DOCTORAL DISSERTATION

Study on Evaluation Methodology of Urban Waste Management Policies by Beijing Residents based on Contingent Valuation Method and Theory of Planned Behavior

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Preface

In 1987, the World Commission on Environment and Development formally introduced the concept of sustainable development in "My Common Future". The core idea is a development model that meets the needs of the present without compromising the needs of future generations, and the three elements of sustainable development are: environmental, social and economic. With the continuous development of urbanization in China, the current sustainable urban development is faced with a series of problems, including housing, production, living and future development, etc. At some levels, the lack of information transparency between government decision makers and urban residents has led to these conflicts and problems. For these reasons, Beijing, a representative city in China, was chosen as the target city for this study. With the analysis of sustainable urban factors representative of it, the relationship between environmental, social, and economic elements regarding the recycling methods of municipal solid waste and the intention of other government policies to be implemented is assessed by the conditional value approach and the willingness to pay is inferred. Factors affecting public payment are also discussed. and the factors that predict each variable of willingness to pay. Beijing is used as an example to contribute to the development of a sustainable society and related policies in China.

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ABSTRACT

In 1987, the World Commission on Environment and Development formally introduced the concept of sustainable development in "My Common Future". The core idea is a development model that meets the needs of the present without compromising the needs of future generations, and the three elements of sustainable development are: environmental, social and economic. With the continuous development of urbanization in China, the current sustainable urban development is faced with a series of problems, including housing, production, living and future development, etc. At some levels, the lack of information transparency between government decision makers and urban residents has led to these conflicts and problems. For these reasons, Beijing, a representative city in China, was chosen as the target city for this study. With the analysis of sustainable urban factors representative of it, the relationship about the environmental, social, and economic elements is assessed by the conditional value approach, mainly in terms of the recycling methods of municipal solid waste and the intention of other government policies to be implemented, and the willingness to pay is inferred. Factors affecting public payment are also discussed. and the factors that predict each variable of willingness to pay. Beijing is used as an example to contribute to the development of a sustainable society and related policies in China. In the questionnaire survey on the recycling methods of municipal solid waste, we mainly used web-based questionnaires. Through the web-based questionnaires, we judged the validity and response of these questionnaires through the conditional valuation method, and through the valuation analysis method of the questionnaires, we predicted that the annual per capita payment in Beijing is $49.93, which is mainly used for a new type of intelligent waste recycling system that can be Effective sorting method can reduce the release of harmful substances by 90%, among the factors affecting payment income level, education level and willingness to pay have a significant normal influence, the higher the income level the more educated residents have a higher attitude to pay, Environment-concern, Attitude, Subjective Norm, and Perceived Behavior Control have a correlation with the willingness to pay of the population, we can state that the predictive power of the expanded model of the theory of planned behavior is very reliable for the non-market willingness to pay.

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Chapter 1

RESEARCH BACKGROUND AND PURPOSE

CHAPTER ONE: RESEARCH BACKGROUND AND PURPOSE

1.1 Background

1.1.1 The background of sustainable development

Sustainable development is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs. [1]” The concept of needs goes beyond simply material needs and includes values, relationships, freedom to think, act, and participate, all amounting to sustainable living, morally, and spiritually [2].

The 30-year journey of four World Summits from Stockholm to Nairobi to Rio and to Johannesburg has put the world on notice that achieving sustainable development in the twenty-first century is not an option but an imperative. During the period 1972–92, over 200 regional and international agreements and conventions for environmental protection and conservation were adopted[3]. However, most of these agreements were negotiated individually and treated as ‘separate entities’, with many lacking systemic integration within the social, economic, and environmental framework of sustainable development. In 1992, the Earth Summit brought the worlds governments to deliberate and negotiate an agenda for environment and development in the twenty-first century [4]. At a parallel Global Forum, nongovernmental organizations from around the world also discussed and deliberated strategies for sustainable development. While there was little formal interaction between these two meetings, the world’s civil societies succeeded in having their voices noticed. It was an important step toward future dialog and active participation of civil society in sustainable development regimes from local to global levels [5].

Agenda 21 pointed out that different populations had ‘common but differentiated responsibilities’ for impacts on the environment [6]. In Rio, the thinking was dominated by the goal of converging trends in different parts of the world. There was the clear hope that the developing countries would catch up, while the rich countries would become increasingly environmentally conscious and curb their excessive consumption and the related pollution and waste. This has not come to pass. Consumption per se is not something to be avoided since it is one important aspect of improving human well-being. Equally important is the recognition that the relationships between well-being, levels of consumption, and environmental impacts depend on

the value systems, the effectiveness of institutions, including forms of governance, as well as science, technology, and knowledge. The lack of progress in turning Agenda 21 into actions for sustainable development leads to the 2002 Johannesburg World Summit on sustainable development. Johannesburg put the thrust on public–private partnerships for sustainable development through an endorsement of some 500 such partnerships but most of these agreements failed to be implemented.

Prior to the Johannesburg Summit, in September 2000, political leaders from around the world took an unprecedented step of setting concrete 2015 targets for millennium development goals (MDGs) related to the priority challenges of sustainable development, namely, poverty, hunger, education, gender, health, environmental sustainability, and a global partnership for development. All these issues are interrelated; one cannot be solved without tackling the others. The progress up to 2007 indicates that many of these MDGs are unlikely to be realized by 2015. The nations of the world at the Earth Summit failed to mobilize the financial resources for the implementation of Agenda 21, and the WSSD in Johannesburg failed to turn agenda into actions. The critical issues of education and human capital were also not on the WSSD agenda. The scientific and technological capacity is essential and educational and research institutions around the world have a fundamental responsibility to contribute to this. Education comprises a lifelong learning system to cope with the changing needs and aspirations of society. The United Nations Decade of Education for Sustainable Development, starting in 2005, lays the foundation to reform and mobilize education at all levels, from schools to universities, in support of sustainable development.(Shows in Tab. 1-1)

Tab. 1-1 Conferences/forums on world stage associated with sustainable cities

Conferences & Projects	Time	Significant Results	Sustainability Related Content
UN Conference on the Human Environment	1972	<Stockholm Declaration on the Human Environment > <Human Environment Action	<Human Environment Action Plan > Planning and Managing Human

(UMCHE)		Plan >	Settlements for Environmental Quality
UN Conference on Human Settlements	1976	Establishment of a UN agency related to urban affairs and the concept of healthy cities	Limiting the growth rate of urban areas
World Commission on Environment and Development Report	1987	Our Common Future	The Urban Challenge describes the co-creation of more sustainable urban communities in both developed and developing countries
UN Sustainable cities program	1991-2001	By the end of 2000, 25 cities worldwide had implemented this project	Cooperation between UN-Habitat and UNEP on Sustainable Cities
UN Conference on Environment and Development	1992	Istanbul Declaration Habitat Agenda Agenda 21	Agenda 21 for sustainable human settlements development
The Habitat Professionals Forum at Urban 21	2000	Expert report on the future development of the city	Focus on implementing the Local Agenda 21 in urban areas
UN General Assembly 2000	2000	UN MDGS	UN Millennium Project Assures MDGS Implementation
World summit on	2002	Johannesburg Declaration on	Support the

sustainable development		Sustainable Development	publication of an annual report on theoretical aspects of cities and sustainability
World Summit	2005	UN Millennium Project presents final initiative	Summit to promote the implementation of the UN Millennium Development Goals
World Urban Forum	2002/2004/2006/2008	Revision of the concept of urban development	Analyze the problems encountered in the development of world cities and make recommendations

1.1.2 The purpose of sustainable development in China

China's urbanization rate has reached 47.5% in 2010, and it is expected that in the coming 2025, more than 66% of China's population will live in cities, and China will have 221 large cities with more than one million people, 23 large cities with more than 5 million people, and 8 cities with more than 10 million people, including Beijing, Shanghai, Guangzhou, Shenzhen, Tianjin, Wuhan, Chongqing and Nanjing giant cities.

After the 1980s, China's economic growth has entered a new stage of economic development driven by urbanization, and rapid urbanization has become an important feature of China's current socio-economic development. The resulting dramatic changes in urban environment and human living environment are mainly reflected in excessive pollution and increasingly poor living comfort, while the development of cities is mainly reflected in the continuous expansion of urban areas and the continuous transformation of non-construction These large-scale and still rapidly advancing cities lack a scientific urban development model, and the excessive pursuit of government interests and performance is leading to increasingly intensified conflicts between residents and the government, and our cities are becoming non-sustainable, no longer comfortable

urban spaces, disorder in urban space (suburban sprawl, backwardness of old cities, chaos in the urban-rural interface) The urban spatial disorder (suburban sprawl, old city backwardness, urban-rural mix chaos), inequality (zoning and segregation) and deterioration of internal and external environment (ecological degradation, environmental destruction, urban-rural conflicts) exist in most cities in different degrees and are on the trend of increasing. In the process of urbanization, how to coordinate the relationship between economic, social and environmental elements, create a sustainable urban spatial environment and find a suitable model for urban development is an urgent issue in the current urban development in China. The severe test brought by over-density and concentration of population. The rapid urbanization process is accompanied by the rapid gathering of population in the surrounding cities, take Beijing as an example.

In 2021, Beijing's year-end resident population will be 21.886 million, an increase of 1.646 million compared to 2011; the natural population growth rate will be 0.96‰ in 2021, a decrease of 1.67‰ compared to 2019 and a decrease of 3.06‰ compared to 2011. In terms of population age composition, the proportion of 0-14 years old (including those under 15 years old) in Beijing in 2021 is 12.09%, 15-59 years old (including those under 60 years old) is 67.73%, and 60 years old (including those over 65) and above is 20.18%, of which: 14.24% are 65 years old and above. According to the population structure of urban and rural areas, in 2021, the resident population of Beijing will be 19.161 million people living in urban areas and 2.725 million people living in rural areas, with an urbanization rate of 87.55%.

While the increasing size of cities brings more diversified contents to people, it also brings many social problems such as environmental pollution, destruction of living space, traffic congestion, etc. that accompany the rapid population growth.

Before 2019, China did not even have clear regulations on domestic waste recycling, along with Shanghai's wet and dry waste sorting method included in the city management regulations, Beijing has gradually started to lead the public to start active waste sorting and recycling, but there is no standard exact criteria and not all transparent and open mode of operation, and the long-existing Chinese society The existence of the "scavenger" profession in Chinese society has led to a large gap between China's waste separation and recycling and other countries that have a complete

waste separation and recycling system. With the increasing lack of landfill capacity, only complete waste separation and incineration can meet the future of waste separation and recycling in Chinese cities.

In addition, many government policies for green development and sustainable development are formulated without taking into account the most fundamental needs of the residents for life and the city. When there are differences in the fundamental needs between the decision makers and the residents of the city, no matter how much human and material resources are invested, the result is bound to lead to the limitations of urban development. Fast reading urbanization has brought many social, economic and environmental problems, such as energy shortage caused by large amount of fossil energy use, climate change and urban heat island effect caused by large amount of greenhouse gas emission, air quality degradation caused by air pollutants and other toxic substances emission, pollution of soil and water bodies will eventually affect the quality of people's life degradation.

Many cities have started to reflect on the mode and direction of sustainable urban development. Sustainable development and urban modernization are not a problem in themselves, but how to achieve green development on the basis of sustainable development is the core issue facing the field of urban planning and urban construction. Sustainable development is a prerequisite for urbanization. At present, China puts the construction of ecological civilization in a prominent position and integrates it into all aspects and the whole process of economic, political, cultural and social construction. China's future development must abandon the shortcomings of traditional industrial civilization and take the path of sustainable development in harmony with people and land. Some studies estimate that urban expansion will lead to a reduction of 1.8%-2.4% of global arable land in 2030, with a quarter of global arable land loss occurring in China [7], and that urban development patterns and species evolution interact with each other [8]. The intersection of natural environmental and urban social issues has become a key to global sustainable development. Urbanization is both a major cause and a potential solution to global sustainable development challenges.4-6 Sustainable cities were first proposed at the Second United Nations Conference on Human Settlements in 1996[9], and a number of international conferences and projects have

emerged since then [10]. In the 2030 Agenda for Sustainable Development, the United Nations set out 17 sustainable development goals, the 11th of which is "to build inclusive, safe, resilient and sustainable cities and human settlements."[10] In 2019, the first UN-Habitat conference proposed to achieve "support for inclusive, safe, resilient and sustainable cities and human settlements" and "strengthening urban-rural linkages for sustainable urbanization"[10]. Research on sustainable cities is also advancing, including assessment of sustainable cities, conceptual and theoretical analysis, and classical case studies [11], and has shifted from the initial research on urban forms such as ecological cities and compact cities to smart cities. The research on sustainable cities in China started late compared with international studies, focusing mainly on economics, ecology, and geography, and later on sociology, urban planning, and architecture, focusing on sustainable city forms, models, mechanisms, and comprehensive evaluation [12,13], with interdisciplinary characteristics. Sustainable society and urban development was a state in which economic, social, and human factors are coordinated and optimized, taking into account both short- and long-term impacts, and it focuses on the future and the present, especially on the ability to sustain human society in the future [14-16]. However, in current practice, sustainable cities and societies are built to address the impact of "development" on the ecological environment, while the impact of "development" on the physical and social environment is relatively weak. Thus, in practice, sustainable social urban development that includes only ecological impacts has many drawbacks that neglect livability and human self-realization [17-20]. Therefore, in the contemporary urban development process, many governments are aware of the difference between the theoretical connotation of the concept of sustainability and its practical implications. " - as the future direction of urban development. [21]

Sustainable urban development is a necessary condition for the existence of sound urban sustainability regulations [22]. The purpose of this thesis is to investigate the basic problems of Beijing, China, based on the goal of sustainable urban development, and to discuss the willingness of people to pay for the recycling of municipal solid waste and the ways and means of evaluating sustainable urban spaces by city managers, in order to design strategies for a sustainable society and city in China in the future [23].

1.1.3 The meaning of sustainable development

This thesis takes the implementation of sustainable urban society as the main research object, based on MSW's willingness to pay, and other policy enforceability predictions, and clarifies the relationship between policy makers and people, based on which the sustainable development model meets sustainable goals and sustainable urban space design strategies can be explored. Only from this perspective can we gain a deeper understanding of the fundamental reasons for the sustainable development model as a key spatial path to achieve sustainable cities and societies, and thus guide the rational and efficient layout and design of sustainable urban spaces scientifically and effectively.

1.1.4 Current status of urban municipal solid waste

The urban population is increasing rapidly because the increase in birth rate and rural to urban migration is due to the expectation of a better life [24]. The urban population is increasing rapidly due to the expectation of a better life, local conflicts and lack of resources in rural areas. This has led to the birth of many environmental problems in cities [25]. According to the China Statistical Yearbook released by the National Bureau of Statistics in 2019, the country， a total of 228 million tons of MSW was collected and transported in 672 Of these [26], 226 million tons were in facilities that met the relevant Chinese national standards [27].

1.1.5 Strategies related to municipal solid waste management

The safe disposal rate was 99.0%, up from 50.8% in 2003 and 77.9% in 2010. (Shows in fig. 1-1 (a)) Municipal solid waste disposal has moved from a predominantly sanitary facility from the dominance of sanitary landfills to the rapid growth of incineration. Incineration and landfill accounted for 45.1% and 51.9% of the safe disposal of MSW in China in 2018, respectively. This compares to 4.9% in 2003. 4.9% and 84.9% in 2003 and 18.8% and 77.9% in 2010(Shows in fig. 1-1 (b))Continuous improvement of MSW treatment capacity and optimization of technology. In 2017, China promoted source separation of municipal domestic waste in 46 key cities and expanded it to about 100 cities[28]. Expanding to about 300 medium-sized cities in 2019, and then to all cities in the next few years. The next decade will cover the whole country, both urban and

rural.1.1.5 Strategies related to municipal solid waste management.

MSW separation system is defined as a dynamically updated chain from separate placement, separate collection, separate transportation to separate treatment. Separation criteria should match MSW composition as well as the capacity and structure of MSW treatment facility. In general, China preferred a four-type separation system, and MSW is required to be separated into recyclable, food waste, household hazardous waste, and residual waste at source. The structure of the MSW separation system in China is designed as Fig. 1-2.

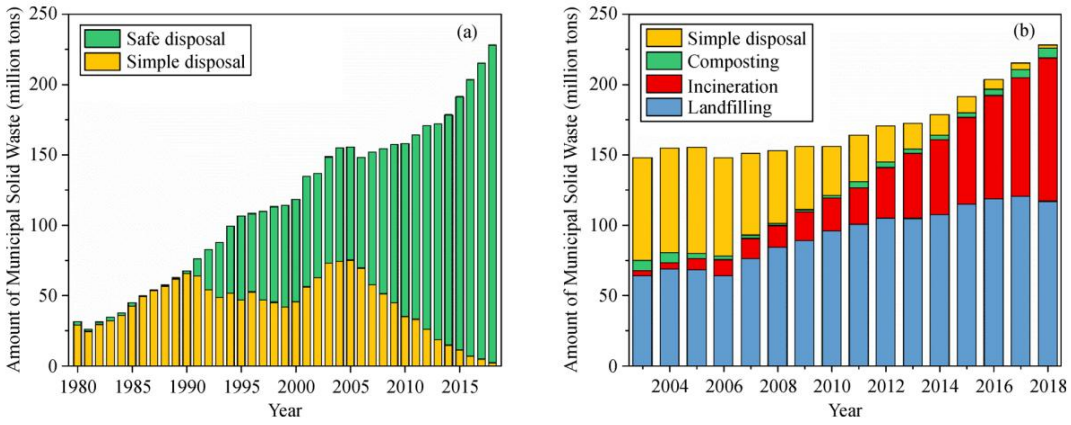

Fig. 1-1 (a) Collection and disposal of MSW, and (b) technology structure of MSW treatment in China.

(Source: Toward separation at source: Evolution of Municipal Solid Waste management in China Front. Environ. Sci. Eng. 2020, 14(2): 36 https://doi.org/10.1007/s11783-020-1232-2)

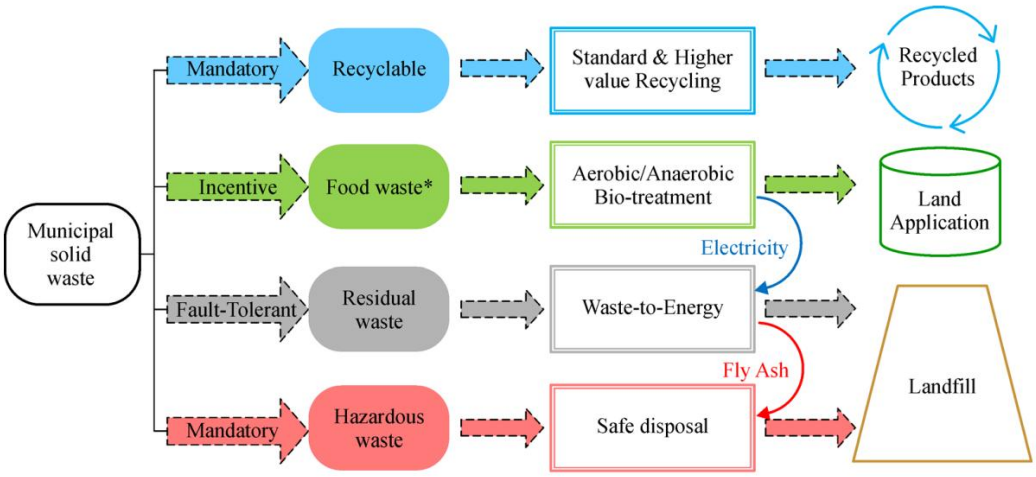

Fig. 1-2 Structure of MSW separated treatment system in China.

1.1.6 Economic assessment of municipal solid waste management

Recyclable waste, especially high-value recyclables like paper, plastic bottles, and cans, is mainly collected by the informal sector, but this low-end business that relies on "scrap selling" is unsustainable because it violates the "polluter pays principle" and poses risks to the environment and occupational health. At the same time, the informal sector group has been declining and will continue to decline further due to the rising cost of living and falling prices of recyclable waste in recent years. Low-value recyclables, such as glass, textiles and some plastics, have no chance of being recycled by the informal sector without special government subsidies. Therefore, a unified traditional MSW management and recycling system should be established and the economics of such management and recycling industry has quite a lot.

1.2 Definition of core concepts

1.2.1 Municipal solid waste

Municipal solid waste originates as the solid wastes of a municipality collected from households, offices, small-scale institutions and commercial enterprises. Municipal solid waste varies substantially in its composition and classification between different municipalities worldwide, although it consists of both biodegradable and non-biodegradable fractions from organic and inorganic materials, respectively. Nevertheless, municipal solid waste typically consists of kitchen waste, yard waste, paper and cardboard, plastic and rubber, metal, glass, electronic waste, inert materials and miscellaneous thrash (Tab. 1-2). The kitchen waste and yard wastes together comprise the organic fraction of municipal solid waste. Among all the components of municipal solid waste, the miscellaneous garbage is the most heterogeneous, which includes textiles, fabrics, biomedical wastes (e.g., sharps and glasses), personal hygiene products, health care items, cosmetics, pharmaceuticals, pet litter, leather, rubber and polymeric residues.

Tab. 1-2. Typical composition of municipal solid waste by component type

Kitchen waste	Food waste, e.g., spoiled meat, fish, bones, eggshells, crab, mussel and lobster shells and expired solid food, e.g., vegetable refuse, fruit shells, peels, rind, seeds Coffee residues and waste tea leaves
Yard waste	Leaves, grass, tree trimmings, twigs, bark, straw, stalks, charred wood
Paper and cardboard	Newsprint, advertisement flyers, magazines, books, tissue paper, parchment paper, thermal paper, copy paper, multiuse paper, shredded office paper, folders, paper bags, cardboard boxes, packaging boxes, corrugated fiberboard
Plastic and rubber	Low-density polyethylene (e.g., shampoo bottles, detergent bottles, edible oil containers and plastic cans)
	High-density polyethylene (three-dimensional printer filament, bottle caps, coax cable insulation, electrical plumbing
	boxes, food storage containers, shoe last, plastic lumber, piping for

	water and sewer, plastic surgery and storage sheds)
Metal	Food packaging cans, cans, aluminum foil, cookware, metal utensils and culinary equipment, knives, wires, fences, bottles, lids
Glass	Food storage containers, glass bottles, casserole dish, utensils, light bulbs, home décor, decorative and framed mirrors
Electronic waste	Dead batteries，Electronic devices
Miscellaneous	Ceramics，Discarded clothes Rags (e.g., torn bags, tote and luggage) Biomedical wastes (e.g., needles, syringe and broken household health devices) Pharmaceuticals (e.g., medicine, pills, capsules, creams and cosmetics products) Diapers; sanitary napkins; contraception Pet litter，Leather and textiles，Carpet
Inert materials	Broken and discarded furniture Stones, soil, silt, concrete, ash, dust, drywall and other inorganic materials Construction, demolition and renovation wastes

The items listed in this table are a general representation of municipal solid wastes. The composition, categorization and classification of municipal solid wastes are subject to some disparity from cities to countries depending on local jurisdiction and solid waste designation.

1.2.2 The management of municipal solid waste

Special emphasis should be laid upon the promising scenarios of efficient management of municipal solid waste in terms of its recycling, energy and resource recovery as well as sustainable landfilling. Landfilling of solid wastes can be sustainable when landfills are designed,

iterated, operated and maintained considering some significant factors such as (1) regulatory protocols, (2) worker safety, (3) lower environmental impacts, (4) recovery and upgrading of landfill leachate and gases and (5) possibility for mining.

Fig. 1-3 illustrates the worldwide trend of municipal solid waste generation. Currently, the top three municipal solid waste-generating countries are the USA, i.e., 258 million metric tons, China, i.e., 220 million metric tons, and India, i.e., 169 million metric tons. Five developing countries, namely China, India, Brazil, Indonesia and Mexico, are among the top ten municipal solid-waste-generating nations because of significant urban populations that are rapidly prospering and adopting high-consumption lifestyles similar to developed countries. Developed countries tend to generate much higher quantities of municipal solid waste per capita than the developing and third-world countries because the waste generation rate is contingent on a nation's economic and social prosperity. Canada ranks seventeen in the list of countries with the maximum generation of municipal solid waste. Canada has a current output rate of 49,616 tonnes/day of municipal solid waste compared to its leading opponent, i.e., the USA (624,700 tonnes/day) [23]. However, Canada ranks second in the list of top municipal solid-waste-generating countries with its current output rate of 2.33 kg/capita/day as opposed to the USA, i.e., 2.58 kg/ capita/day. The current population of Canada is 37.8 million, which includes 81% of its urban population (Worldometers2020). On the other hand, the current population of the USA is 331 million, which includes 83% of its urban population.

Although there is a big difference in the total population of both countries, their urban population is almost equivalent. Therefore, both the USA and Canada have almost analogous per capital generation of municipal solid waste. The greater population density in the urban areas and high standards of living in these two North American countries tend to make them the leaders in per capital generation of municipal solid waste.

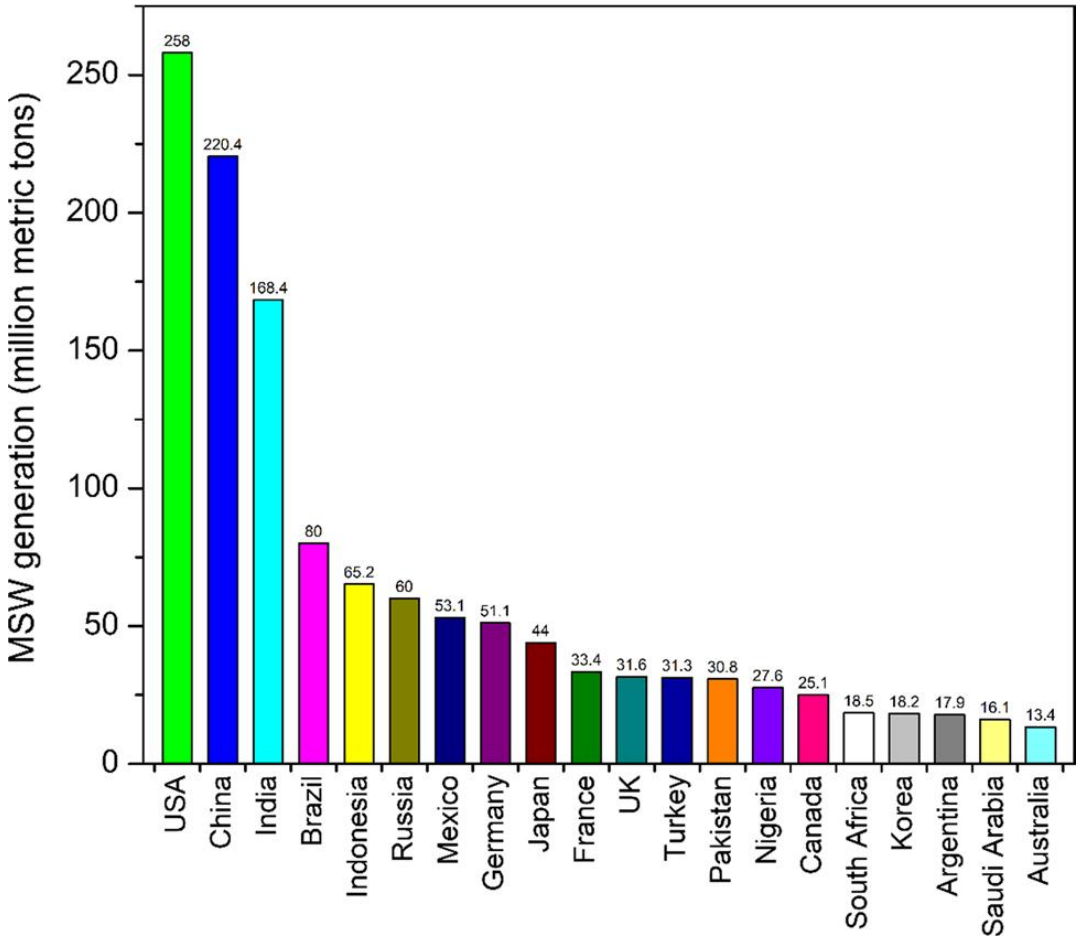

Fig. 1-3 Worldwide generation of municipal solid waste. (Data source: Statista 2020)

1.3 Overview of related studies

1.3.1 Overview of relevant international research

The study of sustainable cities was first developed in the field of urban planning. Geddes' "Eutopia" of nature-integrated cities, proposed nearly 100 years ago, has a similar concept to that of Geddes's "Eutopia" concept of the nature-integrated city, which was developed nearly 100 years ago, and his concept of nature in urban areas, which was developed around the same time as Howard's The "idyllic city" planning theory of Edward Hodges in the same period deeply influenced the conceptions, procedures century urban planning concepts, procedures, methods and theories. After the introduction of the theory of sustainable development, the concept of the theory of sustainable development was proposed, "Ecocity" and "Sustainable Urban Planning" (SUC) were introduced. (Ecocity) and "sustainable urban planning" have emerged. On the other hand,

scholars have begun to explore new urban spatial forms, urban-rural relationships, scale and density, transportation principles and land use patterns, and other factors involved in sustainable urban form. Which is more sustainable, compact or decentralized cities, has not been concluded so far. Scholars have proved or disproved the validity of compact city theory from different perspectives, and the negative effects of compact urban form including the impact of high-density buildings on urban green space ecosystem service functions and urban biodiversity still exist [25-28]. In the evolving theoretical exploration in Europe and the United States, the view that sustainable cities should be developed in compact form has become mainstream. As early as 1994, the Aalborg Declaration in Europe started to advocate compact transportation travel and high-density energy efficiency [29], and then the development of compact cities in combination with public transportation was one of the main strategies for implementing sustainable urban development in Europe and the United States [29]. in the late 1990s, the United States realized the urban sprawl brought by suburbanization and the many problems caused by polycentric metropolises, and under the core smart growth concept is a set of basic principles for suburban land use planning, which fundamentally aims to stop urban sprawl and the proliferation of sanctuary suburbs [30]. In addition to this, criteria for sustainable urban form and structure, and sustainable urban micro- and macro-structures have been proposed and discussed [31]. The research on sustainable cities in Europe and the United States from the 1990s to the present has gradually shifted from the urban system scale to the community scale. proposed the concept of sustainable urban neighborhoods and the 4C model of sustainable related settlements, i.e., environmental protection, resident choice, community and cost, emphasizing compact settlement development within cities and establishing neighborhood communities with equality and integration of all classes, etc. [32]. Sone proposed an ideal model for sustainable housing in large cities based on the compact city idea [33]. In response to the ecological topic of sustainable cities, Ecology for Urbanization (Ecology for Urbanization) has gradually shifted from the traditional scope of ecological theories to cities, habitats, informatization, and spatialization, with specific studies ranging from the reduction of green space to dramatic changes in ecosystems and biodiversity [28], and many theories have emerged on the environmental effects generated by urbanization, for the In recent years, the focus of attention has gradually shifted to environmental

carrying capacity and total urban control, ecological restoration and energy-saving technologies, sustainable urban environmental indicators, ecological land use patterns and urban ecological networks [34]. Urban Metabolism was first introduced by Wolman in 1965 to understand the impact of cities on the environment, and efficient urban metabolism is considered as an indispensable element of sustainable cities [34]. At the same time, the construction of related system dynamics or metabolic models for the sustainability of urban systems has also become a hot topic of research [35-36], for example, Newman further developed the urban metabolic model, and considered that the complete urban metabolic model should also include the social characteristics of the city constructed a system dynamics model to examine the metabolic efficiency of cities and their environmental impacts to evaluate urban sustainability [37]; Egger proposed a systematics-based approach to urban connectivity, potential, and rebound characteristics for sustainability [38].(Shows in Tab.1-3)

Tab. 1-3 Comparative method for sustainable cities

Methodology	**Foundations**	**Concept**	**Critical Elements**
Natural Capital Theory	Environmental Economics Ecological Economics	Applying ecosystem services and energy values to natural capital	Natural income measurement, energy, matter, services
Geography Methods	Urban Geography Economic Geography	Analysis of urban areas, clusters, classifications, and morphology using geographic methods such as GIS to address sustainable urban impacts	Habitat, land use, work-life balance, urban settlement patterns
Urban Planning and Design	Urban Planning Architecture Ecological Planning	The relationship between design, planning and marketing in harmony with ecology	Density, energy consumption, open space, traffic

Ecosystem Management	Ecology Systematics	A complex systems approach to understanding urban ecosystems, sound management to maintain sustainability	Urban ecosystem composition, structure and function; extent of impermeable land surface; ecological footprint, efficiency, etc.
Systematics	Synergism Systems Theory Cybernetics	The sustainable development of urban systems is characterized by multiple objectives and levels, and its development process is a dynamic process	Complex systems, information feedback; urban logistics, urban metabolism and efficiency, system dynamic equilibrium
Policy Analysis	Public Policy Urbanism	A quantitative and qualitative analysis of the process of sustainable urban policy development	Policy modeling, integrated analysis

Egger proposed a sustainable city model for the characteristics of urban connectivity, potential, and rebound from a systemic perspective, and set quantifiable indicators and parameters for the model in terms of both the city itself and its connection with the surrounding area [38]. Crilly et al. proposed a sustainable city management system that the analysis of local policies and practices in mainstreamed and publicly accepted cities and practices in order to help city managers understand the aim is to help city managers understand the needs, implementation strategies, and facilitate communication between managers and planners in urban systems [39]. Whitehead suggests that it is crucial to analyze the interplay between the environmental, economic, and social aspects of the urban system [39]. Whitehead suggests that the key is to analyze the processes and mechanisms of

environmental, economic, and social interactions, flows, and coupling in urban systems, and to analyze the processes and mechanisms that shape the construction of a sustainable system. and the structural policy forces that shape the construction of sustainable cities. Whitehead suggests that the key is to analyze the interactions, flows, and coupling processes and mechanisms between the environment, economy, and society of urban systems, and to analyze the structural policy forces that shape the construction of sustainable cities, and to reflect on sustainable urban policy from a systems science perspective [40]. These studies have greatly enriched the connotation of sustainable cities and provided a foundation for the relevant These studies have greatly enriched the meaning of sustainable cities and laid the theoretical foundation for the practice of sustainable city building.

1.3.2 Overview of China research

Since the 1980s, modern ecological theory and practice in China have developed rapidly, and by the 1990s a set of social-economic-natural ecosystem theory has been formed. Economic-natural complex ecosystem theory as the guide of a relatively completed since the 1980s, modern ecological theory and practice in China have developed rapidly, and by the 1990s a relatively complete set of ecological city construction theories, methodological systems and planning techniques guided by the social-economic-natural ecosystem theory has been formed [40].

At the same time, research on hot-pot areas of urban ecology has flourished. These have provided a good theoretical and practical basis for ecologically oriented sustainable construction [41]. These provide a good theoretical and practical basis for ecologically oriented sustainable construction [41]. Since 1987, there have been many discussions on the concept of sustainable development, especially on the sustainability of China's rapid urbanization process and the resulting unsustainable of population, resources, environment, and society [41-43]. However, the development of the connotation, characteristics, index system, and planning research of sustainable city construction has lagged behind.

In the early stage, most of the studies were based on the introduction of foreign theoretical foundations and theories on urban morphology, traffic patterns, settlements, ecological

environment, etc. In the early stage, we mainly introduced foreign theoretical foundations and successful demonstrations of urban form, transportation patterns, settlements, ecological environment and other related aspects [44-48]. The attention of many scholars, research on sustainable cities in China has been steadily. The research on sustainable cities in China has been steadily carried out with the attention of many scholars [49]. In the 21st century, the main research hot-pots include the main research hot-pots in the 21st century include the evaluation of the population, resource, and environmental impacts of China's rapid urbanization development from a sustainable perspective.

In the 21st century, the main research interests after the turn of the century include the evaluation of the population, resources, and environmental problems arising from the rapid urbanization in China from a sustainable perspective; the analysis and evaluation of different components, structure, function, and metabolism of urban systems; and the model simulation of urban system dynamics.

The study of different components of urban systems, structural, functional and metabolic analysis and evaluation, and model simulation of urban system dynamics [49-52]; the study of the sustainability of urban ecosystems, human ecological perspective on the sustainable development of urban ecosystems, human habitats and their substitutions.

The study of sustainable urban design and planning from the perspective of ecology [53-55]; the study of sustainable urban design and planning from the planning from the perspective of ecology [53-55]; sustainable urban design and planning from the perspective of planning [56]; sustainable macro-regional development, urban form, transportation patterns from the perspective of habitat and geography [57]. Sustainable Development, Urban Morphology, Transportation Patterns, small- and medium-scale urban settlements [58], and consumer patterns, etc. (Shows in Tab. 1-4)

Tab. 1-4 The development course of the main city construction modes in China

Mode	Time	Concept	Indicators	Responsible
Civilized City	1980	Coordination of material,	《Civilized City	Central Spiritual

		political and spiritual civilization and economic development	Measurement System》	Civilization Construction Committee
Sanitary City	1990	Improve the level of urban health and enhance people's health	《National Sanitary City Standards》	National Patriotic Health Campaign Committee
Garden City	1992	Improving urban ecological environment and promoting sustainable urban development	《National Garden City Standards》	Urban and Rural Construction
Healthy City	1993	Formation of effective environmental support and health services	WHO《Basic Assessment Indicators for Healthy Cities》	National Patriotic Health Campaign Committee
Eco-demonstration Area	1994	Principles of sustainable development and ecological economics to advance economic and environmental development	《Outline of the National Ecological Demonstration Zone Construction Plan》	Ministry of Environment
Environmental model cities	1997	Implementing sustainable development based on social development pilot areas	《Basic indicators of national sustainable development demonstration areas》	Science and Technology
Eco-city	2003	Harmonious development of	《Ecological	Ministry of

		socio-economic and ecological environment	construction indicators》	Environment
Eco-Garden City	2004	Strengthen urban infrastructure and greening based on the eco-city concept	《National ecological garden city assessment standards》	Ministry of Construction
Livable Cities	2005	Build a livable city with beautiful environment and good ecological conditions	《Scientific evaluation criteria for livable cities》	Ministry of Construction
Eco-Civilized City	2008	Parallel stages of theoretical and practical exploration	Not available	Ministry of Environment

1.4 Purpose of related studies

1.This study discusses the theoretical basis for the economic evaluation of MSW management. To explain why the management of MSW has economic value, to define the connotation of its economic value and discuss the theoretical connotation of its economic value assessment method.

2. This study conducted a literature review of relevant studies on the use of contingent valuation method to assess the non-market value of urban environmental resources and sorted out the main trends of contingent valuation method in the assessment of urban environmental resources. The main trends in the design of CVM studies on the value of municipal solid waste disposal are sorted out, and the possible biases and their remedies are summarized. Possible biases and their remedies, and discusses the main determinants affecting residents' willingness to pay.

3. This study conducted an on-site questionnaire survey to analyze the willingness of Beijing college students to use the main technologies for campus MSW management.

This study conducted an on-site questionnaire survey to analyze the acceptance and willingness to use the main technology for mitigating campus waste pollution, i.e., smart separation bins, among school students in Beijing.

4. This study designed and tested a behavioral prediction model based on the theory of planned behavior to predict incentives to promote residents' pro-environmental behaviors, such as paying for MSW management.

1.5 Research structure

The research target of this study is MSW management and the research content is its economic value. Except for the introduction section in the first chapter and the conclusion section in the last chapter, the main part can be divided into three parts, which follow the research flow of theoretical study (Chapter 2), methodological study (Chapter 3) and experimental study (Chapters 4-6).

The first part is the theoretical part, which includes chapters 1 and 2. This part mainly composes and reviews the economic evaluation of MSW management, contingent evaluation method, and theory of planned behavior. For the economic valuation of MSW management, this study mainly discusses the economic value content of MSW management and the related economic principles, including externalities, public goods, and willingness to pay. For the contingent valuation method, we mainly explain its economic basis, development history, possible deviations, and its remedies. For the theory of planned behavior, we explain its theoretical development process and connotation, and then discuss the application of the theory in related fields. The second part is the methodological part. Based on a literature review of CVM studies on municipal solid waste waste value, the research design of the contingent valuation method is studied and discussed. First, this study analyzes the experimental subjects and experimental designs of previous CVM studies. Second, this study analyzes the major controversies in academic research on CVM, and summarizes and discusses possible errors and their remedies. Third, this study summarizes the main influencing factors that affect respondents' willingness to pay. This section will provide evidence for the experimental study design.

The third part is the experimental section, which includes Chapters 4 through 6. Chapter 4

explains the development of the questionnaire, details of the field interviews, and data processing methods. The study applied an online questionnaire to collect data, chose a two-key dichotomous selection format to induce WTP, and used SPSS 24 and R language to process the data. To handle the large number of zero-response samples in the study, a spike model was used in the study. The study also explored the determinants that influence residents' participation in supporting MSW management. Chapter 5 focuses on motivating Beijing residents' willingness to pay for strategies to promote IGSS to improve the efficiency of MSW management. In Chapter 7, an extended TPB model is proposed to explain the motivational factors that promote residents' willingness to manage MSW. Amos 24 is used to conduct the structural equation modeling. Based on the findings of the previous studies, Chapter 7 provides recommendations on how to rationalize the extraction of potential funds for UHI effect management and how to effectively promote residents' pro-environmental behavior.

1.6 Innovations of this study

In terms of research object, this paper applied the contingent valuation method to evaluate the economic value of related technical approaches for MSW management for the first time. In addition, it introduces the theory of planned behavior to explore the factors that affecting residents' willingness to pay.

From the theoretical perspective, this study explained the theoretical basis of economic evaluation of MSW management and defined its content and connotation for the first time.

From methodological level, this study summarized the research design of related CVM research through literature review, along with the determinants that affecting respondents' WTP, and the possible bias along with their remedies.

This may provide new evidence for CVM research with regard to urban environment in the future. From experimental level, compared with previous studies, this research introduced and tested.

DBDC plus spike model to deal with the zero responses that often appear in CVM studies. As

for factors that affecting respondents' WTP, this research extended the conventional TPB by introducing the variable of environmental concern, which increases the predictive power of conventional TPB model.

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Chapter 2

THEORETICAL BACKGROUND AND LITERATURE REVIEW

CHAPTER TWO: THEORETICAL BACKGROUND AND LITERATURE REVIEW

2.1 Sustainable cities

Sustainable city is a term used worldwide to describe a city with a healthy environment, a cohesive society and a vibrant economy, all in dynamic harmony with each other.

2.1.1 The Evolution of Sustainable Cities

Through the combing and analysis of existing data and the research on the outline of western urban planning theory, the development of sustainable urban research is divided into three stages: the budding period (from the end of the century to the beginning of the century), the embryonic period (after World War II to the century), and the forming period (from the beginning of the century to the present), and "city and nature (including the countryside)" and "climate and culture" are the two main clues for the development of sustainable urban research[1] .

2.1.1.1 The budding period of Sustainable Cities

Early research on sustainable cities began with the concern for urban ecology in urban planning. Since the industrial Since the industrial revolution, many scholars and designers have been actively exploring this direction in theory and practice[2] .

The system is maintained to improve the functioning of the city by promoting the integration of people and nature in the city. Early designers have begun to explore the possibilities of ecological conservation and urban development in parallel, and a simple view of sustainable cities is beginning to emerge (Shows in Tab. 2-1).

Tab. 2-1 Major Research and Practice in Sustainable Urban Development

Stage	Main Research	Organizations	City and Nature	Climate and Culture
Original	Integral Design (1959)	Dutch planning community	○	
	Human Aggregation (1958)	Doxiadis	○	

	Design combined with nature (1969)	Ian Lennox McHarg	○	
	Historical and Cultural Heritage Preservation (1960s)	United Nations		○
Forming period	Sustainable Development (1972)	United Nations	○	○
	Eco-city (1971)	United Nations	○	○
	Compact City (1990)	Europe	○	○
	New Urbanism (1993)	America	○	○
	Sustainable Cities (1994)	United Nations	○	○
	Green City (2005)	United Nations	○	○
	Low Carbon City (2007)	United Nations		○

After 1950, as the expansion and spreading of cities brought about serious environmental problems, people began to worry about the natural resources and historical environment being trampled roughly and the catastrophic destruction of human living environment. In this period, people have started to develop from only focusing on urban ecological environment to a comprehensive urban environment, which covers many aspects such as people, nature, architecture, environment, history and culture. During this period, people have changed from focusing mainly on form to focusing on more comprehensive contents: people, nature, architecture, environment, history, culture, etc., and gradually established a more systematic environmental science and related interdisciplinary disciplines, which laid the knowledge foundation for the idea of sustainable development and sustainable cities[3-13] .

The forming period，Since the 1980s, the global resource crisis and ecological problems have become more serious, and human beings have been thinking more deeply about their own development. The modern scientific methodologies represented by synergetic theory, mutation

theory and dissipative structure theory have provided strong support for the transformation of urban planning and related theoretical and practical research into "harmony between human and land". According to Harken, the author of the synergetic theory, the modern city is a large system divided into several levels, and the three systems at the first level are the economic system, the social system and the ecosystem, and the systems have mutual constraints. From the ecological point of view, the city is like a complex organism constantly undergoing metabolism. People gradually realize that the biggest problem in the past development of human society lies in self-centeredness, considering nature as an object of conquest and use, and that human beings should get out of the "anthropocentric" area. The concept of urban planning has evolved from the traditional "human domination" and functionalist space creation to the "harmonious development of man and nature". Sustainable development has gradually become the mainstream of today's urban planning concept.

2.1.2 The meaning of sustainable cities

Throughout the research on sustainable cities in China and abroad, we find that different organizations and authorities have different understanding and elaboration of the concepts and meanings of sustainability and sustainable cities[14-18] .(Show in Tab. 2-2)

Tab. 2-2 Organizational interpretation of sustainable city

Related Opinions	Authors & Sources	Viewpoint Description
Integrated Development View	UNCHS/UNEP	A sustainable city is one in which the social, economic and physical environment are developed in a sustainable manner.
Dynamic Balance View	Katie Williams	Urban sustainability in the demand for economic, social and environmental dynamic balance, to obtain sustainability.
Citizen's View of Life	Munier; Tjallingii; Elkin	A sustainable city is defined as a city in which citizens agree on a number of sustainable development principles, citizen participation,

		rational use of resources, ecological, cultural, political, social and economic.
Efficient utilization view	OECD; WHO	Sustainable urban development should make cities more efficient, stable and innovative with minimal use of resources.
Sustainable Development View	Walter; Onishi; Newman; Tjallingii	Sustainable cities are used simultaneously by the present and future generations, reducing natural consumption and waste output, and not making environmental problems worse.

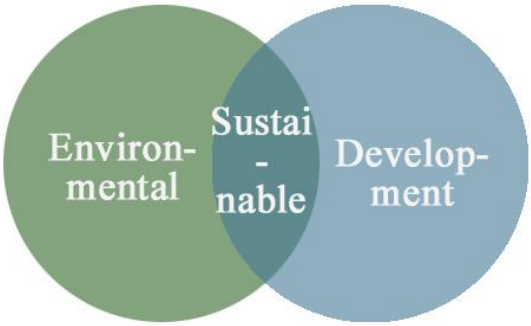

Fig. 2-1 Sustainability concept sketch

Based on the above understanding of sustainability and sustainable cities, this paper argues that sustainability is a concept that focuses on the relationship between development and the environment, which mainly involves human development and the state of the environment. Human development includes political, economic, social, cultural, demographic and other aspects, and is a holistic concept, "the upward movement of all social systems", which is summarized by the United Nations as "economic growth and social change" (Shows in Fig. 2-2). The environmental situation includes ecological, physical and social environment (including The environmental situation includes the ecological, physical, and social environments (social, economic, cultural, etc.)[19] . Sustainability is the economic and social conditions that keep the ecological, physical and social environments The state of economic and social system development that is stable and not damaged[20]. A sustainable city is a city with a sustainable environment, a cohesive society, and a sustainable social system. sustainable city is a city with a

sustainable environment, a cohesive society, and an efficient economy, as well as the coordinated dynamic development of all three[21]. Since development and environment cannot be evaluated without people, the sustainable city is also a humane city. But in practice, sustainability and sustainable cities are more about the ecological impact of urban development[22-35] .(Shows in Tab. 2-3)

Tab. 2-3 The meaning of sustainable cities

Sustainable Environment		Social Development	Economic Development
Ecological Environment	Air, Noise and Water	Political Development	
	Reduction of environmental pollution	Cultural Development	
	Conservation of resources	Scientific and technological development	Economic volume growth
	Protection of ecological space		Improvement and optimization of the economic structure
	Biodiversity Conservation	Increase in population size and quality	
Physical Environment	Mixed and compact land use		Improvement of the quality of the economy
	An ecological urban space	Improvement of living environment and quality	
	Efficient and diverse transportation		
Social Environment	Social Equity	Increase in the scale and level of	

Safety and Health	urbanization
Economic Affordability	
Social Cohesion	
Preservation of culture	
Local Economic Development	

2.1.3 Principles of development within sustainable cities

The International Organization for Economic Cooperation and Development (proposed principles for sustainable cities are: reduce air and water pollution, reduce the production and emission of damaging gases, reduce energy and water consumption, encourage the conservation of biological and natural resources, encourage individuals to take ecological responsibility as consumers, encourage business and industry to use eco-friendly technologies, protect the working environment, encourage the reduction of travel distances, develop protocols to encourage people to follow standards that are ecologically sustainable, provide the necessary public investment, advanced technology and infrastructure services, etc[36].

The Australian Government released the "Our Cities--Building a productive, sustainable and liveable future"[37]. The Australian National Urban Development Policy, which sets out the core objectives of efficient, sustainable and liveable. It argues that sustainable development should include the management of resource use and waste emissions.

The paper suggests that sustainable development should include the management of resource use and waste emissions to better protect our ecosystems and reduce environmental impacts. Rapidly growing urban populations are placing severe pressure on local water, energy, land, and other resources, while producing large amounts of waste, including greenhouse gas emissions[38]. The goal of sustainable urban development is to reduce these environmental pressures and become

more resilient to the impacts of climate change[39]. It divides the principles of urban sustainability into five sections.

In summary, this paper argues that the key development principles of sustainable cities can be summarized as protecting the natural environment and ecosystems, reducing the consumption of non-renewable energies and living resources, reduce pollution of the environment (including air, water, waste, natural environment, etc.) To improving resilience to the effects of climate change[40].

2.2 Sustainable societies

The term "livable city" is a domestic term used to describe a city that is suitable for human work, life and residence. Overseas The main foreign counterparts are "" and "". The meaning of the meaning of "livable city" is the closest to that of "livable city"[41]. At present, there are various understandings of "livability" and "livable city" in China and abroad, but the natural environment, urban environment and citizen's life, etc. However, the natural environment, the urban environment, and the life of citizens are the common themes.

2.2.1The Evolution of Sustainable Cities

By systematically sorting out and analyzing the existing studies on the development history of modern livable cities and the historical outline of western urban planning theory the development of livable cities is divided into four stages: the origin period (from ancient Greece to the Renaissance)[42], the budding period (from the end of the century to the Renaissance), and the development of the urban planning theory. (From the end of the century to the beginning of the century)[43], the formative period (from the post-World War II period to the mid-century), and the formative period (since the end of the century). The "Formative Period" (since the end of the century.) The two main threads in the development of livable city research are "concentration and decentralization" and "humanism and rationality[44]. The two main threads in the development of livable cities research.

In his search for the source of human gregariology, dosadias[45], an advocate of human

gregariology, honored the great men of ancient Greece honored as the founder of this discipline, He argued that, with regard to the rules of gregariousness, the philosopher Rothe Gullus proposed the idea that "man is the measure of all things"[46], thus forming a key criterion in Evaluation of the key criteria in the settlement environment; philosopher Aristotle proposed "the ultimate purpose of building cities is to make the inhabitants live happily in them", which set the ultimate goal for human settlement[47]. (Shows in Tab.2-4)

Tab. 2-4 Research and Practice of Livable City Development

Stage	Key event theory	Organizations	Humanities	Rationality	Concentration	Dispersion
Origination period	Ancient Greece	Greece	○		○	
Sprouting period	Middle Ages	Italy	○		○	
	Renaissance	Italy	○		○	
	Enlightenment	France		○	○	
	Idyllic City	Howard	○		○	
	Integrated Planning	Gaddis	○			
	Glory City	Le Corbusier		○	○	
	Urban Social Ecology	Chicago school of thought	○			
	Neighborhood Units	Perry	○			
	Athens Charter	Wright.	○		○	
	Organic evacuation	International Association of Modern Architecture	○			
	Urban Culture	Shalinen	○			
		Mumford	○			
Embryonic stage	A pleasant city	David Smith	○			
	Human Settlement Studies	Dias	○			
	Organic evacuation of megacities	Western Europe	○		○	

	Satellite City Construction	United Kingdom	○	○	
	Human Integration Planning Ideology	Team10	○		
	Basic concept of living environment	Jane Jacobs	○		○
	The "semi-grid" city	WHO	○		○
Forming period	Consensus on livability	UN	○		
	International Liveable Cities Forum	Leonard	○		
	Healthy Cities	WHO	○		
	Compact Cities	Europe	○	○	
	Strategic Planning for Livable Regions	Canada	○	○	
	New Urbanism and Smart Growth	United States	○	○	

2.2.2 The meaning of Sustainable societies

The industrial revolution at the end of the 19th century not only brought about the mechanization and industrialization of production, but also promoted the urbanization of social development[48]. The decline in the quality of urban environment and the intensification of social conflicts prompted people to start the pursuit about the ideal city model. A series of development models such as the idyllic city, the glorious city, and the wide mu city emerged as active attempts to improve the living conditions and environmental quality of cities. The concept of decentralized concentration also gradually became an important planning idea.

With the development of urban planning, the goal of pursuing a comfortable and pleasant urban environment has gradually been established in urban planning. David Smith (in his book "Livability and Urban Planning", based on the history of the second half of the 19th century[49], advocated the importance of livability and clarified the concept of urban "livability". According to him, the concept of livability includes three dimensions: first, livability in terms of public health and pollution problems; second, livability in terms of comfort and living environment; and third,

livability in terms of historical architecture and beautiful natural environment. The introduction of the concept of urban "livability" and the establishment of theories of human settlement are important signs that the development of livable cities has entered an embryonic stage.

In the late 1980s, livability research took shape. The UN consensus on livable cities and the introduction of the healthy city is an important symbol of this.

The United Nations has become the leading driving force in the development of liveable cities around the world. The Habitat Agenda was adopted at the second International Conference on Human Settlements held in Istanbul in 2007, which showed more attention to the issue of human settlements and established a global action program for the construction of human settlements, putting forward the two themes of "adequate shelter for all" and "sustainable human settlements development in an urbanizing world". The two themes of "adequate shelter for all" and "sustainable human settlements development in an urbanizing world" have made habitat a global issue. In recent years, with the deepening of the concept of sustainable development in society, economy, and people's daily life, sustainable development has become one of the core elements in the construction of livable cities.

2.2.3Principles of development within Sustainable societies

Throughout the research on sustainable cities in China and abroad, the research practices of the International Economic Cooperation and Australia are representative.

Throughout the research on livable cities at home and abroad, different organizations and institutions have different understanding and elaboration on the concepts and connotations of livability and livable cities. The concepts and connotations of livability and livable cities are understood and elaborated in different ways by different organizations and institutions, each with its own focus and without a unified definition.

Based on the above understanding of livability and livable cities, this paper considers livability as a concept that focuses on the relationship between people and the environment, which mainly involves the environmental quality of urban areas and people's experience of it. The environmental quality of livability includes a balanced, clean, and sustainable ecological environment, a safe,

convenient, and pleasant physical environment. A livable environment includes a balanced, clean, and sustainable ecological environment, a safe, convenient, and pleasant physical environment, and a fair, orderly, and vibrant social environment. A livable city is a city with a livable environment and a livable experience, a city that is humane and It is a healthy, safe, convenient, vibrant and sustainable city.

In summary, the key development principles for a livable city can be summarized as: providing more transportation options and reducing reliance on small motor vehicles. Provide a variety of housing options and affordable living. Enhance the quality of cities, neighborhoods, and communities, and improve the quality of the public realm. Enhance urban vitality and create a free, equal, and peaceful living environment. Improve public health and public safety.

2.3 The pulse of sustainable cities and societies

The "New Urbanism" and "smart growth" are the direct theoretical sources of the model. If we look deeper, we can see that the theoretical sources also involve regional planning, community planning, land use and transportation management. If we look deeper, we can find that the theoretical sources also involve regional planning, community planning, land use and transportation theory, function mixing and occupancy balance theory, ecologism, and many others. Theoretical sources include regional planning, community planning, land use and transportation theory, theories of functional mix and occupational balance, ecologism, and many others. In terms of the development of theories the model is closely related to the development of sustainable and livable cities.

2.3.1 Social

In terms of the evolution of modern urban planning theory, urban planning in the United States also has its roots in the early part of the century The concept and practice of the "rural city" and "satellite city" in the United States In response to the challenges posed by industrial society and

machine-based mass production to human settlements, the concept of "urban planning" was developed. industrial society and machine-based mass production, the concept of the "rural city" advocated the use of railroads to connect rural towns to central cities, creating a job-centric network. to form a more balanced employment and housing system, with an appropriate scale and a combination of urban and rural the "rural city" concept advocates the use of railroads to link rural towns with central cities to form a more balanced employment and residential system that combines urban and rural areas of appropriate size. The "satellite city" concept advocates the establishment of an economically, socially, and culturally modern city attached to a large city. The "satellite city" concept advocates the establishment of an independent urban unit attached to a large city that is economically, socially, and culturally modern. The town planning practice based on these theories The practice of town planning based on these theories had a significant impact on the construction of new towns and communities in the United States, and gradually developed regional planning and community planning theories. This had a direct influence on the formation of subsequent theories.

The formation and development of regional planning thinking in the United States is closely related to the contributions and others are closely related to the contributions of this integration led to the subsequent emergence of new theories such as smart growth, compact cities, and urban growth boundaries. This integration has led to the emergence of new theories such as smart growth, compact cities, and urban growth boundaries, which have become important elements of current sustainability theory. The economic linkages between regions have become so strong that a city can no longer ignore its surrounding suburbs and nearby cities to consider its own development. The city can no longer consider its own development by ignoring its surrounding suburbs and nearby cities. The positioning, function, and infrastructure of a city must be coordinated at the regional level. This also determines the need to coordinate public transportation and spatial development at the regional level. This also determines the need to coordinate public transportation and spatial development at the regional level. At the same time, a relatively balanced spatial distribution of employment and residential areas helps to reduce the total number of traffic travel to avoid uneconomic traffic operations due to unbalanced traffic flow in both

directions. These issues These issues must be studied and planned for and addressed at the regional and corridor levels.

2.3.2 Economical

The theory of the relationship between land use and urban traffic is the underlying theory. location theory and central place theory is the root of the theory. In the century, some theories of urban transportation based on the spatial characteristics of economic behavior the most influential theory of the relationship between urban transportation systems and land use was the one developed by Ehrenzo. He argued that distance from the urban center would have a critical impact on the function, intensity, rent, and employment of land use the spatial model describes the distance from the site perimeter to the city center. The spatial model describes the spatial characteristics of land use in a decreasing gradient from the site perimeter to the periphery, which is the spatial model describes the spatial characteristics of land use in a gradient from the site perimeter to the periphery, which includes the mix, concentration, and intensity of functions of activity centers at all levels of the city. The supporting theory is Ehrenzo's The supporting theory is Ehrenzo's competitive land rent theory. In this context, the distance to the city center is understood as the distance from all parts of the city using high-capacity, convenient public transportation.The distance to the city center can be understood as the ease of access to the city center from all parts of the city by high-capacity, convenient public transportation. Since high-capacity transportation brings the important nodes in the city are effectively linked together, the accessibility around the stations is high, and therefore the planning has a high density and mixed functions.The planning is characterized by high density and mixed functions. These areas often become regional or local centers of economic and commercial activity. Early attempts to integrate land use and public transportation at the regional level include the "King County, Washington Land Use, Transportation, Air Quality, and Public Transportation Study. Early attempts to integrate land use and public transportation at the regional level include the "King County, Washington Study of the Integrated Relationship between Land Use, Transportation, Air Quality, and Health" (and the "Atlanta Metropolitan Area Transportation and Air Quality Strategy").Subsequent development plans are based on regional and urban perspectives.The

development plan was then based on a regional and urban perspective, with the urban growth boundary as the scope of urban development, and rail and bus rapid transit systems as the spatial backbone for continued regional and urban development.The spatial skeleton for the continued development of the region and the city is based on the regional and urban perspectives, with rail and rapid transit systems as the spatial skeleton for the continued development of the region and the city.

2.3.3 Environmental

Since the beginning of the park movement, ecologism has been an important thread in the development of urban planning theory around the world. In the early 1900s, the urban beautification movement and the idea of "design with nature" had a profound impact on urban planning and urban design in the United States[50]. Calthorpe's research on sustainable communities began early in the development of green architecture, with the relationship between architecture and the environment as a key concern. The integration of ecological and regionalist ideas furthered the scope of development sustainability research. The 2008 conference proposed the design goal of "higher quality, greener, and denser", with the "green" goal as one of the key elements of regional planning. The "green" goal is one of the primary goals of the development. The U.S. Green Building Council has also proposed a corresponding community built environment evaluation standard, the Neighborhood Development Evaluation Criteria, which aims to promote more compact, transit-oriented and sustainable urban development patterns.

In the process of urban development, emphasizing the natural environment or strengthening urban space has been the focus of debate. The former can be Lake Source to the wide mu city concept, which responds to the deterioration of urban living environment through low-density dispersed layout. But the resulting dependence on small cars and urban sprawl will both bring serious ecological impacts and development constraints to the region and the city. The urbanism theory of Leon Krell is an important theoretical source to strengthen the urban spatial perspective[51]. According to Lioncrell, the essence of cities is aggregation, because it is the aggregation that generates the vitality and diversity of cities. However, excessive agglomeration will not only affect the quality of living, but also bring various environmental problems. The urban

planning strategy is based on the above two views: at the regional level, the integration of compact urban space and ecological natural space is advocated, the growth boundary is the boundary of urban development, and the ecological connection corridor connects urban space with ecological space; at the community level, the street space is advocated to take priority over ecological space, and the compact and diverse functional aggregation is emphasized to form the vitality of the city, and the ecosystem is more integrated in the form of The organization of energy-efficient and low-carbon urban spatial structures has a great impact on the utilization of energy resources. Scholars have discussed.

The correlation between land use function, intensity, mixed spatial characteristics and the demand for public transportation has been studied, which shows that the utilization rate of public transportation is closely related to urban density, the degree of functional mixing, and the reliance of urban centers and transportation centers. The energy and resource consumption of transportation and buildings in cities with low-density sprawl is much greater than that of high-density compact and orderly cities. The relationship between carbon emissions and land use finds that the stricter the restrictions and limitations on land use, the lower the level of carbon emissions from residential life, for example, the per capita carbon emissions in high-density central areas are much lower than in low-density suburban areas It is the use of rapid public transportation as the skeleton of urban spatial expansion, the use of compact for MSW and use the theory is to use rapid public transportation as the backbone of urban spatial expansion, to provide a variety of transportation options and a cleaned urban environment, and to reduce the energy and emissions required for urban operations. The theory of rapid transit as the backbone of urban spatial expansion.

2.4 The current situation of MSW management in Beijing

(1) Beijing, located on the northern edge of the North China plain, has an area of 1368.32 km2 and a resident population of 19.61million in 2010. (2) Followed by rapid urbanization and population growth, the total municipal solid waste (MSW) generated in Beijing increased steadily over the past decade, from 2.96 million tons in 2000 to 6.35 million tons in 2010, with an average

annual increase of 7.18%. This increase exerts obvious pressure on the environment, human health and MSW management system. Effective waste management through MSW composition studies is necessary for environmental protection and for the selection of facilities, which are the main responsibilities of the Beijing Solid Waste Administration Department (BSWAD). (3) MSW management is a major challenge in urban areas worldwide, not only because of the tremendous quantity of waste generated, but also because of waste components and elements, which are variables as a consequence of economic, geographic, seasonal, lifestyle and demographic factors . (4) The main components of MSW are ash, food waste, paper, construction debris, plastics, textiles, glass, wood and metal. These materials are related directly to elemental composition (commonly carbon, nitrogen, hydrogen, sulfur and oxygen) and calorific value. (5) These data are essential in waste management to develop stoichiometric equations for MSW incineration, to establish biochemical models for compost and digestion or to simulate the stabilization process of landfills. (6) Several studies on waste composition in Beijing have been conducted. (7) This article investigates the basic properties of MSW over the last decade and reviews waste management systems in Beijing. The resulting information is necessary for policy-making decisions in future waste management programs[52].

2.4.1 Status of MSW in Beijing

Since May 2020, the Beijing Municipal Regulations on the <Management of Domestic Waste> have been officially implemented, marking a new phase of accelerated progress in the full classification and management of domestic waste in accordance with the law. It has been 8 months since the <Beijing Municipal Regulations on Domestic Waste Management>, and the results delivered by the Beijing Municipal Commission of Urban Management show that important indicators such as household food waste separation rate and waste reduction rate are rapidly increasing, and the public's consciousness of practicing the new fashion of waste separation has been initially cultivated. According to the Annual Report on the <Prevention and Control of Solid Waste Pollution in Large and Medium-sized Cities> published by the Ministry of Ecology and Environment, Beijing was the first among large and medium-sized cities in terms of domestic waste generation in 2017, and the second after Shanghai in 2018.(Shows in Fig. 2-2)

In recent years, the annual waste generation is still growing at a significant rate, with an average annual growth of 5.5%, which is a serious growth trend. With such a large volume of garbage, Beijing produces nearly 26,000 tons of domestic garbage every day, or 1.2 kg per person per day.

Fig.2-2Municipal Solid Waste Emissions in Beijing

2.4.2 Current situation of MSW management methods in Beijing

Faced with the rapid growth of domestic waste in Beijing, the pressure on the waste collection and transportation system and the treatment system is increasing, and the environmental hazards are coming to the fore. In recent years, Beijing has increased the construction of waste classification and treatment hardware, and further improved the disposal capacity to basically meet the demand for domestic waste treatment in Beijing. By the end of 2019, the total design capacity of Beijing's domestic waste treatment facilities was 32,711 tons/day, including 16,650 tons/day of incineration, 8,130 tons/day of biochemical treatment, and 7,931 tons/day of sanitary landfill. Among them, the harmless treatment rate reached 99.98%, and the resource recovery rate exceeded 59.0%. All 29 waste treatment terminals in Beijing are operating at full capacity. If the waste is not transported and treated in time, it will have a great impact on the daily life of the residents[52].

2.5 Current Issues of MSW Management in Beijing

Beijing residents' awareness of environmental protection is generally high, as reflected in their willingness to participate in waste separation, with 84.56% of residents expressing willingness and support for waste separation. Only 3.60% of the residents express their unwillingness and opposition to waste separation. These residents believe that if they separate their own waste and others do not take action, the waste will still be disposed of centrally and the effect of separation will not be achieved.

From the comparison between these data and the above data on residents' willingness to sort, it is obvious that there is a certain deviation between residents' willingness to sort and their behavior. The deeper reasons for the deviation between residents' willingness to sort and their behavior can be attributed to the inadequate construction of hardware and software of the sorting and recycling system. Third, not everyone has the good quality to classify garbage consciously, because there is no relevant system, there is the mentality of "no one cares whether to classify or not, so they are too lazy to classify". Fourthly, residents think that waste separation is too tedious, so they are not willing to do it.

2.5.1 Lack of Policy Support for MSW Management in Beijing

The domestic garbage classification work has been developing rapidly since 2016, and the current target of China's garbage classification work is that by the end of 2020, the 46 key cities in the early and pilot implementation should basically build the working target of garbage classification and treatment system.

Beijing has an important position in China's urban planning map, but it faces serious problems of inadequate domestic waste management during its development, such as people illegally dumping domestic waste, waste exposed on top of open suburban land, and illegal profit-making from black waste transfer stations. According to the data of National Bureau of Statistics, in recent years, the volume of domestic waste removal in Beijing has been increasing year by year, which indicates that the volume of waste production in Beijing is increasing, and how to manage domestic waste has become a serious problem. In the face of such a situation, Beijing has actively

carried out garbage disposal in recent years, and on November 27, 2019, the 16th meeting of the Standing Committee of the 15th Beijing Municipal People's Congress adopted the Decision of the Standing Committee of the Beijing Municipal People's Congress on Amending the Regulations on the Management of Domestic Garbage in Beijing, which stipulates that it will come into effect from May 1, 2020. Before that, there were no relevant regulations and policies in place[52].

2.5.2 The MSW management in Beijing is comparatively single

The current domestic waste collection and transportation system in Beijing refers to the waste being put out, collected, transported, transferred and collected after being generated. The main problems faced are as follows:

1. Insufficient environment and equipment for MSW recycle operation.

2. Insufficient capital investment in the collection and transportation of waste, and large differences in the level of transportation and treatment equipment.

3. Low degree of safety and information of MSW management.

2.6 Scope impact of contingent valuation method

WTP and WTA are an effective way to measure welfare levels in monetary terms. The main techniques of measuring the economic value of environmental goods can be roughly divided into two categories: revealed preference method and stated preference method, as is shown in Fig 2-3 [53]. Revealed preference method revealed consumers' preference with regard to environmental good indirectly using market-related information, and estimating the economic value of environmental quality changes, which, however, can only assess the use value [53]. Revealed preference method includes travel expense method, hedonic price method, market cost method and benefit transfer method. Stated preference method refers to eliciting consumers' preference for specific environmental goods or services by direct asking. The most commonly use stated preference method is the contingent valuation method, which obtains people's willingness to pay for the benefit of environmental improvement or for environmental quality deterioration within a hypothetical market, thereby estimating the economic value of an specific environmental goods or

service. Contingent valuation method can obtain both use value and non-use value [53].

Contingent valuation is a survey-based economic technique for the valuation of non-market resources, such as environmental preservation or the impact of contamination. While these resources do give people utility, certain aspects of them do not have a market price as they are not directly sold. For example, people receive benefit from a beautiful view of a mountain, but it would be tough to value using price-based models. Contingent valuation surveys are one technique which is used to measure these aspects. Contingent valuation is often referred to as a "stated preference" model, in contrast to a price-based revealed preference model. Both models are utility based.

Typically, the survey asks how much money people would be willing to pay (or willing to accept) to maintain the existence of (or be compensated for the loss of) an environmental feature, such as biodiversity. At present, the contingent valuation method is one of the most widely used methods for assessing the value of environmental goods. Within a hypothetical market, respondents were described about the changes in the quantity or quality of an environmental goods or services in the form of a questionnaire, and were asked for their Willingness to pay (WTP) or the willingness to accept for the improvement or for the loss of environmental quality. Consumers' preferences for public goods and services along with it’s the economic value can be estimated in this way. The measurement methods for WTP and WTA should be consistent theoretically, but empirical studies have shown that the measured value of WTA is usually higher than WTP, and the ratio of WTA¥WTP is usually 2-10. At the same time, one of the principles proposed by NOAA indicates “WTP should be used instead of WTA as a measure of value measurement,” so researchers usually use WTP to assess the economic value of environmental public goods.

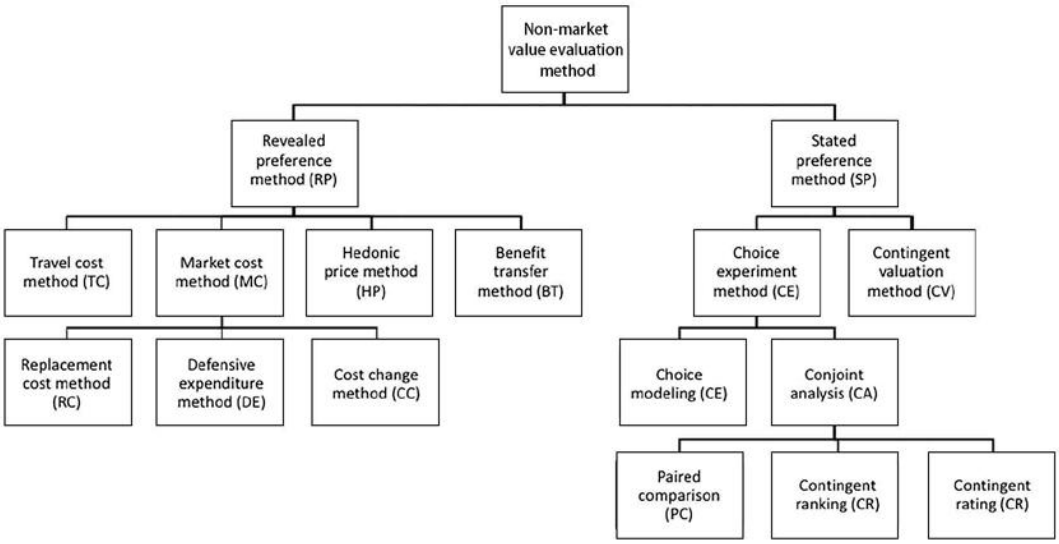

Fig. 2-3. Classification of non-market valuation methods

(Source: Zhiqiang, Zhang. et al., The development and application of contingent valuation method [J].Advance in earth science, 2003, (18): 454-463)

The concept of contingent valuation method was first proposed by economist Ciriacy Wantrup in measuring the positive external effects of soil erosion, which is called direct access method [54].

In 1963, Dr. Davis of Harvard University in the United States applied CVM to the woodland of Maine for the first time for the evaluation of leisure and entertainment value, then it was gradually applied to the evaluation of and aesthetic value and leisure value of natural resources. In 1979 and 1986, CVM was recognized by the US Water Resources Commission (WRC) and the Department of the Interior (DOI) as one of two recommended methods for evaluating the economic value of natural resources, and promote the application of CVM. It has become a commonly used approach for measuring the value of natural resources and the environment and the value of heritage [54]. In 1989, the assessment of environmental pollution losses in the oil spill in Alaska triggered a further discussion of CVM, including whether economic analysis should consider non-use value, the characteristic of hypothetical market, and the gap between willingness to pay and willingness to ay, and remedies for bias, etc. [55]. In 1992, the National Oceanic and Atmospheric Administration (NOAA) conducted a comprehensive and objective evaluation of CVM, and CVM was considered

to be an effective environmental valuation assessment method. NOAA also proposed guidelines to make its assessment results as reliable as possible [55]. Since then, CVM has been widely used in various countries and regions such as the United Kingdom, Norway, Sweden, France, etc., while the scope of research has been expanding continuously.

2.7 Willingness-to-pay elicitation methods

In welfare economics, an effective way to measure welfare levels in monetary terms is willingness to pay (WTP) and willingness to pay (WTA) [55]. WTP refers to the maximum amount of income a person is willing to pay for a change, or avoiding a change. WTA refers to the minimum income compensation that a person is willing to accept for an unfavorable change, or the minimum monetary compensation for giving up specific favorable condition. Take the two choices faced by urban residents as an example to explain the difference between WTP and WTA. One case is that urban residents have monetary income M, and the other is the corresponding UHI effect intensity E, which should be non-exclusive and non-competitive, and the improvement of the urban thermal environment cannot be directly purchased through the market. The preference of rational consumers can be expressed by the indifference curve of utility. As shown in the fig.2-4, U1, U2, and U3 represent three utility levels respectively. The three indifference curves of U1, U2, and U3 are respectively derived from the combination of different monetary incomes and different UHI effect intensity. The utilities on the same indifference curve stay the same. First, we analyze the willingness of urban residents to pay when the UHI effect is alleviated. Assume that the initial welfare level of the residents is at point A. At this time, while the tourists have the monetary income of M0, the UHI effect intensity is E0, and the utility level of the residents is U2.

Compared with A, B is in the same monetary income M0, while the urban thermal environmental.

The quality is E1, E1 is better than E0, and B has a higher utility level U3 than point A. When the thermal environment quality is improved from E0 to E1, rational urban residents are willing to pay for the improvement of urban thermal quality from M0-M1. The urban residents' welfare level is at point C, while M1 represents the currency income, and the urban thermal environment quality

level is E1. Point C has the same utility level U2 as point A. Urban residents are willing to pay M0-M1 for the improvement of urban thermal environment from E0 to E1. In this circumstance, the urban thermal environment has improved and the number of currencies has reduced, while the welfare level has remained unchanged. M0-M1 is the WTP of urban residents who improved the urban thermal environment from E0 to E1.

According to Fig. 2-4, when the urban thermal environment deteriorates from E0 to E2, in order to maintain the tourist's welfare level, there should be monetary compensation of M2-M0. The tourist's welfare level is at point D which represents a combination of higher monetary income and a worsening urban thermal environment compared with point A. M2-M0 is the lowest WTA accepted by urban residents for the deterioration of urban thermal environment.

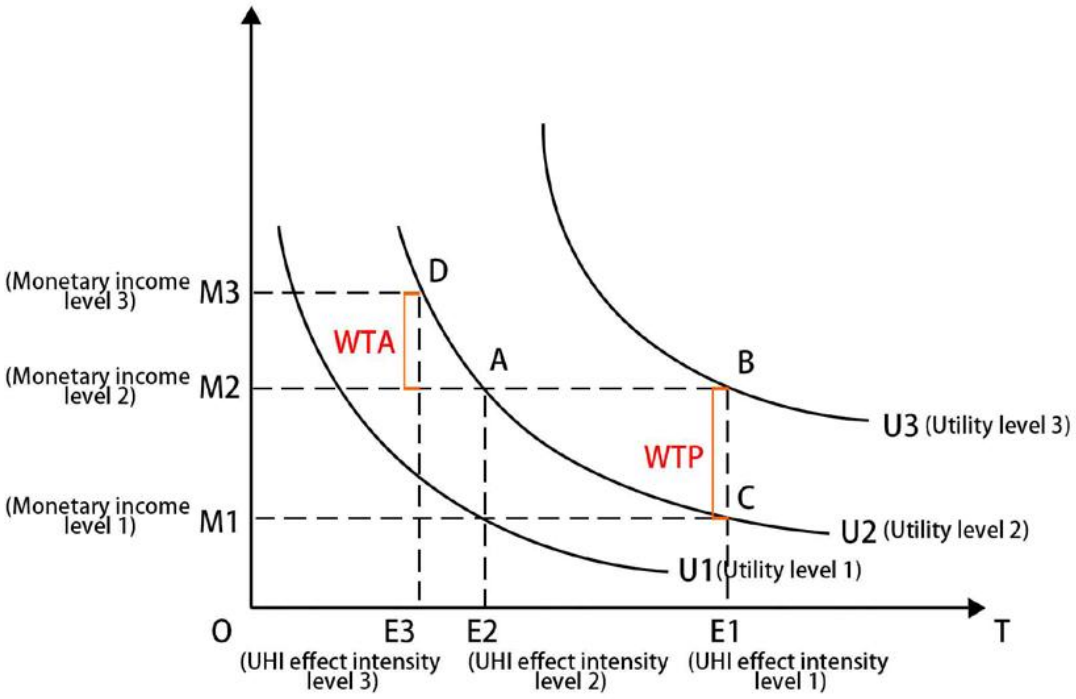

Fig. 2-4. Comparison of WTP and WTA

(Source: T. Tunçel, J.K. Hammitt, A new meta-analysis on the WTP/WTA disparity, Journal of Environmental Economics and Management 68(1) (2014) 175-187

2.8 The Theory of Planned behavior

2.8.1 The connotation of the theory of planned behavior

The theory of planned behavior is a famous theory that links ones' behavior and attitude in social psychology. The theory is based on the theory of expected value, and explains the theory of the general individual decision-making process from the perspective of information processing. It includes five elements (Shows in Fig. 2-5): Behavioral attitude, subjective norm, perceived behavioral control,behavioral intention and behavior. The TPB holds the following five main viewpoints:

1. Behavioral intention is the most direct and most important factor that affecting behavior. An individual's behavior is not completely controlled by personal will. It is also affected by behavioral intention, as well as other constraints of actual control conditions such as individual's ability, perceived resources and opportunities.

2. Accurate perceived behavior control can reflect the actual control conditions, so it can be used as a surrogate indicator of actual control conditions, and predict the possibility of specific behavior directly. The accuracy of prediction depends on the degree of cognition of perceived behavioral control.

3. Behavioral attitudes, subjective norms and perceived behavioral control are three important variables for predicting behavioral intentions []. A positive behavioral attitude, a positive social norm, and a strong perceived behavioral control, will contribute to a greater behavioral intention.

4. The individual can acquire certain behavioral beliefs in a specific time and environment. These beliefs are the cognitive and emotional basis of behavioral attitudes, subjective norms, and perceived behavioral control.

The individual's personal characteristics and social and cultural backgrounds further influence behavioral attitudes, subjective norms, and perceived behavioral control through influencing behavioral belief, which in turn affects behavioral intentions and behaviors. Structural model of the TPB was shown as follows:

Behavioral intention is the motivation of an individual to perform a specific behavior, reflecting the degree to which an individual is willing to work hard and overcome obstacles, etc. It is considered to be able to affect individual's behavior through stimulating motivational factors. In the theory of planned behavior, people's behavioral intentions are affected by three internal factors.

1. Attitude towards the behavior: It refers to the stable position, inclination and opinion of an individual who performs a specific behavior, including instrumental components (useful-harmful, valuable-non valuable) and emotional components (like-dislike, happy-painful), which is determined by the strength of beliefs and the evaluation of behavioral option.

2. Subjective norms: It refers to the social pressures that individuals perceive when deciding whether to perform a specific behavior, which reflects the influence of important groups or others on individual behavioral decisions. This is mainly determined by normative beliefs and motivation to comply. The former is the individual expectation of important groups, or the desire of others to perform a particular behavior, while the latter refers to the extent to which an individual follows the opinion of others when performing a particular behavior.

3. Perceived behavioral control refers to the perceived factors that may contribute or hinder the behavioral option, which reflects the individual's perceived ease or difficulty of performing a specific behavior, and is influenced by the control beliefs and the perceived power. The former one is the individual perceived factors that promoting or hindering the specific behavior option, and the latter is the degree to which the individual considers these factors may affect the conduction of the behavioral option.

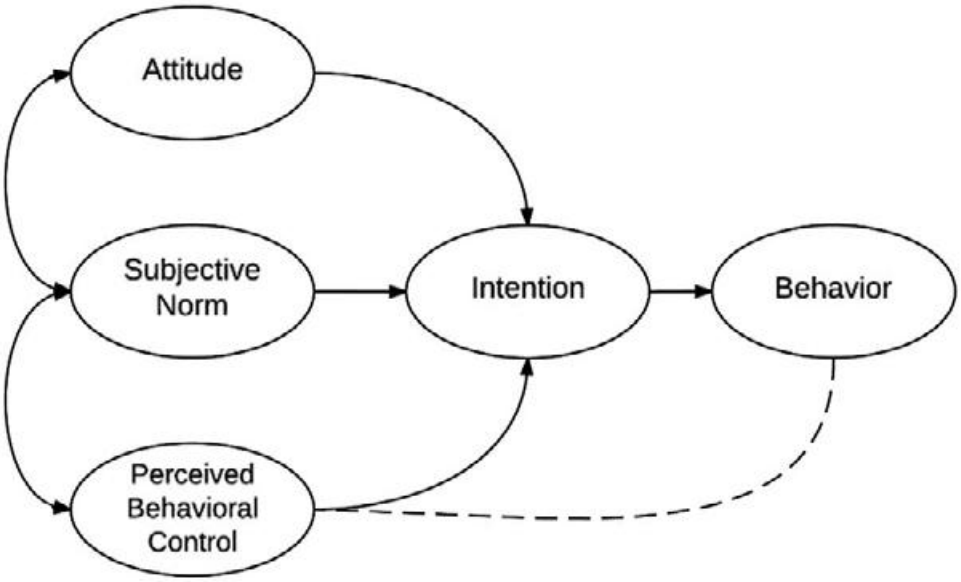

Fig. 2-5. The theory of planned behavior

(Source: https://en.wikipedia.org/wiki/Theory_of_planned_behavior)

Ajzen pointed out attitudes towards the behavior, subjective norms, and perceived behavioral control can be completely conceptually distinguished, but sometimes these three variables may share a common belief, so they are distinguished and related at the same time [56]: 1. Attitudes towards behavior and subjective norms are positively correlated. Individual with a positive attitude toward a particular behavioral option is likely to perceive greater social pressure, and in turn, a greater pro-environment behavior will stimulate a more positive attitude towards the behavior option. 2.The subjective norms and perceived behavioral control are positively correlated, the stronger the subjective norms was perceived, the more likely they will prepare more resources for specific behaviors, in turn, the stronger an individual's perceived behavioral control, the more he/she is willing to have a positive social norm towards the behavioral option 3. Attitude towards the behavioral option and perceived behavioral control are positively correlated. The more positive the attitude towards the behavioral option, the more he/she is willing to prepare more related resources and overcome more challenges. In turn, the stronger the perceived behavioral control, and then the more positive attitude toward a particular behavior.

2.8.2 The development of Theory of Planned Behavior

The development of the theory of planned behavior has gone through three stages. TPB originated from the multi-attribute attitude theory (TMA) proposed by Peter C. Fishbern in 1963. TMA believes that behavioral intentions are determined by behavioral attitudes, while behavioral attitudes are influenced by expected behavioral outcomes and outcome assessments. In 1975, Peter C. Fishbern and I. Ajzen proposed the theory of rational behavior based on the theory of TMA. The behavioral intention is considered to be a direct factor in determining behavior, and it is pointed out that the behavioral intention is influenced by attitudes and subjective norms. The premise of this theory assumes that individual behavior is controlled by the will, while actually human behavior is often under control, which seriously restricts the practicality and application of the theory. Therefore, in 1985, I. Ajzen proposed the TPB theory. The variable of perceived behavioral control is added. In 1991, I. Ajzen published the article of "the theory of planned behavior", which is considered to be the maturity of TPB theory. While the TPB theory has been affirmed and supported, it has also been criticized. Bagozzi, et al. [56] have pointed out that TPB theory only emphasizes the instrumental component of attitude while ignoring its emotional component, which is supported by numbers of researchers. Both types of attitudes have been examined in studies. The study of Chan and Fishbein [57] indicate that relationship of emotional attitude - intention is stronger than instrumental attitude - attention, while the study of Paisley indicate that both relationship are not significantly different.

For the variable of subjective norms, Sheeran and Orbell believe that the definition of the concept does not reflect the influence of society on individual behavior [58], which leads to a weak relationship between the variable and the intention in many behavioral analysis, and proposes that the definition of subjective norms should be improved. These questions have prompted the improvement of the development of TPB theory.(Shows in Tab. 2-5)

2.8.3 Application of TPB Theory

As a method to explain and predict people's behavior, the theory of planned behavior has been widely used in the study of customer's behavior intentions in the health industry, health care, leisure, management and other related fields As a method to explain and predict people's behavior, the theory of planned behavior has been widely used in the study of customer's behavior intentions

in the health industry, health care, leisure, management and other related fields. Armitage found that behavioral attitudes, subjective norms, and perceived behavioral control have an explanatory power of 39%-50%, while the explanatory power of behavioral intention and the perceived behavioral control with regard to actual behavior is 20% to 40% [59]. Chao-Min's research on the continued purchase intention of online shopping consumers shows that behavioral attitudes, subjective norms and perceived behavioral control have an explanation of sustainable consuming intentions of 56% [60]. In the TPB model, attitudes, subjective norms, and perceived behavioral behaviors have different effects on different behaviors. Although the TPB model has a good explanatory power for behavior, a large part of behavioral and behavioral intentions cannot be explained by the main variables. In this regard, many scholars have added variables that related to specific behaviors to the conventional TPB model to increase its predictive power. Pakpour, et al. [61] added variables such as ethical obligations, self-assessments, action plans, and past recycling experience to the TPB model to study household waste recycling behavior. 2,000 households samples were randomly selected from eight medical coverage areas in Kazvin, Iran. Through a questionnaire survey of the same subject at two time of one year, it is found that the past behavior experience has a significant impact on the recycling behavior of domestic, garbage, and the final expanded TPB model explains 47% the variance of the recycling behavior of domestic garbage.

Tab. 2-5. Overview of application field of TPB

Research literature	Research field	Research literature	Research field
Schifter, et al. (1985)	Intention of lossing weight	Burton N, et al. (1990)	Election intention
Doil, et al. (1990)	Intention of playing video game	Godin, et al. (1990)	Exercise intention

Parker, et al. (1990)	Traffic rules violation	Schlegel, et al. (1990)	Intention of drinking alcoholic
Ryn, et al. (1990)	Intention of work	Beck, et al. (1990)	Intention of fraudulent
Beale, et al. (1991)	Limit sugar intake	Beedell J D C, et al. (1990)	Intention of conserving soil and water
Hansen.(2004)(2008)	Intention of online shopping	Fielding K S (2008)	Environmental campaign
Zikic J, et al. (2009)	Intention of work	Zemore S E, et al. (2009)	Recreational activities
Ketal Y V, et al. (2009)	Food safety	Detal L G A, et al. (2010)	Intention of learning
Han H, et al. (2010)	Green hotel selection	Stone T H, et al. (2010)	Intention of academic immorality
Pakpour A H, et al. (2013)	Garbage collection behavior	Yeong Gug Kim (2014)	Intention of consuming genetically modified foods
Schifter, et al. (1985)	Intention of lossing weight	Burton N, et al. (1990)	Election intention
Doil, et al. (1990)	Intention of playing video game	Godin, et al. (1990)	Exercise intention
Parker, et al. (1990)	Traffic rules violation	Schlegel, et al. (1990)	Intention of drinking alcoholic

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Chapter 3

LITERATURE REVIEW OF CONTINGENT EVALUTION METHODS

CHAPTER THREE: LITERATURE REVIEW OF CONTINGENT EVALUTION METHODS

3.1 Contingent valuation method

The contingent valuation method is one of the most commonly used methods for environmental resource value assessment. In environmental economics, it is commonly used for evaluating the use value and non-use value of environmental goods or services, while the scope and number of CV studies of urban green space with regard to its climate effect has expanded in recent years, there is a lack of studies that summaries and examine the quality of these WTP studies. This paper conducts a state-of-the-art review of CV literature regarding UGS by sampling 48 studies and providing background information such as country, data collection method, WTP elicitation method, type of UGS, mean WTP, type of value and payment vehicle, which could become a reference for the future studies. We discuss the validity of different payment vehicles and data elicitation techniques and highlight the need for convergent validity testing in future studies. Moreover, we scan the primary antecedents that influence the WTP for UGS, which helps to explore to what extent a general theoretical framework can be traced in these studies. This chapter focuses on the evaluation of the contingent valuation research regarding the climate value of urban green space. Focusing on the main characteristic of the current research design along with the determinants of WTP.

3.1.1 The Overview of Contingent valuation method

CVM is an important valuation method to study the value of an object by investigating consumer preferences in a hypothetical market based on the consumer surplus theory of modern economics and the principles of welfare economics[1]. It is the most important and widely used method on the valuation of public goods in the last 10 years or so. In the item evaluation system of cost-benefit analysis, unlike the main benefit evaluation methods such as the travel cost method and the characteristic price method, CVM is the only method for assessing the value of items that exist in a hypothetical market and, therefore, the only method for non-use value assessment.

The characteristics of CVM determine its wide scope of application in the evaluation of such non-valued pro-environmental products managed by MSW[2]. CVM can evaluate the value of such pro-environmental products and also non-use values, which have been recognized by academia as belonging to the components of social public benefits; CVM, together with the travel

cost method and the characteristic price method, are among the few evaluation methods for evaluating the benefits of non-market activities, and CVM has the least limitations in its use and is the most qualified to carry out its application in urban management.

In 1947, Ciriacy-Wantrup discovered that soil erosion control measures had positive externalities, and that such positive externalities had the characteristics of public goods that could not be measured directly by certain methods, but their value could be measured by people's willingness to pay for such positive externalities, and he called this method the direct access method, which was the prototype of the conditional value assessment method[3]. In 1963, Dr. Davis of Harvard University first used the conditional value approach to study the value of coastal forest recreation, hunting, and leisure in Maine, USA, which was the first time the conditional value approach was used to value environmental resources[4]. In 1979, the U.S. Water Resources Council applied the conditional value approach to water resources planning and established principles and procedures for conducting cost-benefit analyses, and identified the conditional value approach and the travel cost approach as the two preferred methods for evaluating the benefits of recreation[5]. In 1984. Professor Hanemann of the University of California established the effective connection between the Conditional Value Method and the concepts of Hicks Equivalent Surplus, Compensated Surplus and Willingness to Pay, which laid a solid economic foundation for the Conditional Value Method[6]. In 1986, the U.S. Department of the Interior used the conditional value assessment method for measurement in calculating the cost-benefit analysis of the Superfund Act and recommended it as a measure for evaluating the existence value and future heritage value of natural resources and the environment[7]. In 1992, Nobel laureates in economics, such as Kenneth Arrow and Robert Solow, conducted an in-depth review and evaluation of the conditional value assessment method, identified the principles and methods of the conditional value assessment method applied to natural resource valuation, and affirmed the conditional value assessment method as a valid method of natural resource valuation[8].

In the 1980s, the conditional value assessment method was introduced to Europe for environmental valuation and public decision making, and the application of the conditional value assessment method in Europe showed that it was in fact a technique with great potential[9]. test

method, joint analysis method, condition classification method, travel cost method, etc., among which the condition value assessment method is the most applied environmental.

In the 1990s, the method of conditional value assessment was developed[10]. The conditional value assessment method was introduced to China for the assessment of ecological service values in various aspects[11]. In 2001, Ying Li and Kaizhong Yang applied the conditional value assessment method to analyze the willingness of Beijing residents to pay for the improvement of Beijing's atmospheric quality[12]. Since then, the conditional value assessment method has been widely used in China to assess the value of ecological services such as water quality, air quality and ecological protection. With the development of environmental economics and the continuous improvement of China's economic system, the application of the conditional value assessment method has been widely used in China to assess the value of ecological services such as water quality, air quality and ecological protection. The most common application is to investigate the willingness of residents to pay for environmental improvements. The most common application is to investigate the willingness of residents to pay for an environmental improvement, and then to assess the value of environmental benefits and losses[13].

Since the 21st century, the number of studies on the conditional value approach has increased, and the related survey and statistical methods have become more and more sophisticated. The most commonly used method to evaluate the economic value of non-market environmental goods and resources.

3.1.2 The Fundamental Economics of Contingent valuation method

The evaluation method of environmental resources value is closely related to the value composition of environmental resources, which can be divided into use value and non-use value, and use value includes direct use value and indirect use value. Direct use value is the value of environmental resources that directly meets human production or consumption needs, for example, timber in forests, tourism and minerals belong to direct use value, while indirect use value refers to its indirect benefits that support human production and operation activities, and belongs to the value of ecological services, including functions such as climate regulation and water

protection[14]. Non-use value is the intrinsic value of natural resources, including existence value, heritage value, selection value, etc[15]. That is, the existence of such natural resources means that they have value, even if some environmental resources have no use value for human beings, such as a certain endangered species, which human beings think must be protected, even if it does not have use value, so human beings' willingness to pay for the meaning of the existence of natural resources is the basis of existence value. While direct use value can be measured by the market value method, indirect use value and non-use high value cannot be measured by the market value method because there is no market for trading, and can be measured by the non-market value assessment method. Common non-market value assessment methods include revealed preference method and stated preference method[16]. The revealed preference method derives the value of environmental resources from the behavior of individuals in the actual market, for example, the value of a tourist attraction can be derived from the travel cost of tourists[17]. Common revealed preference methods are travel cost method, hedonic price method, market cost method etc. Stated preference methods elicit the value of environmental resources by guiding respondents to answer directly under hypothetical market conditions. Common stated preference methods include conditional value assessment method, choice test method, etc. The conditional value assessment method is a typical stated in human history.

It constructs a hypothetical market and asks individuals what they would be willing to pay for an ecological service or environmental resource or what they would be willing to pay for the loss of an ecological service. The conditional value method is a typical stated preference method that asks individuals about the maximum willingness to pay for an ecological service or environmental resource or the minimum compensation they are willing to accept for the loss of an ecological service or environmental resource.

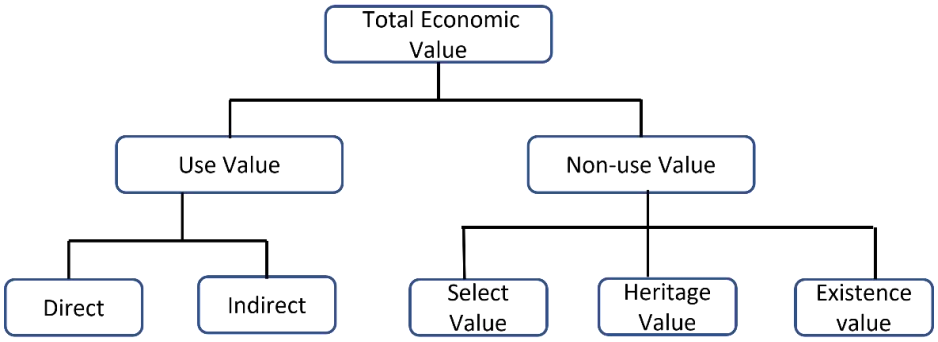

Fig. 3-1 Total value of environmental resources

The non-use value and indirect use value of an ecological service or environmental resource are obtained[18] (Shows in Fig. 3-1).

The basic economic principle of CVM comes from the demand function and consumer surplus. by a fixed price variable. S.t PX = y, according to utility maximization max U (x), Deriving the quantity of consumption X, the resulting function is the Marshell demand function, which responds to how consumers choose to maximize their utility, given price (P) and income. The consumer surplus is calculated from this function as Marshell consumer surplus CSM.

From a fixed utility scalar, S.t U(x) $\geqslant$ U, the quantity consumed, X, is derived according to the payment minimization min(P-X), and the resulting function is the Hicks demand function. This function response keeps utility (U) constant and corresponds to changes in price, quality and requires a certain amount of consumer spending or income compensation. From this function, consumer surplus is calculated as Hicks consumer surplus CSH.

The Hicks demand function, also known as the compensating demand function, "compensates" by indicating that changes in income are used to "compensate" for changes in prices in order to keep the level of utility constant. The equivalence of the Hicks demand function to derive consumer surplus.

The horizontal axis represents the amount of money in public property that is useful to consumers, and the vertical axis represents the amount of money in consumers' private property. Here it can be seen that the price that the consumer can pay in private property in exchange for this favorable change is to return to the vertical line BC of the curve AB, so the line BC is the

equilibrium variable WTP for this favorable change. on the contrary, if a known strategy is removed, the consumer utility curve drops from CD to AB, and if the consumer utility remains as it is, the amount of private property needed to be compensated is to return to In case of an unfavorable change of a public good (if a new waste treatment plant is built near the house), the geometric meaning of WTA and WTP does not change, but the migration process of the utility curve such as knowledge changes.

3.1.3 The main application process of Contingent valuation method

First, a hypothetical scenario is constructed in which the item or facility to be investigated is offered to the respondent through the market, for example, a plan to build a facility or improve environmental quality. The ideal plan should contain as much information as possible to avoid misunderstanding or unclear understanding of the respondents, such as: the details and complete quality of the plan, the plan implementation and completion time, the cost to be paid by the respondents, the way to pay and the security measures for the use of funds.

Second, respondents are asked about their voluntary choices when faced with the choice scenarios constructed above. With the information of WTP and WTA of the respondents, the individual willingness to pay can be deduced from the quantitative economic model built based on this information. The total economic benefit evaluation can be obtained by multiplying a certain trend value (mean or median value) of individual willingness to pay with the total number of relevant people in the study population.

Third, the validity of the value is judged by correlating the socio-economic attributes of the respondents (e.g., age, gender, education level, household income, etc.) with the individual's choice. In practice, the first step and the second part include more specific content, and the first step and the second step are not distinctly separate, and getting the most appropriate questionnaire is not exactly an indoor assignment to complete, there must be a process of feedback and modification according to the actual situation.

3.1.4 Guidance method of Contingent valuation method

The guidance method of the contingent valuation method directly determines the credibility and

accuracy of the condition value appraisal method, and is a guidance technique of the conditional value assessment method can be divided into continuous conditional value assessment and discrete conditional value assessment. The guidance method of the contingent valuation method can be divided into continuous conditional value assessment and discrete conditional value assessment. The guidance technique of the conditional value assessment method can be divided into continuous conditional value assessment and discrete conditional value assessment.(Shows in Fig.3-2)

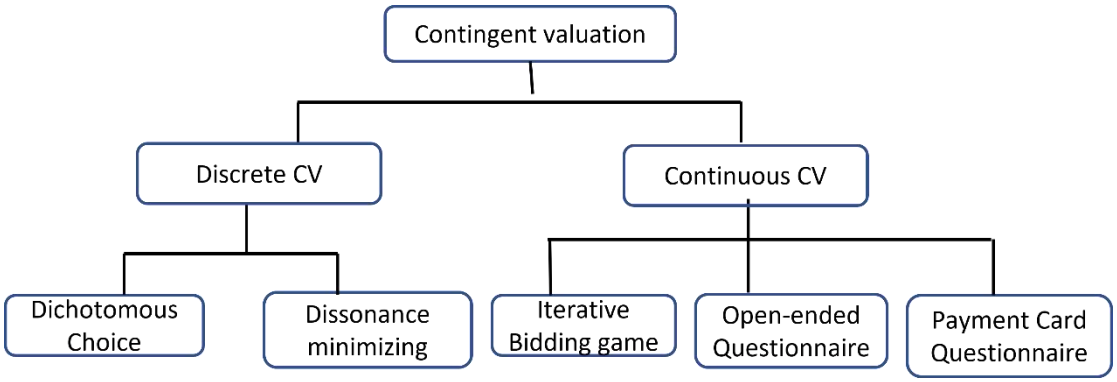

Fig.3-2 Guidance method of Contingent valuation method

Continuous conditional value assessment i.e., maximum willingness to pay is a continuous random variable, and continuous conditional value assessment can be divided into three types: repeated bid game, open-ended question format, and payment card format. Repeated bid game means that the surveyor keeps lowering or raising the offer level until finding the respondent's maximum willingness to pay or minimum willingness to be paid. Repeated bid game is very effective in on-site and telephone surveys, but it is not commonly used anymore considering the existence of bid starting point bias. The open-ended question format allows respondents to freely state their maximum willingness to pay and minimum willingness to be paid levels, and the open-ended question format provides the most comprehensive data and allows for the detection of subtle differences between respondents. too much effort, so many respondents give blank questionnaires, especially if they do not understand the survey, and there is a large information bias. There are anchored payment card format and non-anchored payment card format. The non-anchored payment card format requires respondents to choose the maximum willingness to pay

level or the minimum willingness to be paid level among a given set of payment cards, and the anchored payment card format usually provides respondents with some background information first.

The anchored payment card format usually begins by providing respondents with some background information and asking them about their maximum or minimum willingness to pay level at the same time as the survey. Although the payment card format avoids the information bias in the open-ended question format, the range of choices and midpoint values provided in the payment card format may affect the respondents' willingness-to-pay and willingness-to-receive levels, and therefore there is some degree of bias.

The maximum willingness to pay and minimum willingness to be paid levels for discrete conditional value assessment are discrete random variables, and the discrete type conditional value assessment uses a closed-form problem format, which can be further divided into a dichotomous choice problem format and a discordance minimization problem format. The dichotomous choice problem format is divided into single-boundary dichotomous problem format, double-boundary dichotomous problem format, and multi-boundary problem format. The two-boundary dichotomous problem format is used as an example. Given the initial bid value, the respondents are asked to agree or disagree with the willingness to pay, and the second time the respondents are asked to agree or disagree with the willingness to pay. The second time the respondents are asked about their willingness to pay, the criteria are determined based on their first choice, and a higher bid is given to those who choose to agree and those who choose to disagree. For respondents who choose to agree to give a higher bid value, for respondents who choose not to agree to give a lower bid value, after the survey, the respondents' feedback can be After the survey, respondents' responses can be divided into four categories: "agree - agree", "agree - disagree", "disagree - agree ", "disagree - disagree", from The respondents' willingness-to-pay interval is calculated, and the respondents' willingness-to-pay value is obtained through statistical measurement and other processing. willingness to pay values. In the incongruity minimization question format, respondents need to select their own willingness to pay from the pre-selected price range. willingness value, the method of determining the price interval is the same as in the dichotomous

question format, while the respondent gives several possible statements to distinguish between full agreement and full disagreement, which can reduce certainty bias. The advantage of the dichotomous question format is that it simulates the bargaining power of the market. The advantage of the dichotomous question format is that it simulates the bargaining process in the marketplace and reduces the possibility of respondents overestimating their offers.

However, the dichotomous format also has the disadvantage that it does not provide a direct estimate of willingness to pay, but can only determine a willingness-to-pay interval, which requires a complex statistical process. However, the dichotomous question format also has its drawbacks in that it does not provide a direct estimate of willingness to pay, but only identifies an interval of willingness to pay, which requires complex statistical and econometric analysis to obtain the value of respondents' willingness to pay.

3.1.5 Treatment of deviations in the contingent valuation method

The contingent valuation method is characterized by easy application and relatively simple conditions because it does not require complex theoretical assumptions in that only market conditions need to be assumed. Because of this, the accuracy of the conditional value assessment method has been questioned for the existence of many biases, and the biases that affect the accuracy of the conditional value assessment method are: hypothetical bias, payment method bias, bid starting point bias, strategic bias, information bias, non-response bias, affirmative response bias, protest reflection bias, partial whole bias, embedding bias, question order bias, length-of-stay bias, investigator bias, and survey mode bias. These biases can be corrected by appropriate methods and guidance techniques to reduce the impact of the biases.

First, in response to hypothetical bias and information bias, respondents are likely to give different answers to hypothetical market conditions than the real market conditions. The respondents may give different answers from the real market conditions. This can be avoided by improving the design of the questionnaire, conducting pre-research, and providing respondents with sufficient information. Next, the payment method deviation and bid starting point deviation can be reduced by pre-survey, selection of appropriate payment methods, and selection of

reasonable payment starting values and value intervals.

Thirdly, to reduce payment method deviation and bid starting point deviation, we can choose the appropriate payment method and reasonable payment starting point value and value interval through pre-survey. Then, the bias can be reduced by improving the questionnaire questions for non-reflective and affirmative bias, and by providing a comprehensive background and additional text for partial global and embedded bias. The error value can be reduced by providing comprehensive background and additional textual explanations. The question order bias and time length bias can be reduced by adjusting the corrected question order. to reduce the effect of question order, and compressing the control questionnaire time to reduce the length bias.

3.2 Theoretical derivation of MSW management under CVM

The contingent valuation method approach is used as the main evaluation method for the non-use value of environmental products to assess the ecological benefit value of public benefit forests. The theoretical basis for the assessment of the ecological benefit value of public benefit forests is also the utility value theory.

WTP (willingness to pay) and WTA (willingness to accept) are two important concepts in modern economics and two fundamental concepts in CVM that specifically undertake the evaluation function. The former refers to the maximum amount that a consumer is willing to pay in exchange for a gain; the latter refers to the minimum amount that a consumer agrees to accept in order to compensate for a loss.

3.3 Questionnaire design for MSW management under CVM

The questionnaire design of this research paper is based on the willingness-to-pay price under hypothetical market conditions, where the waste recycling methods in the main urban areas of Beijing are still not sorted and there is a lack of sorting devices to guide the citizens to use more efficient waste treatment and recycling doctors. The questionnaire design is based on a willingness-to-pay survey that can guide farmers to use new recycling devices through government compensation.

At the same time, CVM is based on willingness-to-pay surveys, which are based on hypothetical market conditions, and user responses are uncertain. By using the improved method of CVM, the certainty is increased and the sample error is reduced Municipal solid waste management has typical properties of public goods and is one of the main research topics of current CVM research in urban public management-related fields. In China, the issue of recycling standards and fees for waste separation is currently a topic of discussion and even debate in many cities, and not only do citizens have different views on this issue, but also the city management has considerable difficulties. Therefore, exploring the evaluation of the social benefits of municipal solid waste separation and management has the dual significance of methodological research and practical application.

Experience with municipal solid waste sorting has shown that the service radius of a sorting and recycling site is usually 500-1000 m. This range could not be effectively judged within the study, so the approach of dividing waste recycling sites of equal function was used here, so in the initial experimental design, college students at universities, who were most receptive to the new facilities and policies, were used as respondents for the sampling of this study.

3.3.1Description of the benefits of MSW management based on urban residents

Under the CVM, the setting of conditions directly affects the survey results. Therefore, a detailed description of the surveyed resources before the survey is the key to the success of the survey and is the basis for the respondents to make an accurate valuation of the issues raised. The detailed description of the respondents is to provide them with sufficient and true and accurate

information about the condition of the evaluated environmental goods or services in terms of quantity, quality, and utility. In this study, the survey is conducted. In this study, the willingness to pay for MSW management based on the residents will be described in detail to the respondents. The description will be done in the following aspects.

MSW is closely related to residents' lives, and if not treated and separated in a timely manner, MSW can cause pollution and damage to residents' living environment. Effective waste recycling is an effective way to dispose of municipal solid waste. Efficient separation not only reduces the cost of waste disposal, but also brings new economic benefits to the recyclable portion of the waste.

3.3.2. Questionnaire design principles

The quality of the questionnaire design directly affects the results of the later questionnaires, and also affects the accuracy and reliability of the questionnaire results. The design of the questionnaire should follow the following principles.

(1) the principle of purpose. Purpose is the core of the questionnaire, all questionnaire design and questionnaire research should focus on the purpose of the questionnaire to carry out, the purpose of the questionnaire in this paper is to measure the compensation standard of cotton straw resource utilization and its influencing factors.

(2) The principle of logic. A high-quality questionnaire must have a reasonable and good logic to guide the respondents to draw the right conclusion. The logical idea of the questionnaire in this paper is: first, to ask the basic information of the respondents, including the basic information of individuals and families, second, to ask the influencing factors and value perceptions around the respondents, and finally, to ask the reasonable payment standard and compensation standard that the respondents are willing to give.

(3) The principle of generality. The questionnaire is easy to understand, so that the respondents can give reasonable answers and finally get a real and valid data. In this paper, the questionnaire firstly explains the concept to the respondents, so that they can understand the basic concepts of municipal solid waste, waste recycling and environmental concerns, and then explains the purpose

of the questionnaire for anonymous answers to eliminate the worries of the respondents, in order to obtain real and valid data.

(4) Time principle. If a question is too long or the overall questionnaire is too long, the respondents will be bored, thus creating a dwell time bias and affecting the accuracy and validity of the questionnaire. In this paper, a total of 34 questions were selected, and the response time was not too long to ensure that the respondents could finish the questionnaire within 20 minutes and reduce the dwell time bias. The reasonableness and feasibility of the willingness to pay for municipal solid waste recycling and the influencing factors are closely related to the quality of the questionnaire design, so the implementation of these design principles can ensure a high-quality questionnaire. At the same time in the process of questionnaire implementation, the implementation of the two features of the conditional value assessment method of hypothetical market rules and direct survey methods, and reasonable technical guidance and payment method selection can further ensure the quality of the questionnaire results.

3.3.3 Content of questionnaire design

In the process of questionnaire design, it is important to ensure the comprehensiveness of the questionnaire content on the one hand, and to minimize errors on the other. Before the formal distribution of the questionnaire, the questionnaire was first distributed in the field for pre-survey, with the aim of finding as many ambiguities, similar questions and omissions in the options in the questionnaire as possible. After collecting the opinions, some questions and options in the questionnaire were adjusted.

First, the awareness of MSW management. For some residents, some of the usual behaviors already fall under the MSW management classification, but the residents themselves are not aware of them. This problem was identified in the pre-survey, and the questionnaire will provide a detailed description of the ways of MSW management to minimize bias as much as possible.

Second, the questionnaire is divided into three main areas. The first is the basic information of the residents, which serves as the basis for analyzing the basic attributes of the respondents, including basic personal information: gender, age, education level and annual income: basic

household information: number of household members, per capita monthly income, etc. Next is the residents' perceptions of MSW management: whether they have positive personal attitudes, whether they are influenced by social policies, and whether they are influenced by their friends in the neighborhood, in an attempt to investigate the residents' perceptions of MSW management.

Lastly, the willingness to pay and the payment criteria of MSW management are used to measure the purchasing power of the new waste recycling devices. Third, the core of the survey is to ask users' willingness to pay. First, farmers are asked whether they are willing to MSW management to understand their attitude toward MSW management. Again, a hypothetical market is established by asking: if the government uses this payment to buy smart new garbage cans for MSW sorting and can be subsidized through the equipment, what do you think is the standard of payment? To induce households to accept the payment method to carry out a virtuous cycle of MSW sorting.

3.3.4 Data sources

It is the capital of the People's Republic of China, one of the four central municipalities, the second largest city and the political, transportation and cultural center of the country. Beijing is located at the northern end of the North China Plain, partially connected to Tianjin in the southeast and surrounded by the rest of Hebei Province. Beijing has the highest average education and per capita income in the country.

The research area of this paper is the main core urban areas of Beijing: Dongcheng District, Xicheng District, Chaoyang District, Haidian District, Fengtai District, and Shijingshan District. The survey was conducted in January 2021, and the survey was mainly conducted by online questionnaire. The sample selection method is stratified sampling, based on the density number of the population.(Shows in Tab.3-1)

Tab.3-1 Distribution of the research sample

Location	Sample size	Frequency
Dongcheng	78	14.66%
Xicheng	108	20.3%
Chaoyang	31	5.83%

Haidian	100	18.8%
Fengtai	50	9.4%
Changping	29	5.45%
Daxing	47	8.83%
Shunyi	28	5.26%
Tongzhou	36	6.77%
Others (Miyun,Pinggu,Huairou，Yanqing,etc.)	25	4.7%

Data source: https://www.wjx.cn/report/112597570.aspx

The research process began with a pre-survey, and the questionnaire was adjusted to address the issues found in the pre-survey process before the formal research process was conducted. During the pre-survey process, we found that "Who do you think should pay for the management and disposal of municipal solid waste?"

Many Beijing residents refused to answer this question, believing that it is the government's responsibility, and nearly half of the respondents rejected the possibility of paying for it. At the same time, the pre-study found that citizens had biased answers to the questionnaire, and some were not willing to answer too many questions, so in the formal research, it is necessary to find the root cause that really affects the unwillingness of residents to pay, whether it is the willingness of the amount or the reason of personal subjective attitude will, and further adjust for the options in the questionnaire.

The disadvantages of CVM lie mainly in the reliability and validity of the findings and the various biases. Therefore, we try to avoid and reduce the bias in the design of the survey questionnaire. In order to overcome the bias, the following work was done: (1) Determine a reasonable bid interval through pre-research to reduce the bid starting point bias. (2) Introduce to the public in detail how the new garbage cans are used and how they are compensated. (3) Introduce the identity of the surveyed users and emphasize that this survey is only for academic research to reduce the strategic bias. (4) The questionnaire was designed with a degree of certainty option to reduce bias.

3.4 Sample Statistical Analysis

3.4.1 Statistical analysis of personal characteristics

Among the respondents, 284 were men, accounting for 53.4%, and 248 were women, accounting for 46.6%, and the ratio of men to women was basically balanced. Age stage under 20 years old accounted for 13.5% of the total number of surveyed residents, age stage 20-30 years old accounted for 43.2% of the total number of surveyed residents, age stage 30-50 years old accounted for 34.2% of the total number of surveyed residents, 91% of the surveyed respondents were concentrated in the age of 18-50 years old. There are 56 people with education level of junior high school or below, accounting for 10.5% of the total number of people surveyed.

The educational level of the respondents was high school, accounting for 34.6% of the total number, 230 people had a bachelor's degree, accounting for 43.23% of the total sample, and 62 people had a master's degree or above. This shows that the residents have a balanced distribution in terms of education level. Most of the respondents in this survey have certain knowledge reserves, can analyze problems rationally and have economic autonomy in decision-making, therefore, the sample of this survey is representative. (Shows in Tab.3-2)

Tab.3-2 Statistical analysis of personal characteristics (Pre)

Factors	Options	Frequency	Percentage
Gender	Male	284	53.4
	Female	248	46.6
Age	< 20	72	13.5
	20-30	230	43.2
	30-50	18248	34.2
	> 50	56	9
Educational level	Junior High School	184	10.5
	High School	230	34.6
	Bachelor Degree	62	43.2
	Master Degree		11.7

Data source: https://www.wjx.cn/report/112597570.aspx

3.4.2 Statistical analysis of subjective perceptions

The number of people who think that the current community living environment is not sanitary and because of the reason of untreated garbage is 62.7%, and the number of people who think that domestic garbage classification is necessary is 57.8%, but only 38% of people who want to pay for community garbage disposal, in that everyone has an understanding of the harmful effects of garbage, but the clear refusal is 362 people, accounting for 61.2%,(Shows in Fig.3-3) the main reason for refusal is that they think garbage disposal is The main reason for refusal is that the municipal government is responsible for the disposal of garbage, and that the amount of payment is included in the personal income tax that individuals usually pay, and that the credibility of the government is low, which could lead to misappropriation of the funds.

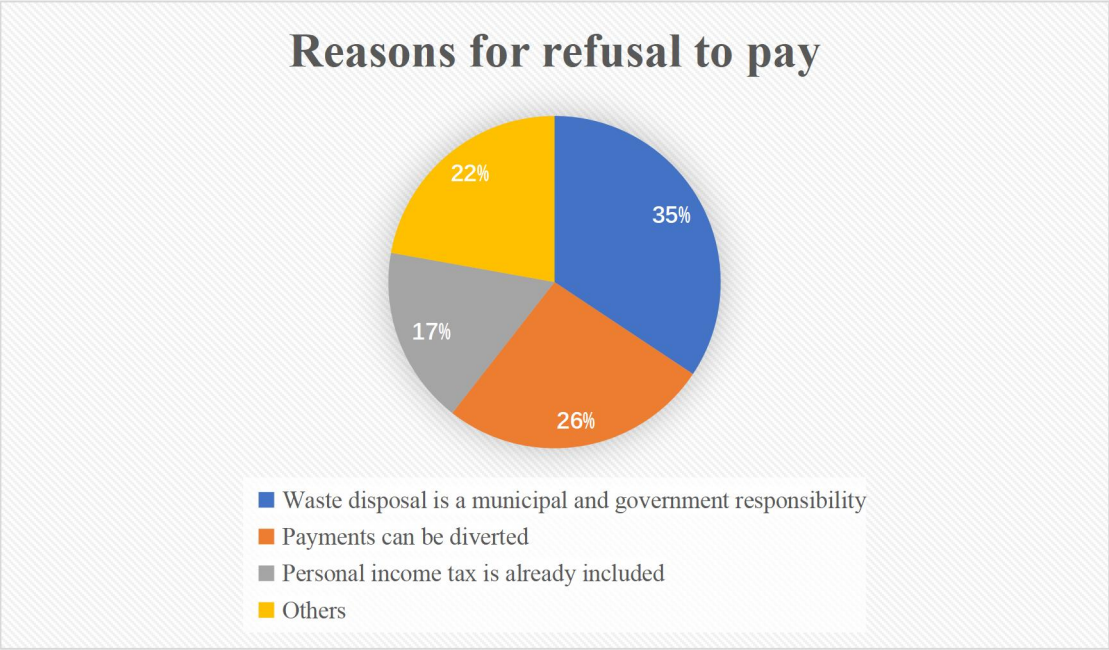

Fig.3-3 Reasons for refusal to pay

3.5 CVM-based model construction and variable settings

3.5.1 Model Construction

The compensation standard is the core of the compensation mechanism, and a scientific and reasonable compensation standard is the key to setting up the compensation mechanism. In order to set a scientific and reasonable compensation standard, besides using non-parametric estimation a reasonable parameter estimation should also be conducted to analyze which factors will influence the compensation standard and estimate the degree of influence through a linear regression model. The compensation standard is taken as the average of the payment standard and the compensation standard of individual residents, and 11 common influencing factors are selected for the analysis. The model is set as follows.

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+...+\beta_{11}X_{11}+\mu \quad (3\text{-}1)$$

where Y is the standard value of ecological compensation, β 0 is the constant term, β i is the regression coefficient, and μ is the random error term. X_1 , X_2 ,... X_{11} denote the various influences that may have an impact on the criteria for citizen compensation.

The linear equation between the expected value of the explanatory variable Y and the explanatory variables X_1 , X_2 , ... X_{11} is the following equation.

$$E(Y) = \beta_0+\beta_1X_1+\beta_2X_2+...+\beta_{11}X_{11} \quad (3\text{-}2)$$

It is called multiple overall linear regression equation, or overall regression equation for short. For N sets of observations Y_i X_{1i} , X_{2i} ,..., X_{11i} (i=1,2,3,..., n), the system of equations takes the form：

$$Y_i=\beta_0+\beta_1X_{1i}+\beta_2X_{2i}+...+\beta_{11}X_{11i}+\mu_i \quad (3\text{-}3)$$

A multiple linear regression model contains multiple explanatory variables that act

simultaneously on the explanatory variable Y. To examine the effect of one of the explanatory variables on Y, it is necessary to assume that the other explanatory variables remain constant for the analysis is performed assuming that the other explanatory variables remain constant. Therefore, the regression coefficients in the multiple linear regression model are partial regression coefficients, which reflect the effect of one of the explanatory variables on Y when the other variables in the model are constant. The regression coefficient in the multiple linear regression model is therefore the partial regression coefficient, which reflects the effect of one of the explanatory variables on the mean of the dependent variable when the other variables in the model are constant.

Since the parameters β_0 , β_1, β_2 ..... $\hat{\beta}_{11}$ are unknown, sample observations (X_1, X_2, X_3, ... X_{11}) can be used to estimate them. If the calculated parameter estimates are $\hat{\beta}_0$, $\hat{\beta}_1$, $\hat{\beta}_2$, ... $\hat{\beta}_{11}$, use the parameter estimates to replace the unknown parameters β 0, β 1, β 2 ..... with the parameter estimates of the overall regression function β 11, then the multivariate linear sample equation is obtained:

$$\hat{Y}_{11} = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + ... + \hat{\beta}_{11} X_{11} \tag{3-4}$$

where $\hat{\beta}_j$ (j=0,1,2,3...,k) is the parameter estimate, $\hat{\beta}_{11}$ (i=1,2,3, ..., n) is the sample regression value of $\hat{Y}_i$ or sample simulated value, sample estimated value.

3.5.2 Variable Settings

According to the theory of planned behavior research, the residents' own basic characteristics and the external environment they live in directly affect the degree of their willingness to pay for and accept compensation for municipal solid waste recycling. According to Xiao Junwei [7], the heterogeneity of farmers' own basic characteristics leads to the fact that the form of utility function is not exactly the same for each person, which has a direct impact on the willingness to compensate, for example, the difference of farmers' income will lead to the difference of the amount of willingness to pay, and the difference of farmers' age will lead to the difference of

farmers' life experience, perspective of things and the ability to accept new things. According to HeKe[8], the UTAUT model, the outcome of behavioral research theory, contains four control variables of gender, age, experience, and voluntariness.

The explanatory power of this model reaches 70%. Zhang Li has suggested that for the factors affecting citizens' behavior toward pro-environment, information sources have the greatest influence, [16] followed by: subjective willingness, social policies, norms, etc., respectively, and Zahard et al. focused on the fact that people's age and their level of knowledge about environmental concerns also have a great influence on their willingness to be compensated. And using a two-boundary dichotomous used a two-boundary dichotomous value assessment method to find that the presence of a household with a long-term illness and the level of education were important factors affecting the willingness to receive compensation. Factors [17], Using a right-end intercept model, haying Zhang et al. found that total annual household income, household size, and age heterogeneity all affect the willingness to pay of farm households.

Based on previous studies and questionnaire pre-studies, five personal and household characteristic factors were selected for inclusion in this paper as control variables, mainly including, gender, age, education level, number of household members, and annual household income. For respondents' personal and family characteristic factors, three characteristic indicators were added based on previous studies: whether they have subjective will, whether they are willing to accept the policy and whether they are influenced by others around them. The following hypotheses were made for the control variables: (1) Gender, age, and education affect the level of willingness to pay and receive compensation through personal experience, knowledge, and ability to accept new things. Men take on more social functions in society than women, and therefore have more experience, and men are able to accept higher levels of willingness to pay and receive compensation than women. The younger the respondents are, the more receptive they are to new things and therefore more able to accept higher levels of willingness to pay, and the older they are, the less able they are to tolerate risk and therefore willing to accept higher levels of willingness to compensate. The higher the level of education, the more knowledgeable about new technologies and policies, and more able to accept a higher level of willingness to pay. The lower the level of

education, the more conservative the thinking, and the less willing to pay a higher level of willingness to pay, and more willing to accept a higher level of willingness to be compensated. (2) The number of people living in the house and the annual income of individuals influence the level of residents' willingness to pay and receive compensation through the factors of household characteristics. The higher the number of people living in the household, the higher the expenditure of the respondents, and the lower the level of willingness to pay and the higher the level of willingness to receive compensation from the perspective of cutting costs. Respondents with higher annual household income have less financial pressure, and they can accept higher willingness-to-pay levels and higher willingness-to-reimburse levels. (3) Higher subjective willingness, better support for the policy and higher trust in the people around them make them more willing to accept and willing to pay as well.

According to behavioral research theories and numerous scholars' studies on MSW management, it can be obtained that subjective attitudes (AT), subjective norms (SN) and perceived behavioral control (PBC) have a greater influence on the compensation standard (payment, acceptance) of MSW management. The subjective attitude influence refers to the influence of respondents' own willingness to pay, willingness to receive compensation. Subjective norms economic value, perception of ecological value, knowledge of other technologies, and ease of access to policies. The perceived behavior control is mainly selected to see whether there are highly educated people, high income earners, and government workers around. The cognitive situation is mainly selected as the perception of economic value, ecological value, whether they know other technologies, and whether they have easy access to policies.

From the above reasons analysis, therefore, in this research, basic characteristics of individuals (gender, age, years of education), and basic characteristics of households (annual income, number of people living in the house) are included in the regression equation. Also included are subjective attitudes, subjective norms, and perceived behavioral controls as shown in Tab.3-3 for the basic descriptive statistical analysis of the eight independent variables, giving the minimum, maximum, mean, and standard deviation, respectively. From the descriptive statistical analysis of the variables, the sample distributions of gender, age, and subjective norms are relatively discrete.

And as well as the sample dispersions of perceived behavioral control, subjective attitude distribution by education and influenced by surrounding people were less.

Tab.3-3 Independent variable meaning and assignment

Variables	Meaning and assignment
Gender	Male=1,female=0
Education	College degree or higher =1,Others=0
Age	Older than 30,20-30=2, younger than20=1
Number of dormitories	More than 3 members=1, others=0
Income	5-10=1, 10-20=2, Over20=3
Distance form home to dust bin	Less than 100m，100-300m, Over 300m
Satisfied with the community environment	Yes/No
Difficult to deal of household waste	Know well about the MSW management = 1, others=0 Food waste，Plastic，Bottles，Metal Glass
Do you know the way of MSW management in China?	Yes/No
Would you like to pay for MSW management?	Yes/No
If you don't want to pay, what is the reason?	Tell the detailed reason.

Source: https://www.wjx.cn/report/112597570.aspx?arc=310000%2C1

3.6 Model test

If the independent variables are highly correlated or perfectly correlated with each other, it will cause the standard deviation of the regression coefficients to be too large, resulting in a poorer fit of the model, so a multicollinearity test is performed to eliminate the highly correlated independent variables. If the independent variables are highly correlated or perfectly correlated with each other, it will cause the standard deviation of the regression coefficients to be too large, and will even lead to the regression coefficients not being determined. Considering that there may be multicollinearity within or among the variables of performance expectancy, payoff expectancy, interpersonal trust, and institutional trust in this study, this study performs multicollinearity tests on the respective variables.

3.6.1 Correlation coefficient tests

The simple correlation coefficient test is an easy way to determine the presence of severe multicollinearity by using the degree of linear correlation between the explanatory variables. Usually, if the simple correlation coefficient of every two explanatory variables is relatively high, such as greater than 0.8, it can be considered that there is serious multicollinearity. The correlation coefficients of all variables were tested by SPSS, and the following results were obtained: the correlation coefficients of most variables were within 0.2 and a few were within 0.5, all of them were less than 0.8, so it was concluded that there was no serious multicollinearity among 11 independent variables.

However, by collating the data, it was found that the data on age and education level among the individual backgrounds in the objective data showed a higher willingness to pay contrary to the overall data.

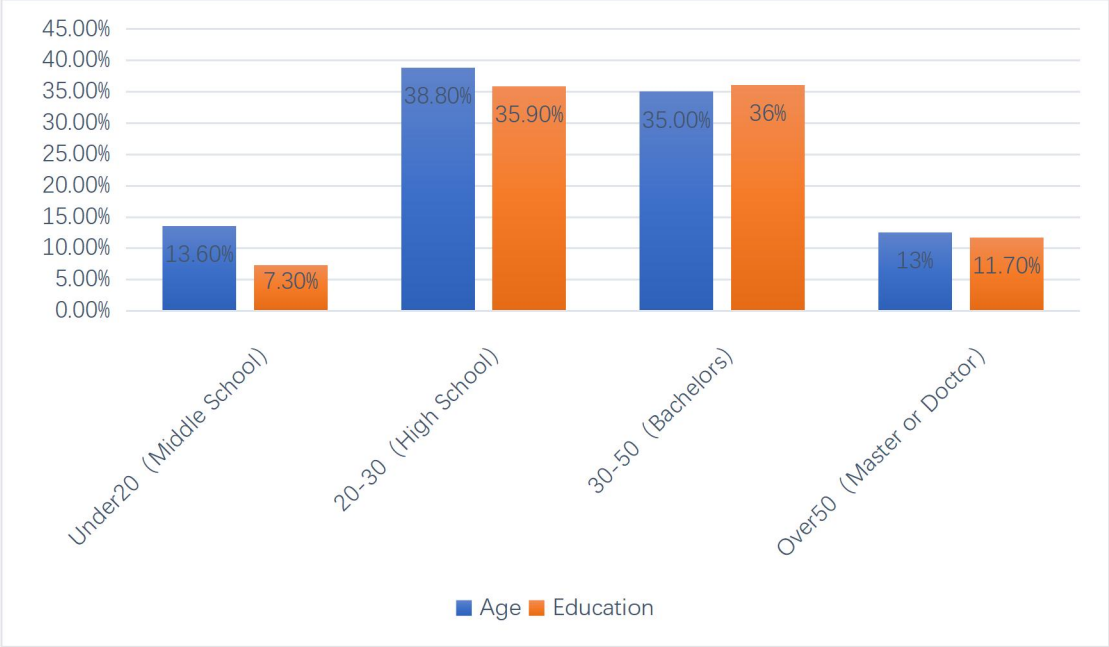

Fig.3-4 Age and education percentage distribution in raw data

For the questionnaire test of this model, the main expectation is to find the main core factors that really affect the willingness to pay. (Shows in Fig. 3-4)

According to the data in the chart, people in the 20-30 age group with a university degree have a higher willingness to pay than other data groups, with a 5% increase in willingness to pay for 20-30 year’ s old compared to the original data, and a 3% increase for university degree holders. Shows in （Fig.3-5）

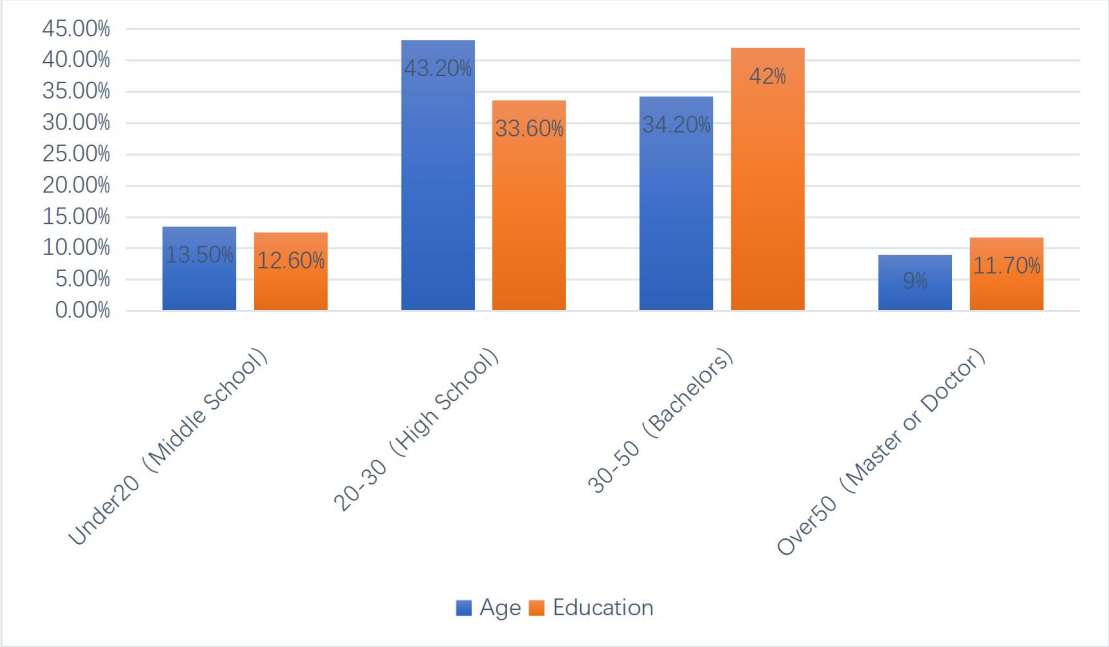

Fig.3-5 Percentage distribution of data agreeing to pay

For the questionnaire test of this model, the main expectation is to find the main core factors that really affect the willingness to pay. Between the background data of the social survey with large deviation values, we decided to put this questionnaire in the universities in Beijing.

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Chapter 4

MODEL TESTING AND METHOD

CHAPTER FOUR: RESEARCH METHOD AND MODEL TESTING

4.1 Research design

Through the data collation of the pre-survey questionnaire in the previous section, the best matched respondents in this study are: age group of 20-30 years old and education background of university bachelor's degree holders, as the social level of the matched respondents, this study will place the next questionnaire survey in Beijing's universities to conduct a willingness to pay survey for MSW management direction for current university students.

4.1.1 Research Location

The present study focus on Beijing, China, whose spatial location is displayed in Fig. 4-1. As the capital, located on the North China Plain (39.26'-41.03'N; 115.25'-117.30'E), Beijing comprises 16 districts for a total area of 16411km2. The population of Beijing was 21.5 million at the end of 2021. Notably, in these 16 districts, six districts are located in the inner city of Beijing, which is called urban area (i.e., Haidian, Chaoyang, Shijingshan, Fengtai, Dongcheng, and Xicheng), the majority of Beijing universities students' distributed in these areas (Shows in Fig. 4-1).

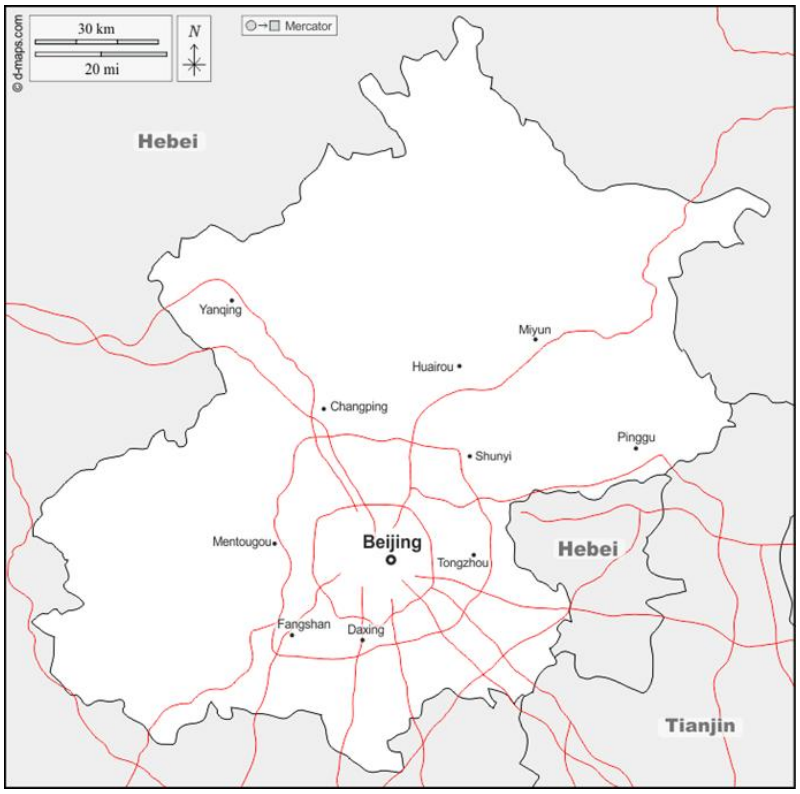

Fig. 4-1. Location map of the study area

4.1.2 Sample size

The CVM research must have a sufficiently large sample to obtain a high quality statistical result, and in general, the number of samples refer to the sampling formula of Lynn, et al. [1], as follows:

$$n = \frac{\mathrm{N}}{(\mathrm{N}-1)\sigma^2} + 1 \tag{4-1}$$

In this formula, n is the number of samples; N represents the overall size; σ is the sampling error.

The number of households in Beijing is 5.38 million, according to the formula, sample size should be over 401 to be statistical valid. As is mentioned by Mitchell and Carson, for the existence of hypothetical bias of hypothetical market, the sample size of CVM research should be larger that the conventional statistical threshold, and 600 samples can guarantee that the estimated WTP value and the true WTP value are controlled within 15% [2]. NOAA's report advised to have a sample capacity of more than 1000 [3].

4.1.3 Design of the questionnaire

To ensure the reliability of questionnaire, the questionnaire was revised and refined through literature review, consultation from experts, and pre-test of questionnaire (Shows in Fig. 4-2).

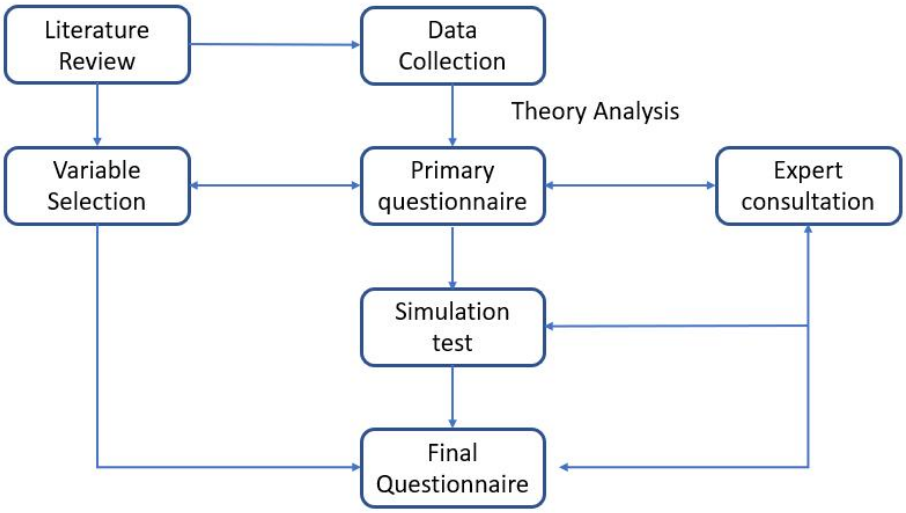

Fig. 4-2. Design process of the questionnaire

4.1.4 Data statistical methods

Online survey (Questionnaires)

In the research of Chapter five and six. The online survey method was applied. Since the 1980s, the widespread of internet technology has made it possible to conduct relatively inexpensive and convenient questionnaires, which has also improved the efficiency and flexibility of questionnaire research. A large number of online-based stated preference researches with regard to social science and business began to emerge. In the early 1990s, not everyone has the opportunity to get access to the Internet since it was a relatively new technology, especially for the elderly. As a result, online questionnaires have long been accused of lack of representative and low response rate [5]. Since the beginning of the 21st century, the number of Internet use has increased rapidly, and doubts about online questionnaires have begun to decrease. Ansolabehere and Schaffner [6] compared different questionnaire research method, pointing out that there are no significant differences between online questionnaire and conventional ones, which is also supported by Kaplowitz, et al. [7].

According to the China Internet Development Report [8], by 2017, the number of Chinese netizens has reached 772 million, and the Internet penetration rate was 55.7%. With the rapid

development of network technology in China, more and more researchers have turned to choose online social platforms and online media for related researches [9].

The online questionnaire research of China began in 1995 [10]. Up to now, researches with online questionnaire have covered areas such as social behavior and psychology [11, 12], consumer behavior [13], and environmental management [9].

Since the 21st century, a number of professional online questionnaire survey system have begun to appear and update continuously. The study was supported by Ranxing Information Technology Co., Ltd., one of the leading online research organizations of China. During the research, invitation emails were distributed to 2.6 million registered members of this research institution randomly. Users who agree to receive the questionnaire interview will receive a certain monetary reward. The questionnaire organization will analyze the user's IP address and account to ensure the authenticity of the sample, and impose certain penalties on duplicate and false answers to ensure the reliability of samples.

4.1.5 WTP Inference Methodology

In chapter four, the WTP elicitation method was the Dichotomous choice (DC) format to elicit respondents' WTP, which is also recommended by the report of NOAA report [3]. The DC method used in this experiment is the double-bounded dichotomous choice (DBDC), in which respondents are usually presented with two bids. If one selected "yes" for the first bid, the following bid will either be higher, or if "no", followed by a lower one. Compared with the other commonly used formats: single-bounded dichotomous choice (SBDC) and open-ended, the DBDC method provides the most conservative results in experimental research [14].

In chapter five, the WTP elicitation method was the SBDC, for it is convenient for data processing and thus suitable for establishing the predicting model.

4.1.6 Payment method study

We used the cash or E-Banking as the payment vehicle. The payment vehicle played an important role in our CVM study because it provided the payment context for the CVM

experiment. To avoid payment bias, the respondents must be familiar with the payment vehicle, and the payment vehicle should have a clear connection with the goods to be valued. We chose a payment vehicle with a compulsory feature such as a tax to reduce biased WTP values arising from potential behavior on behalf of the respondents (free-riding and over-pledging) [15]. Beijing citizens are more familiar with personal income tax than other types of taxation, which is the reason we chose this particular type of payment vehicle. The acceptance of this payment vehicle was tested during the pre-research.

As for the frequency of payment and duration of payment [16], we chose the annual fee with reference to the relevant research [26].

4.1.7 Bias of common methods

Most researchers agree that common method variance (variance that is attributable to the measurement method rather than to the constructs the measures represent) is a potential problem in behavioral research, the systematic error variance of which can have a serious confounding influence on empirical results, yielding potentially misleading conclusions [17]. The potential sources of common method biases in our research may due to respondents' propensity to maintain consistency in their responses to questions, and to attribute socially desirable behavior. Before the onsite interview, all of the interviewers were trained about how to behave and answer the possible questions that may be raised by respondents, including informing that the respondents' anonymity will be absolutely guaranteed. Each interviewer was followed with a supervisor to avoid interviewer bias. In addition, we separated WTP questions and variables with regard to respondents' attitude psychologically. In between WTP questions and TPB questions there is a 5-10mins interview about respondents' social economic characteristic, suggestions for the government, and answer the respondents' question. Following the suggestion of Podsakoff, et al. [18], Harman's single-factor test and partial correlation coefficients are employed to estimate the existence of common method bias.

4.1.8 Determinants of WTP

Over the past few decades, environmental policymakers have been increasingly concerned

about personal responsibility for environmental issues, and individual behaviors have received ever greater attention [19]. Initially, the research about the influencing factors of pro-environmental behavior focused on the characteristic of socioeconomic factors such as age, income, and family size. Such research was criticized as explaining only the variables of the most modest level of pro-environmental behavior. For these reasons, researchers began to turn their attention to psycho-social constructs.

One of the most popular methods is the theory of planned behavior (TPB). TPB is an extension of the theory of reasoned action (TRA). Ajzen and Fishbein established TRA in 1980 [20]. It aims to establish a connection between attitude and behavior. This theory was criticized for its limitation in dealing with behaviors of individuals with incomplete volitional control. TPB is the result of dealing with this limitation. According to the original TPB model, the most proximal predictors of behavior are behavior intention, which is partially influenced by: a) positive or negative attitude towards the behavior option b) subjective norms or society pressure c) perceived behavioral control, which is, the perceived ease or difficulty of this behavior. In experimental study, inspired by the TPB.

In the study of Chapter 4, we added covariates, such as attitude, subjective norms, and perceived behavior control, to the conventional ones used in previous studies (Shows in Fig. 4-3).

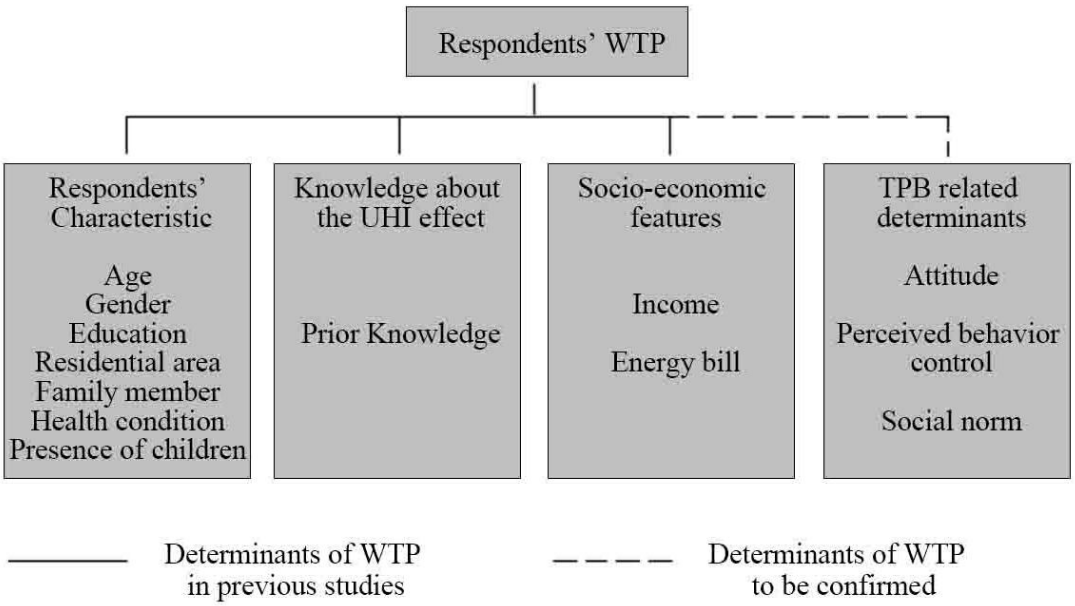

Fig. 4-3. Determinants of WTP

4.2 Data analysis

4.2.1 Mean WTP or medium WTP

In the data statistics of CVM survey, there has been a lot of controversy about whether to use average or median value for value evaluation. On the one hand, the previous analysis of the theoretical basis of the willingness to pay comes from the principle of income compensation of the John R. Hicks' consumer surplus, in which the equivalence variables and compensation variables are the average value; On the other hand, in general, as the analysis of this survey shows, the willingness of residents to pay is more discrete, so the average value is more likely to be influenced by extremum.

However, Bateman and Carson argue that averages have a very solid theoretical and logical basis, and that if the reasonability and efficiency of decision-making are emphasized, averages should be used, but from a fair point of view, because the median value indicates the willingness of 50% of respondents to pay, the median value is more suitable for democratic decision-making [21]. In this paper, the average value is used as the basis for valuation.

4.2.2 DBDC plus spike model

One import issue for the reliability and validity of CVM research is that a considerable proportion of respondents in the survey are unwilling to pay, which is defined as "zero responses" [22-24]. In developing countries, due to the lack of environmental awareness and the unfamiliarity with the CVM scenario, a large number of respondents in the questionnaire are unwilling to pay. According to the underlying motivation, the zero-responses can be further divided into "real zero responses" and "protest zero responses". "Real zero responses" means that the marginal utility of environmental changes is zero, while protest responses means respondents refuse to pay because they are dissatisfied with the payment vehicles or questioned about the validity of hypothetical market [25].

The proportion of protest responses is an important indicator for measuring the effectiveness and reliability of CVM research. Conventional distribution functions typically do not contain zero responses samples when estimating the willingness to pay. Previous studies found that the higher the zero-response rate, the larger the estimated WTP deviated from the real one [26]. The conventional way of dealing with zero-response samples is to either cull them or replace them with small positive numbers. Direct deletion not only ignores the completely different economic implications between the protest response and the true zero response, but also loses the effective amount of information and is more likely to cause sample selection bias [27, 28], while replacing zero responses with small positive numbers lack of theoretical basis, which may lead to subjective randomness. Recently, there have been concerns about the corresponding methods of identification and treatments for protest responses. [29, 30]

How to deal with zero-response problems through statistical models has become one important branch of CVM research. The Tobit model for analyzing restricted data become the earliest attempt to solve this problem. However, the regression coefficient of the Tobit model does not indicate the marginal impact of the variable, and thus it is impossible to analyze the extent to which the variable

affects the probability of the respondents joining the market or paying. In addition, the Tobit model implies a more rigorous assumption that the corner points are only derived from the budget constraints of the respondents, not other factors other than income. For these reasons, B. Kristrom proposed the Spike model based on a closed survey to correct the impact of a large number of zero-response samples under single-boundary condition WTP estimation. B. Kristrom believes that the conventional distribution function can be regarded as a special case of the spike model. The higher the zero-response ratio in the questionnaire and the more asymmetric the WTP distribution is, the better the fitting effect of the spike model will be [31].

1. The basic WTP model

We adopt the utility difference approaches, as suggested by Johansson, et al. [32], for modeling WTP responses. This approach specifies the utility difference using a random utility maximization

model. The utility function is defined as follows:

$$U = V(S, M; T) + \omega_{(1)} \tag{4-2}$$

Where U represents the independent variables of the utility function, including the respondents' income, socioeconomic characteristics, provision state of the goods to be valued, and other factors that affect the utility. In addition, S is the provision state of the goods to be valued; the value of S is 1 if the goods are provided and 0 otherwise. Income and the other factors are M and T, respectively. V is the indirect utility function that we can obtain by inserting the solution to the utility maximization problem into the objective function of the respondents' utility. Finally is a random component of the utility.

The respondent will maximize his or her utility by showing that he or she is willing to pay a certain bid, which is defined as A, if:

$$V(1, M - A; T) + \omega_1 \geqslant V(0, M, T) + \omega_{0(2)} \tag{4-3}$$

Rearranging Eq (2) yields:

$$V(1, M - A; T) - V(0, M, T) \geqslant \omega_0 - \omega_{1(3)} \tag{4-4}$$

The left side of Eq (3) is the utility difference, which is defined as $\Delta V(A)$, and this is the systematic and deterministic part; in contrast, while the right side is the non-systematic and random part. Let $\omega_0 - \omega_1$ be θ and $H\theta$ be the cumulative distribution function (cdf) of θ.

We can express the probability of achieving an answer "yes" to a given bid as:

$$\Pr\{\text{response is "yes"}\} = \Pr\{\Delta V(A) \geqslant \theta\} = H_\theta[\Delta V(A)]_{(4)} \tag{4-5}$$

We can introduce the WTP, X, as a random variable into the description of the probability of the responding "yes" to a presented bid:

$$\Pr\{\text{response is "yes"}\} = \Pr\{X \geqslant A\} = 1\text{-}G_C(A)_{(5)} \tag{4-6}$$

where is the $G_C(A)$ cdf of X. Comparing Eq (3) and Eq (4) yields:

$$1-G_C(A;\ \gamma)=H_\theta\left[\Delta V(A)\right]_{(6)} \tag{4-7}$$

Usually, we assume $\Delta V(A)=\alpha-\beta B$, where $\gamma=(a,b)$ is a parameter vector to be estimated.

2. The conventional DBDC-CVM model

The four possible responses paths in DBDC experiment were “yes-yes”, “yes-no,” “no-yes”, and “no-no”. The associated binary-valued indicator variables are I_i^{YY} I_i^{YN} I_i^{NY} I_i^{NN} respectively.

I_i^{YY} (ith respondents’ sample is ‘yes-yes’)

I_i^{YN} (ith respondents’ sample is ‘yes-no’)

I_i^{NY} (ith respondents’ sample is ‘no-yes’)

I_i^{NN} (ith respondents’ sample is ‘no-no’)

WTP (denoted as C) is recognized as a random variable with a cumulative distribution function (cdf), defined here as , where A is the bid value and is a vector of parameter. The loglikelihood function takes the form:

$$InL=\sum_{i=1}^{n}\left\{I_i^{YY}In\left[1-G_C(A_i^u;\gamma)\right]+I_i^{YN}In\left[G_C(A_i;\gamma)\right]+I_i^{NY}In\left[G_C(A_i;\gamma)-G_C(A_i^d;\gamma)\right]+I_i^{NN}InG_C(A_i^d;\gamma)\right\} \tag{4-8}$$

Formulating as logistic cdf and combining this with yields:

$$G_C(A_i;\gamma)=\left[1+\exp(a-bA)\right]^{-1} \tag{4-9}$$

3. Spike model

We applied the spike model, which is suggested by Kristrom [31] and Yoo and Kwak [33], to deal with zero responses. For people who gave a “no-no” response, a following question was

asked: Are you willing to pay any for this project? For each respondent I, I_i^{NN} can be classified into I_i^{NNY} and I_i^{NNN}, as follows:

I_i^{NNY} =1(ith respondent's response is "no-no-yes")

I_i^{NNN} =1(ith respondent's response is "no-no-no")

The log-likelihood function for the DBDC spike model is given by:

$$InL = \sum_{i=1}^{n} \left\{ I_i^{YY} In\left[1 - G_C(A_i^u;\gamma)\right] + I_i^{YN} In\left[G_C(A_i;\gamma)\right] + I_i^{NNY} In\left[G_C(A_i;\gamma) - G_C(0;\gamma)\right] + I_i^{NNN} InG_C(0;\gamma) \right\}$$

(4-10)

Where

$$G_C(A;\theta) = \begin{cases} [1+\exp(a-bA)]^{-1} & if A > 0 \\ [1+\exp(a)]^{-1} & if A = 0 \\ 0 & if A < 0 \end{cases}$$

(4-11)

4.2.3 Structural equation modelling

In chapter 6, we applied the structural equation model, SEM to establish the predicting model of people's WTP.

Structural Equation Model (SEM) is a very general and commonly used linear statistical modeling technique [34]. It is a comprehensive statistical method for analyzing the relationship between variables based on the covariance matrix of variables. It is also called covariance structure analysis. It is widely used in the fields of psychology, economics, sociology, etc. It is currently one frontier research areas in multivariate statistical analysis. Some scholars have pointed out that the structural equation model is a composite in the process of economic measurement, social measurement and psychometric development [35]. It is the comprehensive

application and improvement of statistical methods such as factor analysis, path analysis, multiple regression and analysis of variance. In research fields such as psychology, sociology, and other related area, a number of variables such assatisfaction, motivation, ability, etc., cannot be directly and accurately measured, which need to be measured indirectly through some direct observation variables. Conventional statistical methods cannot process these latent variables, while the development of structural equation models make up for this vacancy can has become an important tool for multivariate statistical analysis.

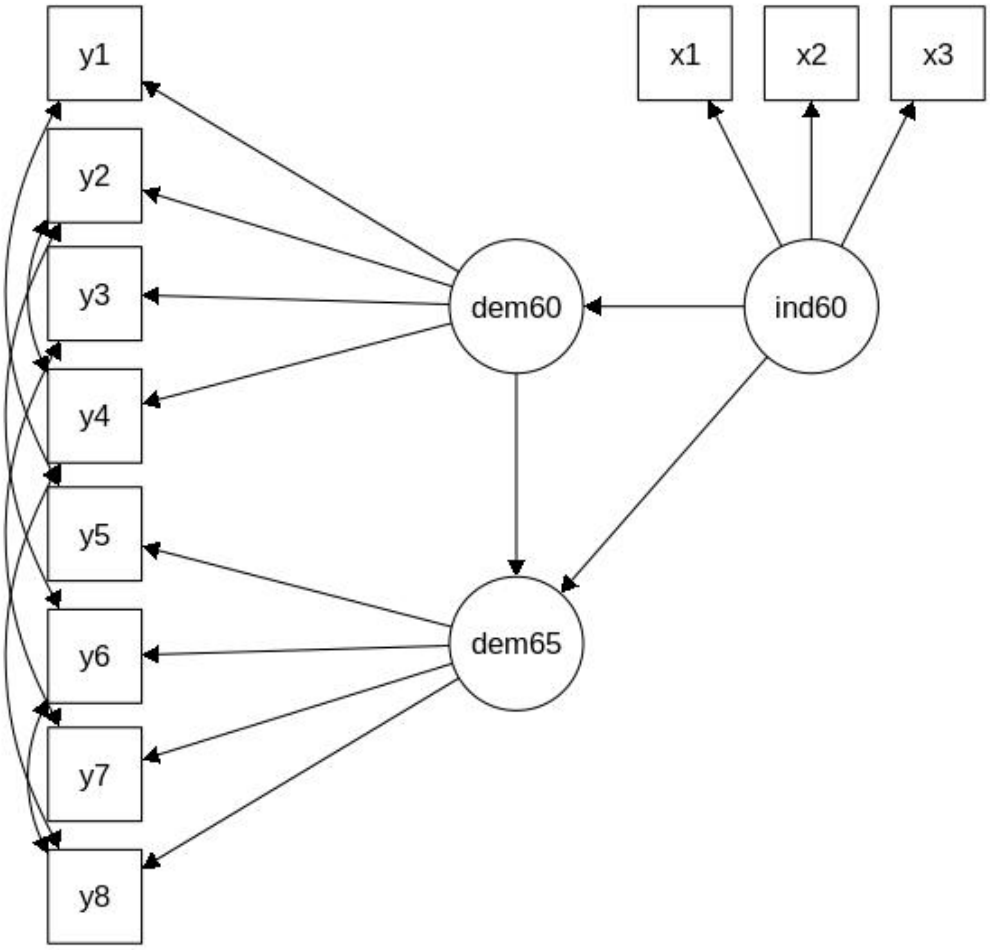

Figure 4-4. Structural equational model

A complete SEM model including measurement model and structural model. The former one describes the relationship between latent variables and observed variables, while the latter describes the relationship between the latent variables and the variance that cannot be explained by other variables in the model. SEM has several main concepts: 1. Observed variables, also

known as dominant variables, index variables, can be obtained through directly observation or measurement.

2. Latent variables are variables that cannot be directly obtained through directly observation or measurement. The fitness index of the structural equation model is an important indicator for evaluating whether the hypothesis model fits the actual data. According to the study of Hair, et al. [36], the fitness index is divided into three categories: absolute fitness index, incremental fit index, and parsimonious fit index.

Before testing the model fitness index, whether the model parameter have irregularity estimation should be checked. The main aspects are as follows:

1. Whether there is a negative error variance;

2. Whether the standardized parameter coefficient is greater than or equal to 1; 3. is there big standard error. It there is no violations, the following model fit index test can be performed. The absolute fitness index mainly includes the chi-square value, the ratio of chi-square and degree of freedom, the adaptive fit index, the adjusted fit index, the residual mean square and square root, and the mean and square root of the progressive residual, which are used to determine the model. The degree of covariance matrix and correlation matrix can be predicted.

3. The incremental adaptation index mainly includes the comparative fit index (CFI), the normed fit index (NFI), the Tucker-Lewis index (TLI) and the incremental fit index (IFI), which are used to measure the fitness of hypothetical theoretical model and he baseline model.

4. The simple adaptation index mainly includes the parsimonious goodness fit index (PGFI) and theparsimonious normed fit index (PNFI) to evaluate the simplicity of the model.The indicators and their evaluation criteria are shown in the Tab. 4-1.

Tab. 4-1. Fitness index of structural equation model

Types of model fit index	Fit index	Adaptability standards or Critical value
Absolute fit index	χ^2	$\rho<0.05$

	χ^2/df	< 3
	GFI	> 0.9
	AGFI	＞0.9
	RMR	< 0.05
	RMEA	< 0.08
Incremental fit index	CFI	> 0.9
	NFI	> 0.9
	TLI	> 0.9
	IFI	> 0.9
Parsimonious fit index	PGFI	> 0.5
	PNFI	> 0.5

The structural equation model has the following advantage:

1. Allow the existence of measurement errors within independent and dependent variables. Latent variables often contain unavoidable errors due to they are unable to be measured directly or cannot be measured with a single indicator. Regression analysis assumes that there is no error in the independent variable and only allows measurement errors in the dependent variable. The structural equation model allows both the independent variable and the dependent variable to contain measurement errors, and the latent variable can also be measured with multiple indicators, making the model fitting results more accurate.

2. It is able to handle multiple variables at the same time. In the conventional regression analysis and path analysis, the processing of multiple variables needs to be calculated one by one, so that when calculating a dependent variable, the existence and influence of other dependent variables are neglected, while the structural equation model can consider and process multiple variables simultaneously.

3. It is able to estimate the relationship between latent variables and observed variables, and the relationship between each latent variable. In order to measure a latent variable using conventional

methods, firstly, it is necessary to conduct exploratory factor analysis to obtain the relationship between the latent variable and the observed variable, which is regarded as the observed value of the latent variable. Then the correlation coefficient is calculated using the observed value, which is the correlation coefficient between the latent variables. The above steps are independent of each other, and the calculation of a certain factor is not considered while the influence of other related factors is not considered. The structural equation model can make the above steps simultaneously, which is, considering the relationship between the latent variables and the measured indicators and the relationship between the various potential variables.

4. Traditional statistical modelling methods have many restrictions for the model setting. For example, an observed variable can only belong to one latent variable. The structural equation model has few limitations, and the SEM modelling and analysis is itself is a dynamic process. Each analysis is based on the original adjustment. Each analysis structure can be the basis for the next adjustment. In addition, the same observed variables can be subordinate to multiple latent variables.

5. It is possible to estimate the fitness of the entire model. The structural equation model is a combination of factor analysis and path analysis. Different models can be designed and fit from the same sample data. According to the fitting parameter values, it is determined which model can reflect the relationship between the sample data more accurately, and optimized fit model and more realistic model interpretation can be obtained.

4.3 Model testing

If the independent variables are highly or perfectly correlated with each other, it will cause the standard deviation of the regression coefficients to be too large, resulting in a model with Therefore, the multicollinearity test is performed to eliminate the highly correlated independent variables. If the independent variables are highly If the independent variables are highly correlated or perfectly correlated, the standard deviation of the regression coefficients will be too large, and even the regression coefficients cannot be determined. Considering Considering that there may be multicollinearity within or among the variables such as performance expectation, payoff

expectation, interpersonal trust, and institutional trust in this study, the regression coefficients of this study are not determined. In this study, multiple cointegration tests were conducted for each variable.

4.3.1 Correlation coefficient tests

The simple correlation coefficient test is a simple method that uses the degree of linear correlation between explanatory variables to determine whether there is severe multicollinearity. The simple correlation coefficient test is a simple method to determine whether there is serious multicollinearity between the explanatory variables. Usually, if the simple correlation coefficient of each two explanatory variables is relatively high, such as greater than 0.8, a serious multicollinearity is considered to exist. The data of all variables were tested for correlation coefficients by SPSS. The results were as follows: most of the variables had correlation coefficients within 0.2 and a few were within 0.5, but all were less than 0.8, so The correlation coefficients of most of the variables were within 0.2 and a few were within 0.5, all of which were less than 0.8.(Shows in Tab.4-2)

Tab.4-2 Table of correlation coefficients

	Gender	Age	Education	Dormitories	Income	Distance	Cognitive
Gender	1	0.115	-0.272	0.21	0.011	0.158	0.552**
Age	0.115	1	0.244**	-0.123	0.368**	0.213	0.237
Education	-0.272	0.244**	1	0.218	0.281*	-0.302*	-0.251
Dormitories	0.21	-0.123	0.218	1	-0.289*	-0.037	-0.118
Income	0.011	0.368**	-0.302*	-0.037	1	-0.289*	-0.225
Distance	0.158	0.213	-0.251	-0.255	0.215	1	0.215
Cognitive	0.552**	0.237	-0.355*	-0.16	0.381*	0.215	1

4.3.2 Multi-collinearity test

Generally, when the variance inflation factor VIF=1, it can be considered that there is no multicollinearity between the respective variables; when VIF>5, it can be considered that there is some degree of multicollinearity between the respective variables; when VIF>10, it can be

considered that the respective variables are highly correlated.(Shows in Tab.4-3)

Tab.4-3 Multiple covariance test

Factors	Mean	Stand	VIF
Gender	0.52	0.21	4.545
Age	29.44	12.636	7.716
Education	12.82	3.231	4.547
Dormitories	3.73	1.536	4.803
Income	2.58	1.745	4.05
Distance	0.82	0.388	5.668
Cognitive	0.7	0.463	6.829

4.3.3 Significance test of the regression equation

4.3.3.1 Regression significance test of factors influencing WTP level

Suppose H_0: $\beta_0 = \beta_1 = \beta_1 = ... = \beta_0 = 0$;

H_1: β_j (j=0,1,2,...,k) is not all zero.

The F-test of the regression equation of the factors influencing payment criteria found that the model passed the F-test (F=6.451, p=0.000<0.05), given the significance level α=0.05, and the critical value of the degrees of freedom k-1=17 and n-k=212 F_α (17,212)=1.99, F=6.451> F_α (17,212)=1.99, at the F-distribution table. The original hypothesis should be rejected.

H_0: $\beta_0 = \beta_1 = \beta_1 = ... = \beta_0 = 0$, indicating that the regression equation is significant. It means that at least one of gender, age, years of education, annual income, total household size, distance to litter, higher education, higher income, economic value, ecological value, knowledge of other technologies, ease of access to policies, cost savings, and increased income will have an effect on the amount paid. That means the model is significant.

4.3.3.2 Regression significance test of WTA influence factors

Suppose H_0: $\beta_0 = \beta_1 = \beta_1 = ... = \beta_0 = 0$;

H_1: β_j (j=0,1,2,...,k) is not all zero.

The F-test of the regression equation of the factors influencing payment criteria found that the model passed the F-test (F=6.451, p=0.000<0.05), given the significance level α=0.05, and the critical value of the degrees of freedom k-1=17 and n-k=212 F_α (17,212)=1.99, F=6.451> F_α (17,212)=1.99, at the F-distribution table. The original hypothesis should be rejected.

H_0: $\beta_0 = \beta_1 = \beta_1 = ... = \beta_0 = 0$, indicating that the regression equation is significant. It means that at least one of gender, age, years of education, annual income, total household size, distance to litter, higher education, higher income, economic value, ecological value, knowledge of other technologies, ease of access to policies, cost savings, and increased income will have an effect on the amount paid. That means the model is significant.

4.4 Regression results analysis

4.4.1 Regression results analysis of factors influencing WTP level

The study used spss24.0 data statistical software to conduct multiple linear regression analysis on the willingness-to-pay level (WTP) of farm households in Xinjiang South Xinjiang Corps. The VIF of each influencing factor was <10, indicating that there was no serious multicollinearity, and the fit was 0.789, indicating that the overall fit of the model was good and the multiple linear regression analysis was scientific and credible. From the Tab, we can see that gender, age, years of education, knowledge of MSW management and fundamentals, surrounding people with bachelor's degree or above, surrounding people with high income, surrounding government workers, economic value, ecological value, knowledge of other technologies, easy access to policies, cost savings, and increased income were used as independent variables, and payment amount was used as dependent variable for linear regression analysis. The above table shows that the R-squared value of the model is 0.789, which means that gender, age, years of education, knowledge of MSW management practices and basics, surrounding people with higher education, surrounding people with higher income, surrounding government workers, economic value, ecological value, knowledge of other technologies, ease of access to policies, cost savings, and

increased income can explain 78.9% of the variation in payment amount. 78.9% of the variation in payments.

The F-test of the model found that the model passed the F-test (F=6.451, p=0.000<0.05), which means that gender, sex, age, years of education, knowledge of MSW management practices and basics, higher education in the surrounding area, higher income in the surrounding area, government workers in the surrounding area, economic value, ecological value, knowledge of other technologies, ease of access to At least one of the following factors had an effect on the amount of payment: years of education, area of cotton planted, surrounding government workers, ease of access to policies, and increased income had a significant positive effect on the amount of payment. The relationship between the number of people with higher education, the number of people with higher income, and the number of people with knowledge of other technologies had a significant negative effect on the amount of payment. However, gender, age, years of education, knowledge of MSW management practices and fundamentals, surrounding people with a bachelor's degree or higher, surrounding people with high income, surrounding government workers, economic value, ecological value, knowledge of other technologies, ease of access to policies, cost savings, and increased income did not have an effect on payment amount.(Shows in Tab. 4-4)

Tab. 4-4 Results of the linear regression analysis of WTP levels

	Non-standardized parameters β	Standard deviation	Standardized parameters Beta	t	P	VIF
Constants	58.834	15.685	-	3.751	0.001**	-
Gender	-15.431	4.692	-0.578	-3.289	0.003	4.546
Age	0.008	0.219	0.008	0.035	0.973	7.716
Education	0.31	0.659	0.083	0.47	0.012*	4.545
Income	-0.66	1.443	-0.083	-0.462	0.647	4.803
Dormitories	0.024	1.308	0.003	0.018	0.986	4.05
Distance	16.571	5.139	0.645	3.225	0.003**	5.885

Cognitive	-13.512	5.639	-0.534	-2.396	0.023*	7,308

Dependent variable: amount paid, D-W value:1.428, F=6.451, p=0.000, *p < 0.05，**p < 0.01

4.4.2 Regression results analysis of factors influencing the level of WTA

The study used spss24.0 data statistical software to conduct multiple linear regression analysis on the willingness-to-pay level (WTP) of farm households in Xinjiang South Xinjiang Corps. The VIF of each influencing factor was <10, indicating that there was no serious multicollinearity, and the fit was 0.76, indicating that the overall fit of the model was good and the multiple linear regression analysis was scientific and credible. From the Tab, we can see that gender, age, years of education, knowledge of MSW management and fundamentals, surrounding people with bachelor's degree or above, surrounding people with high income, surrounding government workers, economic value, ecological value, knowledge of other technologies, easy access to policies, cost savings, and increased income were used as independent variables, and payment amount was used as dependent variable for linear regression analysis. The above table shows that the R-squared value of the model is 0.789, which means that gender, age, years of education, knowledge of MSW management practices and basics, surrounding people with higher education, surrounding people with higher income, surrounding government workers, economic value, ecological value, knowledge of other technologies, ease of access to policies, cost savings, and increased income can explain 78.9% of the variation in payment amount. 78.9% of the variation in payments. (Shows in Tab. 4-5)

Tab. 4-5 Results of the linear regression analysis of WTA levels

	Non-standardized parameters β	Standard deviation	Standardized parameters Beta	t	P	VIF
Constants	71.084	30.677	-	2.316	0.027	-
Gender	0.723	3.958	0.027	0.183	0.856	4.546
Age	-0.251	0.39	-0.243	-0.643	0.525	7.716
Education	-2.848	0.962	-0.735	-2.96	0.006**	4.545

Income	-1.643	1.421	-0.188	-1.157	0.256*	4.803
Dormitories	0.521	1.86	0.061	0.28	0.781	4.05
Distance	12.896	4.952	0.496	2.604	0.014*	5.885
Cognitive	7.793	4.942	0.3	1.577	0.125	7,308

Dependent variable: compensation amount,

D-W value:1.740, F=5.444, p=0.000, *p＜0.05, **p＜0.01

4.4.3 Analysis of the size of factors influencing the level of residents' willingness

Based on the results of the regression analysis, it can be seen that the influencing factors affecting the level of willingness to pay are, in descending order, education level, income level, age, and whether or not they understand the technological approach. The factors influencing the level of willingness to pay are, in descending order, income level, years of education, annual income, and highly educated person. The three influencing factors of years of education, highly educated person, age, and whether to increase income had an impact on both willingness to pay and willingness to be paid levels. (Shows in Tab. 4-6)

Tab.4-6 The factor influencing the level of respondents

Influencing Factors	WTP level	WTA level
Age	0.418	-2.848
Education	0.31	12.896
Income	16,571	-11.911
Dormitories	-13.512	-
Distance	10.394	-
Cognitive	10.396	-

4.5 Conclusion

In this chapter, we analyze the factors influencing the willingness to pay and the willingness to be paid levels of farmers. Secondly, the age of young people, the surrounding people with high education of bachelor degree or above, the surrounding people with high income, and the knowledge of other technologies will have a significant positive influence on the level of willingness to pay. Third, the walking distance of waste disposal will have a significant negative influence relationship on the level of willingness to pay. Fourth, the number of years of education, annual income, and whether to increase income have a significant negative effect on the level of willingness to pay. Fifth, among the influencing factors, the lower the age, the higher the interest in the new technology, the stronger the propensity to know and the willingness to pay, in addition to higher education will have a higher level of willingness to pay and the propensity to use.

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Chapter 5

BEIJING UNIVERSITIES STUDENTS' INTETION TO MANAGEMENT FOR CAMPUS WASTE SEPARATION AND RECYCLING BEHAVIOR

CHAPTER FIVE: BEIJING UNIVERSITIES STUDENTS' INTETION TO MANAGEMENT FOR CAMPUS WASTE SEPARATION AND RECYCLING BEHAVIOR

5.1 Introduction

With the development of sustainable cities in China, the future direction of sustainable city construction will permeate all aspects of city and society. University campuses, as one of the first environments and platforms to connect with society, can offer the earliest social aspects of environmental education to students on campus, in this research, a new way of sorting garbage recycling by using a new type of intelligent garbage recycling system into China green campus construction in China. On the other hand, its suitability for the current practical needs of waste recycling on university campuses in China should be considered. Therefore, this research focuses on the possibility of using the intelligent garbage sorting system in green campuses in China. Taking the representative universities of green campuses in China as an example from the requirement side, the theory of planned behavior is used to evaluate the users' willingness to use green campuses. The survey in the Theory of Planned Behavior is divided into three main factors, Attitude， Subjective norms， Perceived behavioral control. The results show that TPB theory is generally applicable to the evaluation in green campuses in China. The purpose of adapting to the development of green campus in China is to provide willingness to use and suggestions for sustainable technologies and products in green campus in China.

5.2 Research background

Sustainable development has become a requirement of this era. As the core force of development, green campus is an important way to promote the construction of ecological civilization and to advocate the concept of sustainable development. How to improve the sustainable development concept and conduct green campus construction activities in line with national conditions has become a key point in environmental education for college students [1]. As a social model for the harmonious development of man and nature, thus promoting the sustainable development of the whole society. Currently, the planning and construction of green campuses are more mature abroad than in China [2]. In the 1990s, 20 world-renowned university presidents presented the Talloires Declaration [3] at an international symposium on the role of universities in environmental management and sustainable development held in Talloires, France [4]. This

opened the way for the construction of green campuses worldwide. Later, the United States took the lead in proposing the Green University Initiative [5]. Among them, Harvard University released the "Harvard Green Campus Initiative. Campus Initiative", which proposes to implement sustainable strategies in campus construction while encouraging the implementation of a campus-wide environmental satisfaction survey and management system [6].

At present, for example, there are about 1 million people in Beijing colleges and universities in China [7], and the activities of college students produce a very large amount of solid waste every day, and in college campuses, college students have a strong awareness of environmental protection, and it is very easy to achieve results in the work of solid waste separation [8]. The lack of awareness of waste separation, knowledge of waste separation and recycling, and the lack of related systems have led to the persistence of this phenomenon [9].

In addition, the management of garbage sorting in colleges and universities mainly adopts the method of fixed-point putting, and although the separated garbage bins are arranged, the phenomenon of putting solid garbage randomly still exists without fixed incentives and supervision. The basic unit for waste separation on college campuses is the dormitory, which is an important environment for students to develop the habit of waste separation. The last point is the lack of effective guarantee for the behavior of garbage sorting. The lack of variety and practicality of garbage bins to satisfy the students' garbage sorting in student dormitories makes the behavior of garbage sorting lack the most basic material guarantee, on the other hand, the relevant restraint and incentive mechanism has not been established.

The Intelligent Garbage Sorting System (IGSS) is a widely used method of intelligent MSW sorting that is an effective way to improve MSW management and increase the productivity of cleaning contractors on college campuses [10]. It can improve the efficiency of waste incineration processing by significantly increasing the efficiency of recycling and sorting compared to the current MSW processing methods that are primarily performed on college campuses [11]. the MSW sorting function of IGSS is one of the most practical and economical methods that can reduce the cost of asynchronous processing by 80-90% [12].

In this regard, health hazards in MSW, such as germs and other substrates, can be greatly reduced. In addition, pre-sorting of non-combustible MSW (metals, glass, etc.) can significantly reduce the cost of second separation. In this study, willingness to classify MSW was defined as the behavioral tendency of college students toward IGSS use, which was influenced by their thoughts and perceptions. The case for focusing on IGSS use has been frequently discussed in previous studies and has played an important role in improving MSW management in some regions of China [13]. Compared to the domestic experimental use of IGSS, there are not many cases of IGSS use within colleges and universities, and whether IGSS can be successfully used within colleges and universities needs to be investigated after a survey of the willingness of school students.

5.3 Research method

The Theory of Planned Behavior (TPB) model

Previous research has established that environmentally beneficial products, services, or systems associated with IGSS are defined as having "non-market" values that cannot be assessed through market behavior, but rather through non-market assessment techniques [14]. Thus, in this study, the non-market value assessment techniques widely used in previous studies suggest that the behavioral intentions used in IGSS include not only personal context, such as gender, age, and income, but also focus on personal psychological constructs, such as attitude (AT), the behavioral attitude in question, and subject norms (SN), a social factor referring to the perceived social pressure to perform the behavior or not. Perceived Behavioral Control (PBC) is a person's belief about the ease or difficulty of performing the behavior, ease or difficulty of performing the behavior, and is a predictor of behavioral disposition. The Theory of Planned Behavior (TPB) model was first proposed by Ajzen [15]. It suggests that individuals' attitudes, subjective norms, and perceived resources toward particular behaviors can help us better understand pro-environmental behaviors. (Shows in Fig. 5-1.)

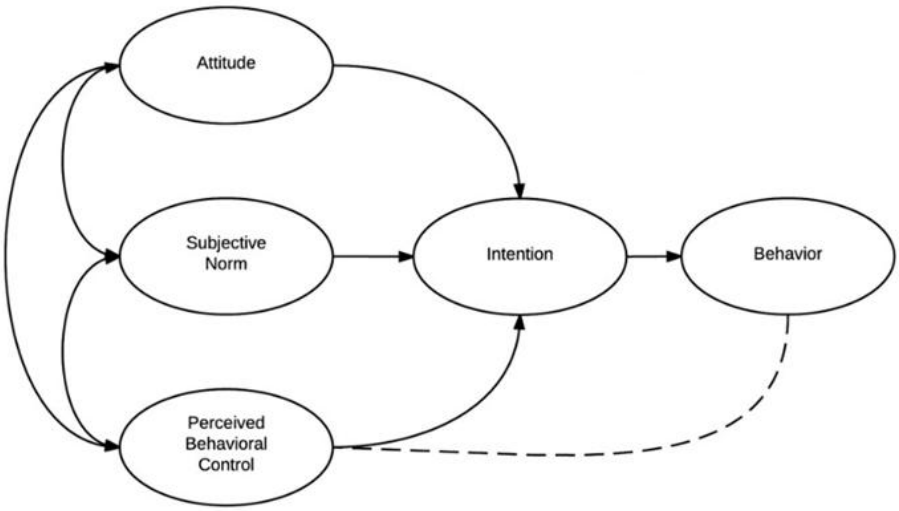

Fig. 5-1. The Theory of Planned Behavior model.

Questionnaire

In this study, we intend to use a questionnaire. The questionnaires were distributed by the relevant responsible department on campus to accurately recruit participants. Participants will receive certain souvenirs, etc.

The core of the questionnaire is whether you, as a college student currently on campus, would like to use IGSS to classify all the garbage in your daily life in the future. The main questions were related to the behavioral characteristics of the interviewed college students. This section uses a 5-point Likert scale by asking respondents about their AT, SN, PBC, and intentions regarding campus MSW management and referring to respondents' attitudinal characteristics regarding pro-environmental behaviors regarding MSW management on 5-point Likert scales. (1=strongly disagree, 5=strongly agree) (Shows in Tab. 5-1)

Tab. 5-1. Constructs and indicators of the TPB model.

Predictors	Indicators	Response scale (1-5)
Attitude (AT)	I think it is very positive for the campus to use IGSS. I think campus use of IGSS is a responsibility. I think campus use of IGSS is pro-environmental	Strongly disagree – Strongly agree
Subject norm (SN)	I think my roommate's will accept the campus use of IGSS. I think my roommate would support campus use of IGSS. I think my roommates would support my agreement to use IGSS on campus.	Strongly disagree – Strongly agree
Perceived behavioral control (PBC)	I think my use of IGSS will improve the environment on campus. It is not difficult for me to contribute to solid waste management on campus. I think I have the time, energy and resources to contribute to solid waste management on campus.	Strongly disagree – Strongly agree

TPB (theory of planned behavior) is intended to predict and explain the behavior of individuals in specific situations. The theory of planned behavior covered six areas: (1) Behaviors that are not completely controlled by individual will are influenced not only by behavioral intentions but also

by actual control conditions such as personal abilities, opportunities, and resources; (2) Accurate perceived behavioral control is reflective of the state of actual control conditions and therefore can be used as a proxy measure of actual control conditions to directly predict the likelihood of a behavior occurring, and the accuracy of the prediction depends on the true degree; (3) AT, SN, and PBC are the three main variables that determine behavioral intention; the more positive the AT, the greater the support of significant others, the stronger PBC, and the greater behavioral intention, and conversely; (4) An individual possesses a large number of beliefs about behavior, but only a fairly few behavioral beliefs are accessible at a certain time and context; these accessible beliefs, also known as contingent beliefs, are the cognitive and affective basis for AT, SN, and PBC; (5) Personal as well as sociocultural and other factors (e.g., personality, intelligence, experience, age, gender, cultural background, etc.) indirectly influence AT, SN, and PBC by influencing behavioral beliefs and, ultimately, intentions and behaviors; (6) AT toward behavior, SN, and PBC can be completely different conceptually, but at times they may share a common basis of beliefs. Thus, they are both independent of each other and interrelated.

5.4 Result and discussion

5.4.1. Data.

A total of 930 formal valid questionnaires were sent, of which 790 samples were willing to pay, accounting for 85% of the total; 140 samples were unwilling to pay, accounting for 15% of the total. It shows that most of the students within Beijing colleges and universities have a tendency willingness to use and they have a high awareness of ecological environmental protection, which is related to the high level of education and the ability of college students to accept new knowledge and technology. It is related to the government's publicity and attention to environmental protection in recent years. There are 10% of students who are not willing to classify garbage, mainly because: there is no perfect equipment base and recycling location in colleges and universities; personal information will be leaked and individuals do not have the will to classify garbage; there are also students who say that the garbage they usually collect can be sold for money and the compensation price after classification and recycling is higher.(Shows in Fig. 5-2)

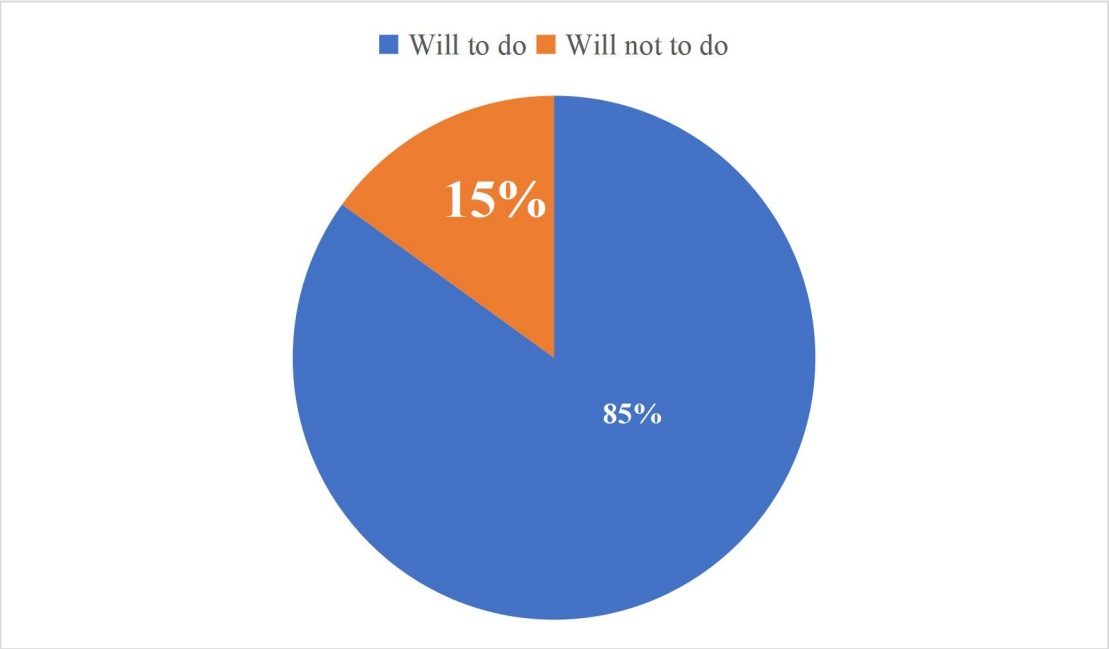

Fig. 5-2 Distribution of students' intention to use

The demographic characteristic of samples are as follows:(Tab. 5-2/ 5-3/ 5-4/ 5-5)

Tab. 5-2. Gender of samples

	Number	Percent	Valid Percent
Male	470	51%	50%
Female	460	49%	100%

Tab.5-3 Age of samples

	Number	Percent	Valid Percent
18-22	489	52.6%	52.6%
22-25	369	39.6%	92.2%
Over25	72	7.7%	100%

Tab. 5-4. Education level of samples

	Number	Percent	Valid Percent
Bachelor degree	489	52.6%	52.6%
Master degree	369	39.6%	92.2%
Higher than Master	72	7.7%	100%

Tab. 5-5. dormitory size of the sample

	Number	Percent	Valid Percent
More than 4	628	67.5%	67.5%
2-4	284	30.5%	30.5%
1	18	2%	2%

Tab. 5-6 explains the distribution of ITU's. In total, four bid combinations are defined. (1/2/4), (4/8/15), (8/15/30), times.

The total number of surveys was 930, equally distributed among the four bid combinations. The number of responses and the number and percentage of "yes" responses decreases roughly with the number of weekly classifications, accompanied by a rapid increase in the percentage of "no" responses was accompanied by a rapid increase in the proportion of "no-no-no" responses. For example, in the (1/2/4) bid combination, the proportion of "yes-yes" responses is 15%, while in the combination, this proportion decreases to 1%.

At the same time, the "no-no-no" responses rose from 32% to 73%. It rose from 32% to 73%. The sample with zero responses accounted for 57% of all samples in this study. accounted for 57%, which indicates the need to apply the spike model.

Tab. 5-6. Distribution of bids

Frequency	Sample Size	Yes-Yes	Yes-No	No-Yes	No-No-Yes	No-No-No
1/2/4	310	49	85	46	36	94
4/8/15	310	23	46	47	36	158
8/15/30	310	17	24	41	44	184
15/30/50	310	13	18	23	57	199
Total	930(310)	102	173	157	173	635

Tab. 5-7 show the definition and analysis of the sample variables. The Beijing Bureau of Statistics only provided values for gender, family size, education level, and age of college students. In our sample, respondents were equally distributed among males (51.6%) and females (48.4%). 57.4% of the sample were in the 18-22 age group, while 23% and 19.6% were above the age of 25, 22-25, respectively. As for dormitory size, 2 to 4 dormitory members were the most members (61.7%), followed by four or more (21.8%) and only one (16.5%). There were 38 of the respondents had reached a master's degree or higher education level.

Tab. 5-7. Definitions and sample statistics of the variables

Variables	Mean	Dev	Census
Gender (male=1, female=0)	0.50	0.50	0.50
Education (college or higher=1,high school or lower=0)	0.38	0.49	0.36
Age (more than 25=3,22-25=2,<22=1)	1.77	0.99	0.36
Dormitory size (more than 4=3,2-4=2,<2=1)	2.05	0.99	1.90
Income (less than 300=1,3000-8000=2,more than 8000=3)	1.88	0.79	-
Employment (have a job=1,don’t have a job=0)	0.63	0.49	-
Attitude (Regarding urban environment as important=1,Regarding urban environment as not important=0)	0.49	0.5	-

Social norm (Family or friends won't support respondents' pro-environment behavior=0,Family or friends will support respondents' pro-environment behavior=1)	0.42	0.49	-
Knowledge (Know well about the effect of green roof in MSW management=1, Don't know about the effect of green roof in MSW management=0)	0.19	0.39	-
Perceived behavioral control (Considering improving urban environment as not difficult=1,Consider improving urban environment as difficult=0)	0.14	0.34	-

5.4.2 Descriptive Analysis

In terms of the individual option for MSW management, 89% of the respondents reported their preference option. "Support the MSW management project financially" was the option that most respondents preferred, accounting for 49% of the answers. About 20% of the respondents opted for participating in activities that alleviate MSW management. In addition, 18% of respondents said they would promote knowledge about the MSW, while 13% said they would not do anything. The public willingness to participate in MSW management is great (Fig. 5-3).

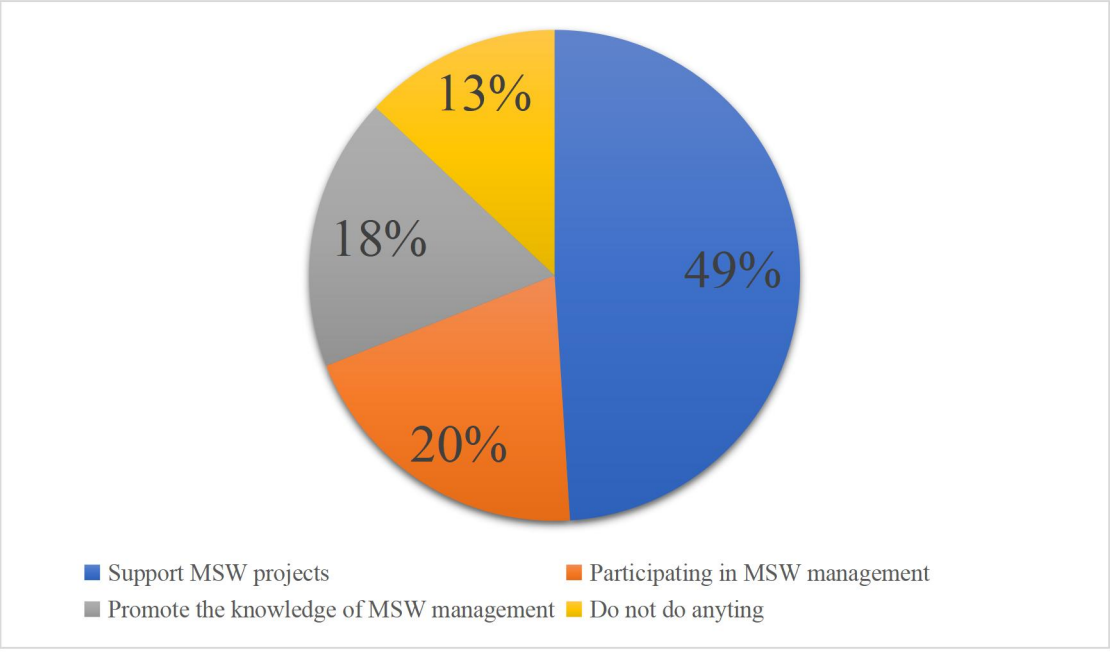

Fig. 5-3 Respondents' preferred option in participating in MSW management

We also surveyed suggestions for strengthening participation in MSW management." Full disclosure of environmental monitoring information" and "elimination of personal information" accounted for 88% of the responses, reflecting the strong desire of campus students for information transparency." Establishing a legally guaranteed incentive mechanism for reporting pollution" accounted for 5% and 3% of respondents wanted to provide environmental protection through legal services (Fig. 5-4).

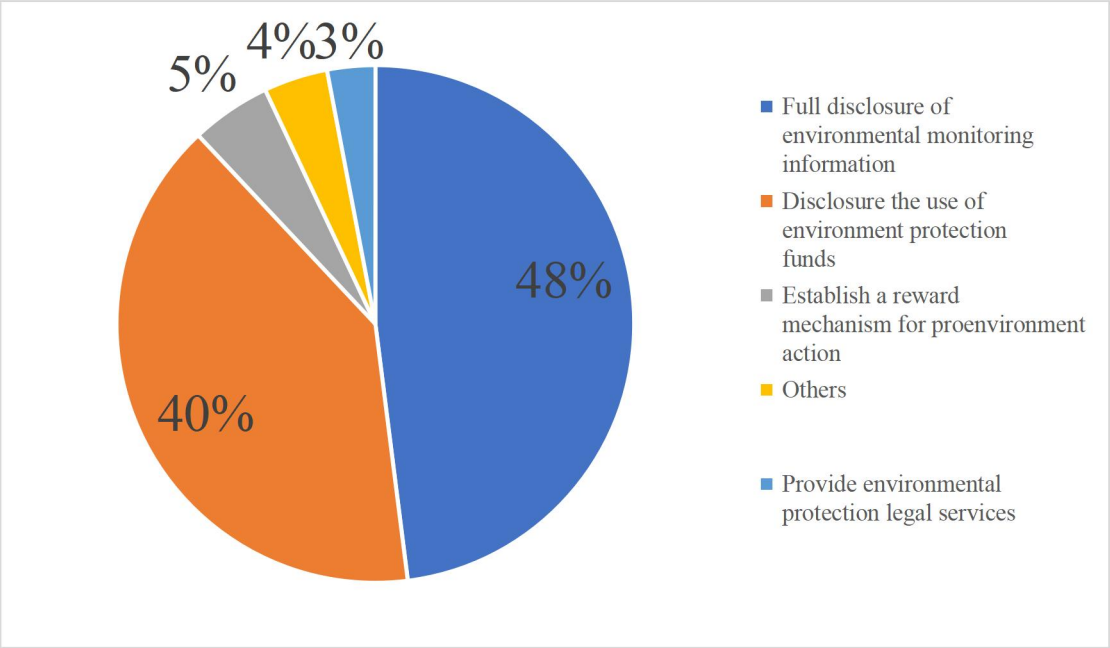

Fig. 5-4. Suggestions for increasing residents' participation in MSW management

The results of the estimation are explained in Tab. 5-8. The parameter can be estimated using the maximum likelihood estimation function. The second column of the table provides the estimation results without covariates. The coefficient on the bid value is statistically significant (at the 1% level).

This means that more frequent use reduces the likelihood of "yes", as expected. The third column shows the estimated results with covariates and variables that may affect the likelihood of a "yes" response. Of the estimated coefficients, attitudes and social norms are statistically significant at the 10% level. Perceived behavioral control, education, and income are statistically

significant at the 5% level. This indicates that respondents believe that they have enough time and resources to do.

This indicates that respondents who feel they have enough time and resources to participate in environmental activities, as well as those with higher incomes and better education, are more willing to contribute to this project. They are more willing to contribute to this project. Also, attitudes toward urban environmental issues and social norms about the environment Also, attitudes toward urban environmental issues and social norms about environmental protection influence to some extent the residents' WTP.

In particular, the estimates of the spikes are 0.56 (model without covariates) and 0.57 (model with covariates). covariates), which is similar to the zero-response ratio.

Tab. 5-8. Estimation results of the model

Variable	Model without covariates	Model with covariates
Constant	-0.08 (-0.99)	-1.36 (-3.20) ***
Frequency	-0.49 (12.19) ***	-0.52 (13.54) ***
Gender		-0.06 (-0.21)
Education		0.87 (2.01) **
Age		0.17 (0.17)
Dormitory size		-0.07 (-0.41)
Attitude		0.42 (1.67) *
Knowledge		0.15 (0.36)
Social norm		1.32 (1.89) *
Perceived behavioral control		0.28 (2.05) **
Spike	0.56 (22.57) ***	0.57 (21.27) ***
Log-likelihood	-1011.48	-992.98
Wald statistic (p-value)	593.7 (0.00)	519.88 (0.00)

Notes: the t-values, computed from the analytic second derivatives of the log- likelihood function, are

reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The null hypothesis is that all the parameters are jointly zero, and the corresponding p-value is reported in parentheses after the statistic.

5.5 Conclusion

Through the questionnaire of the Theory of Planned Behavior, the awareness and tendency of school students for waste separation and recycling can be predicted through the collation and analysis of data. In addition, colleges and universities are needed to build a comprehensive, continuous and normalized formation process through propaganda, education, practice, restraint and incentive, and then form a synergy to promote the formation of environmental habits among college students.

Strengthen garbage sorting education and improve campus garbage sorting facilities. Bring garbage sorting education into the university courses. On the one hand, we can establish the awareness of the necessity and feasibility of garbage classification among college students through public courses on environmental protection and garbage classification, so that the awareness of garbage classification can enter students' subconsciousness and be implemented into practical actions; On the other hand, university campus can promote and popularize the knowledge of garbage classification through establishing the base for cultivating the awareness of garbage classification. We should improve the three-dimensional classification layout of student dormitories, student apartment buildings, campus corners and garbage sorting points, and build scientific and reasonable garbage sorting points to ensure that garbage sorting can be carried out successfully.

Play the leading role of the department in charge of the campus and establish a reward and punishment incentive mechanism. Student cadres in colleges and universities should take the lead in practicing garbage classification, play an exemplary role, make daily activities an important node to actively promote and popularize garbage classification knowledge, and involve college students in specific garbage classification practices through garbage classification volunteers, and

other forms. At the same time, colleges and universities should establish relevant reward and punishment incentive mechanisms, incorporate the reward and punishment mechanism of garbage classification into the assessment, clarify the responsibility of garbage classification, strengthen the behavior of garbage classification and motivate college students by strengthening the civilized hygiene of dormitories, and prompt college students to develop the habit of garbage classification.

Create more atmosphere of garbage classification publicity. The habit of garbage classification is a longtime process, which cannot rely on the power of campus only, such as the winter and summer life may make the habit of garbage classification which has been formed unsustainable, therefore, it needs the joint efforts of family, campus and all walks of life to form a synergy to provide public opinion support and social atmosphere for the habit of garbage classification of college students. Meanwhile, colleges and universities make use of electronic screens, banners, posters and slogans on campus to systematically and effectively publicize the work of garbage classification, so that more college students can feel the importance of their role in garbage classification. Increase the supply of garbage sorting products. Nowadays, the responsibility of garbage classification has been shifted from the initial street and community to more detailed units mainly in families or student dormitories, but the current supply of products, especially the supply of garbage classification products for basic units such as families and dormitories, has not effectively kept up with the times. Sorting and recycling method.

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Chapter 6

EXTENDED THEORY OF PLANNED BEHAVIOR FOR PREDICTING THE WILLINGNESS TO PAY FOR MUNICIPAL SOLID WASTE MANAGEMENT

CHAPTER SIX: EXTENDED THEORY OF PLANNED BEHAVIOR FOR PREDICTING THE WILLINGNESS TO PAY FOR MUNICIPAL SOLID WASTE MANAGEMENT

6.1 Introduction

According to the World Bank’s review, global municipal solid waste (MSW) generation levels are estimated to increase to approximately 2.2 billion tons per year by 2025 [1]. Consequently, the traditional waste management system has encountered difficulties in disposing of large volume of MSW [1], which has led to inadequate disposals and has become a severe problem in many developing countries. China sur-passed the U.S as the world's top MSW producer in 2004. Now, China's MSW generation is growing at an annual rate of 8–9% [1]. From 2010 to 2019, MSW production in Beijing rose from 6.35 million tons per year to 10.11 million tons, averaging 27,700 tons per day, which is 1.2 kg per person per day. With a series of policies, regulations, and measures, the composition structure of MSW management technology has changed in proportion; in 2020, Beijing reached 87% of MSW recycling (43% by incineration, 45% by landfill, 12% by composting). [2] In addition, the main problem of MSW management in China is that the MSW composition is complicated. The average water content of MSW in Beijing reaches 50.19%, and this mixed MSW makes it difficult to sort and recycle. [2] The water contained in MSW not only pollutes recyclables in MSW, but also brings difficulties and increases the cost of MSW disposal, collection, transfer, transportation, and treatment. Therefore, the pre-sorting and treatment of MSW becomes a necessary condition for incineration. [2] In this case, effective MSW management has become necessary, not only from the human health perspective, but also from the aspect of environmental concerns [3]. Effective MSW management approaches such as smart MSW sorting systems [3] have been proposed to minimize the harmful effects of inadequate disposal in urban areas. However, in China, there is a lack of a uniform standard for MSW management charges, with local governments specifying the charges within administrative districts, one of which is levied incidentally through utility charges such as water, gas, and electricity [4]. Specifically, the payments for MSW management have normally been extracted from utilities expenses by local residents, which has become a possible cause of conflict regarding payments between residents and the local government [4]. The intelligent garbage sorting system (IGSS) is a widely used smart MSW sorting approach and is an effective way to improve urban MSW management and increase the productivity of cleaning contractors [5]. Compared with the current MSW treatment methods mainly per-formed in Beijing city, it can improve the efficiency

of waste incineration treatment by substantially improving the efficiency of recycling and separation [5]. The MSW sorting features of IGSS are one of the most practical and economical methods and can reduce the costs of unsynchronized disposal by 80－90% [5]. In that regard, health-hazardous factors in MSW such as germs and other substrates can be substantially reduced [5]. In addition, the pre-sorting of unburnable MSW (metals, glass, etc.) can significantly reduce the costs of the second separation [5]. In this study, willingness to pay (WTP) is defined as the willingness of local residents to pay for IGSS, which is influenced by their thoughts and perceptions. Cases focusing on the WTP for IGSS have been frequently discussed in previous research and have played an important role in improving MSW management in developed countries [6,7]. In Europe, different countries have regulations on MSW separation and recycling, but there is no uniform standard for MSW management (it mainly depends on the consciousness of local residents) [8,9]. In addition, in Germany, the recycling of certain bottles can be rewarded in supermarket recycling devices (Similar to a type of IGSS), which improves the motivation of local residents for MSW separation [10]. In Japan, local residents sort MSW by different colored bags, and different levels of fees are associated with sizes and categories, which significantly increases the treatment capability of IGSS [11,12]. Com-pared with Europe and Japan, MSW management began late in China, with a larger amount of MSW. In this study, investigating local residents' WTP for MSW management will contribute to the development of government policies on MSW management.

Previous studies have ascertained that environment-beneficial products, services, or systems related to the IGSS are defined as having a "non-market" value [13], which cannot be assessed by market behavior, but by non-market valuation techniques [14,15]. Thus, in this study, a widely used, non-market value evaluation technique of the contingent valuation method (CVM) [16,17] was conducted to assess the WTP for the IGSS in Beijing. A standard CVM [16] was used for surveying the WTP for the IGSS by measuring subjective feedbacks using a questionnaire similar to one used in a previous study [17]. The CVM has been used in previous research for assessing the value of various environmental facilities and environmental damage, conservation and restoration of natural and historical culture, health hazard reduction, and health index

improvement [17,18]. Compared to the research on environment protection, the CVM has been used as an approach to study the influence of public opinions on MSW management [18]. Based on a standard CVM, previous studies have suggested that WTP for MSW management not only comprises socioeconomic factors such as gender, age, and income, but also focused on psychosocial constructs, such as AT, which is the behavior in questions [19], and SN, a social factor that refers to the perceived social pressure of whether or not to perform the behavior [19]. PBC, which is the person’s belief as to how easy or difficult performance of the behavior is likely to be [19], is a predictor of WTP [19,20]. The theory of planned behavior (TPB) model was first pro-posed by Ajzen [20]. It demonstrates that an individual's attitude, subjective norms, and perceived resources with regard to a specific behavior can help us better under-stand pro-environmental behaviors [21]. The raw TPB model has been widely used in environmental studies to analyze various behavioral intentions and behaviors, such as participation in environmental activities [22], forest protection [23], wildlife conservation [24], consumption of urban environmental goods [25], and greenhouse gas emissions [26,27].

Compared with previous studies, although some researchers have extended the TPB model for gaining a deeper understanding in the prediction of the WTP, the im-pact of environmental concern (EC), the personal and social awareness, and subsequent concern regarding the quality of the natural environment [27], has rarely been discussed. Thus, this study proposed to investigate the WTP for the IGSS of local residents in China, by introducing an extended TPB model that integrated the predictor of EC [27]. This study mainly aimed to evaluate and compare the following predictors and their relationships: EC, AT, SN, and PBC in the extended TPB model.

Similar works

Compared with the studies over the past five years, based on the raw TPB model for improving urban environmental products, Zahedi and Batista Foguet analyzed residents’ WTP for improve urban air pollution [27], Zhang focused on protecting urban water bodies to mitigate the heat island effect [28]. Zhang used the extended TPB model with EC, in addition, Wang predicted the impact conditions of respondents’ pro-environmental behavior by merging the raw TPB and NAM model [29]. Among the research for MSW management, Ma’s study tends to analyze

human active behavior through the TPB model [30], and Shen’s study, also through the extended TPB model by attended personal moral obligation, aimed to respondents’ behavioral intention [31], and the research on WTP for MSW management methods is not mentioned.

All mentioned abbreviations in this study are shown in Tab.6-1.

Tab.6-1. List of mentioned abbreviations.

Abbreviation	Explanation
MSW	Municipal Solid Waste
IGSS	Intelligent Garbage Sorting System
WTP	Willingness to Pay
TPB	Theory Planned Behavior
CVM	Contingent Valuation Method
EC	Environmental Concern
AT	Attitude
SN	Subjective Norm
PBC	Perceived Behavioral Control

6.2 Materials and Methods

6.2.1. Sampling Area

The investigation of this study was conducted within the following districts in Beijing: Chaoyang District, Haidian District, Fengtai District, Xicheng District, Dongcheng District, and Shijingshan District [32], which have 71% of local residents in Beijing, were defined as the sampling area.

6.2.2. Online Survey

We used online questionnaires in this study. Questionnaires were assigned by a third-party agency, to accurately recruit participants. Participants received a compensation of 100 JPY (about 1 USD).

6.2.3. The Design of the Survey

System of the questionnaire has over 2.6 million sample resources for quick data collection. To ensure the data is accurate and valid, the sample service provided a strict quality control mechanism. Each answer sheet was screened by automatic screening rules and manually checked by customers after submission. Those were not met the requirements were marked as invalid. The number of times a member's completed answer sheet was marked as invalid exceeds a certain percentage. In that case, the system automatically removed the member and no longer allow him/her to answer.

A pre-survey was conducted, which obtained 532 questionnaire answers and was used to determine the question direction and WTP range for the final questionnaire. The formal study began on July 21st, 2021 and lasted for 14 days. The questionnaire was sent to Beijing residents randomly online, and a valid sample was eventually obtained. A large number of studies have shown that the method of guiding WTP has a significant impact on WTP. The payment method proposed in the questionnaire is personal and governmental share, and the frequency of payment is once a month. The first part of the questionnaire is the participants' backgrounds. The second part carried out the WTP for conserving the MSW management. The question about the WTP is:

Suppose the Beijing Municipal Government needed funds to purchase IGSS for community use to improve MSW management to reduce MSW pollution. Based on your personal situation and the information above, considering your annual household income, would you be willing to pay __ yuan (CHY)? Four bid values.10, 20, 30, over 30 yuan to purchase IGSS for your community, these four bid values above will be assigned to all respondents with a dichotomous option. The pre-survey was conducted with 532 questionnaires to pre-survey citizens in core residential areas of Beijing on their essential willingness to pay for environmental concern and MSW management. The above-average payment amounts were obtained based on the average data. In the third part, questions related to residents' behavioral characteristics are asked. This section focuses on the extended TPB model variables by questioning respondents about their AT, PBC and intentions regarding MSW and MSW management, and the key EC directions in the extended TPB model, and refers to respondents' attitudinal characteristics of pro-environmental behavior regarding MSW management payments on 5-point Likert scales. (1 = strongly disagree, 5 = strongly agree). (Shown in Tab. 6-2)

Tab.6-2. Constructs and indicators of the extended TPB model.

Predictors	Indicators	Response scale (1–5)	References used
Environment-concern (EC)	I care about urban environmental issues very much. I think I will reduce other expenses for urban environment improvement.	No concern – Very high concern Extremely negative –Extremely positive	[33,34]
Attitude (AT)	I think paying for MSW management is very positive. I think paying for MSW management is a responsibility. I think paying for MSW management is pro-environmental behavior	Strongly disagree – Strongly agree	[34,35]
Subjective norm (SN)	I think the people who are close to me will pay for MSW management. I think people who are close to me will support the action of paying for MSW management.	Strongly disagree – Strongly agree	[34,35] [35,36]

	I think people who are close to me will support me paying for MSW management.		
Perceived behavioral control (PBC)	I think my payment will improve the urban environment. It is not difficult for me to pay for MSW management. I think I have time, money, and resources to contribute to the MSW management	Strongly disagree – Strongly agree	[34–37]

6.2.4. Data Analysis

6.2.4.1. Estimation of WTP

In this study, we used a contingent valuation method to calculated WTP for MSW management using IGSS. A format of dichotomous selection was used to elicit WTP for residents. The average WTP was calculated according to the formula provided by Hanley [38].

$$\textbf{Mean WTP} = \int_0^{\mathbf{T}} [\mathbf{1} - \mathbf{Gwtp}]\ \mathbf{dW} \qquad \textbf{(6-1)}$$

Gwtp is the distribution function of WTP. T is the infinite value of the true payment intention, which is truncated at a specific value for estimation purposes.

In this study, structural equation modeling was used to calculate the variable factors affecting WTP. In this study, licensed AMOS 26.0 was used for processing the data. Based on the recommendations of Anderson and Gerbing [39], this study used confirmatory factor analysis (CFA) to assess the measurement quality of the extended TPB model and structural equation modeling (SEM) to verify the plausibility of the hypothesized extended TPB model. As for the results of the CFA test, the robustness of the mean squared error approximation (RMSEA) is expected to lie between 0.05 and 0.08. The comparative fit index (CFI), the normative fit index (NFI), and the goodness of fit index (GFI) should be close to 0.9 or 1. At last, the Sobel test and bootstrap method were used to calculate the indirect effects between the variables.

6.2.5. Theoretical Framework and Research Hypothesis

TPB (theory of planned behavior) is intended to predict and explain the behavior of individuals in specific situations. The theory of planned behavior covered six areas: (1) behaviors that are not

completely controlled by individual will are influenced not only by behavioral intentions but also by actual control conditions such as personal abilities, opportunities, and resources; (2) accurate perceived behavioral control is reflective of the state of actual control conditions and therefore can be used as a proxy measure of actual control conditions to directly predict the likelihood of a behavior occurring, and the accuracy of the prediction depends on the true degree; (3) AT, SN, and PBC are the three main variables that determine behavioral intention; the more positive the AT, the greater the support of significant others, the stronger PBC, and the greater behavioral intention, and conversely; (4) an individual possesses a large number of beliefs about behavior, but only a fairly few behavioral beliefs are accessible at a certain time and context; these accessible beliefs, also known as contingent beliefs, are the cognitive and affective basis for AT, SN, and PBC; (5) personal as well as sociocultural and other factors (e.g., personality, intelligence, experience, age, gender, cultural background, etc.) indirectly influence AT, SN, and PBC by influencing behavioral beliefs and, ultimately, intentions and behaviors; (6) AT toward behavior, SN, and PBC can be completely different conceptually, but at times they may share a common basis of beliefs. Thus, they are both independent of each other and interrelated.

The structural model diagram TPB is represented in Fig. 6-1 (for convenience, only the main part of the structural diagram is presented here).

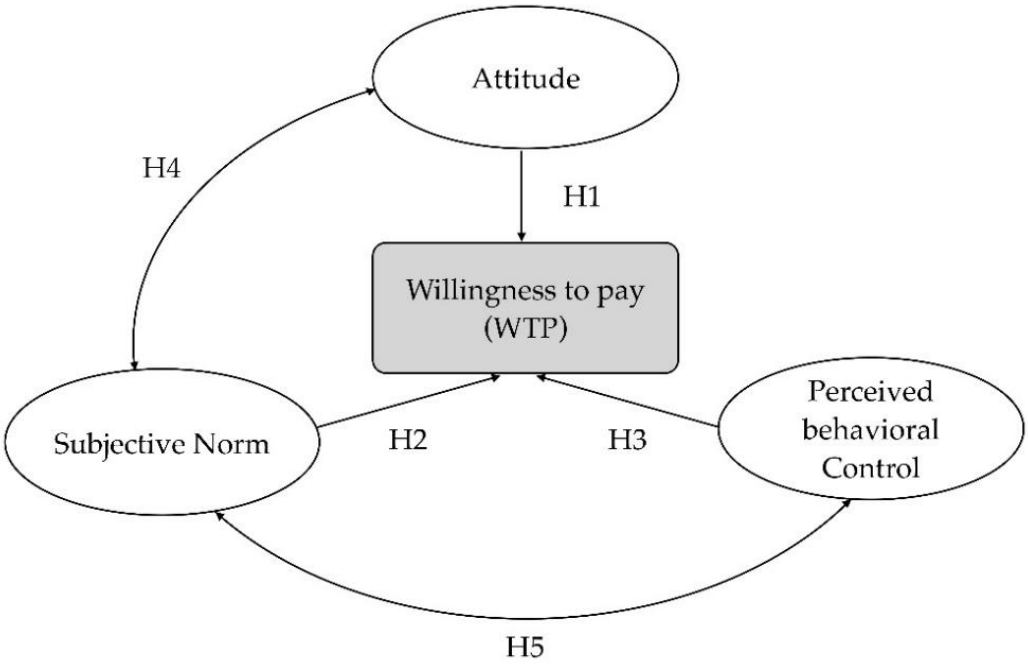

Fig.6-1. The raw TPB model.

The raw TPB model, a respondent is more likely to finance environmental goods if he/she has a positive AT toward behavioral options, if the respondent's family and friends support his/her behavior and if the respondent believes that he/she has the ability to participate in urban waste collection activities to mitigate urban waste management. Based on the discussion above, the following hypotheses are proposed.

Hypothesis 1: If people have more positive AT toward using IGSS to manage MSW, people's WTP will increase.

Hypothesis 2: If people were more optimistic about the SN of using IGSS for MSW management, people's WTP would increase.

Hypothesis 3: If people were more optimistic about the PBC of using IGSS for MSW management, people's WTP would increase.

Under the following relationships between PBC, SN, and AT, the following relationships are proposed:

Hypothesis 4: If people have more positive SN about using IGSS for MSW management, then people have more positive AT toward this behavioral option.

Hypothesis 5: If people have more positive SN about using IGSS for MSW management, then people's PBC over this behavioral option will increase.

In more than 20 years since the raw TPB was proposed, most research findings support the TPB. The results of Armitage and Conner's meta-analysis showed that behavioral AT, SN, and PBC explained 27% of the variance in behaviors and 39% of the variance in behavioral intentions, respectively, further demonstrating the good explanatory and predictive power of the TPB. While being affirmed and supported, the TPB has also been challenged by many research findings and questioned by many scholars, and these challenges and questions have contributed to the development and improvement of the TPB.

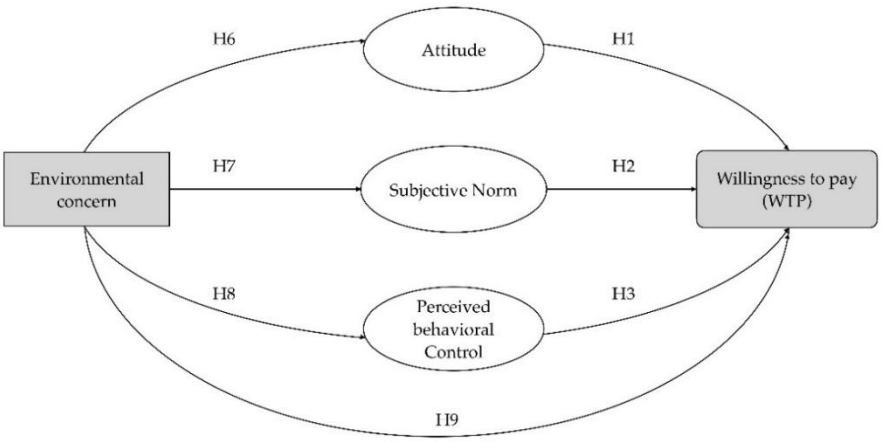

Fig6-2. The Extended TPB model of WTP of MSW.

Firstly, the conceptual content of the main variables has become more prosperous, with personal subjective AT, SN, and PBC being some of the most critical components that have been influential and the possibility of mediating variables between behavioral intentions and behavior. Numerous studies have shown that the concern for the surrounding environment plays an essential role in predicting environmental issues, so we propose the hypothesis that EC is positively correlated with people's WTP. The following assumptions were proposed:(Shown in Fig. 6-2)

Hypothesis 6: EC were positively related to people’s AT towards the use of IGGS for MSW management.

Hypothesis 7: EC were positively related to the SN of paying for IGGS for MSW management.

Hypothesis 8: EC were positively related to the PBC towards the use of IGGS for MSW management.

Hypothesis 9: If EC were more positive, people’s WTP would increase.

In addition to this, EC may influence WTP through behavioral AT, SN, and PBC. The following assumptions were proposed:

Hypothesis 10: EC influence WTP through behavioral attitudes.

Hypothesis 11: EC influence WTP through SN.

Hypothesis 12: EC influence WTP through perceived behavior.

6.3. Results

Tab.6-3. Statistical data of the questionnaire.

Item	Response	Frequency	Percentage
Gender	Male	162	52.1
	Female	149	47.9
Age	18–25	99	31.8
	26–35	99	31.8
	36–45	47	15.1
	46–55	48	15.4
	> 55	18	5.8
Education Level	Elementary school & High school	74	23.8
	Bachelor	205	65.9
	Master Degree	32	10.3

Household Size	2or3	113	36.3
	4or5	114	36.7
	> 5	84	27
Monthly income per people	1000–3000	79	25.4
	3001–5000	71	22.8
	5001–8000	60	19.3
	8001–10,000	64	20.6
	> 10,001	37	11.9

6.3.1. Demographic Characteristics of the Respondents in Questionnaire and WTP

The social background of the respondents included gender, age, education level, household size, and monthly income per person (Shown in Tab. 6-3). Most of the respondents were in the 18 to 55 age range (94.2%). 52.1% of the respondents were male, slightly higher than the percentage of females. As for the education level, more than 75% of respondents have a bachelor's degree or higher. More than 75% of the respondents had a monthly income of 3000 – Yuan and 12% of them who earn more than 10,000 yuan a month. Regarding the family size, 73% of the families were composed of two to five family members.

Tab. 6-3. Individual demographic characteristics.

The result of WTP is presented in Tab. 6-3. As the price increases, the percentage of responses agreeing to pay decreases gradually. Nearly 30% of respondents in the pre-survey and final questionnaire refused to pay. Among those who refused to pay, the top three reasons were: payments can be diverted, unable to pay currently, and the MSW management is the responsibility of the government. Respondents who chose the option such as "I don't have the ability to pay for the fund" and "I don't think the MSW management worth that much" are considered to be "real zero responses" (Figure 3). The survey on social background found that respondents with higher incomes were more likely to pay. ($\beta = 0.49$, $P < 0.05$)

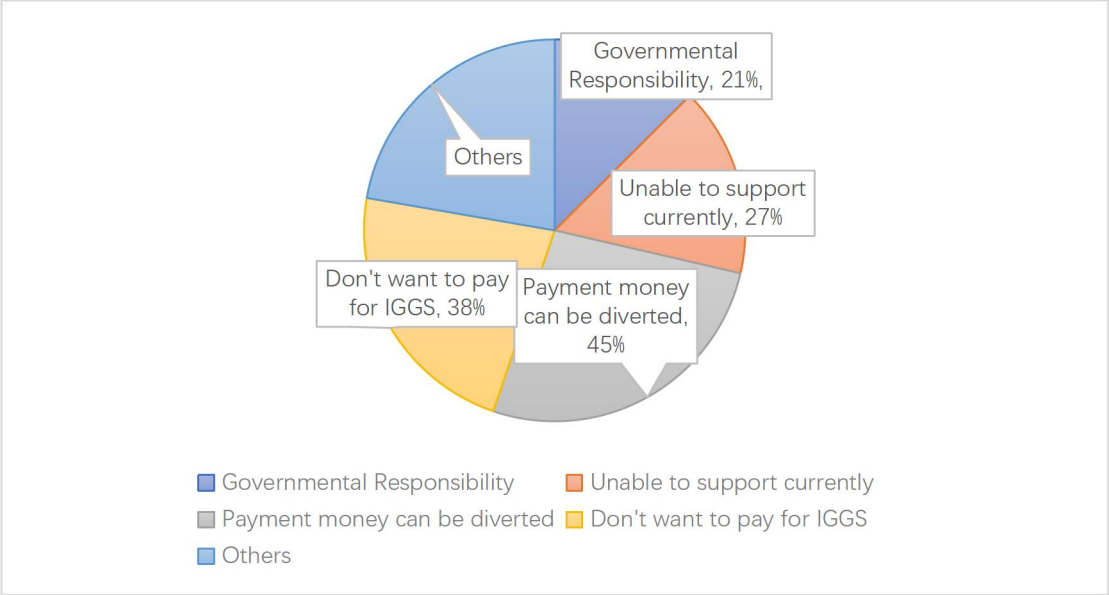

Fig. 6-3. The motivation for the zero responses.

6.3.2. Measurement and Structural Model

The structural model of the raw TPB model was estimated using the maximum likelihood method. In the first step, we tested the plausibility and reliability of the measurement model by confirmatory factor analysis (CFA), then estimated the variable structure and correlations of the current model. To ensure convergence and discriminability, and measurement reliability, we conducted confirmatory factor analysis (CFA), including mainly the components of AT, SN, and PBC (Shown in Tab. 6-4). The results showed that the model data were within the plausibility interval (Chi-Square = 247.1, GFI = 0.808, CFI = 0.867, NFI = 0.804, RMSEA = 0.096). All four variable components were included and tested. The standard regression coefficients of AT, PBC, and EC in 0.01 level. The standard regression coefficient of the subject norm in the 0.05 level. All the scales achieved internal consistency.

Tab.6-4. Distribution of responses.

WTP	10	20	30	TOTAL
Positive	239	226	145	610
Negative	72	32	81	185
Protest zero	53	53	53	159
Total	311	311	311	933

The validity of the questionnaire data is corroborated by the fact that the AVE values in Tab. 6-5 are all higher than 0.5, according to [40], if the squared correlation coefficients of the different constructs are smaller than the AVE of each construct, then the discriminant validity can be confirmed.

Tab.6-5. Reliability and CFA for the extended TPB model.

Scales	Mean（s. d.）	β	CR	AVE
Attitude			0.83	0.77
I think paying for MSW management is very positive	4.04 (1.11)	0.485		
I think paying for MSW management is a responsibility	3.96 (1.15)	0.563		
I think paying for MSW management is a pro-environmental behavior	3.96 (1.12)	0.584		
Subject Norm			0.79	0.59
I think people who are close to me will pay for MSW management	3.83 (1.20)	0.668		
I think people who are close to me will support the action of paying for MSW management	3.72 (1.24)	0.627		
I think people who are close to me will support me paying for MSW management	3.77 (1.20)	0.494		
Perceived Behavioral Control				
I think my payment will improve the urban environment			0.87	0.74
It is not difficult for me to pay for MSW management	3.97 (1.04)	0.466		
I think I have time, money, and resources to contribute to the MSW management.	3.81 (1.27)	0.485		
	3.67 (1.26)	0.593		
Environment-concern				
I care about urban environmental issues very much	3.86(1.23)	0.475	0.82	0.71
I think I will reduce other expenses for urban environment improvement	3.84(1.19)	0.693		

Mean (s. d): Standard deviation. β: factor loading CR (composite reliability); AVE (average variance extracted).

A discriminant validity test of the scale was performed. According to [40], if the squared correlation coefficients of the different constructs are smaller than the AVE of each construct, the discriminant validity can be confirmed, as is shown in Tab. 6-6, the correlations between the factors of the variables in the new extended TPB model. The high correlations between AT, SN, and PBC show profound evidence of validity. Our objective was to discover whether the TPB model, in the context of an integrated framework for understanding consumers' WTP and behavior [41] could also assess willingness towards pro-environmental behaviors that encompass “

AT, SN， PBC. These are the determinants for the WTP for IGGS for MSW management in two successive questionnaires; although a 5-point scale was used in the Likert scale data statistics, it is still reliable for the applicability of the model (Chi-Square = 262.8, GFI = 0.808, CFI = 0.834, NFI = 0.787, RMSEA = 0.094), and all structural coefficients were statistically persuasive ($p < 0.01$). According to the result, AT ($\beta = 0.573$， $p < 0.01$) and PBC ($\beta = 0.692$， $p < 0.01$) affecting

respondents' WTP. So, Hypothesis 1 and Hypothesis 2 can be accepted, and Hypothesis 3 was rejected.

Tab.6-6. The scales' discriminant validity.

Title 1	1	2	3	4
1.Attitude	0.77			
2.Subjective norms	0.48**	0.59		
3.Perceived behavioral control	0.45**	0.50***	0.74	
4.Environment-concern	0.42***	0.42**	0.42***	0.71

1 **p < 0.05 ***p < 0.01.

At the same time, the influence of SN on AT (β = 0.762 p < 0.01) and PBC (β = 0.800 p < 0.01) are confirmed, so Hypothesis 4 and Hypothesis 5 can be accepted.(Shown in Fig. 6-4)

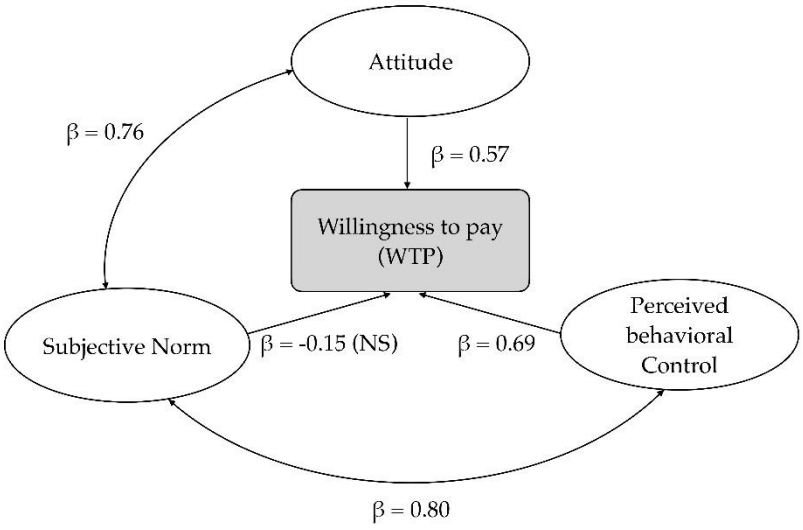

Fig.6-4. Raw TPB model for WTP. β represents standard regression weight.

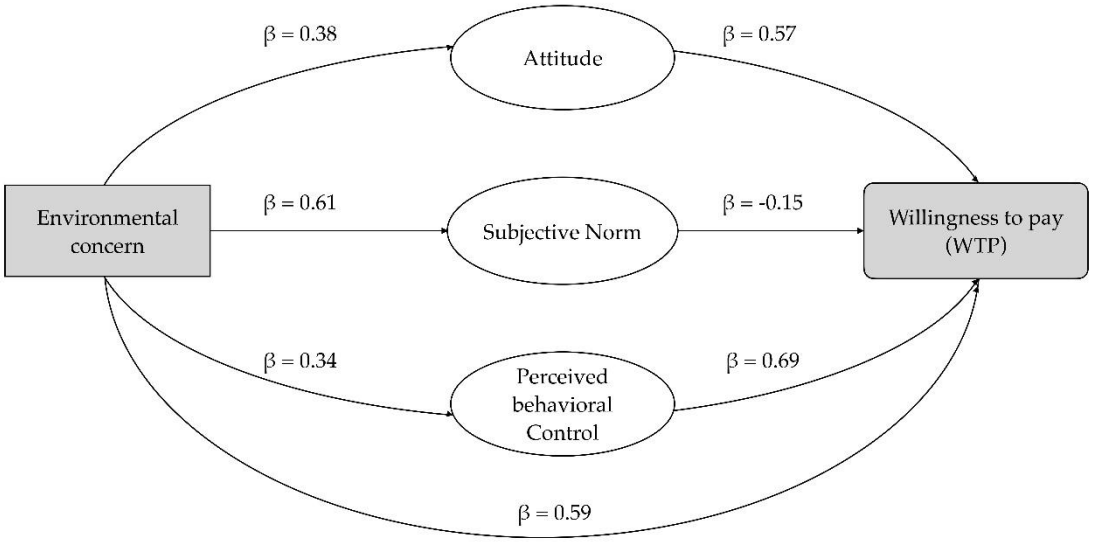

Fig. 6-5. Extended TPB model for WTP. β represents standard regression weight.

The fit measure of the extended model can be accepted (Chi-Square = 243.8, GFI = 0.838, CFI = 0.834, NFI = 0.787, RMSEA = 0.094), and most of the structural coefficients are significant ($p < 0.01$).

When the facts of PBC and EC were compared, PBC had the most significant effect on WTP ($\beta = 0.692$ $P < 0.01$) followed by the EC ($\beta = 0.594$ $P < 0.01$). Hypothesis 3 and Hypothesis 9 were validated. The positive effect relationship between EC and AT ($\beta = 0.382$ $p < 0.05$), SN ($\beta = 0.610$ $p < 0.01$), and PBC ($\beta = 0.341$ $p < 0.05$) can be verified, thus allowing Hypothesis 6, Hypothesis 7, and Hypothesis 8 to be accepted.

Through previous speculations, we hypothesized the indirect effect of environment-concern on WTP for IGGS. Fig. 6-5 shows that AT, SN, and PBC mediate between EC and WTP. However, the regression coefficients from the Sobel test for the Likert scale indicate that all indirect effects did not hold in this questionnaire. Thus, we can conclude that AT ($\beta = -0.31$), SN ($\beta = -0.36$), and PBC ($\beta = -0.12$) in this WTP for IGSS have no indirect effects.(Shown in Fig. 6-5)

6.4. Discussion

Based on Ajzen’s proposed raw TPB model in 1991, we extended the raw TPB model in this study to investigate the Beijing residents’ WTP for the IGSS for MSW management. In terms of MSW management charging policies around the world, on one hand, the taxes were imposed on local residents who use public facilities or enjoy public services for the disposal of MSW management. In Germany, they added a refundable deposit on the recyclable bottles, which is partially refundable through the local residents' recycling behavior, as well as a system of packaging taxes and fees for the producers of the packaging [8]. On the other hand, compared with the method of garbage bag tax used in Japan [9], considering the situation in Beijing, the one of the largest cities with the largest population density, it is meaningful to study the Beijing residents’ WTP for the IGSS for MSW management.

Previous studies showed increasing predictors to the raw TPB model, such as the case of EC, to improve the explanatory of raw TPB model [42,43]. In this study, we compared the raw TPB model and extended TPB model. The result has shown that the extended TPB model provides a more explanatory model for predicting WTP for IGSS and MSW management. The results of research showed that Beijing residents WTP for MSW management is significantly influenced by EC and PBC, and we found a positive relationship between EC and AT, SN, and PBC. The extended TPB model also improves the algorithm on local residents' willingness to pay for MSW management. Introducing EC variables into the raw TPB model, the new TPB model might be a psychological approach to future MSW management policies in China, such as proposing new waste recycling methods and a bag tax system. For the current Beijing government administrations, it is essential to understand what factors guide people's pro-environmental behavior, significantly to improve MSW management to mitigate environmental pollution. So, for example, PBC and EC, which is correlative information, will help improve citizens' pro-environmental behavior.

The mean WTP indicated that the residents of Beijing are willing to pay 319.2 yuan (49.43 USD) annually for IGSS to reduce the MSW of Beijing, the mean WTP, which was calculated through the CVM, if extended the mean WTP to the entire city. In the latest census, the resident population of Beijing has reached 21.893 million people, the total WTP is 6988.25 million Yuan (1082.17 million USD). The WTP for IGGS for MSW management is strong among Beijing citizens. In the two successive questionnaires (pre-survey and final survey), nearly 69.3 percent of the respondents expressed their WTP for IGSS. About 159 respondents refused to pay since they believed that “MSW management is a governmental responsibility,” and, “the use of their payment money can be diverted.” These refusals to pay and data were excluded when the processing data was performed. In addition, the socioeconomic characteristics of the residents also affect their WTP. Respondents with higher incomes were more likely to give WTP questions positive responses [35].

The PBC of residents was the most influencing factors in predicting local residents WTP for IGSS to MSW management. Secondly, residents' EC also influenced residents' WTP for IGSS to reduce MSW pollution. The impact of EC has been reported in numerous studies.

The conclusion is PBC, and EC determine the behavior of the respondents. EC, directly and indirectly, influences residents' WTP for MSW management using IGSS to reduce the MSW, directly and indirectly, which has also been confirmed in previous studies [44 – 47]. However, the impact rate of EC was not as large as PBC, which was different in previous studies by others for the extended TPB model [48,49]. However, a long time in China and the lack of unadvertised charging standard has resulted in the conflict of payment responsibility between residents and the local government. This illustrates that PBC has a significantly direct effect on the WTP for MSW management. Obviously, if Beijing residents thought they have the extra resources to contribute to the MSW management, they will respond more positively toward for environmental behavior. Therefore, it is necessary to strengthen the positive belief of those who already thought they are able to contribute to solving this issue and change the negative belief of those who thought they do not have the corresponding resource currently. It also indicates that the government administration plays a crucial role in motivating people or residents to pay. By compiling and analyzing the data, we have learned that environmental products such as IGSS if they believe they have additional resources to reduce MSW pollution. Therefore, it is necessary to enhance the positive beliefs of those who already believe they can contribute to MSW management and alter the negative beliefs of those who believe they do not have the appropriate resources and capability to pay. Compared with the raw TPB model [50], the extended TPB model, including EC, improves the explanatory ability of the raw TPB model, which has been consistently confirmed.

Therefore, the introduction of EC helps better explain the WTP of Beijing residents for using IGSS to improve MSW management. Finally, the object of this study is the value of IGSS in terms of MSW management effects. The results of the study do not generalize to all approaches to MSW management (landfilling, composting, incineration) [51].

6.5. Conclusions

The raw TPB model proposed by [52,53] was adopted to anticipate Beijing residents' WTP to use IGSS to reduce MSW pollution. Based on the raw TPB model, the extended TPB model is completed by introducing the variable condition of EC [54]. This paper has presented an extended TPB model incorporating the four variables such as EC, AT, SN, and PBC to predict and explain the effect of the variables on willingness to pay. According to the test results, PBC and EC that had a significant positive effect on Beijing residents' WTP. In addition, EC about environmental issues can directly or indirectly influence people's pro-environmental behavior. As is addressed by [55,56], the improvement of WTP depends on the combined effect of PBC, EC, and AT in the extended TPB model. Determinants such as social background, residents' income and education are positively related to the WTP.

The positive effect between AT, PBC, and EC of Beijing residents on the MSW management showed the result of the relationship between the predictors assumed in our extended TPB model, which indicates that residents have a positive attitude towards the improvement of the urban environment, environmental behaviors, and concerns for the urban environment (which were certified by Hypothesis 1, Hypothesis 3, Hypothesis 9). In addition, SN is not a major condition that influences citizens' behavior in Beijing at present. Compared with Europe and Japan, the current legal regulations for MSW management in China are well established, but there is still a time lag between Beijing residents and government for understanding of MSW management regulations. It means the current publicity for MSW management in China is not effective enough (Overturned by Hypothesis 2).

Urban environmental management administration should inform residents about the harmful effects of MSW and the mitigation measures. Environmental protection administration helps promote knowledge and support for environmental protection through various means of communication, such as television, radio, and online media [56]. The increasing EC that accompanies increases people's performance of their pro-environmental behavior. EC can promote the behavior of MSW management. Meanwhile, residents' WTP varies according to their income and education background; policymakers can consider developing potential funding sources and central payment populations for MSW mitigation.

In the pre-survey and final questionnaire, close to 40% of the respondents refused to pay for IGSS. The main reason for the refusal to pay is that they think the environmental fund can be diverted by the environmental needs [57]. Therefore, disclosing the use of utility charges and information related to the management of the urban environment has become necessary to increasing public participation [58,59].

In the pre-survey prediction, EC were ranked the first in terms of local residents WTP. However, in the questionnaire compilation and analysis, we found that the impact of PBC on local residents'

WTP is higher than residents' EC and higher than residents' AT, and we need more accurate data to verify the relationship between these predictors and local residents' WTP.

This study was conducted in Beijing, the capital of China, one of the largest cities with the largest population density. With the rapid urbanization in China, the MSW pollution issue will have the same impact on other cities. However, the WTP and acceptance of IGSS in other regions or rural areas will require further research due to the income disparity between regions. The main novelty of this study compared to similar studies on MSW management is that it predicts the WTP for IGSS (a pro-environmental product) through an extended TPB model, providing a medium of communication between citizens and the government for a future approach to sustainable development in China.

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Online Questionnaire

Survey on willingness to pay for garbage collection and disposal and recycling system services in residential areas

1. Gender Male/Female

2. Age Under18 /18-25/ 26-35/36-45/46-55/Over55

3. Education Middle and High School College/Master degree/Doctor

4. Family Size 1/2-3/4-5/Over5

5. Monthly per household income ＜1000/1001-3000/3001-5000/5001-8000/＞8000

6. Do you usually sort your household waste？ Yes/No

7. Do you live in a community with a regular garbage collection point? Yes/No

8. Are you satisfied with the current state of environmental health in your community? Satisfied/Unsatisfied

9. What do you think are the main reasons affecting the environmental health condition of the community? Other residents in the district littered with garbage/ Community is irresponsible and poorly managed/ Poorly defined local government

10. How do you think the community you live in needs to separate household waste? Very necessary /Necessary/Depending on the situation/Not very necessary/ Totally unnecessary

11. Do you think that paying for MSW management is a responsible way to protect the city's environment? Strongly agree/ Agree/ Neither agree nor disagree/ Disagree/ Strongly disagree

12. Do you think your close friends and family will pay for the city's MSW management? Very definitely will pay/ Would pay/ Not sure will be paid/ Will not pay/ Definitely not paid

13. Do you think your close friends and family would support an ordinance that pays for the city to separate and manage its waste? Definitely support/ Support/ Neither for nor against/ Oppose / Strongly oppose

14. Would your close friends and family support you in paying for your own MSW management? Definitely support/ Support/ Not sure will be supported/ No support/ Definitely not support

15. Do you think your payment for waste collection and management will improve the city's environment? Yes, I am pretty sure/ I am sure/ I'm not sure/ Very Uncertain

16. For me personally, it is not a difficult task to pay for municipal waste collection and management ？ For me personally, it's a breeze/ Not difficult, can do it/ For me, paying for something can be done or not/ Don't really want to pay for it/ Very reluctant to pay

17. Do you think you have enough money and extra time and resources to contribute to the

city's waste collection and management? Very certain/Certain/ Not really sure/ No/Absolutely Not

18. Are you a person who cares a lot about urban environmental issues? Yes, I am a person who is very concerned about environmental issues/ Yes, I usually pay attention/ I am not too concerned about but also pay attention to environmental issues/ I don't care much about the urban environment around me/ I never cared about the city's environmental problems

19. Are you willing to reduce other expenses in order to improve the urban environment in which you live? Very willing/ Willing/ Depends on the situation/ Unwilling/ Very reluctant

20. Let's assume that the community purchases a garbage collection unit and someone will provide a service to separate and collect your garbage, but this service requires you to pay for it, i.e., you pay a monthly fee for a clean environment. Would you be willing to spend a certain amount of money for this service? Yes/No

21. What are your reasons for not wanting to pay for this? Garbage disposal is the responsibility of the city and the government, and I do not need to bear the cost/ Low personal income makes it difficult to afford the cost/ The fees paid will be misappropriated/ Don't want to use smart garbage collection system/ Other reasons

22. What is the most you are willing to pay per month (in CNY)? 10-20Yuan/20-30Yuan/Over 30

Chapter 7

CONCLUSION AND POLICY IMPLICATIONS

CHAPTER SEVEN: CONCLUSION AND POLIY IMPLICATONS

According to a UN report, about 4 billion people in the world lived in urban areas in 2011, and by 2050, urban dwellers are expected to exceed 60%. The overpopulation brings with it the generation of huge amounts of solid waste, and at the same time, these uncontrolled discharges bring irreversible damage to the urban living space. Regarding solid waste management, several mitigation and adaptation techniques have been proposed, including mitigation tools like IGSS.

However, urban MSW management is often neglected in urban construction and renewal. One important reason for this is that policy makers and/or experts responsible for public resources (local municipalities) tend to be more concerned with the economic consequences of a particular urban retrofitting strategy.

Economic consequences of transformation strategies. Since total public resources for urban development are limited, if the value of municipal solid waste improvements cannot be quantified, then urban development policy makers lack valid evidence of investment. There is a lack of linkage between basic MSW management studies and economic consequences. The value of the effects of managing MSW should be defined as a non-market value. Our study uses a contingent valuation approach - one of the most widely used methods for measuring non-market value.

One of the most widely used methods to measure non-market value to estimate the value of MSW waste recovery improvements. In addition, we applied the theory of planned behavior to explore the factors that influence residents Willingness to pay factors.

7.1 Conclusion

The research flow of this thesis is: theoretical research - methodological research - experimental research.

The chapter1 is the general introduction, which focuses on the background of the study and the purpose of the study. Municipal solid waste management and research have had little impact on the development of urban development policies. An important reason is that researchers are concerned with the effects of specific technologies, while urban policy makers are more concerned with economic benefits. Policy makers are more interested in the economic effects of public

investments. The purpose of this study is to create a missing link between researchers and policy makers in municipal solid waste management. To assess the economic value of municipal solid waste management and to explore the factors that influence respondents' willingness to pay. factors on their willingness to pay.

In the data statistics of CVM survey, there has been a lot of controversy about whether to use average or median value for value evaluation. On the one hand, the previous analysis of the theoretical basis of the willingness to pay comes from the principle of income compensation of the John R. Hicks' consumer surplus, in which the equivalence variables and compensation variables are the average value; On the other hand, in general, as the analysis of this survey shows, the willingness of residents to pay is more discrete, so the average value is more likely to be influenced by extremum. However, Bateman and Carson argue that averages have a very solid theoretical and logical basis, and that if the reasonability and efficiency of decision-making are emphasized, averages should be used, but from a fair point of view, because the median value indicates the willingness of 50% of respondents to pay, the median value is more suitable for democratic decision-making [21]. In this paper, the average value is used as the basis for valuation.

Chapter 2 is a theoretical study that explains the relevant theoretical background. In this chapter, we will discuss why municipal solid waste management has economic value and what are the components of its economic value? In this chapter, the reasons why municipal solid waste management has economic value, what constitutes its economic value, and other relevant theoretical backgrounds related to the contingent valuation method and the theory of planned behavior The behavioral theory are presented. I explain the economic value of urban MSW management in terms of the utility theory of value and the labor theory of value. As for the value components of urban MSW management. This study points out that its value is mainly composed of direct use value and non-use value.

Chapter3 is a methodological study in which the literature on contingent valuation of urban MSWs is reviewed. The literature review of the study. The characteristics of previous studies, possible shortcomings of contingent valuation studies, and antecedents of willingness to pay are summarized. The characteristics of previous studies, possible shortcomings of contingent

valuation studies, and antecedents of willingness to pay are summarized. The study finds The proportion of studies in developing countries has increased rapidly since 2000, and the impact of payment instruments has long been neglected. The impact of instruments has long been neglected, and the theory of planned behavior has greatly enlightened researchers in defining the antecedents and consequences of willingness to pay.

Chapter 4 explains information about the study design, including the study site, sample size design of the questionnaire, data collection methods, willingness-to-pay elicitation methods, payment instruments. biases in common methods, and determinants of willingness to pay. In addition, the details of the data analysis process are explained In addition, the details of the data analysis process are explained, especially the application of the spike model in a two-bounded dichotomous choice format.

Chapter 5 contains an experimental study of a college experiment in Beijing, i.e., promoting the willingness to use IGSS. Findings The results show that students in Beijing colleges and universities are willing to accept and use this new recovery method and technology. It can be confirmed that these programs are feasible for regional replication in the city.

Chapter 6 focuses on the factors that influence Beijing residents' willingness to pay. In this chapter, we develop a predictive model to predict residents' willingness to pay for municipal solid waste management. Based on the theory of planned behavior, we developed a predictive model to predict residents' willingness to pay for MSW management using IGSS. Behavioral theory. In addition to attitudes, perceived behavioral controls, I include environmental concerns and social norms. The results show that the extended prediction model has better predictive power than the traditional prediction model. Environmental concerns can directly and indirectly affect residents' willingness to pay.

At the theoretical level, this study sorts out and discusses the reasons why MSW management has economic value through labor economic value theory and subjective economic value theory, and proposes that its economic value is composed of use value and intrinsic value through labor economic value theory and subjective economic value theory. At the methodological level at the

methodological level, this study points out that the influence of means of payment in CVM research has long been neglected.

It has been neglected for a long time. Among the factors that determine residents' WTP, TPB theory can greatly explain residents' pro-behavior. Explain residents' pro-environmental behavior. At the experimental level, the focus of this study is on the environmental intentions of Beijing residents. The study focuses on the willingness of Beijing residents to pay for IGSS, a new type of waste recycling device. Willingness to MSW management. The results show that Beijing residents are willing to pay USD 49.93 per household per year.

7.2 Policy implications

Based on the experiments and discussions above, this research provided policy implications as follows:

7.2.1 Mean WTP or medium WTP

Beijing residents have a great willingness to pay for MSW management. A special environmental fund could be created to tap potential sources of funding to improve the city's waste recycling chain. Numerous studies have shown that. A contingent valuation approach was used to explore the willingness of Beijing residents to pay for MSW management in the city. Willingness to pay for countermeasures. Face-to-face interviews were conducted with 313 city residents. 70% of residents were willing to pay for market-provided conservation measures. Market-provided protections. The majority of them were willing to pay 49.93USD per year to support government MSW recycling and management. In addition, residents' area of residence, gender, income, household size profile, and level of support for government MSW management are all important factors that influence MSW management. In Wang and Mullahy [2], residents of Chongqing, China, were asked to pay for air quality improvements to reduce the risk of death. 500 Chongqing residents were interviewed face-to-face. 96% said they were willing to pay a certain amount of money.

The results of the study indicate that each resident is willing to pay an average of 14.3 CHY per year to improve urban air quality. Residents' willingness to pay will increase with residents' age as residents' age, monthly income, and education level increase, residents' willingness to pay will also increase. sun, et al. [3] focused on Beijing residents' willingness to eliminate urban haze. 1051 Beijing residents A face-to-face questionnaire was administered to 1051 Beijing residents. The results of the study showed that Beijing residents were willing to pay an average of RMB 1905.36 per year, or 1% of their annual income, to eliminate haze. The impact of not being in my backyard is closely related to residents' willingness to pay. Willingness to pay is closely related. Other determinants, such as average household income, energy expenditures, and economic losses due to haze, are largely related to residents' willingness to pay. Losses due to haze also affect WTP

to a large extent. in a study by Lo and Jim [4], the willingness of Hong Kong residents to pay for the protection of urban the willingness of Hong Kong residents to pay for the protection of urban green spaces was studied. A total of 495 city residents were interviewed the results showed that 70% of the respondents had used urban green space in the past week Had used urban green space in the past week.

The majority of urban green space users were accompanied by family members or children. Children. Exercise and enjoying fresh air are the main purposes for visiting urban green spaces. Respondents were asked if they would be willing to pay a certain amount of money to prevent the loss of about 20% of green spaces in their area. 80% of respondents said they 80% of respondents said they would be willing to pay a certain amount of money, with an average monthly payment of $9.90. Chinese residents are increasingly willing to pay extra for quality urban habitat.

7.2.2 Promote related CVM studies

Although much progress has been made in recent years in WTP studies on urban environments, there is very limited research on MSW management. More CVM studies on the effects of MSW management are necessary because they can provide a new evidence for the development of relevant policies. Policy provides new evidence. Studies on Chinese residents' willingness to pay for their urban environment. Most of the studies have focused on improving urban air quality [6-8], protecting urban green spaces and water systems [4, 9].4, 9, 10], and urban waste disposal [11-13].

This study is only a preliminary exploration and is limited by the fact that different types of residents may behave differently when paying for the technical IGSS managed by MSW. In addition, non-market valuation is a way to assign value to environmental goods and services that are not easily traded in the marketplace. In our case, valuation is the most widely used method for estimating non-markets and has long been criticized as methodologically flawed.

One of the key issues is the existence of "protest response," which means that respondents refuse to pay for certain aspects of the protest valuation process, rather than valuing environmental goods and services at zero. goods and services to zero [14]. Reviewing and excluding protest response samples is a common approach to avoid conceptual inconsistencies and undervaluation

of WTP in our study. In our study, respondents who protested against the assessment process, the payment instrument, or those who distrusted the government and believed that it was not the responsibility of citizens to pay for environmental quality were considered as "protest reactions." were considered "protest responses" and were excluded from further analysis.

Finally, there are more possible variables to explore in the predictive model of residents' willingness to pay. In addition to the new variables proposed in this study, several studies have shown that variables such as environmental knowledge have a considerable impact on residents' willingness to pay. Variables such as environmental knowledge have a considerable effect on residents' pro-environmental behavior [15-17]. The impact of these variables on residents' willingness to pay deserves further exploration.

7.2.3 Timely disclosure of environmental information

More than 80% of respondents said they need more information about relevant environmental monitoring data and government information on managing environmental funds, which can be regarded as insufficient trust for the government. In order to improve residents' participation in urban environmental improvement, timely disclosure of related information is necessary, especially the use of environmental protection funds.

Many scholars and institutions have already made certain explorations in the disclosure of environmental information of the Chinese government, especially the disclosure of environmental information. The study of MEP [18] shows that the Chinese government ’ s information disclosure has made some progress since the promulgation of the Government Information Transparency Act.

The Institute of Public & Environmental Affairs (IPE) and the Natural Resources Defense Council (2009) developed a Pollution Information Transparency Index (PITI) assessed the degree of government information disclosure in 113 cities in China. The results show that the eastern developed provinces have higher government information disclosure than the less developed provinces in the central and western regions. Zhang, et al. [19] studied the information disclosure status of the environmental protection departments of different provinces and the Ministry of

Environmental Protection after six months of the promotion of the Chinese Government Information Disclosure Act. Research results show that the government information disclosure system is still need to be perfected. Kosajan, et al. [20] employed entire-array-polygon to assess the performance of the Chinese government in the disclosure of environmental information.

The results show that the environmental information disclosure status of all provinces in China can only be rated as “general”, and no province can be rated as “excellent”, which indicates that the Chinese government's environmental information disclosure system still needs further improvement. The future direction of improvement should be the promotion of relevant regulations to promote public participation and establish an independent monitoring and evaluation system [21], and enhancing the exchange of experience between different environmental protection departments and strengthen the legal status of environmental information disclosure [19].

7.2.4 Promote the education with regard to MSW management

The enhancement of knowledge of MSW management is urgent. Environmental knowledge can greatly affect people's pro-environmental behavior [15]. About 70% of the residents who have an understanding of the MSW learn about related information through television and online.

Although China’s environmental protection education has made some progress in recent decades, there are still many shortcomings. Xiong, et al. [22] analyzed the curricula of 267 out of 810 public universities and colleges in China- a sample of 30% from each of the 12 different type.

The results show that nearly 20% of the samples did not establish a systematic environmental education system. Compared with forestry, agronomy and related majors, linguistics, art and physical education are even more lacking in environmental protection education. In addition, compared with universities directly managed under the Ministry of Education, provincial or local municipal colleges and universities perform more poorly. Some regional governments and institutions have made some attempts in the sustainable development education model. Gao, et al. [23] explored a regional sustainable education framework with three-levels, which is top managers of companies and policy makers of

government, representatives of companies and government, and the public. The educational framework was flexible and comprehensive, endeavoring to ensure a demand-oriented and needbased approach to the local sustainability improvement. In urban environmental education, on the one hand, green education courses need to be implemented more widely in university education and make the concept of sustainable development deeply rooted in minds [24]. Some studies have shown that the role of NGOs in environmental protection should also be fully valued [25]. Other studies have pointed out the importance of information carriers, various information carriers should be encouraged to promote the dissemination of environmental knowledge [26].

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Data Processing of Beijing Citizens' Willingness to Pay for MSW Management

Notes

Output Created		12-AUG-2021 00:44:19
Comments		
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST PAIRS=Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q1 Q2 Q2 Q2 Q2 Q2 Q2 Q2 Q2 Q2 Q2 Q3 Q3 Q3 Q3 Q3 Q3 Q3 Q3 Q3 Q3 Q4 Q4 Q4 Q4 Q4 Q4 Q4 Q4 Q4 Q4 Q5 Q5 Q5 Q5 Q5 Q5 Q6 Q6 Q6 Q6 Q6 Q6 Q7 Q7 Q7 Q7 Q8 Q8 Q8 Q9 Q9 Q10 WITH Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q6 Q7 Q8 Q9 Q10 Q11 Q7 Q8 Q9 Q10 Q11 Q8 Q9 Q10 Q11 Q9 Q10 Q11 Q10 Q11 Q11 (PAIRED) /CRITERIA=CI(.9500) /MISSING=ANALYSIS.
Resources	Processor Time	00:00:00.05
	Elapsed Time	00:00:00.03

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Q1	4.04	311	1.111	.063

	Q2	3.96	311	1.145	.065
Pair 2	Q1	4.04	311	1.111	.063
	Q3	3.96	311	1.118	.063
Pair 3	Q1	4.04	311	1.111	.063
	Q4	3.83	311	1.199	.068
Pair 4	Q1	4.04	311	1.111	.063
	Q5	3.72	311	1.235	.070
Pair 5	Q1	4.04	311	1.111	.063
	Q6	3.77	311	1.202	.068
Pair 6	Q1	4.04	311	1.111	.063
	Q7	3.97	311	1.044	.059
Pair 7	Q1	4.04	311	1.111	.063
	Q8	3.81	311	1.272	.072
Pair 8	Q1	4.04	311	1.111	.063
	Q9	3.67	311	1.259	.071
Pair 9	Q1	4.04	311	1.111	.063
	Q10	3.86	311	1.231	.070
Pair 10	Q1	4.04	311	1.111	.063
	Q11	3.84	311	1.185	.067
Pair 11	Q2	3.96	311	1.145	.065
	Q3	3.96	311	1.118	.063
Pair 12	Q2	3.96	311	1.145	.065
	Q4	3.83	311	1.199	.068
Pair 13	Q2	3.96	311	1.145	.065
	Q5	3.72	311	1.235	.070
Pair 14	Q2	3.96	311	1.145	.065
	Q6	3.77	311	1.202	.068
Pair 15	Q2	3.96	311	1.145	.065
	Q7	3.97	311	1.044	.059
Pair 16	Q2	3.96	311	1.145	.065
	Q8	3.81	311	1.272	.072
Pair 17	Q2	3.96	311	1.145	.065
	Q9	3.67	311	1.259	.071
Pair 18	Q2	3.96	311	1.145	.065
	Q10	3.86	311	1.231	.070
Pair 19	Q2	3.96	311	1.145	.065
	Q11	3.84	311	1.185	.067
Pair 20	Q3	3.96	311	1.118	.063
	Q4	3.83	311	1.199	.068
Pair 21	Q3	3.96	311	1.118	.063

	Q5	3.72	311	1.235	.070
Pair 22	Q3	3.96	311	1.118	.063
	Q6	3.77	311	1.202	.068
Pair 23	Q3	3.96	311	1.118	.063
	Q7	3.97	311	1.044	.059
Pair 24	Q3	3.96	311	1.118	.063
	Q8	3.81	311	1.272	.072
Pair 25	Q3	3.96	311	1.118	.063
	Q9	3.67	311	1.259	.071
Pair 26	Q3	3.96	311	1.118	.063
	Q10	3.86	311	1.231	.070
Pair 27	Q3	3.96	311	1.118	.063
	Q11	3.84	311	1.185	.067
Pair 28	Q4	3.83	311	1.199	.068
	Q5	3.72	311	1.235	.070
Pair 29	Q4	3.83	311	1.199	.068
	Q6	3.77	311	1.202	.068
Pair 30	Q4	3.83	311	1.199	.068
	Q7	3.97	311	1.044	.059
Pair 31	Q4	3.83	311	1.199	.068
	Q8	3.81	311	1.272	.072
Pair 32	Q4	3.83	311	1.199	.068
	Q9	3.67	311	1.259	.071
Pair 33	Q4	3.83	311	1.199	.068
	Q10	3.86	311	1.231	.070
Pair 34	Q4	3.83	311	1.199	.068
	Q11	3.84	311	1.185	.067
Pair 35	Q5	3.72	311	1.235	.070
	Q6	3.77	311	1.202	.068
Pair 36	Q5	3.72	311	1.235	.070
	Q7	3.97	311	1.044	.059
Pair 37	Q5	3.72	311	1.235	.070
	Q8	3.81	311	1.272	.072
Pair 38	Q5	3.72	311	1.235	.070
	Q9	3.67	311	1.259	.071
Pair 39	Q5	3.72	311	1.235	.070
	Q10	3.86	311	1.231	.070
Pair 40	Q5	3.72	311	1.235	.070
	Q11	3.84	311	1.185	.067
Pair 41	Q6	3.77	311	1.202	.068

	Q7	3.97	311	1.044	.059
Pair 42	Q6	3.77	311	1.202	.068
	Q8	3.81	311	1.272	.072
Pair 43	Q6	3.77	311	1.202	.068
	Q9	3.67	311	1.259	.071
Pair 44	Q6	3.77	311	1.202	.068
	Q10	3.86	311	1.231	.070
Pair 45	Q6	3.77	311	1.202	.068
	Q11	3.84	311	1.185	.067
Pair 46	Q7	3.97	311	1.044	.059
	Q8	3.81	311	1.272	.072
Pair 47	Q7	3.97	311	1.044	.059
	Q9	3.67	311	1.259	.071
Pair 48	Q7	3.97	311	1.044	.059
	Q10	3.86	311	1.231	.070
Pair 49	Q7	3.97	311	1.044	.059
	Q11	3.84	311	1.185	.067
Pair 50	Q8	3.81	311	1.272	.072
	Q9	3.67	311	1.259	.071
Pair 51	Q8	3.81	311	1.272	.072
	Q10	3.86	311	1.231	.070
Pair 52	Q8	3.81	311	1.272	.072
	Q11	3.84	311	1.185	.067
Pair 53	Q9	3.67	311	1.259	.071
	Q10	3.86	311	1.231	.070
Pair 54	Q9	3.67	311	1.259	.071
	Q11	3.84	311	1.185	.067
Pair 55	Q10	3.86	311	1.231	.070
	Q11	3.84	311	1.185	.067

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Q1 & Q2	311	.062	.276
Pair 2	Q1 & Q3	311	-.053	.348
Pair 3	Q1 & Q4	311	.053	.352
Pair 4	Q1 & Q5	311	-.047	.410
Pair 5	Q1 & Q6	311	.001	.984
Pair 6	Q1 & Q7	311	.073	.199
Pair 7	Q1 & Q8	311	.050	.376

Pair 8	Q1 & Q9	311	.101	.076
Pair 9	Q1 & Q10	311	-.022	.696
Pair 10	Q1 & Q11	311	-.069	.223
Pair 11	Q2 & Q3	311	.006	.912
Pair 12	Q2 & Q4	311	.145	.010
Pair 13	Q2 & Q5	311	.001	.988
Pair 14	Q2 & Q6	311	-.068	.233
Pair 15	Q2 & Q7	311	-.090	.113
Pair 16	Q2 & Q8	311	-.059	.303
Pair 17	Q2 & Q9	311	.048	.394
Pair 18	Q2 & Q10	311	.055	.331
Pair 19	Q2 & Q11	311	.026	.647
Pair 20	Q3 & Q4	311	.026	.642
Pair 21	Q3 & Q5	311	.079	.167
Pair 22	Q3 & Q6	311	-.074	.195
Pair 23	Q3 & Q7	311	.021	.709
Pair 24	Q3 & Q8	311	-.048	.397
Pair 25	Q3 & Q9	311	-.028	.629
Pair 26	Q3 & Q10	311	-.037	.518
Pair 27	Q3 & Q11	311	.042	.464
Pair 28	Q4 & Q5	311	-.117	.040
Pair 29	Q4 & Q6	311	-.002	.978
Pair 30	Q4 & Q7	311	.002	.976
Pair 31	Q4 & Q8	311	.077	.176
Pair 32	Q4 & Q9	311	-.005	.929
Pair 33	Q4 & Q10	311	-.005	.928
Pair 34	Q4 & Q11	311	-.010	.867
Pair 35	Q5 & Q6	311	-.058	.310
Pair 36	Q5 & Q7	311	.034	.545
Pair 37	Q5 & Q8	311	.018	.751
Pair 38	Q5 & Q9	311	.060	.292
Pair 39	Q5 & Q10	311	-.013	.814
Pair 40	Q5 & Q11	311	-.050	.379
Pair 41	Q6 & Q7	311	-.035	.533
Pair 42	Q6 & Q8	311	.042	.460
Pair 43	Q6 & Q9	311	-.065	.255
Pair 44	Q6 & Q10	311	-.013	.821
Pair 45	Q6 & Q11	311	-.061	.282
Pair 46	Q7 & Q8	311	.147	.009
Pair 47	Q7 & Q9	311	.106	.061

Pair 48	Q7 & Q10	311	-.128	.024
Pair 49	Q7 & Q11	311	-.003	.954
Pair 50	Q8 & Q9	311	-.003	.961
Pair 51	Q8 & Q10	311	-.085	.135
Pair 52	Q8 & Q11	311	-.026	.648
Pair 53	Q9 & Q10	311	-.110	.053
Pair 54	Q9 & Q11	311	.034	.553
Pair 55	Q10 & Q11	311	-.013	.818

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Q1 - Q2	.077	1.545	.088	-.095	.250	.881	310	.379
Pair 2	Q1 - Q3	.074	1.618	.092	-.107	.254	.806	310	.421
Pair 3	Q1 - Q4	.203	1.591	.090	.025	.380	2.246	310	.025
Pair 4	Q1 - Q5	.315	1.699	.096	.126	.505	3.270	310	.001
Pair 5	Q1 - Q6	.260	1.636	.093	.078	.443	2.807	310	.005
Pair 6	Q1 - Q7	.061	1.468	.083	-.103	.225	.734	310	.463
Pair 7	Q1 - Q8	.222	1.646	.093	.038	.405	2.377	310	.018
Pair 8	Q1 - Q9	.370	1.593	.090	.192	.547	4.094	310	.000
Pair 9	Q1 - Q10	.177	1.676	.095	-.010	.364	1.860	310	.064
Pair 10	Q1 - Q11	.193	1.680	.095	.006	.380	2.026	310	.044
Pair 11	Q2 - Q3	-.003	1.595	.090	-.181	.175	-.036	310	.972
Pair 12	Q2 - Q4	.125	1.533	.087	-.046	.296	1.443	310	.150
Pair 13	Q2 - Q5	.238	1.683	.095	.050	.426	2.493	310	.013
Pair 14	Q2 - Q6	.183	1.716	.097	-.008	.375	1.884	310	.061
Pair 15	Q2 - Q7	-.016	1.617	.092	-.197	.164	-.175	310	.861
Pair 16	Q2 - Q8	.145	1.760	.100	-.052	.341	1.450	310	.148

Pair 17	Q2 - Q9	.293	1.660	.094	.107	.478	3.108	310	.002
Pair 18	Q2 - Q10	.100	1.634	.093	-.083	.282	1.076	310	.283
Pair 19	Q2 - Q11	.116	1.626	.092	-.066	.297	1.255	310	.210
Pair 20	Q3 - Q4	.129	1.617	.092	-.052	.309	1.402	310	.162
Pair 21	Q3 - Q5	.241	1.599	.091	.063	.420	2.659	310	.008
Pair 22	Q3 - Q6	.186	1.701	.096	-.003	.376	1.933	310	.054
Pair 23	Q3 - Q7	-.013	1.513	.086	-.182	.156	-.150	310	.881
Pair 24	Q3 - Q8	.148	1.733	.098	-.045	.341	1.505	310	.133
Pair 25	Q3 - Q9	.296	1.707	.097	.105	.486	3.057	310	.002
Pair 26	Q3 - Q10	.103	1.693	.096	-.086	.292	1.072	310	.285
Pair 27	Q3 - Q11	.119	1.595	.090	-.059	.297	1.315	310	.189
Pair 28	Q4 - Q5	.113	1.818	.103	-.090	.315	1.091	310	.276
Pair 29	Q4 - Q6	.058	1.699	.096	-.132	.247	.601	310	.548
Pair 30	Q4 - Q7	-.141	1.588	.090	-.319	.036	-1.571	310	.117
Pair 31	Q4 - Q8	.019	1.679	.095	-.168	.207	.203	310	.840
Pair 32	Q4 - Q9	.167	1.743	.099	-.027	.362	1.692	310	.092
Pair 33	Q4 - Q10	-.026	1.723	.098	-.218	.166	-.263	310	.792
Pair 34	Q4 - Q11	-.010	1.693	.096	-.199	.179	-.100	310	.920
Pair 35	Q5 - Q6	-.055	1.773	.101	-.252	.143	-.544	310	.587
Pair 36	Q5 - Q7	-.254	1.589	.090	-.431	-.077	-2.819	310	.005
Pair 37	Q5 - Q8	-.093	1.756	.100	-.289	.103	-.936	310	.350

Pair 38	Q5 - Q9	.055	1.710	.097	-.136	.245	.564	310	.573
Pair 39	Q5 - Q10	-.138	1.755	.100	-.334	.058	-1.389	310	.166
Pair 40	Q5 - Q11	-.122	1.754	.099	-.318	.073	-1.229	310	.220
Pair 41	Q6 - Q7	-.199	1.620	.092	-.380	-.019	-2.170	310	.031
Pair 42	Q6 - Q8	-.039	1.713	.097	-.230	.153	-.397	310	.691
Pair 43	Q6 - Q9	.109	1.796	.102	-.091	.310	1.073	310	.284
Pair 44	Q6 - Q10	-.084	1.732	.098	-.277	.110	-.851	310	.395
Pair 45	Q6 - Q11	-.068	1.739	.099	-.262	.127	-.685	310	.494
Pair 46	Q7 - Q8	.161	1.522	.086	-.009	.331	1.863	310	.063
Pair 47	Q7 - Q9	.309	1.547	.088	.136	.481	3.518	310	.001
Pair 48	Q7 - Q10	.116	1.713	.097	-.075	.307	1.192	310	.234
Pair 49	Q7 - Q11	.132	1.582	.090	-.045	.308	1.470	310	.143
Pair 50	Q8 - Q9	.148	1.792	.102	-.052	.348	1.456	310	.146
Pair 51	Q8 - Q10	-.045	1.843	.105	-.251	.161	-.431	310	.667
Pair 52	Q8 - Q11	-.029	1.760	.100	-.225	.167	-.290	310	.772
Pair 53	Q9 - Q10	-.193	1.855	.105	-.400	.014	-1.834	310	.068
Pair 54	Q9 - Q11	-.177	1.699	.096	-.366	.013	-1.835	310	.067
Pair 55	Q10 - Q11	.016	1.720	.098	-.176	.208	.165	310	.869