1-21 upper management)
A: How to deal with the ink cartridges of office printers?
J: Sold it separately to the scrap collector.
A: Recyclable waste, residual waste, household food waste, and hazardous waste are sent to a specific company?
J: Yes, there is a company that collects these specialties. I can't remember the company name. It's in the phone. (Check the phone) Uptown Sanitation Transportation Company. This is our waste collector company.
A: Do you have a receipt for the monthly waste fee?
J: You may ask the general affairs of the school. It comes on a quarterly basis. (1-22 someone is responsible)
A: Will there be more rubbish than usual at the end of each semester, after exams or activities? how many?
J: Yes, it will be more before the summer vacation. We will clean up in every classroom, and there will be more residual waste. Before vacation, we should do more than one-time cleaning. (1-23 Special period) After all, there is a lot of paper, and the cleaning is usually 1-2 hours.
J: Let me show you (toilet room). The roll paper is placed in the women's toilet but not in the men's toilets because some student boys are naughty and thrown away the unused toilet paper. Girls won't. Boys are very naughty at this age, unlike little girls. (1-24 Differences in behavior)
A: Do you have hot water here?
J: Yes, we have these electric heaters in use, which were removed from the old campus(Sichuan Road campus). (1-25 Reuse)
A: The drinking water, flushing water, and hand washing water in our school are all the water here, right?
J: Yes, they basically drink water from the drinking fountain. (1-26 focus on quality)
A: Didn't School try to buy reclaimed water recycling equipment to use the reusable water for toilet flushing?
J: No, we didn't.
A: The water was drained from the sewer in the end, just as we usually do.
J: Yes, like at home, we don't need more water for the second time. We just use it once. (1-27 pay attention to safety)
A: Have you recorded the approximate annual consumption of toilet paper?
J: To tell the truth, I always order in 10 boxes at one time. (1-28 bulk purchase)
A: Is this drinking water? Do teachers all drink this water? Will the bucket of this water dispenser be recycled?
J: Yes, some of the teachers like to drink this bucket water and some will also drinking the public drinking fountain. And we also recycle the bucket. This one is 5

liters (a barrel).
A: We saw orange peels and plastic snack bags. (In the classroom)
J: Students eat them. Some naughty students, even the teachers can't catch them. (1-29 Students naughty)
J: Let's take the elevator up to have a look.
A: (See the posters posted in the elevator) Will these posters be recycled if they are removed?
J: This we will also recycle.
A: Is this glossy paper good for sale?
J: is good for sale.
A: Is this usually posted for a semester?
J: Most of the time we don't have this poster.
J: This is a 3D printer digital system workshop.
A: Have 3D printed waste been collected?
J: We just received once.
A: How do you deal with this waste?
J: plastic is recycled as plastic. (1-30 classification knowledge)
A: Like this kind of post-it note, the paper used for this homework?
J: All recycled. Anything that is picked up is recycled. (1-31 sorting capacity)
A: Generally, the whiteboard pen written by a teacher is out of ink. Will it be recycled?
J: Hmm is rubbish.
A: Like we were doing waste sorting at home some time ago. At that time, we divided plastic products, paper products, and food waste into 3 buckets. One month later, we discovered that there were a lot of plastic and paper products, and food waste was very little. I felt very surprised. I originally felt that there was a lot of food waste in daily life, but I didn't expect that the packaging (bringing) was particularly large. Do you have this feeling?
J: We have packaging paper, boxes, and plastics in the cafeteria; like we are on winter vacation, there will be more boxes for students to send out books, but usually there are not. When school starts, we want to distribute books, and students want to distribute new books. There are cardboard boxes. (1-32 special events)
A: So you think during the year.
J (during the year) is during the summer and winter vacations, there will be more packaging waste at the beginning of school. (1-33 special period)
A: Okay, thank you, can you take us to the waste collection room?
J: I will take you there.

Interview with PBL Assistant Teacher Deng:
A- The interviewer D- The PBL Assistant Teacher Deng

A: Mainly wants to know the situation of the PBL course you participated in. First of all, can you briefly describe the class period, schedule, and general overview of the entire timeline?
D: The course is scheduled for one month, with a National Day vacation in between.
A: How many times do you go to school every week in a month?
D: We have a meeting on September 3 to discuss the lesson preparation together. The first lesson is telling the preparation. We will start the class on September 5th. Our class lasts for one month, from September to early October. Classes are held every Thursday, and each class is about 3 hours.
A: Who is responsible for purchasing the teaching aids and materials in the preparation stage?
D: We prepared this class in our laboratory. We brought the materials ourselves and reimbursed them in the college.
A: Did you communicate with high school when preparing materials?
D: Communicated. Because the PBL Media courses are courses from college, not from the high school, we are afraid that the high school teachers aren't clear about the tools and might buy wrong ones, like the Bluetooth shutters. So we asked about the headcount in the class and directly prepared the main stuff. (2-01 Worried about making mistakes) If it is an ordinary tool, it may be prepared by the high school, like A4 paper. (2-02 Ask in advance)
A: Do you think you have encountered any problems when preparing the materials?
D: We can only calculate based on the number of students in the course when preparing materials. Generally speaking, we will prepare doubled materials, or less than doubled, to prevent flaws, such as insufficient materials. (2-03 Ensure sufficient materials) For example, our class had 5 groups at that time, maybe we would prepare 7 or 8 groups of materials. If the main materials are used, we can only buy them in units. For example, we bought 5 to 10 boxes of thumbtacks, because we were afraid that they were not enough, (2-04 ensure that the materials are sufficient) We cannot always estimate the process of the class and how much materials they may need to use. Actually, to ensure the course quality and final outcome performance, we always think about all the accidents and try to prevent accidents in prevalence. But in fact, when the courses begin (the materials we prepare), we mostly find that there are often twice the amount the students really need, maybe less twice. (2-05 Too many materials)
And sometimes I buy less. (2-06 Too few materials) For example, We bought only one box of chalk because we felt that the chalk was unrecyclable after the course(there is no blackboard in the school). and then, the chalk is not enough and

the performance may not be as good as expected. (2-07 Classroom effect)Especially in this school, (most) PBL classes are taught by college teachers as guest professors (not resident in schools), so there is no fixed person to manage the course material. In addition, some PBL courses are prepared by middle schools, and the management is very uncertain. You may want to ask the main person in charge of the course material, but this person does not exist. (2-08 Lack of dedicated management) Even if there is a docking person who is responsible for PBL classes, he is not responsible for managing these materials. (2-09 Lack of management for purchasing materials)

A: How did you arrange this course, for example, what are the contents in the first stage? What is the format of the final class? What is the subject of the course?

D: Our course is divided into two parts, the first part is motion graphic, that is, the animation is a stop motion animation. We used some stationery materials and printed positioning plates for them during the preparatory lesson. Then the classroom was divided into 5 groups, each group of 6 people, a total of 30 students.

A: What is the specific process of the course arrangement?

D: We have 2 course sections, the first section is the basic exercise of motion graphic, the second section is to take a creative Promo of the school. We have 4-5 classes in total, the first 2 classes are about stop-motion animation. In the first part of the class, we let them familiarize themselves with the materials and tools. Then the second lesson is filming and editing. In the third class, we let them present their short motion graphic video and start on introducing the second-course section, about the school promotional film. Then after the part of the promotional film was finished, they began to talk about the film in-depth, and they began to build up some concepts to make the promotional film.

A: So you mainly have 5 lessons. The 1st lesson is a lecture, mainly to teach and familiarize them with the tools; The 2nd lesson is to start doing stop motion animation; The 3rd lesson is to report. Any use of materials? The next two classes are doing middle school promotional videos, so has the video been filmed? Is there a form for reporting?

D: Right. During the promotional video, I felt that there was not enough time, so the report was a bit rushed.

A: Can you talk about what materials you used in the teaching process? And how to use them?

D: Each group has a mobile phone holder, 2 scissors, and a box of markers. The first team used paper clips, the second team used chalk, the third team used erasers, the fourth team used sticky notes, and the fifth team used thumbtacks. During the period, they had to draw a dynamic storyboard in the early stage and also printed a lot of tutorials. In the middle, this stationery, such as paper clips, may be folded and cannot be used later; (2-10 material discarded) The thumbtacks can be used, they just put them together at random, and the eraser will be cut into small pieces and

can’t be used anymore; The sticky notes will be folded, crumpled into circles or folded into different shapes to create a graphic. In short, it involves some deformation of stationery. (2-11 Material deformation) There may be a lot of materials involved in the previous lesson. In addition to the mobile phone holder, there are also Bluetooth wireless shutters, one for each group. We all issued a set of tools for each group, all prepared by our laboratory. It probably costs 400-500 yuan. Then the next class is to shoot a promotional video of the school, which doesn't use too many tools and stuff.

A: What is the finished product after using these materials? Is it glued to a display board or how to display it?

D: Those things are mainly props for video performance. We also think that stationery is something closer to them in life, and choose some stationery that is more malleable, which may have some deformation. For example, thumbtacks, it may be scattered. With an eraser, we think it can be spelled, like building blocks, and then we think the chalk can be (deformed). But it is a little wasteful of chalk because they will cut the chalk into small pieces, or make it into powder for the video. But we only gave them a box of chalk, so the quantity is not as much as other material volumes.

A: So these materials are only used in the shooting process and not used to form a complete result, right?

D: Yes. If we (the PBL teacher) do not recycle the materials, it is estimated that the (high school) teacher will accept the teaching aids for PBL in the future. (2-12 Rely on teacher management)

A: Can you describe the final state of some materials in detail? If it is cut into small pieces, how can you go back and make teaching aids?

D: The small pieces are not recyclable, they should be thrown away. The sticky notes should be thrown away if they are rubbed. What I said about recycling should be considered redundant, that is, the recycling of the unused part. (2-13 Recycling standard)

A: After course, how did you deal with these materials?

D: After we finished the first half of the course, we didn't want tools, but we got them back. (2-14 Don't want to recycle) Others I don't know how to deal with. (2-15 unclear)

A: Why did you buy scissors and markers again? Is it because you don’t know that the high school has also prepared basic teaching aids for PBL?

D: We don't know that there are scissors in high school, let alone markers. (2-16 I don't know the situation of the school) The students may forget to bring the tools and we are afraid it would affect the teaching performance. (2-17 Guarantee the classroom effect)

A: Then you only asked the number of people when you started communicating with the teacher? Did not ask about the material situation?
D: I didn't contact teachers directly, maybe some other teachers asked about it. I don't know.
A: So these materials are only used in the shooting process and not used to form a complete result, right?
D: Yes. If we (the PBL teacher) do not recycle the materials, it is estimated that the (high school) teacher will accept the teaching aids for PBL in the future. (2-12 Rely on teacher management)
A: Can you describe the final state of some materials in detail? If it is cut into small pieces, how can you go back and make teaching aids?
D: The small pieces are not recyclable, they should be thrown away. The sticky notes should be thrown away if they are rubbed. What I said about recycling should be considered redundant, that is, the recycling of the unused part. (2-13 Recycling standard)
A: After course, how did you deal with these materials?
D: After we finished the first half of the course, we didn't want tools, but we got them back. (2-14 Don't want to recycle) Others I don't know how to deal with. (2-15 unclear)
A: Why did you buy scissors and markers again? Is it because you don't know that the high school has also prepared basic teaching aids for PBL?
D: We don't know that there are scissors in high school, let alone markers. (2-16 I don't know the situation of the school) The students may forget to bring the tools and we are afraid it would affect the teaching performance. (2-17 Guarantee the classroom effect)
A: Then you only asked the number of people when you started communicating with the teacher? Did not ask about the material situation?
D: I didn't contact teachers directly, maybe some other teachers asked about it. I don't know.
A: What is the positioning board you mentioned?
D: It is a piece of A3 paper, printed with positioning, for students' convenience on making motion graphic. I don't know how to call it, just call it positioning.
A: Positioning board is one for each group, right?
D: 6 to 8 sheets per group.
A: You just mentioned that you will print some tutorial materials to them during the film class. What format is that? Is it book by, or scattered A4 paper? How many photos are there in each group?
D: 10 sheets per group, A4.
A: Are these papers finally left in high school?
D: Yes.

A: There is also the storyboard mentioned earlier, is it also paper? How many photos are there in each group?
D: is about 10 sheets per group, A4.
A: After that, you still use a lot of paper. I did a calculation. There are about 140 pieces of paper in total. You didn't recycle these papers. Did you leave them in school? Why not let it go?
D: Yes. Because these things are not necessary for secondary use, (2-18 recycling standard) the high teachers told us that we just put it on the table, and they might clean it up by themselves. But If they don't reuse the paper, we will take the papers away and keep them for use. It doesn't seem to be useful and we just put them there. Sometimes we will use it for a draft. (2-19 Rely on teacher management)
A: Why is there no need for secondary use? Is it because there are traces of writing on these papers? Or is it because something has been printed on it that affects its use?
D: As a storyboard, next time we will do a new lesson preparation, a new storyboard, this storyboard is useless. (2-20 Specially customized) But as paper, it can still be used for schools. Some of the paper has traces of writing and drawing, we did not check them one by one. Because we are far away, there is no need to take it away. The other tools were brought back because we can still use the money. (2-21 Price consideration)
A: So you tend to recycle materials with high value and long service life?
D: Paper reuse efficiency is low, (2-22 efficiency priority) we basically work in a paperless office, we take it back and put it there. (2-23 Usefulness) In middle school, there are many situations where the paper is needed to write and draw.
The teacher may call a few classmates and collect the paper. Because I saw the teacher often asked my classmates to help take it to the office, or just take it away and clean it up, and then if the students didn’t take it away, it was the aunts who cleaned it up.
A: Where did you purchase the materials?
D: On Taobao online shopping website. If there is any need to add materials temporarily, we will buy them at the stationery store.
A: Why did you choose Taobao? Which business will you focus on?
D: Taobao has big stores that could send an invoice, it is best to buy all the materials in one store at once. (2-24 bulk purchase)
A: Do you think in the process, students lack environmental awareness in the use of materials?
D: In the first lesson when we distributed the materials, the group that got the rubber said that they felt the material was lacking. Later, to meet their needs, we bought a box of erasers for them. But they finally didn't use it bought. Actually, with one box or two boxes, they could find a way to solve the problem and finish

the video, implement material is not the only way. Another example is that another group using chalk. They also said they lack material. We went to find more chalk for then, but none of the offline stationery stores sold chalk, so we didn't buy for them. Then they finished their homework with a box of chalk. The students are used to sufficient materials. If there is not a lot of materials, they will think that it's not enough and they can't finish things, but they can solve it. (2-25 More is better than less)

A: Do you think the use of materials is wasted in the process? why?

D: For the first section, the motion graphic part, I think erasers and sticky notes are wasteful. Most of the time students just start to record videos without drawing a storyboard, in this way they won't think about videos in detail and do a lot of 'experiments' on practice. (2-26 student behavior) Erasers they cut into small pieces, that's to say, these erasers would become useless in the future. And about the positioning board, when we made them, we thought it would be useful for guiding, but we found the students don't like to use them. So in fact (in the classroom) they were not (being) used. (2-27 students didn't use it) For the storyboard, we thought we would teach them to draw the storyboard. They would find the position of the lens better when they took the video and then have an idea in advance. But they didn’t want to think about it, so they just started shooting directly without using the storyboard (2-28 student attitude). Later, we brought some of the papers back, and some of them were left there.

A: Students do not use auxiliary teaching aids, have you communicated and guided?

D: Yes, we tried. But they didn’t think it was necessary. There was enough other homework in the high school. They didn’t want to take too much time on making the video and do it step by step. They felt that the group discussion was helpful and enough for the video idea. (Student) are confident and have their personality and ideas. They won't do things they don't want to do and follow the traditional strict way of doing things. They will do things in their way and just want to reach the result.

Interview with PBL Teacher Gong:
A- The interviewer G- The PBL Teacher Gong

A: Interview mainly wants to know about the materials and resources that may be consumed in the PBL teaching activities in middle schools, and what is the output of these materials through the process of students' use, and how to deal with the discarded materials?
A: As a course designer and lecturer, could please introduce the process of PBL teaching activities?
G: This is the same as any class, that is, of course, you have to prepare before class. What do you want to teach? When I was the teacher, there are the first group of students in the school, actually, at that time, our schedule is not completely determined. If it was a micro-course, it will be finished for 3 weeks. It was in 2017 when it started, basically, the schedule of the course was decided by Tiina. The time of the PBL courses was quite limited. And in the second year, I was mainly in charge of all the PBL courses. One kind of course was called "I participated". That is, I participated in courses that other teachers were responsible for. Another kind of course that I'm in charge of has 2 types, called 'THEY' and 'SIPP'. The 'SIPP' is the student initiate a project program, which is found by the students and is the research project we are doing now. For example, under normal circumstances, we hope to have a little more time here, because the courses are not enough under our arrangement, so I always asked for lessons so that we could have more time throughout the teaching process.
After the first semester I tried once for finishing the entire project course time, the teaching experience could be helpful and give the other teachers feedback, for example, how many class hours should it take for a project. I was like a pioneer, just as Teacher Lou said,'cross the river by feeling the stones. 'I am the 'first few stones'. Resources have been designed before the class. In the process of attending, we will think of many resources in the early stage and contact to determine who will come. The last part of the evaluation was at the beginning of 2017. It was mainly based on the evaluation of Tiina design, but it was my design evaluation during SIPP.
A: What exactly does this evaluation refer to? Is it to evaluate the results of students? Or a review of the whole process?
G: The evaluation of SIPP is complicated. It will be given to you by a teacher every time after the class is finished because it used to be graded. This is an objective description of the evaluation. In the end, there will be mutual evaluations between students. Inter-evaluation means the group makes suggestions with other groups. So one is to reflect through evaluation (the performance of students) and another is to evaluate the course.
A: So this evaluation will be conducted at the end of each class?

G: After each class, I am not sure how many formative evaluations there are. But this process is very energy-intensive because we used a lot of resources, each group will have 2 teachers, one high school teacher, and one university teacher, whether it is 2 classmates or 5 classmates. , So it was very time-consuming for the teacher to comment on this.
A: Do you provide any auxiliary tools in this process?
G: A paper-based template that will tell you what the evaluation means, how much each part occupies, and what kind of (projects) it has. One is the evaluation of the team members, and the other is the evaluation of the group. I prefer to be all paperless, (3-01 Paperless Teaching Awareness), but it will be troublesome to operate. (3-02 Operation is difficult)
A: How many templates do you prepare for this?
G: I haven't counted this. Anyway, if a group has one sheet, it will be around 15 sheets each time. I personally tend to be paperless and let everyone write electronically during the process of evaluation. However, many teachers were invited to the final evaluation, and the evaluation will finally print out. (3-03 is easy to operate). There are 49 students and 9 teachers. If all students and teachers have their own sheet, there will be about 100 printed copies.
A: What do you think is a big obstacle when trying to try paperless teaching?
G: Firstly, students cannot use mobile phones. It is very troublesome if you ask them to fill in something. They can only use their phone after school, which means that it will be difficult to give timely feedback in class. This is a difficulty. (3-04 hardware is missing) Secondly, the cooperation between high school teachers is different from that of the enterprise. The enterprise will use some applications or cloud to share the folders, like Google Drive, which allows online multi-person cooperation. I recommend 'ShiMo'(a Chinese folder share app) to the teacher for the domestic version, that is, if we do something, whoever writes it can get feedback immediately. But I feel that the teacher is not used to this way of working. Maybe the tool is on one hand, and more about the form of cooperation. (3-05 Cooperation method) I believe that high school teachers may have a habit of their own, and also I have my own habit, but in fact, we should understand their habit of group cooperation.
A: How about the course?
G: 3 weeks long at that time. The first part is to let them understand the UN's sustainable development goals and some basic things about the circular economy, mainly lectures. In the second part, we invited a lot of enterprises that have practice in various fields in China. We chose agricultural, industrial, and plastic-related start-ups because they are more inclined to the industrial direction. They may do the lectures and let the students work at the same time. After the third week, students have to do their target project by themselves. In fact, the most important thing for

sustainable development is systemic thinking, so we found a relatively small topic, which is the school's The circulatory system of food, you draw your own school food where it comes from and where it will go, just do this. At the time, the hope was that the students could help improve after doing this. Because the school has always been in development, many things tend to be temporary. At that time, food was delivered from outside.

A: I remember that there was a class on the packaging of 'Double Eleven'(Chinese On-line shopping festival, just as Black Friday). The main purpose of this class is to understand different materials or to cultivate students' awareness of waste sorting?

G: Mainly like this, it is a combination of disciplines. The course is about chemistry. It has a lot of such content and experiments, so we considered to integrate the content of basic courses in this course. At that time, there was another content. In addition to the combination of chemistry and biology, there was also a political teacher. The students went to investigate everyone's purchases and looked at Double Eleven from an economic perspective.

A: What is the basic feedback from students? Is it mainly knowledge popularization or awareness training?

G: The most important thing is the combination of knowledge from different subjects. Because at that time, it was mainly to see how high school teachers were integrated. They designed specific knowledge content, such as disassembling them to show different materials. We provided the template, and we gave some design support. I think these consciousnesses are already there for high school students, and the biggest integration with their subject knowledge points should be said that they have been seen in books before, through experiments on their own, and combined with double eleven. The packing box should be prepared by the high school teacher. The students simply tried it on the spot and did a small experiment.

A: The template you provide is A4 paper size?

G: We have designed a template. How can we help the students to separate the boxes, for example, to classify the five modules, materials, and boxes corresponding relations? (3-06 Teaching aids)

A: The main purpose of the food system class is to cultivate their systematic thinking. Did the students produce any special conclusions or discover any problems?

G:, when they did the mapping in advance, they found that there is much more work to do to truly understand recycle. Including that students should go out of the school to observe. We didn't achieve this because of the safety restrictions. So this is more for them to map out and let the school see what the whole process is like. At that time, it was done in groups, and the output was a map. The problem they mentioned was, for example, that the food delivery was very serious because the school did not

have an elevator, for those aunts.
A: Every time in PBL class, there will be the output of students' achievements, such as models and exhibition boards? Is there any teacher who manages results? For example, like this map of the food system, is this type of achievement managed?
G: In the first session, because these management tasks were done by the school's teachers, the teachers in charge of connecting with PBL at the time were course teachers. You know that in schools such systems generally have educational affairs, they mainly worked for teaching, so there was relatively little participation in educational affairs at that time. (3-07 Lack of dedicated participation) The teacher who was in charge of this at the time was a course teacher and she also had a class, so she should have all sorted out, but I don't know how it was sorted out at the end, but the pictures are all preserved. They are all on the school computer. (3-08 Electronic archive) Then in the second session, the teacher in charge of the courses was younger. They documented the results of each session and collect and manage the materials for each class. Therefore, the information in the second session was improved.
A: So basically the teacher will digitize the results, and the entity will be lost?
G: It should be part of it. Of course, when designing the course, we also consider which waste can be reused.

A: To what extent do middle school students understand sustainability?
G: They all have the common sense we have, but the circular economy has given them some new perspectives. I think that things like this are more abstract in contact with students, and some teachers say they are more abstract in feedback. Our main purpose of this class is to let students have preliminary systematic thinking, that is, when you look at a problem, you can't just see one point, it's closely related. Because our entire PBL class is in, I call it Finnish, but there are no rigid evaluation criteria, for example, what must be achieved, you must produce, we do not have competition, so after each group has done it, everyone All presentations, exhibitions, but no awards.
A: In your impression, which material or tool do you think you use the most?
G: Paper, cardboard. A0 paper is the most common, and there are also many post-it notes.
A: Mainly some stationery tools that can help students express quickly?
G: That's right, it's convenient for their group activities and the presentation of preliminary ideas. (3-09 Quick Expression Tool)
A: Have you ever encountered the situation that the students have not fully used the materials or design flows because of understanding problems or communication problems?
G: Well, I'm thinking. I thought of a class. It was in the 'THEY' part. In the first lesson of the class, I sent the students a produced brochure, which (introduced) what

this class was about, What do you want every time? Then the teachers thought it was very good and later took my temple. We can send the electronic version, but when a booklet is given to the students, this sense of ritual will make the students feel better about the course. Paying attention to it, I feel that the teacher has designed it quite well, and it feels like this is a must. (3-10 Real sense of ritual) What you said is unnecessary, I think as long as it is used, there is no waste. (3-11 is used) For example, whether it is not used will be compared to waste? I think about it, I think middle school is okay. Every time everyone in the university ends the course and after the completion of the exhibition, there are a lot of things left behind, including some rulers and utility knives, which may be thrown away. In high school, these are the property of the school. It was managed by the teacher, and then by the students in turn. Later, I don't know how it is now. Each group has their stationery box and they have to manage things by themselves, (3- 12 Tool Management) This is how it operates, so I think in middle school, I feel that this aspect is okay, instead of throwing it away after using it, they can always use their group's toolbox.

Interview with teacher Xu from middle school:
A- The interviewer X- Teacher Xu

A: Good morning Mrs.Xu, I would like to know about the use of materials in high school teaching and the management of materials after use?
X: We leave all the materials to the students for management because we find that students do not measure the amount of these materials during the use process. They often take them all at once, and then the waste is very serious. (4-01 more.) So, for example, when there was a Lego model class in this senior year of high school, they grabbed all Lego at once, but they didn't need it, and then there was a lack of management. No way to measure. So our second-year high school students didn't use Lego at all, and we didn't distribute all of them. It was a waste.
A: Yes, we also understand that once the materials are used by the students, they will be deformed and lost, so the use-value is very low.
X: this is very troublesome and another point. Sometimes you make posters in PBL, and some daily utensils, such as colored pens, scissors, glue, and paper. At the earliest, we sent a box as a group, but the problem was we nowadays, some activities in high school are short and fast. It is not a long-term activity project. fir example there might be 3 projects carried out at the same time in a week and with only one material and toolbox? How can this box be used? (4-02 time) Most of the time, there will be mistakes. And later we might find that one of the boxes was extremely full, and one of them had nothing inside. So in the first half-semester of this year's high school, what we implemented is that your group leader leads the box. We still subdivide. I think because these children are not like college students with strong self-management skills. (4-03 personal ability) They have poor self-discipline ability, so the team leader still leads the box, and then collects the colored pens according to their categories, and then puts them back in place after receiving them, which is what to put in one area and what to put in one area. This is better than giving him a package of things. Although the manager will spend time on it, at least there is a responsibility system. (4-04 Responsibility Management)
Especially when the PBL is in the second semester, its project is so interspersed and messy. It is not like cultural and creative courses. The highest density at that time is that there were 3 projects a week, which painful for us to manage. There is another one that I have always wanted to develop, whether it is a loose-leaf document such as a basic subject or an extended subject because we have a relatively small number of students now, that is, the students are more special, whether it is PBL or basic subjects, we are all It is student-oriented, and there will be more one-to-one teaching modes. (4-05 personal customization) If you are like my chemistry, I will have a study plan for each class, and the date will be written on it, What day of the month of 2020, then the main content and homework of the day are all on this piece

of paper, instead of taking external teaching aids or ready-made books or workbooks for them, because there may not be Pertinence, then I will talk about a knowledge point that will have some questions to assist in how to practice, but this has been a practice in my work for the past ten years. It is to use school plans without external materials, but good children will Take a document bag to hold it or hold it in a two-hole printed MUJI clip, but most of the students are (unmanaged), (4-06 personal management ability) like this type of back equation paper is It's everywhere.
A: After they use this material, they don't keep it well and manage it, and the littering will be thrown away as waste paper.
X: Right, so I always think that some children can be attracted by product design. (4-07 The media of inducing behavior) For example, if you have a better-looking document bag, he has a sense of exclusiveness. (4-08 sense of exclusivity) Now you see that there are some document bags on Taobao on the market, which indicate that they are in chemistry or language. Some girls will buy them to store for example chemical course materials and language course materials. The beautiful covers attract people, so it might help to change their storage habits. They are going to do this sort of thing, this is only from this perspective.
A: Apart from you, do other teachers subscribe to some supplementary materials?
X: Yes, but many teachers have their study plans. For example, for the English course, the teacher held an activity called English word every day to help students recite words because I think it will be more effective.
A: Is your study plan designed according to modules or knowledge points?
X: Teaching progress can be adjusted in this modular way. Because no one knows which issue is still stuck in this class, I might feel that it is not my focus in this class, but the students do not understand, then maybe I will spend some time on this in the next class. Then this is adjusted through the study plan.
A: How many sets of study plans do you have to do each semester? How much material will it cost?
X: Mainly paper and printing.
A: Like PBL course reports, they are all in the form of exhibition boards or maps. I see that some self-portraits will be displayed, but some are purely brainstorming. How are these handled?
X: I did the file management of their second year of high school, (4-09 teacher management) I will show you. In their materials, this is the debate material, this is the workshop they made without a card, this is the catalog of his first semester, this is his course materials are called to them, if some children want to go abroad, They can take the data away and generate their portfolio. So this kid is doing more comprehensively, this is the summary of PBL, and then this is the second semester, he has already taken things away. This is the workshop of Tongchuang Value. Put his own according to each project. Some of his self-portraits may have been taken

away by them. This is a speech from their My Dream School, and this is a photo of them receiving foreign guests.

A: Did you organize these by yourself?

X: It is a team of us. This matter is also a headache for us. That is to say, we implemented it first. We wanted to take photos of students and put them in the big pool, and then students would choose to form their file folder, our teacher Just responsible for certification. But the first one in our school does not have this kind of server (4-10 high-efficiency hardware) to store these things, I can only rely on Baidu network disk, the student experience is very poor, some lazy children are not willing to do it. (4-11 Poor sense of use) This was not done in our semester, because it was too wasteful of paper, (4-12 saving consciousness), so we print a copy according to the project, such as a group of five children. We printed 5 copies before, and everyone has them. Now we are putting the stuff here. If a student needs then, he can take them. We are changing. This includes the output of all inspections of moral education and party-building work completed with these materials. So we think that if you rely on the electronic version to manage, you have to have a good understanding of this process, then the teacher will not work all day, and will deal with all aspects of obtaining materials. (4-13 Difficult to manage) We now decided to print out all the materials of ME and WE (modules) and put them over there. I also have the electronic archive for the project set of documents. The student can ask me to print the electronic manuscript, because this is only a part, and we have saved the video including the roadshow for them. But we have discovered that for students when he gets this item at the end of the semester, he will think it is a gift. (4-14 gift) and feel that I have not done it in vain this semester. If we just give him a digital thing, we also thought about whether to give everyone a USB flash drive, but he would not know (weight) when he got the USB flash drive, just like he would feel heavier when he got the paper one, the digital version cannot be felt and valued immediately. I don't know why.

A: Do you think the school's teaching has developed in the direction of paperless teaching?

X: If it is a normal basic subject, it is difficult. But PBL may be able to do it. I am still worried about where these models and posters made by the students will be put there?

A: Yes, it is a problem.

X: You see, we have already displayed everything that can be displayed. This is their 3D printing, and there is their travel brochure. I put everything they can display. I think it’s still piled up there. Why not stand up if you can exhibit. But here comes the problem. By the time the next children come, this space will not be enough. (4-15 Space is limited)

A: If you graduated from this year's senior year, what would you do with the results

that have not been exhibited?
X: Yes, this is what we are asking. I took over from this year's first year and second year of high school. I always want to keep all of their things, but I find it so difficult, so I wrote them in the form of a photo with a postcard description, and then generated this Archives, I at least give them this (document), but the real thing may not be there anymore.
A: why do you think that paperless teaching is impossible?
X: Because the College Entrance Examination is not paperless, (4-16 national requirements) you must still do the questions, and there are many subjective questions in the college entrance examination, which must be expressed by you. And it's okay to express it verbally, but it's not good to write it down. So I have to ask them to write it down anyway for this class of kids, not just talk, they must have a manuscript. So you will find that this cultural and creative class must be What, Why, How, and must be expressed in words and written down. Today's fast-food-style reading is too much, there is no precipitation, it is short and quick information.
A: Do you do the chemical experiments now?
X: The school does not have a laboratory now, and many experiments use micro videos or show them in the form of videos.
A: Can you do the chemical experiments in class?
X: Sometimes, but the problem is that as we rebuild, some experiments can't be done at all.
A: Where did they go for this study?
X: Xiangshan Campus of China Academy of Art and Yunqi Town. We arrange individual homework for each of the children in the first and second year of high school because teamwork will become a single homework for one person.
A: How long does study?
X: Only two days.
A: Are all the teachers going?
X: No, 13 teachers.
A: How many students go?
X: 87.
A: When preparing materials for the PBL class, sometimes we will prepare more than the amount of the course.
X: The PBL teachers must communicate with us normal teachers in advance, I think it is very good like their 'Cultural and Creative' course. A lot of communication work must be done in the early stage, including student management. It is a two-way request, that is, how many class hours we have given you, how we want you to use it, and how you manage students. Because you are responsible for the content of the course, and the follow-up is not done as soon as it is done, and there is constant communication in the middle. You found out, so there won't be (more) coming to

those two people later.
A: Yes, because students sometimes have difficulty completing the specified requirements, the design team needs to temporarily prepare some materials to guide them.
X: You will feel very tired in the second year of high school, because there are many children in the second year of high school, especially the students in the back must keep up because the running-in between the students will be oily. It is very difficult for you to manage, and it will be much better to manage in small classes like this. Once a kid in high school made posters, people from all districts came to attend the class. There were four thorns, which meant that they took the poster and went outside to do it. What should I do? Your university is a "wake up" student, and we are a "discipline" student. How to find this point of balance? Because the students (in the PBL class) are not under test pressure, all the pain points are borne by our high school teachers. Over time, they see that this high school teacher is you who come to me for homework, even if it is PBL homework, we will collect it. They will not want to see you, and then our conflict will be very intensified.
A: Whether it is PBL or basic class, after assigning homework, will you manage the students after class?

X: Yes, yes.
A: In the management, students may not be obedient and unable to hand in their homework.
X: Another thing is that the school does not have a hard and fast rule, and the self-discipline ability of high school students cannot be achieved. The best condition is to be able to achieve the perfect fit and integration of college and high school. You can come to sing white face, we are responsible for singing red face, but the premise is that there must be communication. Because the university is not long-term, unless you have a dedicated team here, and you must participate in the daily activities of the school in order to experience (difficulties in management).
A: What trouble will it bring if there is no communication in advance?
X: For example, if you do not communicate in advance, the middle school teacher's ability to cope with emergencies will be reduced.
A: Do you have the expected cost for buying these teachers?
X: No, we do not have a special fund for PBL. It can only be emergency, we can only do general affairs now. And can't buy Taobao. It is the teacher who needs it, and then I have to go to the general affairs person, and then the general affairs person to buy, link to Jingdong, Jingdong can buy, this is the operation.
A: In general, there are many material requirements for PBL courses. This is the general affairs to help you purchase.
X: and asked us to bring it up and the principal's approval.
A: Based on your experience, do you know the approximate cost of course

materials?
X: Zero expenses. If it’s the bridge, you have to buy model materials, and you have to buy sporting goods, raincoats, or even a designated event.
A: For the course of that semester, do you have any management of project expected funds?
X: No, that is to say, including my side, there is no item detail, that is, some may be bought by the general affairs department without knowing him, so there is no general ledger here. (4-17 Information Asymmetry)
A: Is it because there are so many participants in the course, do you think there is a lack of a general manager?
X: Right.
A: If another teacher goes to the general office to buy materials, don't you know this?
X: Right.
A: There is no communication between you and general affairs are not clear.
X: General Affairs will buy fixed items in advance, such as document bags and paper, and he will keep stacking them there, and just pick them up as needed.


APPARCAMENT