International Review for Spatial Planning and Sustainable Development

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For investigation regarding the impact of planning policy on spatial planning implementation, International Community of Spatial Planning and Sustainable Development (SPSD) seeks to learn from researchers in an integrated multidisciplinary platform that reflects a variety of perspectives—such as economic development, social equality, and ecological protection—with a view to achieving a sustainable urban form.

This international journal attempts to provide insights into the achievement of a sustainable urban form, through spatial planning and implementation; here, we focus on planning experiences at the levels of local cities and some metropolitan areas in the world, particularly in Asian countries. Submissions are expected from multidisciplinary viewpoints encompassing land-use patterns, housing development, transportation, green design, and agricultural and ecological systems.

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Content

Main Section: Community Planning

Section A: Planning Strategies and Design Concepts

Editorial introduction
Community Planning

Guest Editors

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The term "community planning" appears in various disciplines. Perhaps, there is no universal definition that would be accepted by all scholars given the broad meaning of "community", the changing players and the evolving approaches of urban planning. "Community" usually refers to people, place and the ties between people in those places. Planning was once the actions of governments for the common well-being of a place. However, in recent decades, a movement of citizen/NGO participation has deepened the practice. According to research that analyzed a total of 1,681 articles with the keyword "community planning" published from 1999 to 2014 in the fields of "Planning Development", "Geography" and "Urban Studies" in Web of Science databases, the most discussed themes were "collaboration and participation", "physical planning at the community level", "special community" (such as gated communities), "safety", "emotion and identity" (such as the feeling of belonging), "sustainable development", "revitalization", and "application of GIS" (Yuan, Liu, & Lin, 2015). In this sense, all the seven articles included in this special issue well fit the meaning of "community planning".

Among the seven articles, Tsuang and Peng (2018) provide an interesting framework for thinking about what community planning should consider. They applied Maslow's theory of a Hierarchy of Needs to define a livable community, arguing that for the physiological needs, such as food, water, clothing and housing, the community should be a place where these materials and facilities can be obtained at a bearable cost. For the safety needs, a community should provide a safe and friendly barrier-free environment with adequate medical resources so that the residents can live and work in contentment and good health. A sense of belonging could be met by providing care facilities for children and the elderly, green leisure facilities, and common spaces, in order to enable residents to engage in exercise and social contact. The authors then link the needs for esteem with the sufficiency of educational resources and coexistence with the natural environment. Finally, the need for self-actualization is explained to be satisfied by a high-quality living environment, inclusive of sustainability, achieving the goal of self-sustained circular development of the community. They further apply a Strength-Weakness-Opportunity-Threat (SWOT) analysis to an area of a former military plant in Taipei City, and then propose suggestions for the government to meet the needs of the people living in the social housing of the area.

Tutuko, Subagijo, and Aini (2018) and Yuliantari, Hafsari, and Prima (2018) both discuss physical planning at the community level in the context of Indonesia. The former research vividly depicts the situation of a poor area called Kampong Muharto in Malang City by providing a series of photos and maps, combined with a SWOT analysis of the area. Their design of garbage facilities, ornamental plants and childrens' playground/community centers would certainly upgrade the landscape of the place for people to meet their communication and sanitation needs. The latter research also addresses the planning of facilities, but focuses on puskesmas, the centers for public health, in an area called Purworejo in Central Java province. They analyze the factors of population distribution, geographical features, and vulnerability to natural disasters using GIS, and then apply a Spatial Multi-criteria Evaluation (SMCE) method to find the best locations for establishing the puskesmas.

The remaining five papers address comparatively higher needs for community development in China. Wu, Qin, and Zhou (2018) conducted a survey on people's fitness and sports activities in Shenzhen City, based on the background of growing health problems in Chinese cities such as obesity, dyslipidemia and fatty liver, high blood pressure, and so on. The survey results show high sporting frequencies of the citizens, and calls for providing more facilities to meet their diversified needs. Yu et al. (2018) study garbage separation in Hangzhou City. They apply the Theory of Planned Behavior to analyze the sample questionnaire results with structural equation modelling, and find that people in the city realize the need for garbage separation, but lack implementation through their real behaviors. Also concerned with the environmental impact of urbanization, Tian and Li (2018) investigate the reasons why less developed regions in China have showed slow development of green buildings. While low income is assumed to be the greatest impediment, on the contrary, by using both descriptive and statistical methods to analyse the questionnaire data, they find that knowledge related to green building and awareness of environmental protection have a more significant impact on the people's willingness to pay for green buildings. Thereby, they argue that governments should promote green building policies and devise instruments to support developers to adopt green building standards. In addition to the above-mentioned articles that focused on healthy and sustainable development of Chinese cities, the last paper of this issue, written by Zou and Zhu (2018), pays attention to the attractiveness of Changchun City to foreign students, which could be recognized as an attempt to address the "esteem" need of a community.

Most of the papers included here were presented at the biannual International Conference on Spatial Planning and Sustainable Development held at Seoul National University, South Korea, during August 18-20, 2017. We would like to express our sincere gratitude to the researchers who joined the conference and submitted their works to International Review for Spatial Planning and Sustainable Development. We also give special thanks to the reviewers who have granted us their most generous support with their time and valuable comments. We hope all our efforts will enhance the knowledge and practices of community planning globally.

REFERENCES

Tian, X., & Li, Y. (2018). "Key Factors of the People's Willingness to Pay for Green Buildings in a Less Developed Region in China: A Pilot Research in Shanxi Province". *International*

Review for Spatial Planning and Sustainable Development, *6*(3), 78-93. doi: http://dx.doi.org/10.14246/irspsd.6.3_78.

Tsuang, H.-C., & Peng, K.-H. (2018). "The Livability of Social Housing Community in Taiwan: The Case Study Base in Taipei City". *International Review for Spatial Planning and Sustainable Development*, *6*(3), 4-21. doi: http://dx.doi.org/10.14246/irspsd.6.3_4.

Tutuko, P., Subagijo, E., & Aini, N. (2018). "The Planning and Design of Residential Facilities in Poor Areas with Limited Land - a Case Study of Muharto Residential Area Along the Brantas River, Malang, Indonesia". *International Review for Spatial Planning and Sustainable Development*, *6*(3), 22-36. doi: http://dx.doi.org/10.14246/irspsd.6.3_22.

Wu, X., Qin, X., & Zhou, H. (2018). "A Study on the Behavior of Fitness Sports and Community Spaces - a Case of the Questionnaire of Urban Inhabitants in Shenzhen City, China". *International Review for Spatial Planning and Sustainable Development*, *6*(3), 49-62. doi: http://dx.doi.org/10.14246/irspsd.6.3_49.

Yu, S., Lu, T., Qian, X., & Zhou, W. (2018). "Behavioral Intention Analysis of Waste Separation in China - Case Study of Hangzhou Using Theory of Planned Behavior". *International Review for Spatial Planning and Sustainable Development*, *6*(3), 63-77. doi: http://dx.doi.org/10.14246/irspsd.6.3_63.

Yuan, Y., Liu, Y., & Lin, J. (2015). "Review on Community Planning Research of Foreign Countries in the Past 15 Years: A Visualized Analysis Based on Citespace Software". *Shanghai Urban Planning Review*, (4), 26-33.

Yuliantari, E., Hafsari, T. A., & Prima, R. (2018). "Site Selection of Public Health Center (Puskesmas) Using Spatial Multicriteria Analysis in Purworejo Regency". *International Review for Spatial Planning and Sustainable Development*, *6*(3), 37-48. doi: http://dx.doi.org/10.14246/irspsd.6.3_37.

Zou, X., & Zhu, X. (2018). "Soft Power of Chinese Cities: Factors That Attract International Students to Study in Changchun City". *International Review for Spatial Planning and Sustainable Development*, *6*(3), 94-109. doi: http://dx.doi.org/10.14246/irspsd.6.3_94.

The Livability of Social Housing Communities in Taiwan: A Case Study of Taipei City

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Abstract: Social housing is a welfare strategy geared to meeting the housing needs of working people and the middle class. Apart from resolving the basic housing problem of disadvantaged members of society, social housing also seeks to provide excellent residential quality, and achieve the goal of livable cities via enhancement of the quality of the urban living environment as a whole through a community-based approach. The goal of this paper is to explore social housing community development strategies for Taipei City, and examine how they can create livable social housing communities. The chief focal points include determination of problems currently faced by social housing communities in Taipei and formulation of development strategies based on livability criteria. After employing literature analysis to gain an understanding of problems cited in the literature and connected with current standards, the integration of livable city assessment items are discussed in the context of Maslow's hierarchy of needs. The publicly-owned idle space consisting of a former Army Maintenance Plant base in Taipei's Xinyi District that can be reused as a social housing community was chosen as the study case, SWOT analysis of the site's internal and external environmental factors and its current state of development were performed, and finally conclusions have been submitted concerning the development needs of livable residential communities and recommendations for Taipei City addressing social housing community development strategies. It is found that current development strategies tend to neglect communities' basic economic loads, and that an appropriate development strategy be constructed on the basis of Taiwan's current "Eco-Community Evaluation System" is recommended by incorporating basic community economic load factors, which will facilitate the sustainability of community management and maintenance.

1   INTRODUCTION

As part of its mission of investigating global competition and climate change, the United Nations Human Settlements Program's (UN-HABITAT) reports on global human habitats, emphasizing the themes of urban livability, and stress that a livable city should be people-oriented, meet residents' quality of life needs, and allow residents to live and work in contentment; a livable city is a place which is suitable for human work, living, and dwelling; in economic, social and environmental development, a livable city offers a good living environment, and is able to meet residents' material and spiritual needs

(Wikantiyoso & Tutuko, 2013; Yeh & Wu, 2010). For a variety of reference sources, there are various assessments of livable cities worldwide, and many cities with good livability are also selected on an annual basis in accordance with various assessment criteria. On the basis of the world's highest-ranking cities and the content of different assessment instruments, city livability should encompass at least good economic development, stable social security and welfare, convenient and complete life functions, adequate medical and educational resources, and a good-quality living environment.

Livable communities ensure that the cities where they are located have better livability, can provide community residents with an economically vibrant, safe, healthy, and comfortable living environment, and offer complete life functions, so that residents can live and work in peace and stability. The elements of a livable city's quality of life needs should include shared-prosperity communities (local economic development), safe communities, caring communities (social service development), green communities (environmental development), appropriate places of residence, and sustainable communities (Taylor, Barr, & West, 2000). From the perspective of Maslow's hierarchy of needs, the elements of a livable city should correspond to lower- and higher-level needs as follows: (1) good economic development meets Maslow's most basic physiological needs; (2) adequate medical resources and stable social security and welfare meet safety needs; (3) convenient and comprehensive life functions meet love and belonging needs; (4) adequate educational resources and coexistence with the environment meet esteem needs, and (5) a high-quality living environment meets the need for self-actualization. This study employs this framework to explore the basic elements of social housing community livability.

Due to poor community living quality, public housing in Taiwan was originally stereotyped as having poor quality, and public housing developments were seen as undesirable facilities (Liao, 2012). To change this state of affairs, the purpose of social housing should be to improve the housing market, enhance residential quality, and ensure that all people can live in appropriate housing and enjoy a dignified living environment. And when homes are only rented, and not sold, residential space can be used flexibly in a cyclical fashion, and residential living costs can be reduced while maintaining a good-quality living environment. What are the problems currently facing efforts to enhance the livability of social housing communities in Taiwan? What are appropriate development strategies for livable social housing communities? This study takes a former Army Maintenance Plant base in Taipei City, which is slated for development as a social housing community, as the study case, and investigates environmental impact factors inside and outside the site. Employing SWOT analysis in connection with the elements needed for a livable city and the concepts of Maslow's hierarchy, this study analyses the livability development strategy of the social housing community based on the five elements of a livable community.

The development strategy recommended in this paper is based on Taiwan's existing "Eco-Community Evaluation System", but incorporating economic factor considerations, and employs an upgraded system more appropriate for practical applications, which improves on the current lack of consideration paid to economic factors in social housing community development planning. This strategy represents a shift from the exchange "eco-innovation" framework toward a greater focus on environmental protection, while also addressing both environmental and economic factors within a "circular economy" framework (de Jesus & Mendonça, 2018). The strategy further

attempts to resolve conflicts between environmental protection and economic development, while seeking to achieve "livable" results in practice, and bringing an approach closer to environmental sustainability.

2   CONTENT AND METHOD

2.1   Literature Review

2.1.1   Livable Cities

Suresh (2016) believes that to become a livable city with a healthy and productive population, it is first necessary to resolve such urban environmental issues as sources of clean water, reduction of air and noise pollution, effective resolution of health and sewerage problems, and possession of good traffic conditions able to reduce the commuter pain index. Kashef (2016) pointed out that a holistic view of a livable city should incorporate the aesthetics and physical properties of architecture, streets, and regional development; and another point of view is that cities should focus on the sustainable development of the environment.

In the case of recent global assessments of livable cities, the standard items of assessment used by the Economist Intelligence Unit (2016) are stability (accounts for 25%; concerns personal safety, such as prevalence of petty crime, threat of civil unrest/conflict, etc.), healthcare (accounts for 20%; concerns medical care, such as quality of private healthcare, availability of public healthcare, etc.), culture and environment (accounts for 25%; includes humidity/temperature rating, cultural availability, and consumer goods and services, etc.), education (accounts for 10%), and infrastructure (accounts for 20%; includes quality of public transport, quality of energy provision, water provision and quality of telecommunications, etc.). The US human resources consulting firm Mercer LLC has conducted regular quality of life assessments for more than 460 cities worldwide to assist companies and professionals in assessing allowances and bonuses. The assessment benchmarks of the 2016 Mercer Quality of Living Survey (Mercer, n.d.) are political and social environment (crime, safety, and stability), economic environment (currency exchange regulations and banking services), socio-cultural environment (media, censorship, and personal freedom), medical and health considerations (hospital services and medical supplies, air pollution, infectious disease, and waste removal), schools and education (private and public schools), public services and transport (transport, network and utility services), recreation (restaurants, theatrical and musical performances, cinemas, sport and leisure activities, market and consumer goods), housing and natural environment (climate, natural disasters and extreme weather). A 2010 study of livable cities in Taiwan by Yeh and Wu (2010) refers to the seven global livable city assessment aspects of "public safety", "social welfare and healthcare", "education, culture and leisure recreation", "environmental ecology and living quality", "urban life and service facilities", "financial autonomy and financial burden", and "public economic power and viability".

In view of the content of these different livability assessment items, urban livability should include at least robust economic development, stable social security and welfare, convenient and sound life functions, adequate medical and educational resources, and a good-quality living environment. In other words, apart from convenient life functions, welfare, medical care, and

education, good economic development and construction must also take into consideration damage to the environment caused by development, and improvement and maintenance of environmental quality, so that residents can enjoy stable survival and development in a prosperous, convenient, healthy and comfortable environment.

2.1.2   Livable Communities

What are the characteristics and constituent elements of communities needed in order to realize a livable city? The livable city concept emphasizes a human-centered perspective, and it is possible to satisfy livability requirements when the working and other needs of people living in a city are met. The livability of a human community has been defined as the ability to lead a pleasant, safe, affordable, healthy, and sustainable life, and the residents of the community can easily reach any place they want to get to (Hahlweg, 1997). In 2000, scholars suggested definitions for the elements of quality of community living, which they proposed should include the following six items: A shared-prosperity community (local economic development), safe community, caring community (social service development), green community (environmental development), appropriate residences and sustainable community (Taylor, Barr, & West, 2000). These correspond to the five levels of needs in Maslow's hierarchy of needs, which consist of physiological needs, safety needs, love and belonging needs, esteem needs and the need for self-actualization (Maslow, 1954). These five levels of needs can be linked to the corresponding elements of a livable community as follows:

(1) The most basic needs: A community should be able to provide residents a residence with costs that can be borne with their working incomes. In addition to being able to bear living costs, residents should be able to obtain sufficient, convenient food, clothing, and transportation (Kochera & Bright, 2006). In keeping with the items required by a livable community, community residents should enjoy good economic development conditions.

(2) Low level needs: After satisfying the need for food, clothing, housing, and transportation, a community should also provide a safe and friendly barrier-free environment with adequate medical resources, so as to meet the need of residents to live and work in contentment and good health (Riffe, Turner, & Rojas-Guyler, 2008). In keeping with the needs of a livable community, a community should possess adequate medical resources and stable social security and welfare.

(3) High level needs: A community should be able to create a sense of community identity and belonging among residents. As for the community environment, care for children and the elderly, green leisure facilities and spaces enabling residents to engage in exercise and social contact, and convenient transportation and social networks can meet residents' need to create a warm and caring environment (Rousseau, 2010). In keeping with the need of a livable community for convenient and comprehensive life functions, a community should have a friendly environment allowing residents to communicate with and socialize with each other.

(4) Higher-level needs: Community residents may have sufficient educational resources, clearly understand their living environment, and rely on mutual aid and sharing to create ecological cycles in their environment, which will help establish a self-sufficient livable community. Respecting the natural environment, and creating and maintaining biological diversity in the environment will enable residents to coexist with the natural environment, and obtain respect and feedback from the environment, which will satisfy their

need for an excellent quality of life (National Research Council, 2002). In keeping with the items required by a livable community, a community must have adequate educational resources, while maintaining a living environment of mutual coexistence with nature.

(5) Highest-level needs: After the community plans and builds an environment to meet residents' living, safety, social contact and respect needs, it can take into consideration the need for economic development and low energy consumption and realize a high quality living environment with sustainable development, achieving the goal of self-contained cyclic development of the livable community (Ellen MacArthur Foundation & McKinsey Center for Business and Environment, 2015). In keeping with the items required by a livable community, a community should have a good-quality living environment. The constituent elements of a livable community corresponding to the levels of Maslow's hierarchy of needs are shown in the figure below.

Figure 1. The constituent elements of a livable community paired with the levels of Maslow's Hierarchy of Needs (Source: Modified by authors, concept from Maslow (1954)).

2.1.3   Social Housing

In the eyes of governments worldwide, housing is an important and widespread issue closely connected with peoples' livelihoods (Wei et al., 2016). Social housing is intended chiefly to solve the problem of provided housing to city residents. Governments build and subsidize social housing, and restrict social housing residents to persons who have no homes or who are socially or economically disadvantaged, which ensures that these individuals can also enjoy appropriate housing. Early public housing in Taiwan was called "national housing", and the *Public Housing Act* was issued by the Ministry of the Interior in July 1975 as basis for the implementation of the relevant measures, although Article 2 of the *Public Housing Act* states that public housing refers to housing planned by the government and sold or rented to low-income households or built by such households with government loans or loan interest subsidies. However, unlike social housing in other countries, which emphasize the principle of renting and not sale, social housing in Taiwan generally involves the subsidized sale of homes, and is seldom rented to residents. In order to reduce the cost of home ownership, most public housing is built inexpensively, and although most public housing is adequate to meet residents' needs, there have been many lingering problems with poor community environmental quality and building maintenance issues. To date,

responding to changes in Taiwan's economic and social situation, as well as to residential development trends, the *Public Housing Act* was replaced by the *Housing Act*, which was promulgated in 2017, and the *Public Housing Act* was abolished on January 4, 2015. These changes reflected domestic conditions and needs and were implemented in reference to foreign social housing practices.

The intent of the *Housing Act* set forth in Article 1 is to establish a robust housing market, improve the quality of housing, and thus allow all citizens to enjoy suitable housing and a dignified living environment. In contrast to the government's original strategy of drafting special laws governing public housing, the *Housing Act* includes the quality of housing as a whole, including public housing, among its considerations. The third chapter defines public housing as "social housing," showing that social housing is an important part of the *Housing Act*. Table 1 provides a comparative look at the differences between social housing and the original public housing.

Table 1. Comparative look at differences between original public housing and social housing.

Type of housing	Social housing	Original public housing
Management	public sectors, private organizations	public sectors
Management approach	Rental (At present, the Taipei Social Housing Lease Regulations limit lease terms to a maximum of six years in the case of tenants who meet general tenancy terms and to 12 years in the case of special tenants)	Sale or rental (in the past, most public housing was sold)
Development approach	Construction by the government: (1) New construction (direct construction, joint construction and allocation of housing units, and construction with private participation and establishment of subsidies). (2) Additional construction, renovation, repair, and modification of existing public buildings. (3) Acceptance of donations. (4) Renting and purchasing private housing. Construction by private organizations: Can be newly built, enlarged, modified, renovated, and repaired.	(1) Direct government construction. (2) Self-built with loans. (3) Built through incentives to invest. (4) Assist for purchase by residents.
Applicable subjects	A family or an individual who has no home or a certain income and whose property is below a baseline value; persons 30% above the baseline (originally 10%, but adjusted in an amendment) must provide evidence of a special situation or identity; the Act's provisions are as follows:	Low-income families

	(1) Low-income households, (2) families in special circumstances, (3) persons with three or more children who are minors, (4) persons under the age of 25 who are unable to return home after being placed in a residential institution or foster home , (5) senior citizens aged 65 and above, (6) domestic violence or sexual assault victims and their children, (7) persons with disabilities, (8) persons infected with human immunodeficiency virus (HIV) or acquired immunodeficiency syndrome (AIDS), (9) indigenous citizens, (10) disaster victims, and (11) homeless persons.	
Purpose	To enable all people to live in suitable housing and have a dignified living environment.	Providing shelter to low-income families
Value	Providing rental housing purely meeting housing quality needs, managing occupants' use behavior, reduce use of housing for the commercial purpose of gaining profit, improve the housing market, and enhancing the quality of living.	Providing non-profit residential sale or rental, so that disadvantaged people have houses in which to live.

(Source: Reconstruction by authors, including data from the *Public Housing Act* (*Construction and Planning Agency Ministry of the Interior, 2005*) and *Housing Act* (Construction and Planning Agency Ministry of the Interior, 2011))

From the above comparison, it can be seen that legal policies relating to public housing have shifted to consideration of housing quality as a whole from the original focus of public housing on solving the housing problems faced by disadvantaged groups. As for applicable subjects, while still providing a certain degree of protection to vulnerable socioeconomic groups, the scope of potential residents has expanded to all members of the public without their own homes. The purpose of non-profit-based public housing is to meet the housing needs of all people, including vulnerable socioeconomic groups, and also to ensure the quality of these individuals' living communities. As a consequence, community environmental quality will become the basic standard for both public and private housing. Taiwan's public housing also includes "suitable housing" and "youth housing", but these are handled with the approval of the Executive Yuan, and there is as yet no clear legal basis for implementation. As a result, these types of housing are not discussed in this study. Social housing, as defined in Article 3 of the *Housing Act*, refers to housing and necessary facilities built by the government or by the private sector with subsidies from the government that is primarily rented, and at least 30% must be rented to economically or socially disadvantaged persons. The goal of this study is to investigate what kinds of planning strategy can foster better urban livability and create livable social housing communities.

2.2   Methods

This study takes the former Army Maintenance Plant base in Taipei City, which is slated for development as a social housing community, as the study case. A review of the literature is first performed to define livable city, livable community, and social housing community, and to determine how to build a livable city as the goal. Case analysis and SWOT analysis focusing on existing conditions inside and outside the site are then conducted, and the results of analysis are used to draft a development strategy for livable social housing communities. This study's research flowchart is shown in Figure 2:
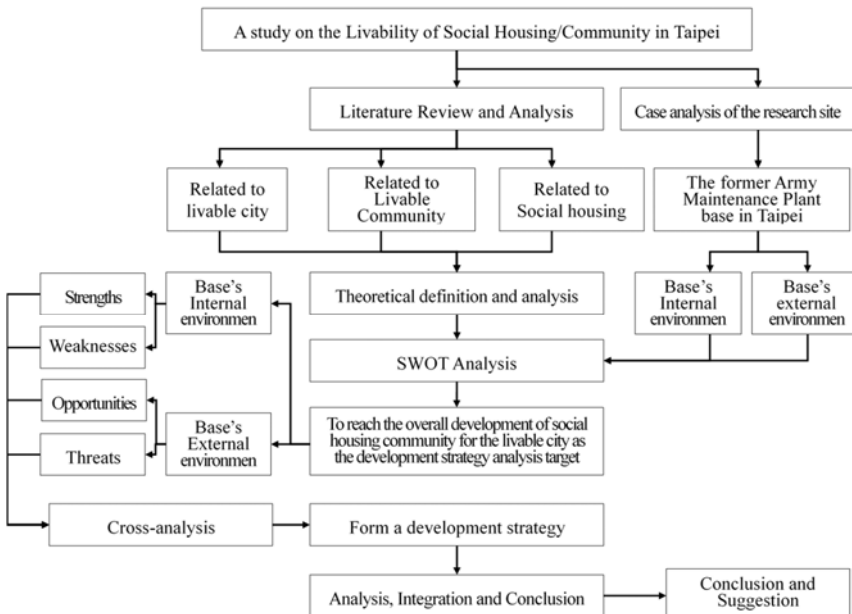
Figure 2. Research flowchart.

3   RESEARCH ANALYSIS

3.1   Case study of the former Army Maintenance Plant base in Taipei city

The case chosen by this study consists of a former Army Maintenance Plant base located in the Xinyi District of Taipei City. According to the content of the June 2005 Land Details Plan for the former Army Maintenance Plant base, the Ministry of National Defense moved this service center to the Xindian District in July 2004. The site now is idle, and has been transferred to the National Property Administration, Ministry of Finance for disposition, which means that the former service center no longer has its original spatial functions. The Xinyi District is a very important part of Taipei; there is much construction activity in the district, and development planning is very representative of Taiwan (Tsai, Chen, & Ning, 2016). According to its original content, the plan for the site is chiefly to establish a healthy residential community for the elderly and also to incorporate a biomedical technology R&D function, and this plan will be implemented in conjunction with the Ministry of the Interior's "Program for Promoting Private Participation in Construction of Housing for the Elderly". In response to social and policy changes, a May 28, 2015 press release from CTnews (2015) pointed out that

this site is expected to be reused for the construction of a youth creative city. A press release from August 19, 2016 (CTnews, 2016) also indicated that, in order to tie in with the new government's promotion of a social housing project, the Taipei City government has negotiated with the Ministry of National Defense concerning development of the former Army Maintenance Plant base as a social housing area by means of "cooperative development". The scope of this site is shown in Figure 3.
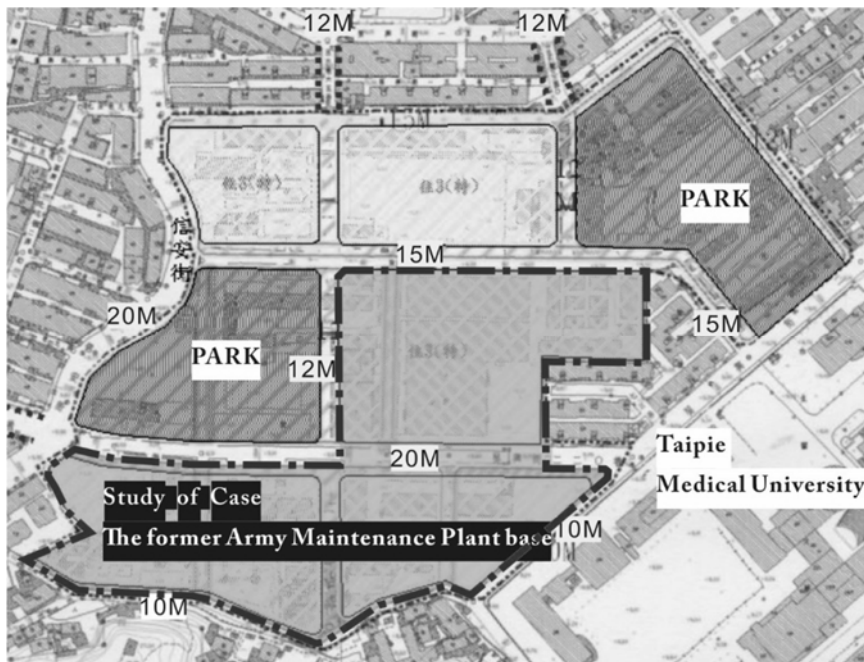
Figure.3 The scope of the former Army Maintenance Plant base. (Source: Taipei City Government (2005))

3.1.1   External environment at the case site

(1) Working and living environment in Taipei:

Taipei is Taiwan's administrative and economic center, and its administrative resources and tax revenue are higher than those of other cities in Taiwan, and its public transport system, social welfare and job opportunities are also better than in other cities. On the other hand, its cost of living is higher, and due to excessive real estate speculation, its housing prices have remained consistently high. It is not easy to live in Taipei, which has forced many people working in Taipei to move to neighboring cities in order to reduce their housing costs and increase their quality of life, which has come at the expense of increased commuting time and cost. According to a survey of the public's social housing needs and expectations commissioned by the Ministry of the Interior, among members of the public with social housing application qualifications, the most important criteria they consider are "rent" (57.9%), "ease of access" (54.2%), and "location" (34.8%); looking at the influence of other aspects on social housing, another roughly 5.2% of the respondents believed that social housing policy could raise the willingness of residents to marry or have children (Ministry of the Interior, 2017).

(2) The surrounding transportation system:

The site adjoins 20m Xin'an Street in the west, and a 15m lane in the southeast; the main access roads to the site consist of the 30m Keelung Road and 20m Zhuangjing Road. Due to the narrowness and curvature of the roads

adjacent to the site, vehicle access to the site is inconvenient, and the main access roads have large traffic volume and low road service levels. In addition, there is some distance from the site to the nearest MRT station, and the site remains to be connected via other forms of transportation and public transport (see Figure 4 for the area around the base).

(3) Nearby public facilities:

The chief residual public facilities include Sanxing Elementary School, Sanxing Market, and Sanxing Park in the north, George Vocational High School in the southwest, and Taipei Medical University in the southeast (see Figure 4 for the area around the site).

(4) Problem faced by the social housing community:

Nearby residents may feel concern that social housing may reduce the quality of the surrounding area and lead to falling house prices. In line with the government's active promotion and explanation of social housing policies, the Ministry of the Interior commissioned a survey of public support for social housing and gauged local residents' acceptance of the establishment of social housing nearby, with the intention of finding ways to increase public acceptance and favourable impressions. Items eliciting the highest levels of public concern included "proper management of social housing" (85.1%), "providing feedback to local residents" (76.8%), "increasing common use space in the neighborhood" (76.3%), and "architectural design" (63.5%) (Ministry of the Interior, 2017).
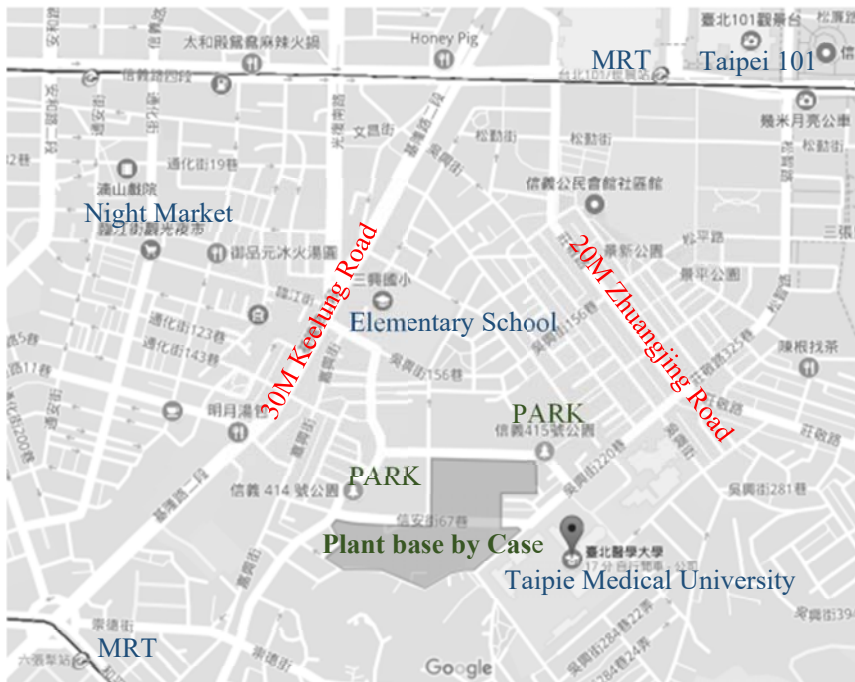
Figure.4 The map of the area around the base.

3.1.2   Case site internal environment

(1) Base status:

Land use zoning in the original urban plan chiefly consisted of class 3 residential area and road land; private land accounted for only about 7/1,000 of the total site area, and the remainder was public land. The site is currently idle, and some of original buildings are still on the site. As for the land use zoning of adjacent land, in addition to school land and park land in the north

and a protected area in the south, most of the remaining land consists of class 3 residential areas. Since the site has a certain size, comprehensive development promoting the integrity of living functions can meet the needs of the public.

(2) Base reuse planning:

The press releases cited above only refer to the current state of development. That social housing is currently the only form of public housing with a clear legal basis(Ministry of the Interior, 2017) and can further the government's realization of housing justice, should serve as a major consideration in the reuse of public idle space for development of a social housing community.

(3) Problems faced by social housing communities:

In the case of social housing that can only be rented and not sold, an important task is to determine the duties and powers of landlords and tenants, and attention must also be paid to maintenance during use and promotion of community participation, with the goal of achieving an effective community, promoting community interests, and maintaining a good-quality residential environment. However, limited by the current restricted supply of social housing, the actual implementation content has been limited to determination of the rental period, and this limiting factor will unfortunately affect tenants' motivation to participate in community affairs (Kochera & Bright, 2006). There is therefore need for effective strategies for creating social housing communities.

3.2   Developmental strategy for promoting the livability of a social housing community: SWOT analysis

The goal of development strategy analysis was to determine how to develop social housing communities within a livable city. While reflecting the definitions of livable city, livable community and social housing, the investigation in this study combined analysis of the site's internal and external environment, cross-analysis of the strengths, weaknesses, opportunities and threats of different strategies, and formulation of a livability development strategy for the social housing community in the study case.

This study determines the current status, weaknesses, opportunities and threats of the case site—the former Army Maintenance Plant base in Taipei's Xinyi District. The results of the analysis are shown in Table 2: SWOT Analysis of Livability Development of a Social Housing Community.

Table.2 SWOT Analysis of Livability Development of a Social Housing Community.

	Strengths	Weaknesses
Internal analysis	S1: Because the site constitutes public land, development as public social housing will entail relatively low acquisition costs.	W1：The public transportation system's road service standards are low.
	S2：The land can be developed on a relatively large scale, which will facilitate holistic development of living functions.	W2：The abandoned buildings still present at the site must be handled properly during development, so as not to cause construction waste or pollution.
	S3：Renting, and not selling, social housing can reduce	W3：Since the social housing is rented and not sold, and actual

	the cost of housing and facilitate planning of living environment quality. S4：Renting, and not selling, social housing can facilitate the regulation of tenant use behavior through the content of rental contracts and allows the public sector to implement managed living environment quality.	implementation during the current period is limited to the lease term, this may give tenants the feeling of being only temporary residents, which will reduce their sense of belonging and community cohesiveness.
External analysis		
Opportunities O1：The site is located in Xinyi District, Taipei; at the site area, external activity functions, including employment, administration, medicine, dining, and leisure are convenient, and there are good development conditions. O2：The site is near a medical center, making access to medical services quite convenient. O3：The site is near a school and a large public park, so leisure and cultural and educational living conditions are good. O4：Thanks to holistic development and new construction, effective building and environmental quality management can be planned out in advance. O5：Overall development and new construction allows Taiwan's current social trends and environmental needs to be taken into consideration, helping alleviate such social and environmental problems as demographic aging and long-term care, children's daycare, youth entrepreneurship, and other social needs. In addition, application of	**Maxi-Maxi strategy (SO)** Using strengths, taking advantage of opportunities SO1: S1, S3, O1, O5 SO2: S3, S4, O4, O5 SO3: S2, S3, S4, O2, O3, O5 SO4: S2, O1, O3, O5 SO5: S3, S4, O4, O5	**Mini-Maxi strategy (WO)** Overcoming weaknesses, grasping opportunities WO1: W1, O4, O5 WO2: W2, O4, O5 WO3: W3, O4, O5

green buildings, intelligent buildings, green transportation, and ecological environment creation can meet environmental needs.		
Threats T1：The site is located in Taipei, which has a high level of economic development. However, compared with other regions, environmental quality conditions, such as the urban heat island effect, air quality and noise levels are poor, so improvement methods should be considered. T2：Except for buses (which require walking some distance), the site is relatively far from the nearest MRT station and transfers are needed to go to most places; effective planning is needed to resolve the site's public transportation issues. T3：Existing residents living near the site have misgivings about the development of the social housing; development strategies need to consider such matters as "proper management of social housing", "providing feedback to local residents", "increasing the use of neighborhood space", "architectural design", and other issues to reduce resistance from surrounding residents.	**Maxi-Mini strategy (ST)** Using strengths, avoiding threats ST1：S2, S3, S4, T1, T3	**Mini-Mini strategy (WT)** Overcoming weaknesses, avoiding threats WT1：W1, T2

    After assessing the strengths, weaknesses, opportunities, and threats connected with development of the study site, development strategies were analyzed as follows:

(1) Making good use of strengths, taking advantage of opportunities:

    SO1: The site is located in Xinyi District, Taipei, and this location has good development conditions. The site consists largely of public land, which will entail lower development costs for the development of a social housing community, and the funds saved can be used to construct buildings and create a high-quality living environment. The fact that social housing is rented, and

not sold, will reduce the cost of housing and allow residents to enjoy a good quality of life in affordable homes.

SO2: Prospective residents who wish to enjoy a low-cost, high-quality residential community environment will need to sign comprehensive rental contracts, which will regulate their use behavior and encourage them to jointly maintain the buildings, safety, public welfare and environmental quality. The application of holistic development and new construction at the site can facilitate planning and ensure safety maintenance and management, and the presence of barrier-free spaces, etc., in advance, providing the community with a safe and comfortable environment.

SO3: The site is adjacent to a medical center, schools and parks. The medical, educational and leisure functions of the surrounding environment are good and community development can reserve certain areas for long-term care of the elderly, childcare and youth entrepreneurship functions, which will allow the community to play a role in the common development of the surrounding environment.

SO4: Because development of the social housing community will take place on a relatively large-scale and involve new construction, comprehensive planning to meet the public's living needs can be implemented, resulting in the establishment of a well-functioning, self-sufficient residential community. An effective community network will be established during early development, which will facilitate the sound maintenance and management mechanisms of a smart community, so that the community can form an integrated development area, which will be connected to the outside world by roads and network links, and achieve the goal of a livable city.

SO5: To achieve the goals of low cost and high living environment quality, the scale of development and new construction can ensure balanced economic development and maintain environmental quality, and a green economy can be fostered within the community in line with environmental protection considerations. Maintaining a high-quality living environment can reduce and ensure funds for follow-up maintenance and management, helping achieve the community's sustainable development.

(2) Overcoming weaknesses, grasping opportunities:

WO1: To address the site's relatively low road service level, the road system inside the site can be re-planned and developed comprehensively. In addition, green transportation can be employed to connect the site with the city's MRT transit system and form an effective transportation network, and various measures can be taken to resolve the transportation problems affecting the site.

WO2: With regard to the demolition of existing old buildings and disposal of construction waste, the effective classification and disposal of waste will facilitate holistic development. Waste with reuse value can be recovered, and other waste can also be classified on the basis of its materials, which will reduce the environmental load of building development and waste disposal and create economic value through waste recycling.

WO3: In order to promote resident participation in community development after the social housing is occupied, the management unit must assess the impact of the lease length and the fact that all residents will be tenants, and must consider promotional measures to encourage community residents to pitch in to maintain the quality of their living environment.

(3) Using strengths, avoiding threats:

ST1: Thanks to a certain scale of new construction, appropriate planning and design can be conducted to improve the quality of the site's living environment through the adoption of green buildings, smart buildings, and

ecological community practices. These measures can also improve the quality of the surrounding environment. In the course of planning, such aspects as providing feedback to local residents, increasing the common use of neighborhood space, and implementation of environmentally-friendly, attractive architectural design should be taken into consideration.

(4) Overcoming weaknesses, avoiding threats:

WT1: To address the site's low road service standards, applications can be made to re-route external public transportation systems, and green transportation can be employed to link the site with the MRT transit system, forming an effective transportation network and resolving the site's transportation problems.

3.3   Results and Discussion

Employing the content of community livability development defined in this study, the following conclusions and recommendations are submitted reflecting the results of SWOT analysis of social housing community livability development:

(1) Good economic development

By taking advantage of the site's superior life function and development advantages, and developing social housing that will be rented and not sold, the land's economic value and benefits can be used effectively, while taking into consideration social care aspects and reducing residents' living costs, and residents can enjoy affordable economic conditions, convenience and good quality of life. In addition, the effective classification and recycling of construction waste during the development process will create economic value from waste, which can not only offset the cost of waste disposal, but also reduce environmental load.

(2) Stable social security and welfare

Prospective residents who wish to enjoy a low-cost, high-quality residential community environment will need to sign comprehensive rental contracts, which will regulate their use behavior, and encourage them to jointly maintain the buildings, safety, public welfare and environmental quality. The application of holistic development and new construction at the site can facilitate planning and ensure safety maintenance and management, and the presence of barrier-free spaces, etc., in advance, providing the community with a safe and comfortable environment.

(3) Convenient and comprehensive life function

Because development of the social housing community will take place on a relatively large-scale and involve new construction, comprehensive planning to meet the public's living needs can be implemented, resulting in the establishment of a well-functioning, self-sufficient residential community. An effective community network can be established during early development, which will facilitate the sound maintenance and management mechanisms of a smart community, so that the community can form an integrated development area, which will be connected to the outside world by roads and network links, and achieve the goal of a livable city. To address the site's relatively low road service level, the road system inside the site can be re-planned and developed comprehensively. In addition, green transportation can be employed to connect the site with the city's MRT transit system and to form an effective transportation network, and various measures can be taken to resolve the transportation problems affecting the site.

(4) Adequate medical and educational resources

The site is adjacent to a medical center, schools, and parks. The medical, educational and leisure functions of the surrounding environment are good, and community development can reserve certain areas for long-term care of the elderly, childcare and youth entrepreneurship functions, which will allow the community to play a role in the common development of the surrounding environment.

(5) A good-quality living environment

The adoption of green buildings, smart buildings and ecological community planning and design practices will not only improve the quality of the site's living environment, but also promote economic development and environmental quality in the surrounding environment. During the planning stage, consideration should be given to such aspects as providing feedback to local residents, employing attractive architectural designs, and increasing common use of neighborhood space. At the same time, a green economy should be developed within the community. Maintaining a high-quality living environment can reduce and ensure funds for follow-up maintenance and management, helping achieve the community's sustainable development. Furthermore, the management unit must assess the impact of the lease length and the fact that all residents will be tenants, and must consider promotional measures to encourage community residents to pitch in to maintain the quality of their living environment.

The results of this study indicate that the five elements of a livable community correspond to the levels of Maslow's hierarchy of needs with the assessment of a livable city. Apart from ensuring social care and a cyclic supply of rental homes, planning of the internal environment in an effective social housing community development strategy should focus on a more appealing green environment, good transportation, and the promotion of management and social network linkage. In addition, with regard to economic considerations, construction waste should be handled properly, and effective maintenance and management performed. With regard to the external environmental, planning should focus on more convenient public transport connections, linkage with features and needs of the surrounding environment, and the establishment of friendly relations with nearby neighborhoods. These analysis results correspond to the "Eco-Community Evaluation System", which is based on the "eco-innovation" concept, and addresses the aspects of ecology, energy saving and waste reduction, health and amenities, service functions, categories and public safety (Architecture and Building Research Institute, n.d.). However, this system seems to lack the basic economic factors and considerations found in this study. The "eco-innovation" concept entails the development of economic processes responding to the needs of the community for environmental protection and sustainability, and seeks to provide innovative products and services with an environmental concept (Carrillo-Hermosilla, del González, & Könnölä, 2009). The government has drafted standards and measures in line with this concept as a basis for building and community development. However, as analysis shows, economic development is chiefly needed to meet the most basic physiological needs. While striving to achieve good environmental quality, a community should therefore also not ignore the impact of development on its economic load.

4   CONCLUSIONS AND SUGGESTIONS

Social housing can help regulate the housing market and solve the problem of urban residents being unable to buy their own homes. In addition, social

housing can reduce the cost of living, taking social care and the community as a whole into consideration while ensuring safety, health, good living conditions, convenient transportation, a friendly community, the natural ecology and other environmental quality aspects contributing to the livability of the community, while also encouraging residents to participate in community affairs, which will ensure effective maintenance and management, maintain a good quality of life and change the stereotyped view that public housing is undesirable and entails poor community living quality (Liao, 2012). This paper suggests a development strategy based on Taiwan's existing "Eco-Community Evaluation System", but incorporates economic factor considerations and employs an upgraded system more appropriate for practical applications. And while the "eco-innovation" concept focuses on environmental protection, it can also take both environmental and economic factors into consideration.

The "circular economy", which is currently much discussed and an issue of much importance for many countries, provides a model that can be applied to social housing community development. As explained by the Ellen MacArthur Foundation (2015), a circular economy is a cyclic economic model (involving reuse, reduction and recycling) that can replace the linear economic development model (involving taking, making, using and disposing) that has prevailed for a long time. "Eco-innovation" adds environmental protection and the concept of sustainability to economic development as a whole, creating a linear development model of green energy economic innovation, while circular economics can further regulate conflict between environmental protection and economic development, and establishes a multi-dimensional development model linking the behavior of government, producers and consumers in society as a whole. Bringing new business models and technologies into decentralized and traditional architectural domains (Ellen MacArthur Foundation & McKinsey Center for Business and Environment, 2015) can achieve livability and approach environmental sustainability more closely.

This paper focuses on the development of a social housing community on publicly-owned idle land in Taipei. As a consequence, the research scope and recommendations are applicable solely to Taipei City or similar cities. In addition, further research can examine how to apply the circular economy concept to the adjustment of development strategies.

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REFERENCES

Architecture and Building Research Institute, Ministry of the Interior, Taiwan. (n.d.). "Intelligent Green Building: Eco-Community". Retrieved from http://smartgreen.abri.gov.tw/art-en.php?no=65&SubJt=Eco-Community on May 30, 2017.

Carrillo-Hermosilla, J., del González, P. R., & Könnölä, T. (2009). "What Is Eco-Innovation?". *Eco-Innovation* (pp. 6-27). London: Palgrave Macmillan.

Construction and Planning Agency Ministry of the Interior. (2005). "Public Housing Act". Retrieved from http://glrs.moi.gov.tw/EngLawContent.aspx?Type=E&id=149 on May 30, 2017.

Construction and Planning Agency Ministry of the Interior. (2011). "Housing Act". Retrieved from http://glrs.moi.gov.tw/EngLawContent.aspx?Type=E&id=176 on May 30, 2017.

CTnews. (2015). "2015/5/28 News". Retrieved from http://www.chinatimes.com/newspapers/20150528000061-260202 on May 30, 2017.

CTnews. (2016). "2016/8/19 News". Retrieved from http://www.chinatimes.com/newspapers/20160819000131-260202 on May 30, 2017.

de Jesus, A., & Mendonça, S. (2018). "Lost in Transition? Drivers and Barriers in the Eco-Innovation Road to the Circular Economy". *Ecological Economics*, *145*, 75-89.

Economist Intelligence Unit. (2016). "A Summary of the Q Ranking and Overview". Retrieved from https://mn.kbs.co.kr/datafile/2016/08/0820_10.pdf on May 30, 2017.

Ellen MacArthur Foundation. (2015). *Delivering the Circular Economy: A Toolkit for Policymakers.* Chicago: Ellen MacArthur Foundation.

Ellen MacArthur Foundation, & McKinsey Center for Business and Environment. (2015). "Growth Within: A Circular Economy Vision for a Competitive Europe".   Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthur Foundation_Growth-Within_July15.pdf.

Hahlweg, D. (1997). "The City as a Family". In Lennard, S. H. C., von Ungern-Sternberg, S., & Lennard, H. L. (Eds.), *Making Cities Livable*. California: Gondolier Press.

Kashef, M. (2016). "Urban Livability across Disciplinary and Professional Boundaries". *Frontiers of Architectural Research*, *5*(2), 239-253.

Kochera, A., & Bright, K. (2006). "Livable Communities for Older People". *Generations*, *29*(4), 32-36.

Liao, C.-S. (2012). "Community Empowerment in Social Housing: An Action Research of Bodhi Chang Ching Village". *Journal of Environment & Art*, (12), 66-88.

Maslow, A. H. (1954). *Personality and Motivation.* New York: Harper & Brothers.

Mercer. (n.d.). "2016 Quality of Living Rankings". Retrieved from https://www.imercer.com/content/mobility/quality-of-living-city-rankings.html on May 30, 2017.

Ministry of the Interior. (2017). "2017/1/13 News". Retrieved from http://www.moi.gov.tw/chi/chi_news/news_detail.aspx?sn=11525&type_code=02 on May 30, 2017.

National Research Council. (2002). *Community and Quality of Life: Data Needs for Informed Decision Making.* Washington, D.C.: Board on Earth Sciences and Resources, Division on Earth and Life Studies, National Research Council, National Academy Press.

Riffe, H. A., Turner, S., & Rojas-Guyler, L. (2008). "The Diverse Faces of Latinos in the Midwest: Planning for Service Delivery and Building Community". *Health & Social Work*, *33*(2), 101-110.

Rousseau, G. (2010). "Handy Lessons from Overseas on Walking and Bicycling". *Public Roads*, *73*(4), 28-33.

Suresh, K. (2016). "What Works to Make Cities Good for Living?". *Journal of Health Management*, *18*(3), 367-380.

Taipei City Government. (2005). "Taipei City Planning Book to Revision of the Land Use Control Regulation Detailed Plan of the Original Army Maintenance Plant Base in Xinyi District Published on 2015". Retrieved from http://www.budwebgis.tcg.gov.tw/twobook/pdf/P094062.pdf on May 30, 2017.

Taylor, M., Barr, A., & West, A. (2000). *Signposts to Community Development.* London: Community Development Foundation and National Coalition for Neighbourhoods.

Tsai, S.-Y., Chen, T.-Y., & Ning, C.-J. (2016). "Elderly People's Social Support and Walking Space by Space-Time Path". *International review for spatial planning and sustainable development*, *4*(3), 4-13.

Wei, Z., Wang, B., Chen, T., & Lin, Y. (2016). "Community Development in Urban Guangzhou since 1980: A Social Sustainability Perspective". *International Review for Spatial Planning and Sustainable Development*, *4*(4), 58-68.

Wikantiyoso, R., & Tutuko, P. (2013). "Planning Review: Green City Design Approach for Global Warming Anticipatory". *International Review for Spatial Planning and Sustainable Development*, *1*(3), 4-18.

Yeh, C., & Wu, J. (2010). "A Study on the Development Strategy of Greater Kaohsiung's Livable City".   Development and Evaluation Commission, Kaohsiung City Government, Kaohsiung.

The Planning and Design of Residential Facilities in Poor Areas with Limited Land

A Case Study of Muharto Residential area along the Brantas River, Malang, Indonesia

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Abstract: This paper summarises the proposed physical planning and design in the poor area of Kampong Muharto, Malang City. As a community, the residents want to adjust their spatial setting to accommodate for social activities. This research lays out several options for their neighbourhood with consideration for the available space. The study area was analysed using the Strength-Weakness-Opportunity-Threat (SWOT) method and it was found that there were two sections of the area in need of planning and design. The primary objective of this work is to figure out the spatial arrangement for the project with a direct understanding of the various needs of the housing facilities within the limitations of the land boundaries.

1.   INTRODUCTION

Urban settlement in developing countries, such as Indonesia, often leads to substandard living conditions as one of the negative impacts of urbanisation. The development of cities often triggers development on land that should not be used for residential purposes (El Menshawy, Aly, & Salman, 2011; Orenstein & Hamburg, 2009; Tutuko & Shen, 2016). This leads to increasing environmental degradation, both in urban and rural areas, as well as problems for economic sustainability (Wikantiyoso & Tutuko, 2013). It is therefore necessary to focus on economic orientation (development orientation), environmental sustainability (environmental orientation) and community interests (community orientation). The central issue for the transformation of dwellings from a cultural perspective is that of the transition from the agrarian culture context into the modern urban culture context. According to Supriyadi, Sudarwanto, and Werdiningsih (2012), most habitation is still based on rural cultures, which are marked by a simple way of life, sense of togetherness and strong social interaction. Most people generally live on limited land and pay little attention to the physical conditions of their housing (Anggraini, 2012; Tutuko & Shen, 2014). Urbanisation often occurs along riversides, and the issue of spatial arrangement in these limited land areas has been widely discussed, especially regarding densely inhabited

areas. According to Ahmad et al. (2002), due to the small sizes of the plots in their specific case study, the amount of land was inadequate for many households, especially because certain complexes contained inter-family relationships and the number of family members tended to quickly expand beyond the original housing capacity. In relation to limited land, the spatial pattern of human settlement has also been discussed in terms of social norms and cultural settings (Nunta & Sahachaisaeree, 2012; Tutuko & Shen, 2014), its transformation in accordance with modern society (Saleh, 2000, 2001), and human behaviour and satisfaction of living (Cho & Lee, 2011; Lewis, 1997; Marmot, 1983; Wang & Chien, 1998).

Inner city communities, especially those of low income, often require community participation to improve. Such participation is also needed in the construction of residential facilities in rural-urban areas (Njoh, 2011). Several studies have shown the difficulty of aligning the needs of community projects with an effective type of community participation (Abbott, 2002; Lizarralde & Massyn, 2008). The study of improving the infrastructure of residential neighbourhoods on riverbanks with limited land suggests that a positive perception of security is crucial in encouraging people to invest in their settlements (Winayanti & Lang, 2004). Planning and design in poor areas are needed to reduce slums within urban areas. One way to achieve this is to improve residential facilities (Wekesa, Steyn, & Otieno, 2011). According to Majale (2008) and Benjamin, Arifin, and Sarjana (1985), slums and informal settlements are an integral and inevitable part of most cities in developing countries, and they also play a key role in their socioeconomic development. Their significance to the housing of most of the urban poor cannot be overstated.

Planning and design also involve various parties. Aesthetic input comes from architects, but the design process should also be open to input from the community. The formal aspects of architecture have limited application in relation to this independent development process. Coupled with the low quality of buildings and slow construction, independent technical assistance is required (Segaar, 1979). The complexity of aesthetic and environmental significance demands academic oversight. It is crucial for universities to assist in the planning and construction of these residential facilities. According to Kowaltowski (1998), technical assistance should focus on environmental design and home placement guided by knowledge of aesthetic preferences.

The dwellings in the study area, Kampong Muharto (in district 10), known as *kampong*, are the typical type of urban dwellings in Indonesia. Kampong Muharto is dominated by families with children. The neighbourhood of Muharto is located by the river and is strongly influenced by kampong culture, which has resulted in marked deviations from the surrounding city developments. This paper attempts to arrange the facility space in the Muharto neighbourhood with respect to the fact that the community planning and design of this settlement is still dominated by the activities and culture of the residents. The children have no space to play, and the parents do not have a common place to gather. The main concern for the slums, and the starting point for their development, is to address the lack of facilities; this is an urgent problem that can only be resolved through research. It is the slow speed of the development of housing and the environment that causes the area to look "slummy"; this is coupled with the fact that most residents make a living by scavenging trash, although it should be noted that their activities do assist the city's programs in municipal waste management.

This research attempts to arrange this neighbourhood by offering several alternatives for the area, especially with respect to the function of its spaces.

This paper is divided into five sections. The first section explains the background and prior research on housing on limited land, especially in cities in developing countries. The second section focuses on the Muharto neighbourhood specifically, including housing facilities and housing conditions, and maps the environmental conditions in two areas. The third section describes the methodology, data collection, and SWOT analysis. Further explanation is also given about residents' actions in arranging the community facilities. The fourth section discusses decisions on planning and designing residential facilities based on the SWOT analysis. Finally, the conclusion highlights the planned spaces and designs that would provide residential facilities on the limited land.

2.   RESEARCH AREA

2.1   Overview

The study area, Kampong Muharto, is in the southeastern part of Malang City, on the eastern part of the island of Java, Indonesia. It is a kampong settlement, an area inhabited by families at a lower economic level and the predominant type of settlement across the city. Kampong Muharto (*Figure 1*) is located within the urban village Kotalama, with an area of 0.86 square kilometres and a dense population of 29,126.
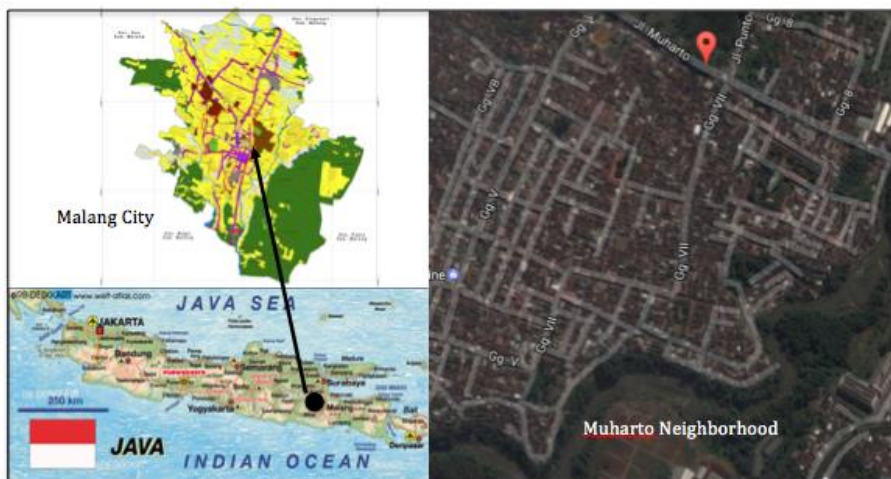
Figure 1. Map of Malang City and aerial view of Kampong Muharto area

The kampong has a population density of 33,867 people per square kilometre. There are 142 districts and 11 sub districts within 1 km of the city centre, adjacent to the public cemetery of Polehan-Kotalama. In the past, no one would have thought that Kampong Muharto would be the neighbourhood it is today as the area was originally mostly filled with the graves of ethnic Chinese residents. Even if there were houses, most of them were made from fragile bamboo and plastic shacks, and the inhabitants were commonly prostitutes and people connected to crime. With the expiration of the contract period on the tombs, many newcomers began to arrive and live there. They came from different regions in Indonesia, such as Madura (Madurese), Sumatra (Sumateranese), and other areas. The immigrants there were serious about improving the image of the kampong area.

With this as the historical backdrop, the government and community were committed to improving the area for habitation. This study on the settlement

was undertaken to offer options for reconstruction of the Muharto area in district 10 specifically. The improvements focused on environmental aspects and the arrangement of the Muharto facilities, such as parks and streets for the general improvement and beautification of Muharto.
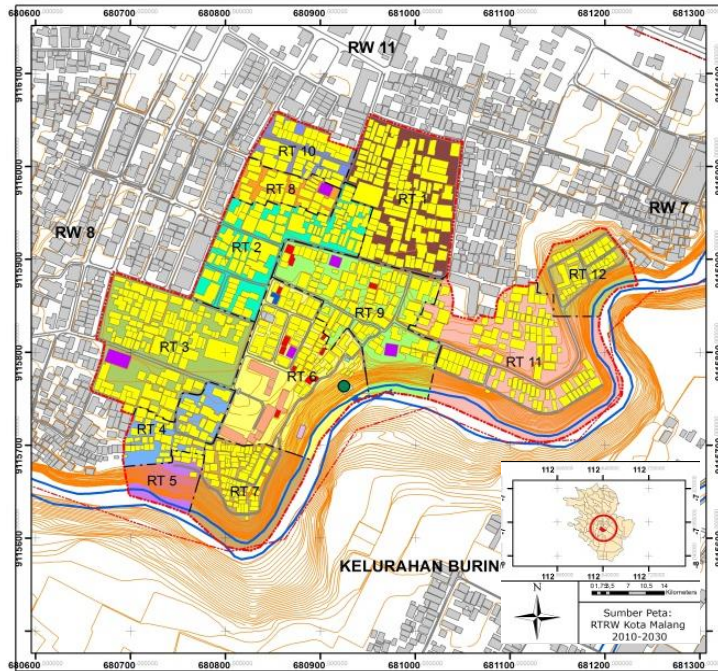
Figure 2. District 10 of Kampong Muharto

The selection of district 10 in Kampong Muharto was based on its high density of buildings, which have made it difficult for the government and the community to develop the area, despite the community's interest in improving the environment. Due to this lack of development, there has been a gradual decrease in the number of people who live in district 10 (Figure 3 and Figure 4).
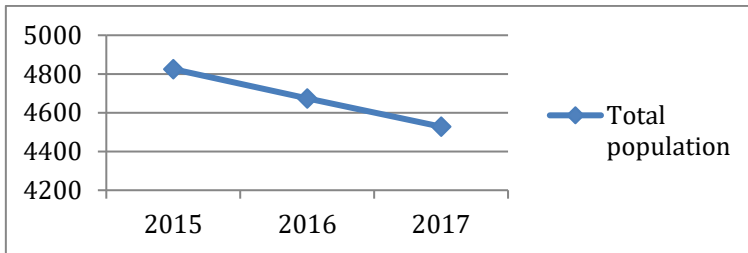
Figure 3. The population of District 10, Kampong Muharto.
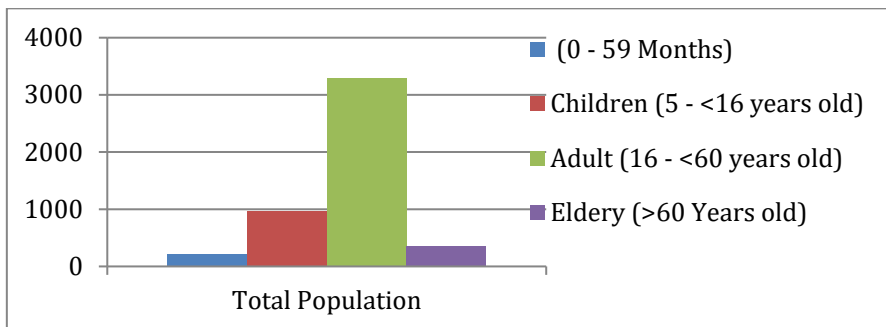
Figure 4. Graph of Population by Age in District 10, 2016

2.2   Housing Conditions

The local government encourages people to participate in city waste management by collecting recyclables from refuses. After several years in the program, the community has increased in size and has begun formally organising its participation. Due to this, Kampong Muharto has become known as the "scavenger kampong". Collected items are kept in front of homes in preparation for being sent to the collection centre (*Figure 5*). Workers going to the market frequently crowd the Muharto area, creating traffic jams on the road to the Kebalen Market. This area is also an alternative route to the south and east of Malang. Jalan Muharto will soon have an entrance and exit toll road for Malang-Pasuruan, although the process of land acquisition for the project is ongoing.

The road has a bridge connecting the Muharto region with the city over the Brantas River. On the Muharto bridge, garbage is often found at the edge and near the river as well. Garbage collects on both sides of the bridge, adding to the degraded environmental conditions, although no one has ever been caught for the offense of littering there (Figure 6).

Figure 5. Housing conditions: residents put their collected goods at the front of their house. It contributes to a bad aesthetic for the house and neighbourhood (Source: Photos by Aldira and Andika)

Figure 6. Housing conditions: most of the houses are incrementally built. People develop their houses gradually based on their financial capacity at the time. (Source: Photos by Aldira and Andika)

The local government did not provide infrastructure development in all areas in District 10, because development near the main road has been the

priority. Physical conditions on the north side of the district are relatively good. Malang city has a tropical climate, so high rainfall often causes flooding, especially in the low-cost housing areas, so the use of paving materials in the district has been very helpful (Benjamin, Arifin, & Sarjana, 1985; Sedyowati et al., 2017). The entrance to the district is clean and good quality, as the road is paved with asphalt. Paving blocks are also used on the narrow streets (width of 2-3 meters) in this area. There is a sufficient supply of electricity and water in this district. On the south side, however, the areas along the riverside lack adequate infrastructure and residential facilities.

A long time ago, before the eviction of residents from the banks of the Brantas River, this kampong was mostly bamboo forests and Chinese tombs. According to local residents, there was an assumption that the land was haunted and the area was a dumping ground for the bodies of murder victims, however, after evictions along the Brantas River, these settlements managed to attract people. Even so, this kampong is considered a slum because most of the people work as scavengers and beggars. The area has historically received minimal attention from the city government.

2.3 Housing Infrastructure and Facilities

The Government of Indonesia, in its effort to improve the quality of housing, applies the concept of "100-0-100". The 100-0-100 targets were introduced by the Ministry of Public Works and detailed in the Long Term Development Plan 2015-2019. The targets are 100% access to water for drinking, 0% slum areas, and 100% access to proper sanitation. Facilities and infrastructure that exist in Muharto do not currently achieve this goal because the environment does not have proper waste management, streetlights and ditches, and the roads area are also in a state of disrepair. Meanwhile, facilities supporting homes in this area include only one public bathroom, a small mosque and a common septic-tank (*Figure 7* and *Figure 8*). Moreover, there is no children's playground.

Figure 7. The poor condition of the community washroom, sometimes also used for laundry. (Source: Photos by Aldira and Andika)

Figure 8. The conditions of a small mosque used by the community. (Source: Photos by Aldira and Andika)

The conditions in Kampong Muharto are, in fact, common in neighbourhoods across Indonesia. Public facilities are the concern of city governments, but the cleanliness of the living environment is also a public concern.

2.4   Mapping Environmental Conditions

This research focuses on two sections of Muharto. Section 1 is an area with no streetlights and damaged roads with waste litter. The neighbourhood looks dirty because the majority of residents are waste pickers and they place their collections in front of their houses (*Figure 9*).

Environmental conditions in Section 2 of the kampong indicate that the road mostly has no pavement, so if it rains, the road will easily become muddy and dirty (*Figure 10*). The road is also very narrow between the two rows of houses. The narrow roads make the supply of building materials difficult, but they also facilitate socialisation amongst the people.
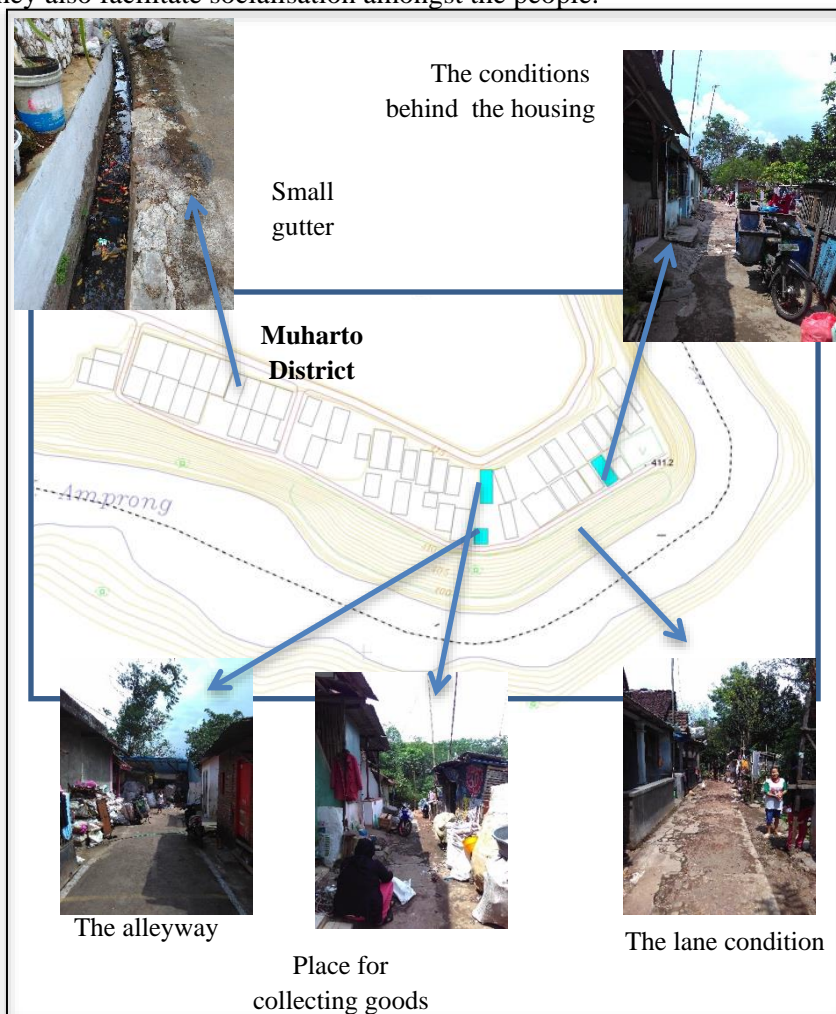
Figure 9.Section 1, the location near the riverside. (Source: Photos by Aldira and Andika)
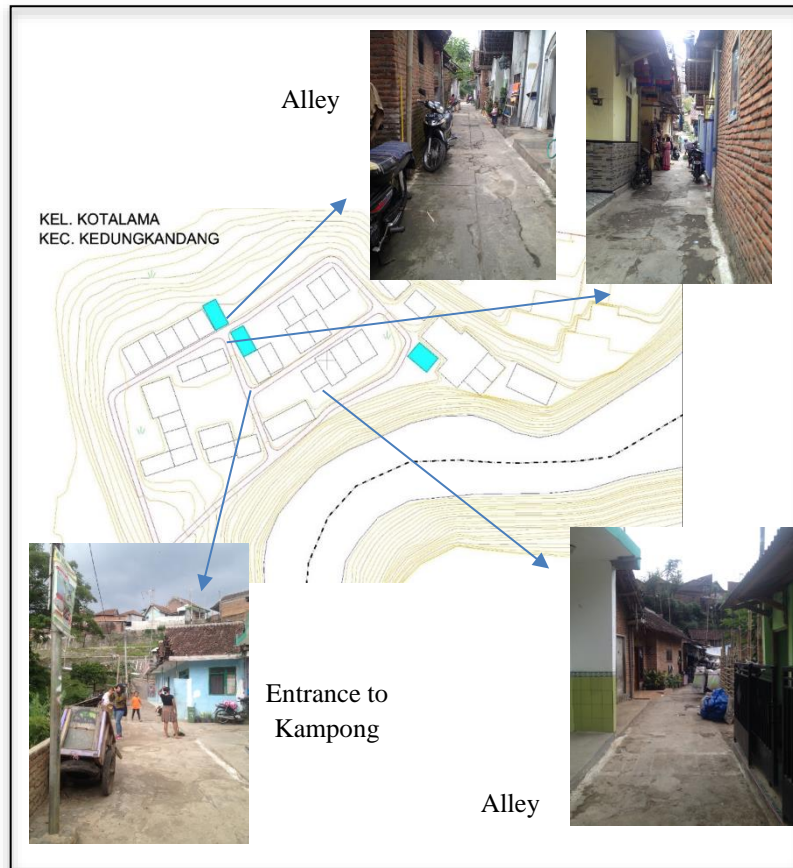
Figure 10. Section 2, the location in the middle of the kampong. (Source: Photos by Aldira and Andika)

3.   METHODOLOGY

The research approach used in this study is based on descriptive qualitative research methods. Qualitative research aims to understand the holistic experience of the study subjects, through their behaviour, perceptions, motivations, and actions. The descriptive qualitative research method in this study is used to describe the location, as it relates to 1) the conditions of the infrastructure in the settlement, 2) the provision of infrastructure and the parties involved, and 3) the factors that affect the conditions of slums in Kampong Muharto.

3.1   Collecting Data

The data in this study is collected in various ways, specific to the required information. 1) Interviews are used to obtain data and information from individuals living in the vicinity of the environment (Questionnaires are used as the main interview method in this study); and 2) Documentation of data from the questionnaire as well as a photo collection, which supplements the primary data obtained through the interviews and observation.

3.2   Data Analysis

The method of analysis used in this study is the SWOT analysis method. Attributes are categorised as: 1) strengths, which are advantageous attributes of the planning area that have not yet been maximally utilised or that have been neglected; 2) weaknesses, which are negative or compromising attributes of the planning area; 3) opportunities which are broader positive possibilities that may be exploited on a future urban-rural/regional scale; and 4) threats, which are largely external factors that threaten the success of implementation.

Table 1. SWOT Analysis

No	Aspects	Descriptions
1	**Strength**	• Kampong Muharto had traditionally been the location of the tombs of Chinese Indonesians • Strategic location • Communities have good community work as scavengers and traders. • Kampong Muharto is on the government agenda for the Kampong Improvement Project 100-0-100
2	**Weakness**	• The absence of vacant land for public facilities • Minimal supporting facilities • Poor utilisation and not well organised • Minimal public awareness of hygiene • The river banks in this area have not been well managed
3	**Opportunity**	• Rearrange residential areas • Improve existing facilities and infrastructure • Create solutions for public facilities on limited land • Create open space for people to gather for daily activities
4	**Threat**	• Difficulties transporting construction materials to location • Unstable funding for development • If it is needed, community relocation is rarely an option

Based on the SWOT analysis, decisions can be made over which parts of the environment require spatial adjustment. This decision also considers the needs and availability of land that can be allocated for facilities.

4.   RESULT AND DISCUSSION

The decision over spatial arrangement in Kampong Muharto is based on this SWOT analysis (*Table 2*), which shows requisite development.

Table 2. SWOT Analysis Result

	OPPORTUNITIES	THREATS
ASPECTS	• Strategic location as a service centre • City administered facilities for kampong • Cultural activities, such as carnivals, often held in the region.	Fear that the Brantas River will overflow into the housing area

STRENGTHS	STRATEGIES S - O	STRATEGIES S - T
• The potential for vertical development, facilitating more homes • Potential location for parking development	• Develop as a green area • Create cultural events	• Improve decent infrastructure and ensure user comfort, safety, and attractiveness • Create more frequent events to increase the area's attractiveness
WEAKNESSES	STRATEGIES W - O	STRATEGIES W - T
• Build density is high, with building coverage approaching 100%. • Absence of unity of building theme in the region • There is no temporary garbage collection • The lighting is less than adequate • Benches and public seating is less organised and not well maintained. • Open space is not maintained	• Organise areas with contextual themes related to the environment • Organise public benches and seating areas • Arrange street lighting so as to ensure security • Create an open space for children	Create integrated, safe, and comfortable thoroughfares

4.1 Section 1

In Section 1, the planned and designed area could make use of local materials, as local natural materials greatly assist in the sustainability of facilities to be used for the next generation (*Figure 11* and *Figure 12*).
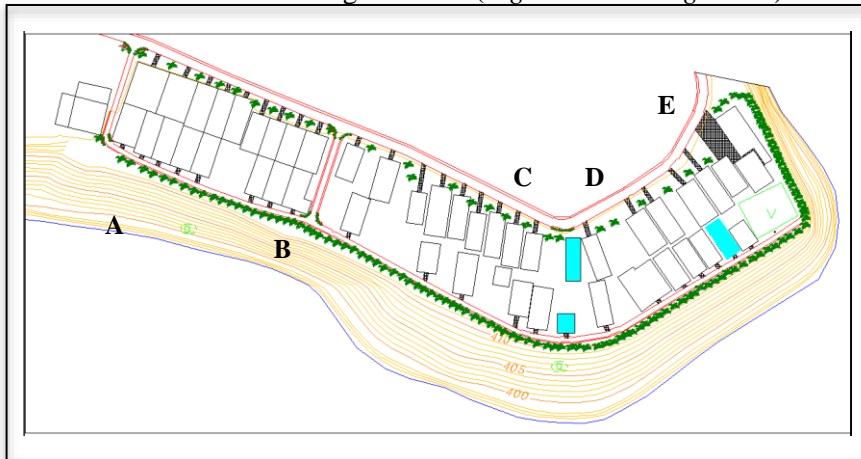
Figure11. Planning for Section 1

A **B**	Provide a dumpster for every house, so garbage will not be thrown in the river. Dumpsters should be bamboo bins.
C **D** **E**	Focus on the location of the waste, and placing street lamps and ornamental plants to beautify the environment. Place trash cans in front of houses to encourage care towards the environment. The street lights are also placed at fixed intervals (every seven meters). Ornamental plants used are primarily bamboo, which complement the current aesthetic.

Figure 12. Planning decisions for Section 1

4.2   Section 2

This park area is made up of 2 zones (*Figure 13, Figure 14* and *Figure 15*). Adjacent to the waste collection area is an open space for training people in recycling garbage. This garbage receptacle is made of bamboo material, which is easy to access. The selection of bamboo plants around the park further serve as a shade garden and offers soil reinforcement along the steep topographical contour.
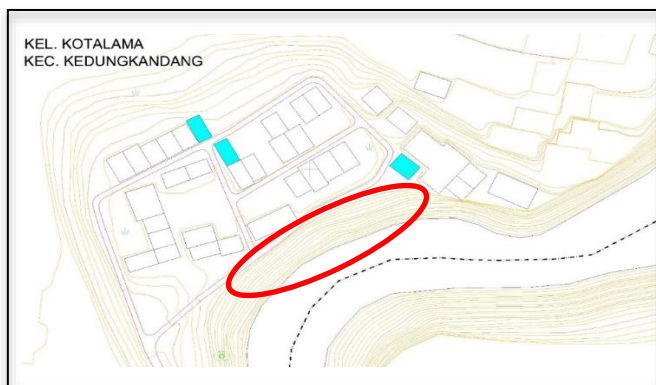
Figure 13. Planning for Section 2
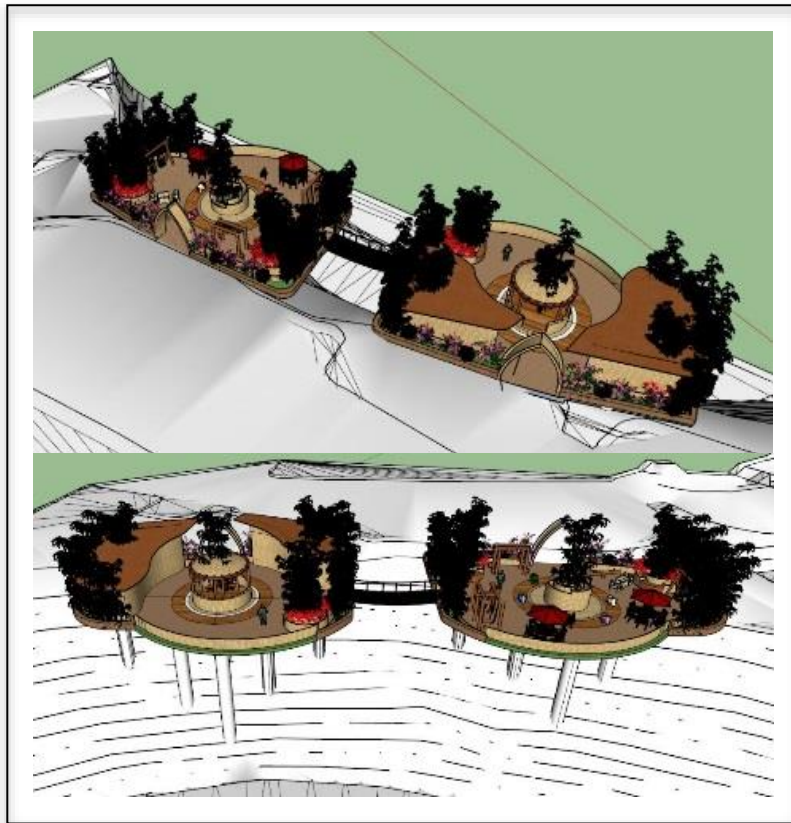
Figure 14. The riverside garden is a concept of a child-friendly park design
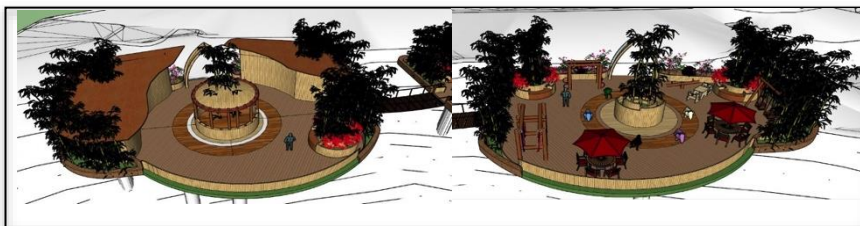
Figure 15. Two types of park

Figure 16. The design of temporary garbage disposal facilities and the construction of riverside roads

Children's playgrounds include swings, seesaws and other equipment common in playgrounds. Seats are provided for parents to watch over the children while they are playing. Spatial arrangement decisions in the planning and design facilities of Kampong Muharto (*Figure 16* and *Figure 17*) provide an alternative solution to traditional problems in the area. Residents of all ages can enjoy the environment comfortably and safely, especially children. By

improving the environment and providing a playground for children, it is hoped that the area once known as a slum will be a clean and comfortable area.

Figure 17. Design for neighbourhood roads and playgrounds for residents who can take advantage of riverside access and river views

The planning and design of residential facilities in poor areas requires consideration of the location of the facilities to be built, the activities of the people there, and the limited land conditions on the riverside. The results obtained required meaningful discussion between academics and affected residents.

5.   CONCLUSION

Given the challenges of land constraints and the maintenance of environmental quality, there is a required intensification of community cooperation with academics in the planning and design of residential facilities. Through the SWOT analysis method, inputs and options were offered to solve problems regarding the selection of plans, designs, locations and themes in line with the location and activities of the region. Mutual understanding is needed in the planning and design of residential facilities on limited land, especially on riversides.

Despite the limitations of the land, most of the inhabitants still work, mainly scavenging recyclables. With the increasing development of the city, Kampong Muharto faces a situation in which the city needs to meet the needs of all its residents. An understanding of the relationship between space requirements and residents' activities is needed. By understanding the spatial arrangement of housing, geographic condition and population growth, the best spatial arrangement for residential facilities can be realised. This study is expected to help respond to the rapid growth in urban areas, where problems often arise in residential areas. The planned and designed facilities are expected to provide solutions to similar conditions in other cities, especially in densely populated areas with limited land located on riversides.

ACKNOWLEDGEMENT

REFERENCES

Abbott, J. (2002). "An Analysis of Informal Settlement Upgrading and Critique of Existing Methodological Approaches". *Habitat International*, *26*(3), 303-315.

Ahmad, A. M., Sultan, A. E.-I. M., Abdalla, M. M., Malik, A. O., Said, M. A., Mukhtar, E.-S. M., & El-Mufti, N. M. (2002). "Low-Cost Housing Projects in Khartoum with Special Focus on Housing Patterns". *Habitat International*, *26*(2), 139-157.

Anggraini, L. D. (2012). "Spatial Arrangement in Chinese and Javanese Shop House in Yogyakarta City". *Procedia-Social and Behavioral Sciences*, *36*, 557-564.

Benjamin, S., Arifin, M. A., & Sarjana, F. P. (1985). "The Housing Costs of Low-Income Kampung Dwellers: A Study of Product and Process in Indonesian Cities". *Habitat International*, *9*(1), 91-110.

Cho, S. H., & Lee, T. K. (2011). "A Study on Building Sustainable Communities in High-Rise and High-Density Apartments–Focused on Living Program". *Building and Environment*, *46*(7), 1428-1435.

El Menshawy, A., Aly, S. S., & Salman, A. M. (2011). "Sustainable Upgrading of Informal Settlements in the Developing World, Case Study: Ezzbet Abd El Meniem Riyadh, Alexandria, Egypt". *Procedia Engineering*, *21*, 168-177.

Kowaltowski, D. C. (1998). "Aesthetics and Self-Built Houses: An Analysis of a Brazilian Setting". *Habitat International*, *22*(3), 299-312.

Lewis, J. S. (1997). "Housing and Social Support Needs of Elderly Persons: A Needs Assessment in an Independent Living Facility". *Evaluation and Program planning*, *20*(3), 269-277.

Lizarralde, G., & Massyn, M. (2008). "Unexpected Negative Outcomes of Community Participation in Low-Cost Housing Projects in South Africa". *Habitat International*, *32*(1), 1-14.

Majale, M. (2008). "Employment Creation through Participatory Urban Planning and Slum Upgrading: The Case of Kitale, Kenya". *Habitat International*, *32*(2), 270-282.

Marmot, A. F. (1983). "Flats Fit for Families: An Evaluation of Post-Occupancy Evaluation". *Design Studies*, *4*(2), 92-99.

Njoh, A. J. (2011). "Municipal Councils, International Ngos and Citizen Participation in Public Infrastructure Development in Rural Settlements in Cameroon". *Habitat International*, *35*(1), 101-110.

Nunta, J., & Sahachaisaeree, N. (2012). "Cultural Landscape, Urban Settlement and Dweller's Perception: A Case Study of a Vernacular Village in Northern Thailand". *Procedia-Social and Behavioral Sciences*, *42*, 153-158.

Orenstein, D. E., & Hamburg, S. P. (2009). "To Populate or Preserve? Evolving Political-Demographic and Environmental Paradigms in Israeli Land-Use Policy". *Land Use Policy*, *26*(4), 984-1000.

Saleh, M. A. E. (2000). "The Architectural Form and Landscape as a Harmonic Entity in the Vernacular Settlements of Southwestern Saudi Arabia". *Habitat International*, *24*(4), 455-473.

Saleh, M. A. E. (2001). "The Evolution of Planning & Urban Theory from the Perspective of Vernacular Design: Momra Initiatives in Improving Saudi Arabian Neighbourhoods". *Land Use Policy*, *18*(2), 179-190.

Sedyowati, L., Suhardjono, S., Suhartanto, E., & Sholichin, M. (2017). "Runoff Velocity Behaviour on Smooth Pavement and Paving Blocks Surfaces Measured by a Tilted Plot". *Journal of Water and Land Development*, *33*(1), 149-156.

Segaar, T. (1979). "Some Basic Problems of Slum Improvement and Its Consequences for Training: Some Lessons from Pakistan and Indonesia". *Habitat International*, *4*(1-2), 51-62.

Supriyadi, B., Sudarwanto, B., & Werdiningsih, H. (2012). "In Search of the Power of Javanese Culture against the Cultural Urbanization in Kotagede, Yogyakarta-Indonesia". *Procedia-Social and Behavioral Sciences*, *68*, 676-686.

Tutuko, P., & Shen, Z. (2014). "Vernacular Pattern of House Development for Home Based Enterprises in Malang, Indonesia". *International Review for Spatial Planning and Sustainable Development*, *2*(3), 63-77.

Tutuko, P., & Shen, Z. (2016). "The Effect of Land Use Zonings on Housing Development: The Introduction of Cdl Approach in the Border Area of Surabaya and Sidoarjo Regency, Indonesia". *Procedia-Social and Behavioral Sciences*, *227*, 107-114.

Wang, M.-S., & Chien, H.-T. (1998). "Environmental Behaviour Analysis of High-Rise Building Areas in Taiwan". *Building and Environment*, *34*(1), 85-93.

Wekesa, B. W., Steyn, G. S., & Otieno, F. F. (2011). "A Review of Physical and Socio-Economic Characteristics and Intervention Approaches of Informal Settlements". *Habitat International*, *35*(2), 238-245.

Wikantiyoso, R., & Tutuko, P. (2013). "Planning Review: Green City Design Approach for Global Warming Anticipatory". *International Review for Spatial Planning and Sustainable Development*, *1*(3), 4-18.

Winayanti, L., & Lang, H. C. (2004). "Provision of Urban Services in an Informal Settlement: A Case Study of Kampung Penas Tanggul, Jakarta". *Habitat International*, *28*(1), 41-65.

Site Selection for Public Health Centres (Puskesmas) Using Spatial Multicriteria Analysis in Purworejo Region

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Abstract: Increasing population size puts pressure on each region, epseically on basic services, such as the provision of clean water, sanitation and health facilities. Centres for public health (Puskesmas) are a basic health facilities provided by the government at the administrative level, with one puskesmas per district. Puskesmas based on this administrative requirement cannot be accessed by the entire community because of their relatively difficult affordability. This study aims to provide advice on the development of puskesmas by modeling their development in consideration of several factors, including the condition of the population, the vulnerability of the population to natural disasters, and spatial factors. This model uses the spatial multicriteria evaluation (SMCE) method based on various scenarios. This research will help decision-makers to choose from various simulation results. Site selection models are tested through crosstabulation against the vulnerability of disease to select the best model. This research was conducted in the Purworejo region, Central Java. The results of this research show that there are varying levels of suitability for site selection. The Bruno district, Kemiri district, Grabag district and Bener district are classified as very suitable, while the Purworejo district and Kutoarjo district are classified as not suitable.

1.   INTRODUCTION

Due to high levels of migration, populations are increasing in almost all cities on the world. This has a positive impact on regional incomes and human resources, however, there are also negative impacts, one of which is the declining quality of the environment, which affects the health of communities. Good public health is crucial to the productive activities of the community, which in turn enhance human development. The government has made efforts to improve public health by building and optimizing puskesmas in every region. Puskesmas are responsible for providing health services, both for the implementation of preventive activities, as well as the control and cure of disease. Being responsible for preventative healthcare, puskemas aim to reduce the prevalence of life-threatening disease (Verter & Lapierre, 2002).

As a developing country, Indonesia has a high risk of environment-related diseases due to its topography, limited access, and tropical climate;

such diseases include TBC, DHF, diarrhea, philariasis, pheneuomia and malaria (Fitriani, 2013; Tsani, 2013; Wardhani, 2010; Tamza R & Dharminto, 2013).

The location of health facilities is a key factor that is closely related to the level of community accessibility to health services. Tarigan (2008) defines accessibility as how easy or how attractive a location is to visit compared to other locations. In addition, Daskin and Dean (2005) add that the ease of access of health facilities in a region is related to the amount of illness and death there. Location is an important factor in the success of preventive health programs (Verter & Lapierre, 2002) and other health programs (Gu, Wang, & McGregor, 2010).

Another important factor is the aim to have health services well placed geographically within the community itself. Christaller (1933) says that the selection of a location depends on user or consumer factors that are typically associated with supply and demand. Although Christaller's theory focuses on the concept of location development, it can also be applied in other cases, including the case of health centre development. Isrenia (2011) states that health care facilities tend to develop based on accessibility and target consumption; he states that population density is highly correlated to users of health services.

In the context of Indonesia, there are several factors that should be considered in the development of the construction of health centres, such as vulnerability to disasters. Ahmadi-Javid, Seyedi, and Syam (2017) explain that the healthcare sector is also responsible for responding to emergency situations in the case of disaster management and in the mitigation of distster risk; Huang, Kim, and Menezes (2010) explain that healthcare facilities should be able to respond to large-scale emergencies caused by disaster.

Puskesmas as healthcare facilities have so far been built based on administrative requirements; this means the hierarchy of an area is prioritised over the rate of disease there. In practice, environmental health conditions and the development of disease vectors are not limited by administrative boundaries. For health planning, there are many factors that should explicitly be considered (Calvo & Marks, 1973). Each factor represents the effectiveness of the location of health facilities and rational decision making. The impact of poor decisionmaking on health site selection can lead to inneficient use of resources and poor service delivery. Additionally, Daskin and Dean (2005) explain how the development of poorly sited facilities leads to degraded customer service. Thus, the selection of the best location for puskesmas requires consideration of the physical conditions of the region.

Problems associated with choosing appropriate locations for healthcare facilities have been studied for many years. For example, Varnakovida and Messina (2006) argue for the significance of travel time in optimising healthcare services. The World Health Organization (WHO) (1998) considers size of facility, physical conditions of the region, utilities available, and natural features to be significant. Meanwhile, Wichapa and Khokhajaikiat (2017) argue for the selection of a traditional health location involving only minimal criteria, using mathematical methods to resolve location network problems, so that minimum distance and low cost are prioritised in selecting the best locations.

There are many methods developed to solve the problem, one of which uses a multicriteria decision-making method. This method is selected to address problems that require difficult interpretation with multiple objectives and related allocation of resources, which is a best fit for puskesmas.

The Analytical Hierarchy Process (AHP), is a method that helps to solve complex problems using mathematical techniques in which the variables are ordered by priority, is utilised in the multicriteria analysis. Using this method, the effect variable is assigned a value, based on its priority, within a pairwise comparison matrix to give a particular structure. In recent years, the use of AHP has been controversial as it gives different results with different decision hierarchies even with the same or similar decision-making objectives (Whitaker, 2007). Wichapa and Khokhajaikiat (2017) add that because it applies an exact value to express the decision-maker's opinion, as opposed to alternatives, it returns unbalanced judgements and results in a subjective model. Additionally, the AHP method cannot represent the decision spatially as an end result of a study. Recently, researchers have integrated AHP with other concepts, such as fuzzy logic and spatial analysis (Chauhan & Singh, 2016; Wichapa & Khokhajaikiat, 2017).

The development of Geographic Information Systems (GIS) has enabled the integration of AHP and spatial analysis, and accommodates continuous data, representing it in map form. This method is referred to as Spatial Multicriteria Evaluation (SMCE). This research uses SMCE to choose the best sites for the development of puskesmas in order to offer strategic alternatives for health development; it is based on the following variables: total population of women, population density, disaster vulnerability, existing puskesmas at the location, distance of streets, and landuse arranged in a criteria tree.

2.   RESEARCH METHOD

2.1.1   Study Area

The study area is located on the south side of Java, at 109°47'28" – 110°8'20" longitude and 7°32' – 7°54' latitude, with a total population of 896,631 in 2010. Directly constrained by hills, this region has a varied topography with an average of 70 - 90% humidity and average temperature of 22° - 26° C. The Purworejo district is one of the areas with highest disease vulnerability. Local health reports state there are at least six sub-districts in this region with endemic malaria, in which the number of sufferers is the highest in Java. In addition, the Purworejo region also has a prevalence of DBD disease, diarrhea, pneuomia and tuberculosis. This condition is exacerbated by the high population growth that is even higher than the population growth in Central Java Province (BPS, 2016a); it must be met with comprehensive health prevention and management programs to facilitate access to health services.

2.1.2   Tools and Materials

This research uses the RupaBumi Indonesia Map: the Purworejo region is given at the scale of 1:50,000, and uses the region administration boundaries, and landuse and street base map. Furthermore, this research also uses secondary data for population size, disaster vulnerability, disease incidence in 2015 and existing locations of puskesmas.

This research uses a variety of analysis methods, including ILWIS 3.3, SPSS and ArcGIS 9.3 softwares to process data. ILWIS 3.3 is an open-source software that processes the SMCE model. SPSS is used to perform

statistical tests. ArcGIS 9.3 is used for spatial data analysis and better map visualisation. It is also used to prepare spatial data, both vector and raster, before analysis using ILWIS 3.3.

2.1.3   Methodology

2.1.3.1   Spatial Multicriteria Analysis

The SMCE method considers the priority rank of the variable as the determinant of the decision, using standard GIS procedures. The first step is to determine the objective, in this case the best decision for developing the location of puskesmas. The second step is to determine the object. The object of the study itself is the location of puskesmas, which has several interrelated factors and becomes a consideration in the decision-making. Finally, the third stage is the determination of the criteria tree, shown in Figure 1. The criteria tree defines the calculations to be performed during the analysis, in which multiple maps of attribute entries are combined in accordance with the rules set by the researcher to obtain the final map. This criteria tree consists of the main goal, constraints, factor groups and factors. The main goal must be determined before the data processing is conducted and is referred to as the main root. Constraints are variables that inhibit or interfere in the achievement of goals. The factor group defines some of the goals, and is derived from several factors. Factors are variables used in research that usually support the achievement of goals (Looijen, 2010). In this study, the variables used are those that support the best location selection, however, in the SMCE method these can also be added as variable constraints.
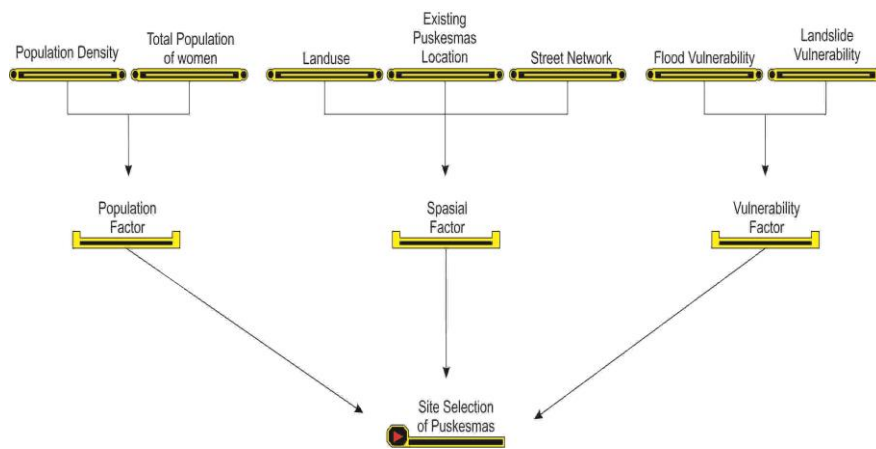
Figure 1. Criteria Tree

Variables were selected based on assumptions of local conditions and prior studies. The population factor is considered a consumer target indicator, whereas population density is a representation of the population in a certain area. Tarwater and Martin (2001) add that population density, in general, has an impact on the dynamics of the spread of disease. Higher population density in a region means higher disease transmission among humans, especially for infectious diseases. The size of the female population is significant because females tend to be more prone to health problems and they are directly related to children. Spatial factors are important because they illustrate accessibility of health facilities. In Indonesia, the development of puskesmas at the administrative level is governed by an SNI Number 03-03-1733-2004. SNI itself is a standard provision used in Indonesia and made

by the government as a criterion limit. Under the SNI, puskesmas are built to serve one district, a regulation which does not respect the differences in districts' demands regarding their area size and regional conditions; this study accounts for these spatial aspects, in the form of road networks, existing puskesmas and land use. Last is the disaster vulnerability factor, as an indicator for local conditions, which is also stated in the regulations from the ministry of health, which states that health facilities must meet the requirements of geography, one of them being vulnerability to disaster (Minister of Health, 2007). Purworejo region is vulnerable to disaster due to the old soil structure and the local climate. Disasters often occur and claim many casualties.

2.1.3.2 Weighting Research Criteria

The SMCE method uses weighted values to describe how the priorities of variables relate to other variables. The more prioritised a variable is for a particular goal, the higher that variable is weighted for that goal, indicating its influence. The disadvantage of weighting in SMCE is assessment subjectivity: different sources (experts) will provide relatively different values, given the decision-making motivations. The objectivity of AHP is also made uncertain by the structural complexity of the problem. Sometimes observed decisions need to be made immediately, but such complexity cannot be recorded quantitatively, depending on the perceptions and experience of the institution (Saaty, 2008). Therefore, in this study, subjectivity is eliminated by randomising all possible variable priorities, given 72 scenarios and models for selecting locations with different priority orders. Each scenario in the site selection of puskesmas has a different value, which is quantified in the SMCE process.

The randomisation of priority scenarios is shown in Figure 2, which describes how Model 1 was made, with the population factor as the first priority followed by the spatial factor as the second priority and the vulnerability factor as the third priority. In the first model, population density was selected as the first priority and total population of women as the second priority, in the population factor. Subsequent modelling then randomized or mixed the priority order of variables, so that there were 72 models.
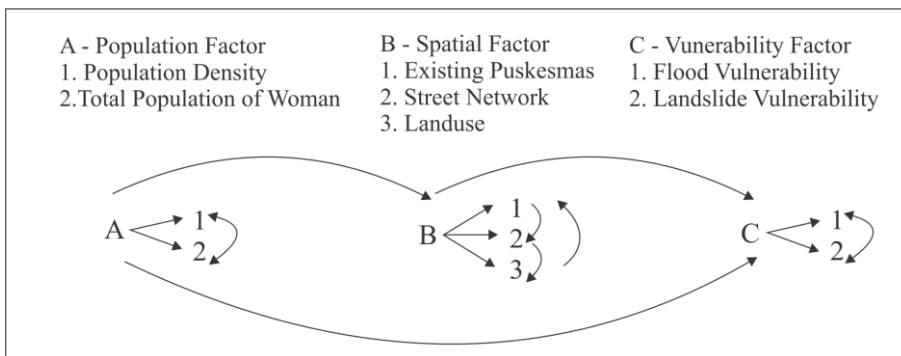
Figure 2. Prioritiy Randomization of Scenario Making

3. RESULT AND ANALYSIS

3.1 Selection of Best Models

There are six common diseases in the Purworejo region caused by environmental conditions they are malaria, dengue fever, tuberculosis, diarrhea, pneumia and filariasis. The disease with the highest incidence rate is malaria. This is due to topography and land use. Vegetation density, high rainfall, and hilly topographies are factors that increase the vector development of the disease. The two districts with the highest incidence rates of malaria are the Bagelen and Kaligesing districts, which can be seen in Figure 3. Figure 4 shows the distribution of puskesmas with their disease vulnerability.
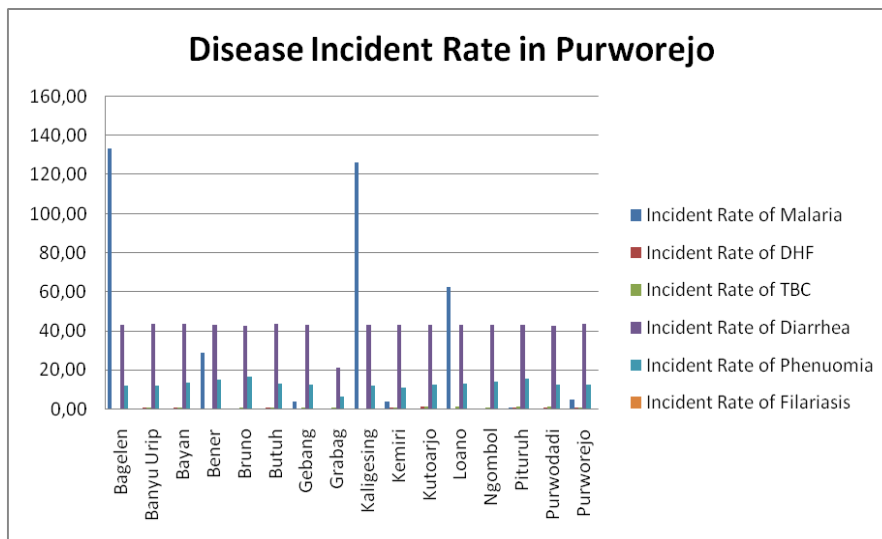
Figure 3. Graph of Disesease Incident Rate in Purworejo
Source : BPS (2016b)

The Bagelen and Kaligesing districts have the highest malaria incidence because they are hilly areas with high vegetation density, while diarrheal diseases infect almost all regions to the same extent. Diarrhea occurs most often due to environmental conditions, sanitation and poor knowledge of hygiene by parents. Diarrheal diseases can be prevented by vaccinating toddlers, environmental improvement and education of healthy living standards.

Disease susceptibility and incidence rates in the Purworejo region are illustrated in Figure 4. On the map, it can be seen that the Kaligesing and Bagelen districts only have one puskesma, while both areas have very high disease vulnerability. In addition, these two sub-districts do not have good accessibility, as indicated by the density of the road networks. On the other hand, the Purworejo district has more than three health centres. This is because this district is the region's capital and has better health services, including from both governmental and private institutions. The Kutoarjo district similarly has more health services even though the area is not vulnerable. Additionally, the Grabag, Purwodadi, and Banyuurip districts have a very non-vulnerable disease incidence rate but still provide health care.
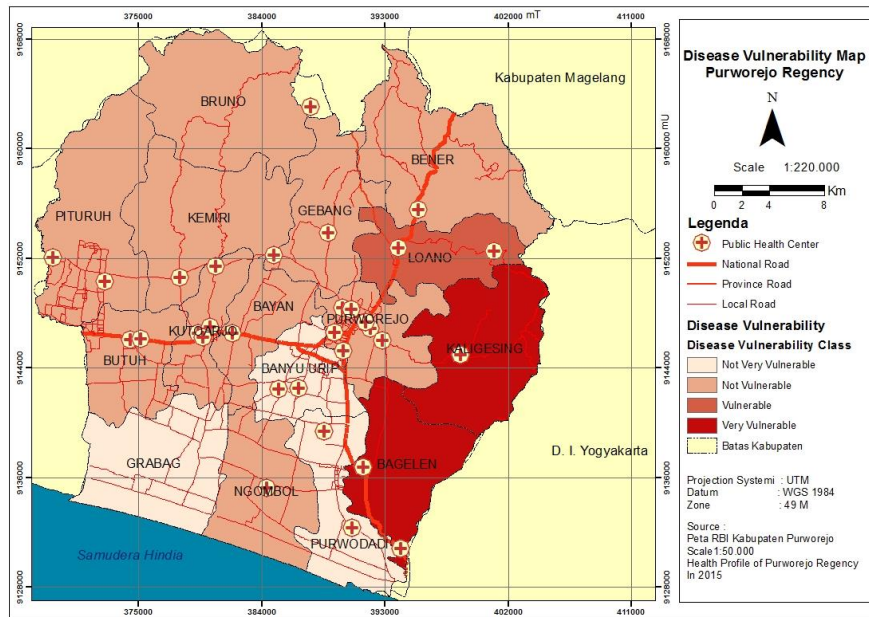
Figure 4. Disease Vulnerability in Purworejo Regency/region

The results from the 72 scenarios show the best location selection map for puskesmas. The 72 models are then compared against the incidence the disease in the Purworejo region using statistical tests to obtain and validate the best model. Validation is the process of determining whether the simulated conceptual model is really an accurate representation of the real system being modeled (Law & Kelton, 1991). The real system in the context of this research is the condition of disease vulnerability in the Purworejo district. This is based on the assumption that there is a positive correlation between an area's vulnerability to disease and its need for health services.

Validation can be performed in various ways; in this study, the model was tested on a real system, where the model can be said to be valid if it does not show significant difference. The significance of the difference can be assessed statistically, where the test chosen is a descriptive statistic test using crosstabulation, selected by the type and number of data used. The crosstabulation method is used to analyse nominal and ordinal data, which is a technique for comparing the relationship between variables by calculating the percentages of respondents for each group (Widya, 2013). One method of calculation in crosstabulation is the chi square. The chi square test is used to discover if a proportion that is derived from a model is equal to the proportion obtained by a pre-existing theory. In addition, the crosstabulation is a simple tool that is able to describe the relationship between two phenomena more clearly because of its quantitative nature. The analysis of disease vulnerability is conducted using secondary data of disease incidence rates over the past three years. This statistical test is performed using SPSS, where phenomena are said to be related if the calculation results in the Asymp. Sig. column returning less than 0.05. If the null hypothesis is accepted, the research result cannot be generalised (Hasan, 2004).

The level of significance (α) for the statistical tests is 0.05, where the total data is 16, describing the number of districts in Purworejo. The level of significance and the number of data influence the x^2 value shown in the Chi Square Distribution Table. The given value of x^2 is 24,996. Decision-making is represented by the Asymp. Sig. number and x^2 (value column). The result

of the stastistical test shows that some models with null hypotheses are rejected, as shown in Table 1.

Table 1. Result of Statistic Test Using Crosstab; Chisquare

	Value	df	Asymp. Sig.
Pearson Chi-Square – Model 26	18.184[a]	9	.033
Pearson Chi-Square – Model 28	17.524[a]	6	.008
Pearson Chi-Square – Model 32	17.524[a]	6	.008
Pearson Chi-Square – Model 36	17.524[a]	6	.008

3.2   Site Selection Model Using SMCE

The relationship and validation tests conducted in this research intended to check whether the models are applicable to real conditions. The result of the statistical test shows that there are four valid location selection models for health centres relating to the vulnerability of disease in the Purworejo region. Selected locations for puskesmas are expected to provide optimal health services and cover the areas of highest demand. The result of the statistical test shows that model 26 has an Asymp. Sig. value of 0.033, while models 28, 32 and 36 have an Asymp. Sig. value of 0.008; these are the most valid models and represent the location selection. The models can be seen in Figures 5a-d below.
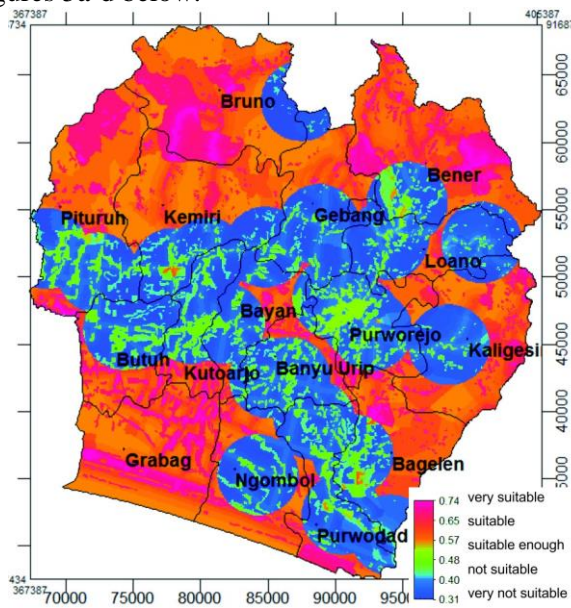
Figure 5a. Model 26
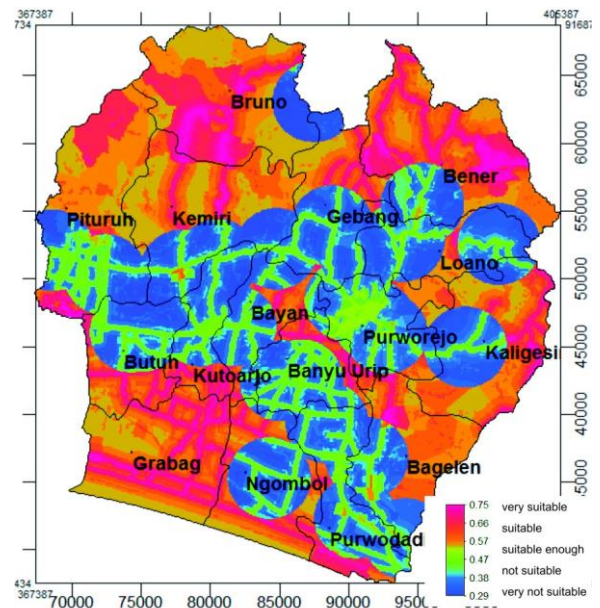
Figure 5b. Model 28
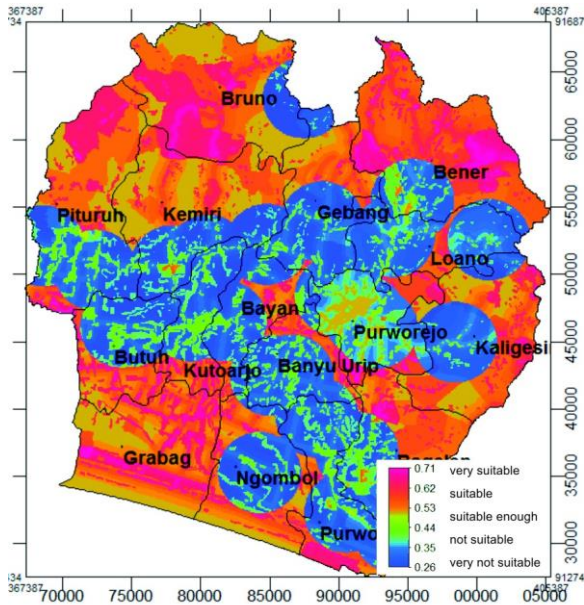
Figure 5c. Model 32
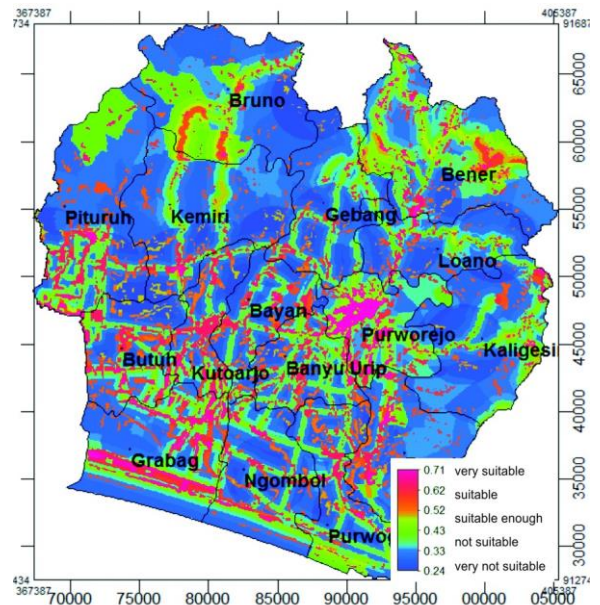
Figure 5d. Model 36

The four models have different priority levels for each variable, which can be seen in Table 2. The best location for puskesmas is almost identical for the three models, 26, 28 and 32, although the value is different. The areas with suitable locations for puskesmas cover most of the Bruno, Grabag, Bener, Bagelen and Kaligesing districts. As shown in Figure 4, the best locations for puskesmas are districts vulnerable to disease that do not have many health care facilities. The other areas, which are not very suitable for puskesmas' site selection, are the Purwodadi, Purworejo, Butuh and Kutoarjo districts. Additionally, model 36 is significantly different from other models; this is because the model prioritizes land use as one of the first priority factors. For more details, the scenarios of each model can be seen in Table 2.

Table 2. Scenarios of the Best Four Models

Model	Scenario Group		Scenario Factor	
Model 26	First Priority	Spatial Factor	Priority 1	Existing Puskesmas' Reach
			Priority 2	Land Use
			Priority 3	Road Buffer
	Second Priority	Natural Disaster Vulnerability	Priority 1	Flood Disaster Vulnerability
			Priority 2	Landslide Disaster Vulnerability
	Third Priority	Population Factor	Priority 1	Population Density
			Priority 2	Size of Female Population
Model 28	First Priority	Spatial Factor	Priority 1	Existing Puskesmas' Reach
			Priority 2	Road Buffer
			Priority 3	Land Use
	Second Priority	Natural Disaster Vulnerability	Priority 1	Flood Disaster Vulnerability
			Priority 2	Landslide Disaster Vulnerability

	Third Priority	Population Factor	Priority 1	Population Density
			Priority 2	Size of Female Population
Model 32	First Priority	Spatial Factor	Priority 1	Existing Puskesmas' Reach
			Priority 2	Land Use
			Priority 3	Road Buffer
	Second Priority	Natural Disaster Vulnerability	Priority 1	Flood Disaster Vulnerability
			Priority 2	Landslide Disaster Vulnerability
	Third Priority	Population Factor	Priority 1	Size of Female Population
			Priority 2	Population Density
Model 36	First Priority	Spatial Factor	Priority 1	Land Use
			Priority 2	Road Buffer
			Priority 3	Existing Puskesmas' Reach
	Second Priority	Natural Disaster Vulnerability	Priority 1	Flood Disaster Vulnerability
			Priority 2	Landslide Disaster Vulnerability
	Third Priority	Population Factor	Priority 1	Size of Female Population
			Priority 2	Population Density

The models' scenario factors reflect the priority needs to be satisfied by puskemas. Regarding the spatial factor, the second priority of model 26 is land use, while in model 28 it is the road buffer. For model 32, the difference lies in the population factor in which the size of the female population becomes the main priority.

Model 32 and model 36 have similar scenarios; their differences are due to the main priority of the spatial factors - the spread of existing puskesmas in model 32 and land use in model 36. This results in a map with significant differences. In model 36, the selected location for development of the puskesmas is located in the residential area, while in model 32 it is located on the outskirts of the Purworejo region.

The four models chosen as the best location models are those that have scenarios in which the spatial factor becomes the most important factor for determining the best location. The second factor is consistenty vulnerability to disaster, and the last is the population factor. The method used, SMCE, provides the best location selection option for the construction of puskesmas. In this study, SMCE provides location selection options with several different priority considerations, although none are significant. These results can aid decision-makers in their analysis of the interrelationship of factors, allowing for proper location selection after considering multicriteria factors.

The restriction of goverment administration boundaries for health faciltities should be reviewed. The complexity and entangled factors of site selection can be understood through multicriteria analysis; the goverment can review its policy to reprioritise health facility site selection. Appropriate health facilities, such as puskesmas, and preventative health programs would be more easily accessible to communities in need if government were to undertake such a review.

Using SMCE, selection of the best location is not limited to the use of the supporting variables, since in this study the modelled location selection factors were generalized and the models simplified real-world phenomena. In the future, it will be possible to choose locations with more explicitly

related variables, such as the social and economic conditions of society. The object compilation stage in the SMCE method is capable of elaborating complex issues within the criteria tree, making it easier to assess and analyse spatial phenomena.

4.   CONCLUSION

The conclusions that can be drawn from this study are as follows: (1) the SMCE method can be used for modelling the 'best' location for community health centres, which are also validated by reality; (2) there are four preferred models among the 72 scenarios created, with four districts that should be prioritised for the construction of health centres, which are the Grabag, Pituruh, Bruno and Bener districts. The best site selection models all set spatial factors as the first priority. There should be other factors included in SMCE for public health centres, such as amenities and degrees of health, to allow for more precision in selecting suitable areas for developing public health centres.

Consideration of the site selection for the development of puskesmas using the multicriteria method will increase the likelihood of achievinghealth development targets. Health facilities with good locations meet the demand within their areas. The current policy should be revised to include a wider set of factors and multicriteria analysis of site selection.

REFERENCES

Ahmadi-Javid, A., Seyedi, P., & Syam, S. S. (2017). "A Survey of Healthcare Facility Location". *Computers & Operations Research*, *79*, 223-263.

BPS. (2016a). *Provinsi Jawa Tengah Dalam Angka 2016 (Jawa Tengah Province in Figures 2016).* Semarang: BPS.

BPS. (2016b). *Purworejo Regency in Fuures 2016 (Purworejo Regency in Figures 2016).* Purworejo: BPS.

Calvo, A. B., & Marks, D. H. (1973). "Location of Health Care Facilities: An Analytical Approach". *Socio-Economic Planning Sciences*, *7*(5), 407-422.

Chauhan, A., & Singh, A. (2016). "A Hybrid Multi-Criteria Decision Making Method Approach for Selecting a Sustainable Location of Healthcare Waste Disposal Facility". *Journal of Cleaner Production*, *139*, 1001-1010.

Christaller, W. (1933). *Central Places in Southern Germany (Translation into English by Carlisle W. Baskin in 1966).* Englewood Cliffs, NJ: Prentice-Hall.

Daskin, M. S., & Dean, L. K. (2005). "Location of Health Care Facilities". In M.L., B., F., S., & W.P., P. (Eds.), *Operations Research and Health Care. International Series in Operations Research & Management Science* (Vol. 70, pp. 43-76). Boston, MA: Springer.

Fitriani, E. (2013). "Faktor Resiko Yang Berhubungan Dengan Kejadian Tuberkulosis Paru (Related Risk Factor of Pulmonary Tubercolosis)". *Unnes Journal of Public Health*, *2*(1), 2-5.

Gu, W., Wang, X., & McGregor, S. E. (2010). "Optimization of Preventive Health Care Facility Locations". *International Journal of Health Geographics*, *9*, 17. doi: https://doi.org/10.1186/1476-072X-9-17.

Hasan, I. (2004). *Analisis Data Penelitian Dengan Statistik (Research Data Analysis with Statstics).* Jakarta: PT Bumi Aksara.

Huang, R., Kim, S., & Menezes, M. B. (2010). "Facility Location for Large-Scale Emergencies". *Annals of Operations Research*, *181*(1), 271-286.

Isrenia. (2011). *Distribusi Dan Pemilihan Lokasi Apotek Berdasarkan Sistem Informasi Geografis Di Kota Bandar Lampung (Distribution and Location Selection of Drugstore Based on Geographic Information System in Bandar Lampung City).* Yogyakarta: Universitas Gadjah Mada.

Law, A. M., & Kelton, W. D. (1991). *Simulation Modeling and Analysis.* (2 ed.). New York: McGraw-Hill

Looijen, J. (2010). "Risk Based Site Selection of Waste Disposal Using Smce". Retrieved from http://drm.cenn.org/Trainings/Risk%20Management%20and%20Environmental%20Assessment%20for%20Spatial%20Planning/Lectures_ENG/Site%20selection%20for%20waste%20disposal%20using%20SMCE-joan2010.pdf.

Minister of Health. (2007). *Pmk No. 949 Criteria of Health Service Facilities.* Jakarta: Minister of Health.

Saaty, T. L. (2008). "Decision Making with the Analytic Hierarchy Process". *International Journal of Services Sciences*, *1*(1), 83-98. Retrieved from https://www.colorado.edu/geography/leyk/geog_5113/readings/saaty_2008.pdf.

Tamza R, S., & Dharminto. (2013). "Hubungan Faktor Lingkungan Dan Prilaku Dengan Kejadian Dbd (Environmental Factors and Human Behavior Relation with Dhf Incident)". *Jurnal Kesehatan Masyarakat*, *2*(3), 360–368.

Tarigan, R. (2008). *Perencanaan Pembangunan Wilayah, Edisi Revisi Kedua (Regional Deveopment Planing, Second Revised Edition).* Jakarta: PT Bumi Aksara.

Tarwater, P. M., & Martin, C. F. (2001). "Effects of Population Density on the Spread of Disease". *Complexity*, *6*(6), 29-36.

Tsani, F. R. (2013). "Hubungan Antara Faktor Lingkungan Dengan Kejadian Penyakit Jantung Koroner (Relationship of Environmental Factors and Coronary Heart Disease)". *Unnes Journal of Public Health*, *2*(3), 1-9.

Varnakovida, P., & Messina, J. P. (2006). "Hospital Site Selection Analysis". Proceedings of IMAGIN annual Conference. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.121.4330&rep=rep1&type=pdf.

Verter, V., & Lapierre, S. D. (2002). "Location of Preventive Health Care Facilities". *Annals of Operations Research*, *110*(1-4), 123-132.

Wardhani, E., Pharmawati, K., Sururi, M. R., and Nia, K. (2010). "Diare Pada Balita Di Kelurahan Cicadas Kota Bandung (Diarrhea in Infant in Cicadas Bandung City)".

Whitaker, R. (2007). "Criticisms of the Analytic Hierarchy Process: Why They Often Make No Sense". *Mathematical and Computer Modelling*, *46*(7-8), 948-961.

Wichapa, N., & Khokhajaikiat, P. (2017). "Solving Multi-Objective Facility Location Problem Using the Fuzzy Analytical Hierarchy Process and Goal Programming: A Case Study on Infectious Waste Disposal Centers". *Operations Research Perspectives*, *4*, 39-48.

Widya. (2013). "Test Untuk Data Nominal Dan Ordinal (Test for Nominal and Ordinal Data)". Retrieved from http://widya.lecture.ub.ac.id/files/2013/01/4.-crosstabs.pdf.

World Health Organization (WHO). (1998). *District Health Facilities: Guidelines for Development and Operations.* Manila: WHO Regional Office for the Western Pacific. Retrieved   from http://www.wpro.who.int/health_services/documents/district_health_facilities_-_guidelines_for_development_and_operation.pdf.

Use of community spaces for sports and fitness – a case study of urban inhabitants in Shenzhen City, China

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Abstract: Shenzhen is a Chinese city with a very fast-paced work and life environment. Because people there are often under high pressure, fitness and sports have great benefits for their health. In order to study the correlation between inhabitants' fitness and sports activities and the community environment, a questionnaire is designed based upon a review of the literature on fitness behavior and the community environment, and then 595 inhabitants of Shenzhen are surveyed in 2016. The survey involved the demographic information of the subjects, their fitness and sports activities, and the satisfaction of spaces for sports in urban communities. Through analysis of the questionnaire data by cross tabulation, patterns of how and where people like to do exercise have been found. Jogging and walking are the most popular individual activities, where the preferred places are neighborhood gardens, urban squares and parks. The most popular team sports are badminton, table tennis and tennis, where the preferred places are professional fitness clubs, urban squares or parks. Gender differences significantly determine the choice of sport. Males tend to cycle or run individually, and to play ball games as a team. Females prefer to do yoga or eight section brocade individually, and square dance as a team. The factors influencing the satisfaction of places for exercise are ordered as follows: accessibility, fresh air and a clean environment, and low cost. The main requests from locals for the improvement of the recreation environment are the supply of more kinds of sports facilities and fields and better maintenance and management of sports facilities. Some urban design strategies for enhancing the community's sports environment are recommended.

1   INTRODUCTION

Rapid economic development is placing a lot of pressure on people in Chinese urban areas. In June 2013, Ciming Health Checkup Management Group Company Limited (2013) released a white paper on the health of Chinese urban inhabitants in Beijing with The Association of Chinese Physicians, Chinese Hospital Association and the Beijing Institute of Health Assurance. The report revealed that 35-65 year olds suffer the most from chronic disease in China. Some unhealthy phenomena, such as obesity,

dyslipidemia and fatty livers, and high blood pressure not only show a significant upward trend in this age group, but also similar issues in younger people. The survey highlighted that the prevalence of diabetes in first-tier cities in China was significantly higher than in second-tier cities. There is again significantly higher rates of these problems in second-tier cities than in third-tier cities. The survey also revealed that the number of inhabitants with osteoporosis and dental disease significantly increased between 2010 and 2012. Medical experts point out that the causes of urban inhabitants' chronic diseases are mainly related to urban environmental pollution, high work pressure and bad lifestyles. These health problems are more common and serious in Shenzhen, being a fast-paced metropolis. In 2014, according to a range of government statistics, high cholesterol in Shenzhen (18%) was much higher than the national average (5.6%) (Zheng, 2017), and the prevalence of gout in Shenzhen was 0.42%, which was the three times more than the national average (Zhao & Huang, 2016).

On March 16, 2016, the 12th National People's Congress (NPC) voted to approve a resolution on health issues in the 13th five-year plan for economic and social development. In the Chapter 60, "in order to promote the construction of [a] healthy China", the outline clearly proposes the implementation of the national fitness strategy. The government will develop sports, strengthen public sports fields and facilities, and open public sports facilities with little or no entry fees. In the action plan, it pointed out that the urban community would promote its 15 minute fitness circle, and public sports services should be fully provided to all inhabitants. The World Health Organization (WHO) issued proposals for achieving global health through sports which identified that for people over the age of 18 who do half an hour of moderately intense exercise more than twice per week, the possibility of suffering from cancer and other non-infective diseases will be significantly reduced. Children (5 to 17 years-old) can reduce the risk of certain diseases in the future if they undertake more than one hour per week of medium- or high-intensity exercise (Sina Health Blog, 2011).

There are several studies on the correlation between fitness activities and the spatial environment in China. Ma et al. (2008) studied factors related to Xi'an inhabitants' physical fitness by conducting a questionnaire survey on the inhabitants of six communities in the city. The results showed that the choices for fitness venues in Xi'an were relatively wide. The number of people who chose public health facilities (such as fitness squares) was up to 25.9% and those who chose a public open space accounted for 34.1%. The number of people choosing sidewalks was the least at 10.3%. It showed that the closest and most convenient fitness places were still preferable. Li (2013) discussed the correlation between sports behavior and the urban environment through case studies and data analysis. At the same time, she further compared the correlation between economic indicators and local sports facilities across different regions. Her results demonstrated that the level of economic development affected the development of the sports industry and expenditure for the construction of sports venues, and facilities in the exercise areas were lacking. Wei, Xia, and Wang (2014) studied the outdoor fitness areas of Chinese cities and gave a preliminary discussion on optimizing the fitness environment and improving health benefits by focusing on plant configuration. Weng et al. (2010) established a research model of the effect of the urban built environment on the health of inhabitants through the analysis of the impact of the urban built environment on the inhabitants' physical activity; his results illustrated that the urban built environment could cause a

lack of physical activity and, in turn, a lack of physical activity would affect the inhabitants' health. The urban built environment was the main factor affecting physical activity due to multiple factors, such as the street grid layout, landscape architecture, fitness facilities and land use planning and environmental safety. There were three kinds of models, concept models, comprehensive models and data models, which could be used to study the influence of the urban built environment on physical activity and health. Liu, Liu, and Peng (2014) explained that by altering the city street design and municipal construction, countries in the European Union have changed the primary modes of travel for urban inhabitants; EU designs have reduced the use of motor vehicles and have taken other measures to increase opportunities for walking and cycling. This change has improved levels of physical activity by inhabitants. Research by Jiang et al. (2015) suggests that elaborate design of the urban green landscape could keep people healthy through different channels, including promoting physical activity, reducing mental issues and recovering from fatigue. Previous studies have shown that the green landscape can also supply ecological products and services, promoting social capital as well. Tsai, Chen, and Ning (2016) assesses the walking space and the living path of elders by out-door activity type, walking range time and walking environment to understand the activity conditions and types of elders in Taipei.

Besides Chinese research in this field, (Stevinson, Wiltshire, & Hickson, 2015), through an interview survey of jogging groups of green roads in the UK, found that the participation rate of jogging was related to the pursuit of health and vitality, green road accessibility, community social cohesion, and outdoor natural setting, among other factors. Through the study on sports and fitness behavior of 1,803 inhabitants of Perth, Australia, Giles-Corti and Donovan (2002) found that locals' sports activities were affected by the social and physical environment, accessibility of sports facilities, and the social environment, while a good landscape promoted walking; inhabitants in Perth often used informal community facilities, such as streets, public open spaces, and beaches. Humpel, Owen, and Leslie (2002) studied 19 published papers on environmental factors affecting adults involved in sports activities; the conclusion was that accessibility, opportunities, and the aesthetic characteristics of the environment had significant impacts on their activities, and they proposed developing an environmental and ecological model to explain further. Jiao et al. (2015) aim to investigate the strengths and weaknesses of predictive models of outdoor recreation travel in UK.

Recent literature has revealed that fitness and sports correlate with many social, economic and physical environmental factors, however, some issues are rarely explored, such as how inhabitants do fitness activities. For example, there is little focus on companionship in these activities, regarding the choice to exercise individually or in teams, places for particular sports activities, or gender differences. This paper aims to fill this gap. Inspired from the above research, a study model can be made (Figure 1) from an environmental psychological perspective; this will be the theoretical model for this study on the correlation between urban inhabitants' community spaces and their fitness and sports.

Personal factors   Sports behavior   Physical environmental factors

| Personal data
Socioeconomic data | → | Exercising habits
Sports activities | ← | Neighborhood space
Urban open space
Sports facilities |
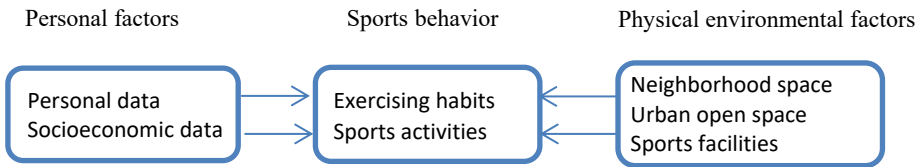
Figure 1. The model of the relation between the built environment and fitness and sports

2   DESIGN OF THE QUESTIONNAIRE

The questionnaire (Figure 2) is designed based on the environment and behavior model (Figure 1). The thirteen questions are mainly concerned with personal information, health status, exercise habits and modes, the choice of sports venues and satisfaction.

In November 2016, the students in Shenzhen University were invited to undertake a questionnaire survey on the fitness places in urban communities in Shenzhen. The respondents were all inhabitants of Shenzhen. The questionnaire was conducted via random sampling. The sampled sites were 15 communities, each over ten years old, in the urban area of Shenzhen. The research targeted respondents mainly near sports places, and they were interviewed at community centers.

There were 595 respondents and 525 samples were valid. The respondents consisted of 55.2% men and 44.8% women. The largest group was 19-30 years old, at 42.3%; the group of 30-50 year olds followed with 23.4%; the percentage of 50-60 year olds was 18.1%; while the group aged between 7-18 years made up 10.5%; , and the percentage of over 60 year olds was 5.7%. By the end of 2015, according to the statistics of the national population census of Shenzhen, the total residential population of Shenzhen City was 11,378,900. The average age of the city's resident population was 32.53 years old. The male population was 6,100,100 residents, accounting for 53.61%, and the female population was 5,278,800, accounting for 46.39%. The respondents were from many different educational backgrounds: 49.7% with university degrees, 9% with higher education, 23% with a high school education, and 17.5% with a junior high school certificate or below. The subjects closely reflected the population characteristics of Shenzhen. The questionnaire data were analyzed with IBM's SPSS statistics software.
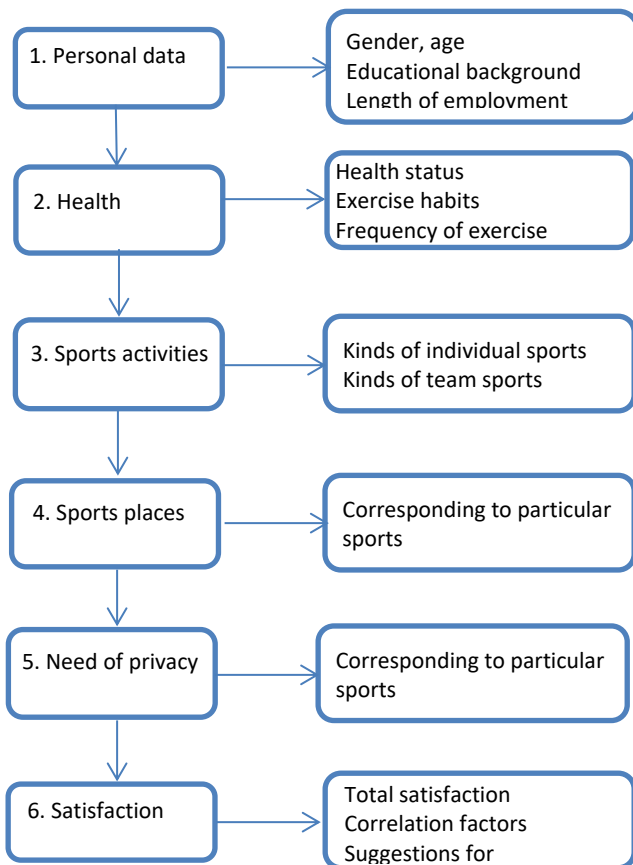
Figure 2. The Framework of the Questionnaire Design

3   DATA ANALYSIS

3.1   The exercise habits of the respondents

3.1.1   Proportion of people with sports habits

Among the respondents, 85.5% were in the habit of regular exercise. Males accounted for 48.4% and the females 36.6% of this. The group with no regular exercise accounted for about 14.5%, with males at 6.9% and females composing 7.6% of this number. This shows that the majority of respondents in this survey make exercise a habit, and that men prefer sports more than women.

3.1.2   Sports habits and educational background

Data analysis indicates that 87.7% of those with tertiary education play sports and that 87.2% of those with graduate degrees or higher play sports. There is minimal difference between the two groups. 80% of those with senior high school education play sports, and of the remainder, with junior high school or lower education, 78.3% play sports. The group of people with tertiary education is significantly higher represented than other groups.

3.1.3　Exercise frequency and working time of the sports group

According to cross analysis of exercise frequency and working time of the groups (Table 1), those who exercise 2-3 times a week accounted for 44.2% of the total population, and those who exercise daily made up 30% of the total population. The highest exercise frequency of a regular commuting group was 2-3 times per week, while those who were paid for their time while exercising tended to exercise every day, constituting 56% of this group. In the group who do periodic shift work, there are 12 who exercise 2-3 times per week - just half of the total, 24. This shows that an exercise frequency of 2-3 times a week is the most common for regular commuters and periodic shift workers.

Table 1. Exercise frequency * Working hours Cross Tabulation

			Working hours			
			Arrange time freely	Regular commute	Periodic shift work	Total
Exercise frequency	Every day	count	75	52	7	134
		% of exercise frequency	56.0%	38.8%	5.2%	100.0%
		% of the total	16.8%	11.7%	1.6%	30.0%
	2`3times per week	count	72	113	12	197
		% of exercise frequency	36.5%	57.4%	6.1%	100.0%
		% of the total	16.1%	25.3%	2.7%	44.2%
	Once a week	count	30	55	3	88
		% of exercise frequency	34.1%	62.5%	3.4%	100.0%
		% of the total	6.7%	12.3%	.7%	19.7%
	Two weeks or longer count		9	16	2	27
	% of exercise frequency		33.3%	59.3%	7.4%	100.0%
	% of the total		2.0%	3.6%	.4%	6.1%
Total		count	186	236	24	446
		% of exercise frequency	41.7%	52.9%	5.4%	100.0%
		% of the total	41.7%	52.9%	5.4%	100.0%

3.1.4   The choice of individual sports mode of sports group

The most popular individual exercises were running and walking, which made up 49% of the total, followed by cycling with 17.9%. Gymnastics, tai chi, qigong, yoga, and eight sections brocade accounted for only 10.1% of the individual sports population (Table 2).

Table 2. Individual Sports

	Types of sports	Frequency	Proportion (%)
Valid	Gymnastics, Tai Chi, Qigong	64	14.3
	Yoga or Eight sections brocade	45	10.1
	Cycling	80	17.9
	Running or walking	219	49.0
	Other sports	39	8.7
	Total	447	100.0
Deficiency		78	
	Total	525	

The most frequently chosen team sports were badminton, table tennis, and tennis, accounting for 29.5% of the total. Secondly, football, basketball, volleyball and other ball games accounted for 21.5%. The percentages for other types of exercise, which together accounted for 18.6 percent of the total, were not included in the questionnaire (Table 3).

Table 3. Team Sports

	Types of sports	Frequency	Proportion (%)
Valid	Square dance	57	12.8
	Football, basketball, volleyball and others	96	21.5
	Badminton, table tennis, tennis	132	29.5
	Chess, cards	44	9.8
	Hiking, running	35	7.8
	Other sports	83	18.6
	Total	447	100.0
Deficiency		78	
	Total	525	

3.1.5   Health status and exercise habits

The data shows that 36% of the respondents who were in poor health did not exercise regularly. 89.6% of people who were in good health made a habit

of regular exercise. By the Spearman Rank Correlation analysis, there was a correlation between health status and regular exercise (Table 4).

Table 4. Cross Coefficient of Regular Exercise Habits and Health Status

			Health status	Regular exercise habits
Spearman rho	Health status	Cross Coefficient	1.000	.182**
		Sig. (two-tailed)	.	.000
		N	525	525

**. When the confidence level (two-tailed) was 0.01, the correlation was significant.

3.1.6   Analysis of the correlation between gender and exercise preference

Table 5. Cross Coefficient of Gender and Individual Sports

			Gender	Individual Sports
Spearman rho	Gender	Cross Coefficient	1.000	-.202**
		Sig.(two-tailed)	.	.000
		N	525	447

**. When the confidence level (two-tailed) was 0.01, the correlation was significant.

The Spearman Rank Correlation analysis showed that there was a correlation between gender and individual sports types (Table 5). Regarding individual sports options, the percentage of women who chose yoga or eight sections brocade exercise was up to 82.2%, while the percentage of men who chose cycling was up to 68.8%. There was no significant gender difference in other individual sports. In terms of gender and team sports, men preferred ball activities, such as football and basketball, and women tended to prefer square dancing. There were few differences between men and women for other team sports (Figure 3).
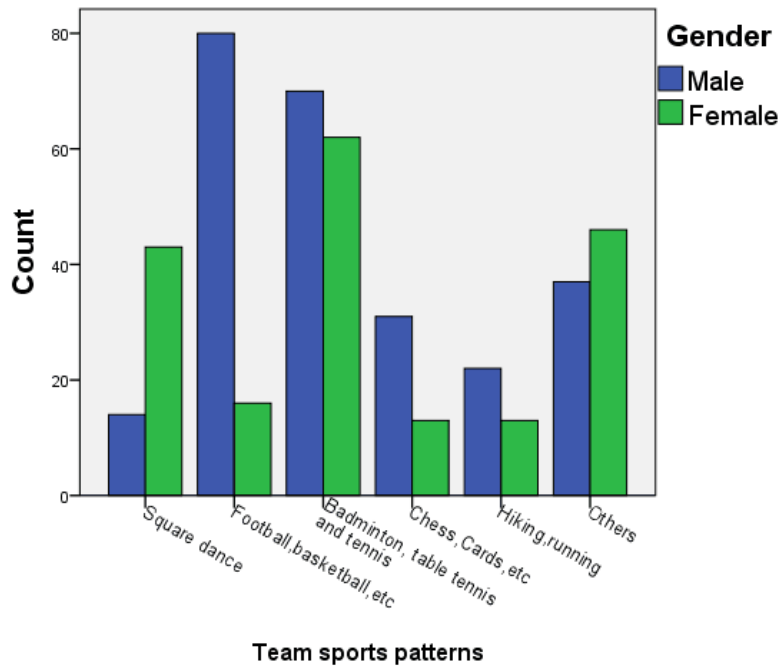
Figure 3. Team sports patterns and gender

3.2 The preference of spaces for sports groups

3.2.1 Individual sports and their places
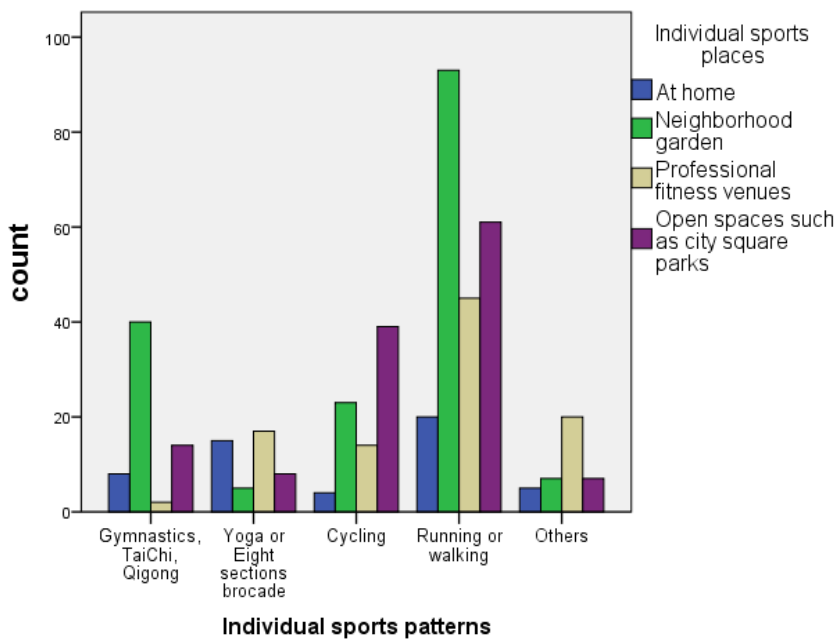
Figure 4. Cross tabulation of individual sports patterns and individual sports places

As can be seen from Figure 4, the most popular exercise type was running or walking, and the favorite places to exercise were neighborhood gardens and public open spaces like urban squares or parks. Home space was the least popular option, revealing that inhabitants preferred to go out and exercise in open spaces, rather than doing fitness sports at home.

3.2.2   Team sports and their places
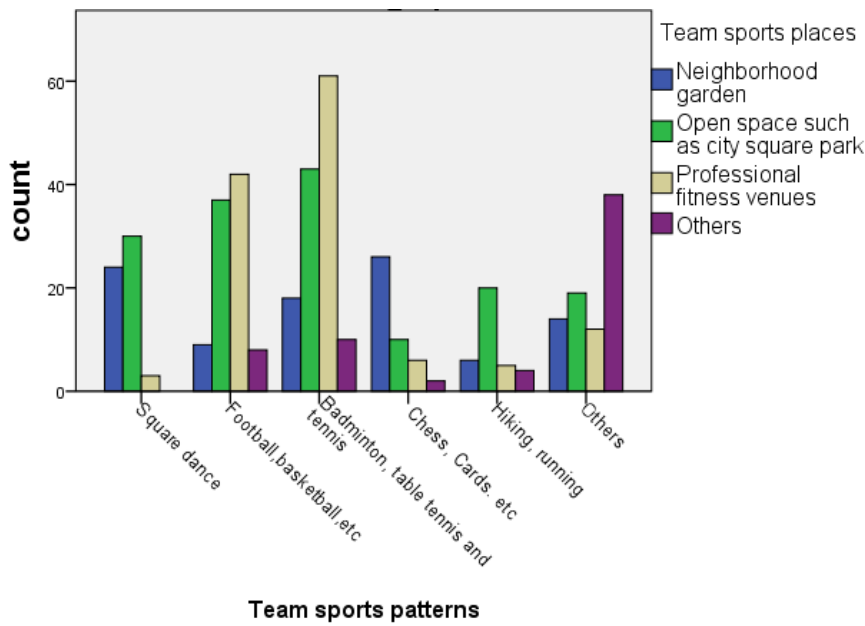
Figure 5. Cross tabulation of team sports patterns & team sports places

Figure 5 showed that the more popular forms of team sports among the respondents were badminton, table tennis, and tennis, followed by football, basketball, and volleyball. The places where inhabitants were most likely to go for team sports were professional fitness venues and open spaces, such as urban squares or parks.

3.2.3   Privacy for individual sports
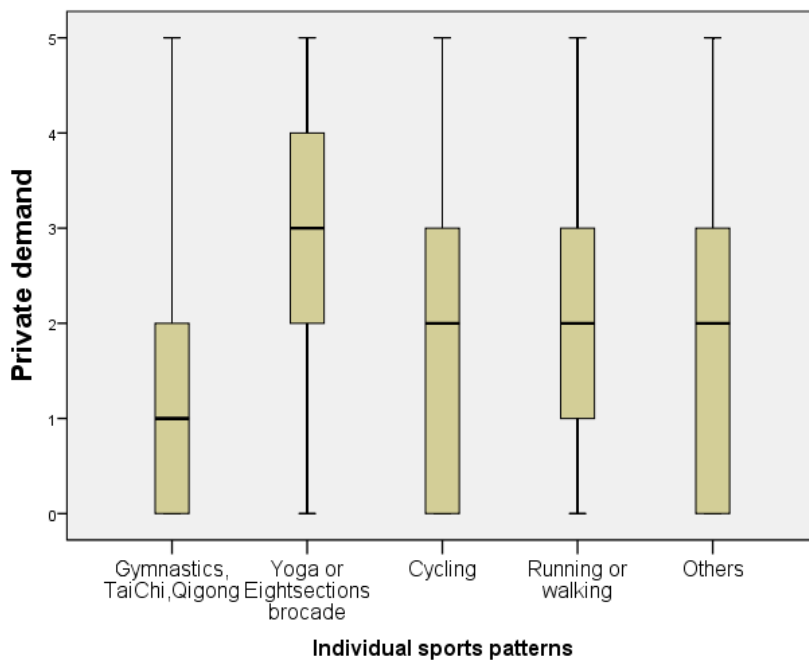
Figure 6. Privacy for individual sports (0 = "No requirement" 1 = "Very low privacy" 2 = "Low privacy" 3 = "General privacy" 4 = "High privacy" 5 = "Very high privacy")

It can be seen from Figure 6 that the individual sports that required the highest privacy were yoga and eight-section brocade, while those requiring the lowest privacy were tai chi or qigong.

3.2.4   Privacy for team sports
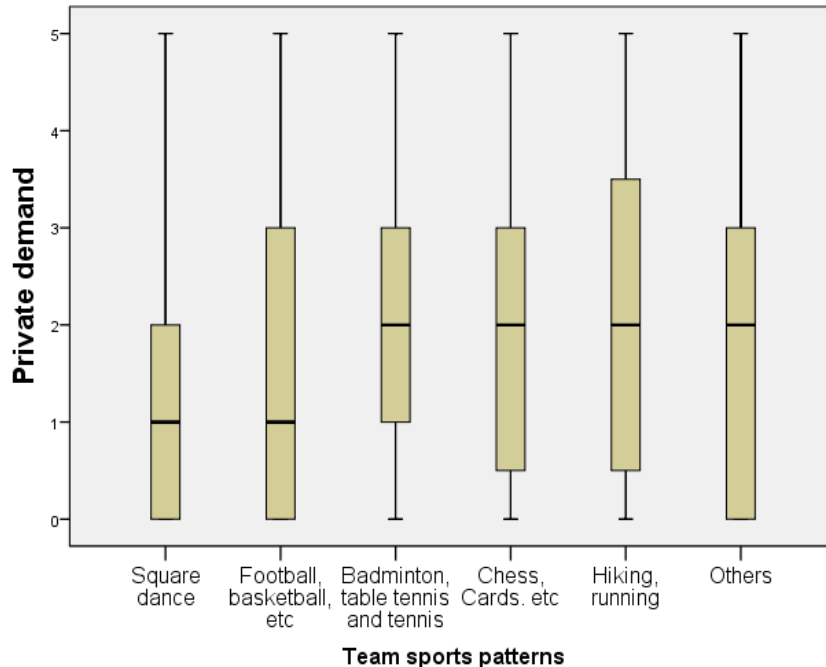
Figure 7. Privacy for team sports (0 = "No requirement" 1 = "Very low demand" 2 = "Low demand" 3 = "General requirements" 4 = "High demand" 5 = "Very high demand")

It can be seen from Figure 7 that there were no significant differences between the different team sports in relation to privacy. Hiking and running required a little more privacy than the other types, possibly owing to the fact that team hiking and running are engaged in on a more professional basis. Square dancing needed lower privacy than any other group activity.

3.3   The satisfaction of sports places

3.3.1   Overall satisfaction statistics

The mean satisfaction was 0.66, which showed that respondents were generally satisfied. (- 2 = "very dissatisfied" - 1 = "not satisfied" 0 = "general" 1 = "satisfied" 2 = "very satisfied").
From the cross tabulation between individual sports places and overall satisfaction, the respondents were most satisfied with places where they did individual activities; the rate of satisfaction (satisfied and very satisfied) was 60.6% (42.2% and 18.4% respectively).

3.3.2   The satisfaction of individual sports places

Regarding the specific choice of exercise location, 11.7% chose home and the corresponding satisfaction rate was 63.8%. The proportion of the people who chose their neighborhood gardens as their exercise location was 37.8%, and the corresponding satisfaction rate was 63.4%. The proportion of those

choosing professional fitness venues was 22.0%, and the corresponding satisfaction rate was 55.1%. The proportion choosing public open spaces like urban squares or parks, accounted for 28.5%, and their satisfaction rate was 59%. It is clear that the most satisfying places for individual exercise were homes and neighborhood gardens.

3.3.3   Analysis of the satisfaction of team sports places

Regarding the choice of location for team sports, 21.6% chose neighborhood gardens and the corresponding satisfaction rate was 71.9%. The proportion of people who chose open spaces, such as urban squares or parks was 35.7%, and the corresponding rate was 64.8%. The selection of professional fitness venues accounted for 29%, and the corresponding satisfaction rate was 49.6%. The other options made up 13.7%, where the corresponding satisfaction was 55.7%. The spaces with the highest satisfaction for team activities was neighborhood gardens, followed by public open spaces.

3.3.4   The ranking statistics of the factors that affect satisfaction

Table 6. Descriptive statistics of the factors that affect satisfaction

		Accessibility	Good air quality and tidy environment	Low cost	Quality of facilities	Perfect and friendly management	Unaffected by the weather
N	Valid	426	427	422	425	421	421
	Missing	99	98	103	100	104	104
Mean		2.49	2.81	3.51	3.52	4.17	4.45
Median		2.00	2.00	3.00	4.00	5.00	5.00
Mode		1	1	3	4	5	6

Table 6 shows the factors that influence satisfaction, from strong to weak, ordered by the mean, from smallest to largest: 1) accessibility, 2) good air quality and tidy environment, 3) low cost, 4) quality of the facilities, 5) perfect and friendly management, 6) unaffected by the weather.

3.4   Recommendations on the improvement of community sports places

The last question of the survey was an open request for recommendations for the improvement of community sports places. The respondents were able to express their ideas to the investigators. From the 525 valid subjects, 190 answers were received. There were a high number of similar answers, given here from most to least frequent: 1) increase the types and quantities of sports facilities (including the number and size of venues) (119); 2) strengthen the management of sports venues (44); 3) reduce the impact of sports venues on the residential environment(12); 4) lower the venue fees (10); 5) improve the safety of sports venues (7); 6) increase accessibility to sports venues(5).

4   CONCLUSION AND DISCUSSION

Due to the random sampling of this survey and the limited samples, the results may not reflect sports groups in Shenzhen with a high level of completeness and accuracy. The analysis shows that the proportion of the subjects regularly exercising was quite high, accounting for 85.5%. The number may be higher for subjects who were interviewed near sports places, so this does not necessarily reflect the overall proportion of sports groups in Shenzhen. Compared to the recent literature, this study in Shenzhen, China, focuses on the link between different modes of exercise, individual and team, preferred locations, and the influence of gender differences. It is inclusive of multiple sports locations and features of sports groups.

The most popular individual activities are jogging and walking. The most popular team sports activities are ball games, including small ball games (like badminton, table tennis, etc.) and big ball games (like football, basketball, etc.). Regarding the options for sports places, the main choices for individual activities were neighborhood gardens and public open spaces like urban squares or parks; as for team sports places, the main choices were public open spaces and professional fitness venues.

Sport choices are related to gender. Males tend to cycle or run individually and play ball games in teams. Females prefer to do yoga or eight section brocade individually and square dance together. Yoga and eight section brocade require more privacy than other individual activities, and hiking and running as team activities need a little more privacy than other team sports, according to the survey; It is postulated that professional reasons like long-term training and careful preparation may be the reason.

The analysis of the factors influencing the satisfaction of location shows that accessibility, good air quality and tidy environment, and low cost ranked as the top three factors, which showed the importance of accessibility for sports venues. In the recommendations on the improvement of community sports places, the sports groups expected to be able to access more types and quantities of public sports facilities (including the number and size of venues), and they would like better and friendlier management of sports venues.

According to the analysis, if the urban community fitness environment is going to be improved with the goal of a healthier city, the following urban design strategies may be put forward:

• Firstly, focus on the layout of public open spaces in urban planning. Public open spaces are important places for informal sports and social interaction. Multifunctional spaces have great significance on the quality of public life, including providing places for inhabitants' daily fitness activities, so a balanced distribution of urban open spaces will promote the accessibility of sports places.

• Secondly, more must be done to slow the traffic network for walking and cycling. Non-motorized vehicle lanes are the main places for cycling and jogging.

• Thirdly, the types and quantities of sports facilities should be improved; sports facilities in the urban open space should be designed according to the needs of sports groups, and should be friendly, safe and healthy.

• Lastly, it is necessary to construct a management system that involves public participation, which can support the ongoing maintenance, regular post occupancy evaluation, and collection of public opinions and suggestions for improving services that increase inhabitants' satisfaction.

REFERENCES

Ciming Health Checkup Management Group Company Limited. (2013). Investigation of Urban Inhabitants'health Status. *Daily Sunshine,* pp. 2013-2006-2026-B2019.

Giles-Corti, B., & Donovan, R. J. (2002). "The Relative Influence of Individual, Social and Physical Environment Determinants of Physical Activity". *Social Science & Medicine*, *54*(12), 1793-1812.

Humpel, N., Owen, N., & Leslie, E. (2002). "Environmental Factors Associated with Adults' Participation in Physical Activity: A Review". *American Journal of Preventive Medicine*, *22*(3), 188-199.

Jiang, B., Zhang, T., Sullivan, W. C., & Wu, X. (2015). "A Healthy City: The City Green Landscape on the Influence Mechanism of the Public Health and Important Research Issues". *Landscape Architecture Frontiers*, *3*(1), 24-35.

Jiao, X., Jin, Y., Gunawan, O., & James, P. (2015). "Modelling Spatial Distribution of Outdoor Recreation Trips of Urban Residents". *International Review for Spatial Planning and Sustainable Development*, *3*(3), 36-49.

Li, M. (2013). "Correlation Analysis of the Relationship between Sports Behavior and Urban Environment". *Journal of Nanjing Sport Institute(Social Science)*, *27*(1), 82-85.

Liu, L., Liu, R., & Peng, C. (2014). "The Influence of Urban Construction Environment on the Inhabitants' Physical Activities and the Measures Taken by the European Union". *Journal of Xi'an Physical Education University*, (5), 526-530.

Ma, L., Lv, Y., Ren, Q., & Zhang, X. (2008). "The Selection of Environmental Factors Related to Physical Fitness of Some Inhabitants in Xi'an". *Journal of Environment and Health*, *25*(3), 266.

Sina Health Blog. (2011). "The World Health Organization : Moderate Exercise Can Reduce the Incidence of Cancer". Retrieved from http://health.sina.com.cn/d/2011-02-11/075821936682.shtml.

Stevinson, C., Wiltshire, G., & Hickson, M. (2015). "Facilitating Participation in Health-Enhancing Physical Activity: A Qualitative Study of Parkrun". *International Journal of Behavioral Medicine*, *22*(2), 170-177.

Tsai, S.-Y., Chen, T.-Y., & Ning, C.-J. (2016). "Elderly People's Social Support and Walking Space by Space-Time Path". *International Review for Spatial Planning and Sustainable Development*, *4*(3), 4-13.

Wei, W., Xia, H., & Wang, W. (2014). "Exploration on the Plants Configuration of Outdoor Fitness Environment of the City". *Sports Culture Guide*, (8), 198-201.

Weng, X., He, X., Wang, X., Lin, W., & Li, D. (2010). "Urban Building Environment Effects of Inhabitants Physical Activity and Health - New Research Field of Sports and Health Promoting". *China Sport Science*, *30*(9), 3-11.

Zhao, H., & Huang, S. (2016). The Incidence of Gout in Shenzhen Is 3 Times the National Average. *Shenzhen Economic Daily*. Retrieved from http://szsb.sznews.com/html/2016-07/18/content_3573016.htm

Zheng, J. (2017). The Patients with Dyslipidemia in Shenzhen Higher Than the National Average. *Shenzhen Economic Daily*. Retrieved from http://szsb.sznews.com/html/2017-04/14/content_3768424.htm

Behavioral Intention Analysis of Waste Separation in China - Case Study of Hangzhou Using Theory of Planned Behavior

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Abstract: In China, governments are promoting waste management as an urgent environmental issue. Hangzhou is one of eight cities in China that have launched a pilot run for household waste separation since 2010. The government survey and a previous study of the authors have confirmed the gap between citizens' positive attitudes and their real behavior related to waste separation. In our study, the theory of planned behavior (TPB) is applied to analyse the factors that could influence the behavioral intention of the citizens towards separating waste. The structural model based on TPB was constructed to represent the framework of the citizens' intentions related to their waste separation behviour, based on a pilot survey and expert interview. Following the model, a 211-sample questionnaire survey was designed and conducted in Hangzhou. 19 extracted factors are categorized and structured following TPB. The result shows: attitude, subjective norm, and perceived behavioral control have positive influence on behavioral intention; perceived behavioral control exerts stronger influence than the other factors. Based on the findings, this study discusses policy implications and recommendations for improving the current policy and the situation of household waste separation.

1. INTRODUCTION

Since the "reform and open-door" policy implemented in 1978, China has made huge progress in economic growth and increasing incomes, as a result, the quantity of household waste has increased rapidly as well (Huang et al., 2006). Many cities in China are confronted with the situation of a "city besieged by waste". Hangzhou, the capital city of Zhejiang Province, is facing the same problem. Due to rapid economic and population growth, the amount of household waste in Hangzhou has more than doubled, from 1.42 million ton in 2005 to 3.31 million tons in 2014 (Figure 1) (Hangzhou Environmental Protection Bureau, 2015). To mitigate this situation, Hangzhou, along with seven other cities in China, launched a pilot project of household waste separation in 2010.
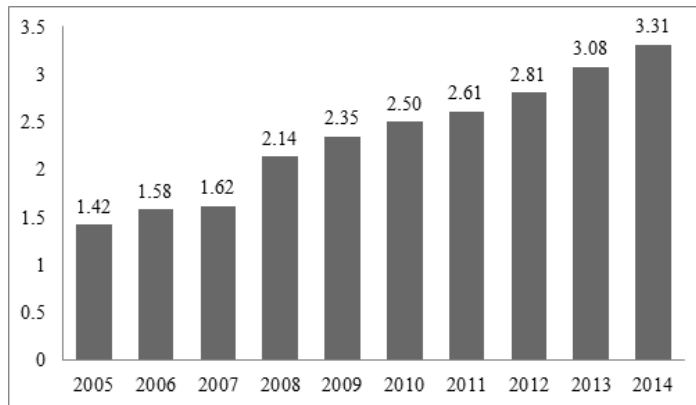
Figure 1. A trend of amount of household waste in Hangzhou from 2005 to 2014 (million tons) Source: Hangzhou Environmental Protection Bureau (2015)

Separating waste is one of the most effective ways to manage waste. The current waste separation system in Hangzhou divides household waste into four types: i.e. kitchen waste, recycled waste, hazard waste and other waste. Presently landfill is the main method to dispose of waste in Hangzhou, but the capability of landfills no longer satisfies the amount of waste. Therefore, separating waste helps reduce the total amount of waste as recycled waste can be recycled and part of kitchen waste can be utilized as biomass to generate electricity. The alternative method appears to be incineration for which waste separation is an indispensable prerequisite. Without waste separation, toxic gas such as SO_2 and dioxin emitted from the incineration plants largely exceed the standard amount, thereby exerting negative impacts on the atmosphere and residents' health. Household waste occupies a significant amount (30.46%) of the total municipal waste (Hangzhou Environmental Protection Bureau, 2015). Hence, household waste is focused on in this research.

Based on a study of the history and current state of household waste separation in Japan, a rough comparison of the legal system in Japan and that of Hangzhou was made. Japan has tackled its waste problem for more than 30 years and the current waste management system is one of the most mature systems in the world. In addition, the main cities, such as Tokyo, have some similar features as Hangzhou in terms of waste management development. Through more than 40 years, Japan has established a sound legal system on waste management. Currently the most relevant law about waste management is the Waste Management and Public Cleansing Law which took effect in 1970 and falls under the Fundamental Plan for Establishing a Sound Material-Cycle Society (2003). Above the Plan is the Basic Act for Establishing a Sound-Material-Cycle Society (Basic Framework Act, 2000) which comes under the Basic Environmental Plan which was enacted in 1994 (Ministry of the Environment of Japan, 2012).

Hangzhou has also enacted a series of law and regulations on waste management. Regulation on the management of the city appearance and environmental sanitation in Hangzhou (Chinese Government Public Information Online, 2007) took effect from 1997. In December of 2015, the Regulation on Household Waste Management in Hangzhou (Legal Affairs Office of Hangzhou Municipal Government, 2015) came into force, in which detailed contents on regulating household waste separation is included. Under the Regulation, there are measures for municipal household waste management (2013) (Hangzhou Municipal Government, 2012) and methods and standards for household waste separation (2010) (Hangzhou.com.cn., 2013). Compared with Japan, Hangzhou started to establish its

comprehensive legal system on waste management much later. Also, many regulations and policies are new, so not yet mature.
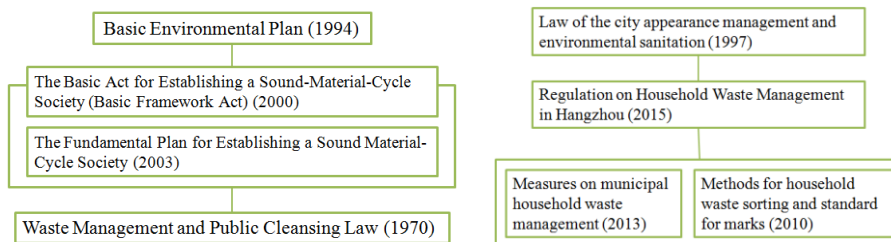
Figure 2. Legal system in Japan (left) and China (right)

Most citizens hold a positive attitude towards the waste separation project while actual performance did not reflect this. At the beginning of the project, the municipal office conducted a survey regarding citizens' attitude towards sorting activities. It showed that 97.82% of citizens think waste separation is good and should be implemented in the city (Zheng, 2013). Though more than five years have passed, significant progress was not observed in most communities. It is reported frequently that in numerous communities, household waste is still being mixed and residents' awareness is still low. Despite general unsatisfactory consequence, there are some communities which have achieved good effects and been regarded as model communities. By observing the situations above, the initial research question is why citizens do not take actual action whilst they have a good attitude, and what other factors influence their actual behavior.

The current waste separation system was merely implemented in urban areas (4,876 km2, 9 districts) which took up approximately 29.4% of the total area of Hangzhou. By the end of 2014, there were 8.892 million long-term residents in Hangzhou, with 6.678 million (75.1%) in the urban area. In urban areas, the average population density reached 1,461 people/km^2 in 2014. Particularly, the number was as high as 19,594 people/km^2 and 17,235 people/km^2 respectively in the core districts, i.e., Shangcheng and Xiacheng District (Hangzhou Statistical Information Net, 2015).

Not only population density, but also economic growth have led to the waste problem in Hangzhou, one of the most developed cities in China. The gross domestic product (GDP) per capita in Hangzhou in 2014 reached around US$16,000 (103,813CNY) which is as more than twice the average level of that in China (US$7,200, 46,628.5CNY) (Hangzhou Statistical Information Net, 2015). The annual municipal GDP growth rate kept above 8% in past five years (Hangzhou.com.cn, 2015). To some extent, Hangzhou can represent many other cities which have similar development features, by that reasoning this case study is also generally applicable in those areas.

From the observation above, it is not difficult to deem that there is a gap between people's attitudes and their actual behavior, which leads to a concern about other potential factors influencing their actual behavior besides their attitude. The key to solving this problem possibly lies in the decision-making process. Considering that the decision-making process, as a human cognitive process, is complex, the theory of planned behavior (TPB) is applied in this study to predict the behavioral intention of participating in household waste separation. The TPB model (shown in Figure 2) which consists of three main factors, attitude, subjective norms and perceived behavioral control, is based on the assumption of rational behavior and volitional consideration of actions and considers that the immediate

determinant of a behavior is the individual's intention to perform, or not (Ghani et al., 2013). The study aims to use/take the advantage of interdisciplinary research by integrating waste management with social psychology, yet to go beyond and discover the facts behind the current situation from a human behavioral perspective. Hence, the theory of planned behavior, a social psychological modelling method, is selected as a suitable tool for the study.

In the following sections, the development and application of TPB are reviewed in Section 2, the method and the survey conducted in Hangzhou are introduced in Section 3, the findings from the analysis are explained in Section 4, and some policy implications are concluded in the last section.

2.   LITERATURE REVIEW

Several behavior change theories could be applied to help predict behaviors, such as the theory of reasoned action (Ajzen & Fishbein, 1980) and the theory of planned behavior (Ajzen, 1991). The psychological model used in this study is the theory of planned behavior (TPB), which is further developed from the theory of reasoned action (TRA). Initially, intentions are in turn influenced by attitude (behavioral beliefs) and subjective norms (normative beliefs). However, the theory of planned behavior was extended from the previous theory of reasoned action by adding the construct, named perceived behavior control (control beliefs), an individual's perception of whether they are able to perform the behavior or not. Attitude, subjective norms, together with perceived behavior control (PBC), account for considerable variance in actual behavior (Ajzen, 1991). Further, Liska (1984) also argues that the performance of many behaviors will be constrained by the lack of appropriate opportunities, skills and resources. The TPB provides a theoretical framework to systematically examine factors that affect behavioral change (Pakpour et al., 2014), thereby, the researchers will be able to discover the influencing factors (attitude, subjective norms, PBC) specified in the household waste separation program along with the gap between attitude and actual behavior (the fact that people have developed a willing attitude towards performing household waste separation in their community, however barely put this into practice, shows more likely the gap between intention and actual behavior) and further improves it based on the prospective results. Heretofore, the TPB has been used successfully to understand a range of environmentally responsible behaviors, for instance, an application to moderate the effects of food technology neophobia of genetically modified food (Kim, Jang, & Kim, 2014), a household waste separation case in Iran and Malaysia (Pakpour et al., 2014; Ghani et al., 2013), and so on.

Briefly, the theory of planned behavior can be described as a formation of three contents as also noted above: behavioral beliefs, normative beliefs, and control beliefs. In the case of this study, the behavioral belief is the favorable or unfavorable attitude towards household waste separation; the productivity, intellectual and challenge aspects, for example. The normative belief is the subjective norm of waste separation, the perceived social pressure from other people such as family, colleagues or superiors, while the control belief is the perceived behavioral control over performing this waste separation, the perception of the ability to do it or not (Solikhah, 2014). As it is commonly agreed, the theory of planned behavior supports that individuals who have positive attitudes together with adequate normative

facilitation, and who perceive there is less impedance to engage in the activity, should have strong intentions to perform the behavior (Fielding, McDonald, & Louis, 2008). However, intention is considered just as the immediate antecedent of behavior (Ajzen, 1991), and the likelihood or chance to behave, not the definite decision made to perform the actual behavior.
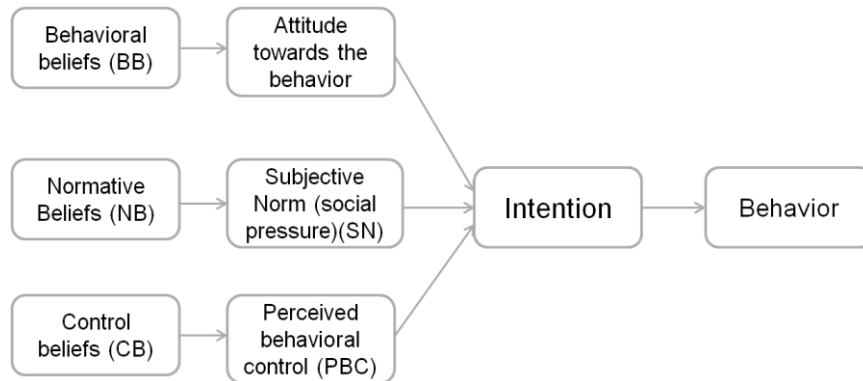
Figure 3. The TPB model used in this case study

In a case of household waste separation conducted in Malaysia, the authors (Ghani et al., 2013) mentioned that promoting waste separation is a complex process since the behavior needs considerable decision making as the process requires individuals willingly participating in sorting, preparing and storing household waste as a part of the responsibility. In a similar way, in order to smoothly promote the waste separation program primarily being piloted through communities in Hangzhou, China, theory and hypothesis-based research needs to be conducted to understand public attitudes and to analyze the pattern of people's behavior towards garbage sorting. The TPB is highly recommended to systematically identify the factors that influence participation in household waste separation.

Attitude towards the behavior is defined as the degree to which a person's positive or negative evaluation of performing the behavior is questioned. Since quality of life has been improved, environmental issues have started to draw the public's attention. General studies (Zheng, 2013) show that people are becoming strongly aware of an individual's responsibility to improve waste separation, which obviously shows their favorable attitude towards household waste separation. Nevertheless, social psychological research has shown that attitudes do not have a strong impact on people's behavior (Wicker, 1969). However, it has coincidently explained the embarrassing reality that people hold positive attitudes towards implementing household garbage sorting, but actual behavior barely reflects this. Therefore, the present stage is to examine whether the intention to perform household waste separation is formed or not.

The subjective norm refers to the perception of social pressure from other people to perform or not to perform the behavior (Ajzen, 1991). In other words, it is an individual's perception of whether other people important to the individual think the behavior should be performed (Solikhah, 2014). Armitage and Conner (2001) in 2001 have disclosed that the subjective norm is expected to be the weakest predictor of behavioral intention in the TPB.

Perceived behavioral control (PBC) requires volitional control over a behavior. Ajzen developed the PBC concept to extend the theory of reasoned action in 1991, defining it as an individual's perceived ease or difficulty of performing a particular behavior, an individual's beliefs about the presence

of factors that may facilitate or impede performance of the behavior. Perceived behavioral control (PBC) not only predicts behavioral intention but also can be used, together with intention, to predict behavior (Pakpour et al., 2014).

Some researchers have criticized the TPB suggesting that attitudes, subjective norms, and perceived behavioral control might be insufficient to predict intentions and behavior because the TPB model often neglects affective aspects of attitude and considers only rational and cognitive factors. Therefore, additional variables are commonly constructed, such as perceived need, self-identity, past behavior, affective beliefs, action planning, etc. Few studies have examined additional variables with respect to household waste behaviors (Miafodzyeva, Brandt, & Andersson, 2013).

3.   METHODOLOGY AND DATA

The aims of this study are to identify and evaluate the influencing factors that cause the difference between behavioral beliefs (attitude) and actual behavior by the aid of the TPB model. Accordingly, measures to positively change people's intention to ultimately achieve wide participation in household garbage sorting are discussed in the following sections.

3.1   Structure of questionnaire

The study took a 44-sample pilot survey at the preparing/initiating stage using a paper format. All the respondents were affirmed as holding a permanent resident status. Additionally, the respondents were also randomly, nonetheless prudently, chosen from the eight districts which are progressing household waste separation programs in Hangzhou. Before conducting the survey, individual permissions were certainly acquired from the participants and the purpose of the survey and study was also specifically explained to them. Through the pilot survey, useful feedback from the survey participants was gained and used for working out the final questionnaire. The final questionnaire was constructed by utilizing the TPB and based on the pilot survey.

The questionnaire is divided into seven main parts: behavioral beliefs (BB), normative beliefs (NB), control beliefs (CB), and correspondent attitude, social norm (SN), perceived behavior control (PBC), and intention to perform sorting behavior (see figure 3). Question style is as multiple choice measured with a 7-point Likert-type scale (e.g.1= strongly disagree; 7=strongly agree).

Behavioral beliefs: According to Fishbein and Ajzen (1975), in one's behavioral beliefs, performing a particular behavior will lead to a behavioral outcome and therefore, items for behavioral beliefs are formed by strength of behavioral beliefs and outcome evaluation (OE). They need to be multiplicatively combined, or to say BBs*OE. In total, 7 items were designed with seven-point Likert scales ranging from strongly disagree (1) to strongly agree (7) for both BB and OE. A sample question of BB was: "Household garbage sorting is beneficial for keeping the family environment clean" and that of OE was: "Keeping the family environment clean is important for me".

Attitude: Items for attitude were divided into two clusters for different targets. They were: "Generally speaking, household garbage sorting is

_____ for families; is _____ for society". Each of them is measured from meaningless at all (1) to very meaningful (7) and from not important at all (1) to very important (7).

Normative beliefs: Normative beliefs are one's consideration of opinions about performing a behavior of his/her referents and according to Ajzen (2002), with regard to each normative referent, items should be formed by strength of normative beliefs and the motivation to comply (MC) with that referent. Six items were designed in total including six statements for NBs measured from should not (1) to should (7) and six statements for MC measured from very low (1) to very high (7). Correspondent statements of NBs and MC were also multiplied and combined. A sample question for NB was: "My families think I ____ carry out garbage sorting at home", and the correspondent MC was: "The possibility for me to listen to them is ____".

Subjective norm: There were three statements for SN covering different normative scales: "I think most Hangzhou citizens would do household garbage sorting", ranging from strongly disagree (1) to strongly agree (7); "People who are important to me think I ___ carry out household garbage sorting", from should not (1) to should (7); and "New regulation will take effect soon while some communities have specific reward and punishment systems. Under those express terms, my enthusiasm towards participating in household garbage sorting will increase", from strongly disagree (1) to strongly agree (7).

Control beliefs: Control beliefs about whether it is easy or not to perform a behavior will be influenced by control factors which are the perceived facilitators or inhibitors standing in front of performing that behavior. For that, both the strength of control beliefs (CBs) and how powerful control factors will facilitate or impede performance (P) need to be assessed in this section (Ajzen, 2002). That is, statements of CBs and P need to be again multiplicatively combined (i.e., [CBi*Pi]). There were six items in total and one of them was: for CBs, "I think household garbage sorting is a time-consuming thing", measured from strongly disagree (1) to strongly disagree (7); and for P, "Whether it's time-consuming or not would influence me from participating in garbage sorting", measured from not at all (1) to greatly will (7).

Perceived behavioral control: Items for PBC were repeatedly concerned due to the special relationship with behavioral intention to actual behavior. Primarily, it is assumed that PBC influences positively the formation of behavioral intention and the possibility to act. Armitage and Conner (2001) provided another assumption that is "PBC will influence directly actual behavior to the extent that perceived control reflects actual control". Three statements were concluded at the end measuring from strongly disagree (1) to strongly agree (7). For instance, "I have ability (personal ability, e.g. knowledge about sorting garbage, economic ability) to participate in household garbage sorting" and "I think our family is able to do garbage sorting.".

Behavioral intention: One of the items demonstrating the strength of behavioral intention towards participating household waste separation was "I intend to start or perform better in garbage sorting in half a year. " measured from strongly disagree (1) to strongly agree (7).

3.2   Survey method and respondents' profile

The survey was conducted online through a Chinese professional online survey conductor, SOJUMP Corporation. The questionnaire was designed

and distributed in Chinese originally and translated into an English version for academic use. In Hangzhou, internet penetration is up to 80.0%, thus the online samples can represent most citizens. In the final online questionnaire, the purpose of the survey was explained at the beginning (66wz.com, 2014).

A total of 211 questionnaires were collected. Since the questionnaires were distributed by using a sample service from a professional online survey company, questionnaires were ensured of their quality generally in terms of completeness and responsibility.

Of the 211 completed and usable questionnaires, females and males represented about half of the sample respectively (54.0% and 46.0%). Among respondents, up to 54.0% were between 20 and 30 years old, the second largest age group was 30 to 40 years old (26.1%); about two-thirds of them held a university/college degree (65.9%). The average number of respondents' family members (including the respondent) is 3.6; more than half of the respondents' family has two generations in the household (57.8%); more than one-third of families have income between 10,000 CNY and 20,000 CNY per month (35.6%). Most profile figures are close to normal distribution, which indicates the appropriateness of the sample.

3.3   Data analysis

In this study, the Statistical Package for Social Science (SPSS) software was used to examine the correlations between each construct, and Cronbach's reliability was used to perform a factor analysis (Bacon, Lynd Bacon & Associates Limited, & SPSS Incorporated, 1997). Then, a path analysis was conducted with Analysis of Moment Structures (AMOS) (Wuensch, 2016). AMOS, initially created for structural equation modelling (SEM), path analysis ,etc., is able to read the data from an SPSS database or other sources and accordingly draw a graphical interface that allow researchers to analyze models specifically.

4.   FINDINGS AND DISCUSSION

4.1   Construct validity

Table 1 demonstrates correlations and reliabilities of constructs used in the research. Attitude, subjective norm and perceived behavioral control are all positively related with behavioral intention. Furthermore, right directions are observed in all correlations between behavioral beliefs and attitude, normative beliefs and subjective norm, control beliefs and perceived behavioral control. The Cronbach's alpha (Cronbach, 1951) was examined through a reliability analysis to determine the internal consistency for overall and individual constructs. According to Nunnally (1978), the threshold for an acceptable index of Cronbach reliability is 0.7, and on this basis, the higher value the scale is, the more reliable it is. In this case, the Cronbach's alpha of the total scale was 0.904.

Table 1. Correlations and reliabilities of constructs

Constructs	1	2	3	4	5	6	7
1.Behavioral beliefs	[0.94]						
2.Normative beliefs	0.30**	[0.74]					
3.Control beliefs	0.14*	-0.03	[0.56]				
4.Attitude	0.64**	0.45**	0.02	[0.87]			
5.Subjective norm	0.13	0.26**	-0.11	0.34**	[0.50]		
6.Perceived behavioral control	0.06	0.10	0.28**	0.04	-0.07	[0.30]	
7.Behavioral intention	0.65**	0.51**	0.07	0.60**	0.20**	0.07	[0.69]

$**p<0.01$ and $*p<0.05$

Reliability coefficients of the respective constructs are shown in brackets.

Factor analysis was conducted by using principal component and Varimax rotation methods in order to observe the distinction of each construct, from BBs to behavioral intention. In addition, the extracted number of factors was deliberately set as 7. The Kaiser-Meyer-Olkin (KMO) index obtained was 0.888 while 0.60 was recommended, indicating a high adequacy of the sampling data for performing factor analysis (Garson, 2001). As it is shown below in Table 2, the Barlett Test of Sphericity was 4004.686 with a significance of 0.000 and the cumulative percentage of variance of components was 65.17%. A few deficiencies of construct discriminating were expected since the research was explorative.

4.2 Result of structural equation modelling

SEM was utilized to investigate the relationships between the criterion variable of behavioral intention and the respective predictor variables of attitude, subjective norm, and perceived control. Figure 4 displays the structural model parameters and summarizes the degree to which the data fit the model. Three standard indices, goodness-of-fit (GFI), adjusted goodness-of-fit (AGFI) and root mean square error of approximation (RMSEA), were taken use of to evaluate the fit between the structural model and data. The GFI estimates the amount of variance explained by the model, and the AGFI adjusts this estimate by considering the degrees of freedom. Both estimates can vary from 0 to 1, and the higher the value is, the better the model fits the data. The RMSEA index additionally compensates for sample size, with low values indicating a good fit. Some studies have suggested 0.10 as a cut-off for poor fitting models (Kenny, 2015). The three standard indices indicated an acceptable fit for the model of this study (GFI = 0.726, AGFI = 0.682, RMSEA = 0.094).

Table 2. Factor analysis of the measuring instrument

Scale items	Factor loadings	Eigen value	% of variance	Cumulative %
Behavioral belief		5.217	16.302	16.302
Family environment	0.675			
Community environment	0.806			
Municipal environment	0.826			
Life quality	0.587			
Family education	0.839			
Good habit	0.813			
Benefit municipal waste sorting	0.671			
Behavioral intention		4.026	12.581	28.883
Have intention to participate	0.647			
Have a detailed plan	0.717			
Motivate family members	0.655			
Normative belief		3.124	9.763	38.646
Listen to family	0.694			
Listen to community	0.544			
Listen to friends	0.783			
Follow most citizens	0.660			
Conform to regulation	0.499			
Influenced by reward and punishment system	0.755			
Attitude		3.109	9.717	48.363
Meaningful for families	0.551			
Important for families	0.800			
Meaningful for society	0.542			
Important for society	0.800			
Control belief		2.680	8.374	56.737
Time-consuming	0.424			
Garbage bag provision	0.631			
Knowledge provision	0.652			
Products easy to disassemble and sort	0.601			
Family cooperation	0.550			
Enough space	0.572			
Subjective norm		1.752	5.475	62.212
Agree/disagree with waste sorting	0.606			
Should/should not sort waste	0.709			
Encouraged by new regulation	0.548			
Perceived behavioral control		1.396	4.362	66.574
Family able to sort waste	0.684			
Personal ability	0.731			
Convenience	0.834			
Total scale reliability	0.904			

KMO=0.888

Bartlett's Test of Sphericity = 4004.686 at df = 496 with a significance of 0.000.
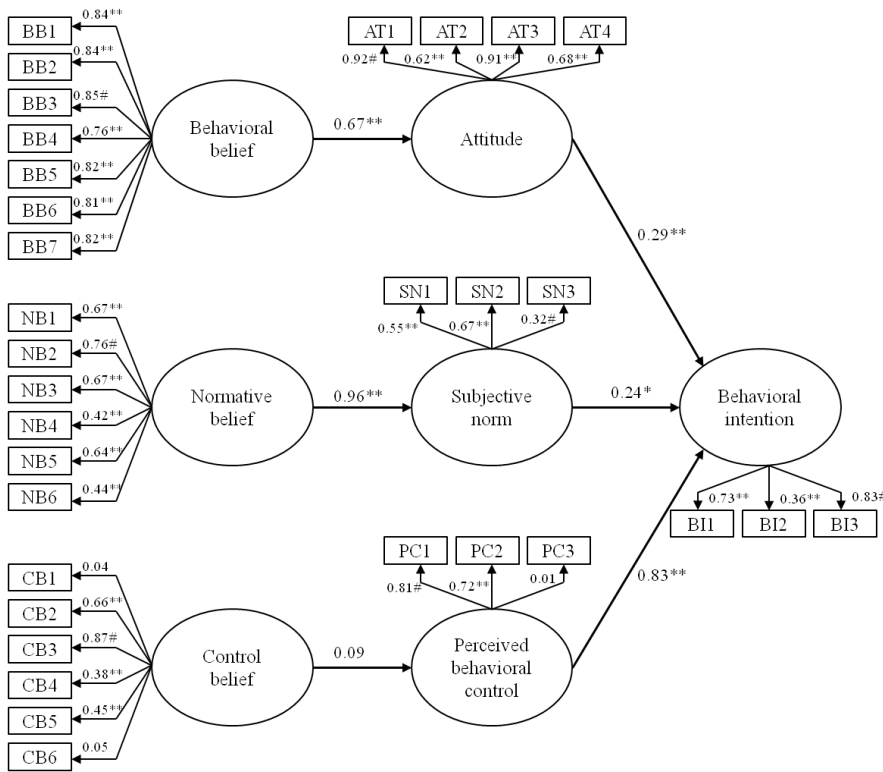
GFI=0.726   Adjusted GFI=0.682   RMSEA=0.094 # Value fixed at 1.0 *p<0.01 **p<0.001

BB1=Family environment	CB1=Time-consuming	NB4=Follow most citizens
BB2=Community environment	CB2=Garbage bag provision	NB5=Conform to regulation
		NB6=Influenced by reward
BB3=Municipal environment	CB3=Knowledge provision	and punishment system
BB4=Life quality	CB4=Products easy to	BT1=Have intention to
BB5=Family education	disassemble and sort	participate
BB6=Good habit	CB5=Family cooperation	BT2=Have a detailed plan
SN1=Agree/disagree with	CB6=Enough space	BT3=Motivate family
waste separation	NB1=Listen to family	members
SN2=Should/should not sort	NB2=Listen to community	PBC1=Family able to sort
waste	NB3=Listen to friends	waste
SN3=Encouraged by new		PBC2=Personal ability
regulation		PBC3=Convenience

Figure 4. Structural equation model of waste separation behavioral intention

4.3   Discussion on the analysis result

Several findings were extracted from the analysis result. Among the three factors influencing the intention formation, citizens' attitude towards waste separation supports a formation of the intention, but the relation is weak (b = 0.29, p<0.001), which confirms the previous observation that people hold good attitudes, but do not perform de facto actions of separating waste. It also indicates that instead of good attitudes, there are other factors which form the separating waste behavior intention more significantly and directly.

Subjective norm has, but little, influence on the intention (b = 0.24, p<0.01), which indicates that citizens' social relations such as family members, neighborhood, and friends do not exert a strong impact on the

waste separation behavior. This may be attributed to individualism. Though Chinese culture is regarded as a collective culture, features of individualism can usually be observed, especially regarding young people. A likely reason is that China's one-child policy strengthened the consciousness of individuals. In addition, since reform and opening-up policies have been implemented, the value of individuals has been emphasized in a more open and market-oriented society. Another explanation is that the social atmosphere of separating waste has not formed yet, so that not much social pressure is felt by people who do not perform sorting behavior.

Different from the above two factors, PBC exerts a much stronger impact on the intention to separate waste (b = 0.83, p<0.001). Thus, certain constraints could diminish such an intention to sort household waste. Those constraints were mostly related to the perception of family and personal capability and convenience to sort waste. Additionally, an especially weak correlation between CB (which is supposed to form PBC) and PBC (b = 0.09) stands out. Two assumed explanations are: 1. Questions in CB are not sufficient for PBC, as other ability enhancement methods such as education in schools and companies were not included in the questions. 2. Citizens have a concept of waste separation (as Hangzhou started the waste separation program early in 2000), which may lead to a misperception that they have already mastered how to sort waste, but actually they do not have an explicit understanding.

5.   POLICY IMPLICATION AND CONCLUSION

Results of this study demonstrate the partial utility of TPB as a conceptual framework for analyzing the behavioral intention of sorting household waste among Hangzhou citizens. The various GFI indices (GFI, AGFI and RMSEA) indicated that the result is acceptable, but not satisfactory, meaning that there may be more variables influencing the behavioral intention. Thus, a further and more comprehensive study will be developed in the next stage of research. Currently, findings show that all the three factors, i.e. attitude, subjective norm and perceived behavioral control had direct impacts on behavioral intention. However, among them, only perceived behavioral control showed a strong correlation with behavioral intention.

Based on the findings of the study, a number of implications and applicable policy proposals for the municipal government can be obtained. Under the circumstance that the waste transportation system and sorted waste disposal ability will be improved, the government should focus on enhancing citizens' PBC, that is, to convince people of their own capability towards household waste separation. Despite brochure distribution and on-site instruction being utilized to teach residents how to sort waste, brochures in some communities were difficult to understand due to tedious and small-word instructions. Easy-to-understand illustrations such as anime characters and dialogs would be more attractive and instructive especially for children and the elderly. As for on-site instructions, quite a lot of survey respondents reflected that those instructions were rarely provided in most communities, for some, such instructions were never conducted. As on-site instruction is a most direct and effective method, popularizing waste separation training programs in communities would enhance residents' capability of waste separation and improve their awareness of how easy it is. To prevent people from worrying about any possible inconvenience during the process of waste separation, the government should be aiming at notifying residents of

categories to which different waste items belong, as clearly and detailed as possible. In addition, food and other consumption companies are responsible for developing technologies in terms of packing and product constructs, or introducing that from others which have already been developed. Other measures to strengthen PBC include putting more public service advertisements in mass media, supporting schools and companies to organize field trips in waste management facilities, and so on. While taking use of mass media to promote waste separation campaigns, plots relevant to waste separation could be added into movies or televised dramas as well, to raise people's consciousness. Such plots can often be seen in Japanese movies and TV dramas. On the one hand, waste separation has already become a part of a Japanese national's daily life, on the other hand, it deepens people's consciousness of waste separation to help reinforce there already established habits.

From the perspective of improving citizens' subjective norm, promoting waste separation campaigns from more various ways is considered as essential. Currently, not only the government, but many local volunteer groups, NGOs, and education institutions are involved in waste separation campaigns (Hangzhou Daily, 2014; Hangzhou Volunteer, 2014). As civilian power takes a significant role in such campaigns, the government should support those non-governmental social organizations. Promoting school education can not only enhance children's knowledge, as mentioned above, but also help to spread the idea of waste separation, as those educated children are able to influence their parents' minds positively.

On the other hand, citizens need to perceive correctly their actual capability of waste separation and achieve a paradigm shift from "none of my business" towards "it's my duty". To that end, schools and children, local volunteer groups and organizations should play main roles as models to lead the campaign. Only by combining both the governments' and citizens' efforts, can the waste separation system be enhanced and reach the expectations.

Limitations of the study included the online survey as a research method; even though the respondents' profile was close to a normal distribution, people who do not often use internet such as the elderly may have been excluded from the research. In addition, future studies may investigate the power of current policy and regulations on household waste separation.

REFERENCES

66wz.com. (2014). "Online Shopping Consumption of Zhejiang Citizens". Retrieved from http://zj.sina.com.cn/news/m/2015-07-01/detail-ifxemzey4956503.shtml on March 31, 2017

Ajzen, I. (1991). "The Theory of Planned Behavior". *Organizational behavior and human decision processes*, *50*(2), 179-211.

Ajzen, I. (2002). "Constructing a Tpb Questionnaire: Conceptual and Methodological Considerations". Retrieved from https://pdfs.semanticscholar.org/0574/b20bd58130dd5a961f1a2db10fd1fcbae95d.pdf.

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behaviour.* Englewood Cliffs, NJ: Prentice-Hall.

Armitage, C. J., & Conner, M. (2001). "Efficacy of the Theory of Planned Behaviour: A Meta-Analytic Review". *British Journal of Social Psychology*, *40*(4), 471-499.

Bacon, L. D., Lynd Bacon & Associates Limited, & SPSS Incorporated. (1997). *Using Amos for Structural Equation Modeling in Market Research.* Lynd Bacon & Associates Limited and SPSS Incorporated.

Chinese Government Public Information Online. (2007). "Regulation on the Management of the City Appearance and Environmental Sanitation in Hangzhou". Retrieved from http://govinfo.nlc.gov.cn/zjsfz/xxgk/zjs/201112/t20111206_1151866.html?classid=434 on Dec 12, 2016.

Cronbach, L. J. (1951). "Coefficient Alpha and the Internal Structure of Tests". *Psychometrika*, *16*(3), 297-334.

Fielding, K. S., McDonald, R., & Louis, W. R. (2008). "Theory of Planned Behaviour, Identity and Intentions to Engage in Environmental Activism". *Journal of Environmental Psychology*, *28*(4), 318-326.

Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research.* Reading, MA: Addison-Wesley.

Garson, G. D. (2001). "Pa 765 Statnotes: An Online Textbook (Vol.2001)". Retrieved from https://faculty.chass.ncsu.edu/garson/PA765/statnote.htm.

Ghani, W. A. W. A. K., Rusli, I. F., Biak, D. R. A., & Idris, A. (2013). "An Application of the Theory of Planned Behaviour to Study the Influencing Factors of Participation in Source Separation of Food Waste". *Waste Management*, *33*(5), 1276-1281.

Hangzhou Daily. (2014). "Everyone Participates in Waste Separation in Hangzhou". Retrieved from http://hzdaily.hangzhou.com.cn/hzrb/html/2014-10/31/content_1828217.htm on Feb 12, 2017

Hangzhou Environmental Protection Bureau. (2015). "Environmental Conditions Communique of Hangzhou". Retrieved from http://www.hzepb.gov.cn/zwxx/gkml/14/1402/ on Feb 18, 2017

Hangzhou Municipal Government. (2012). "Measures on Municipal Household Waste Management". Retrieved from http://www.law-lib.com/law/law_view.asp?id=403104 on Feb 16, 2017.

Hangzhou Statistical Information Net. (2015). "2015 Hangzhou Statistical Yearbook". Retrieved from http://wap.hzstats.gov.cn/tjnj/nj2015/1.pdf on March 16, 2017.

Hangzhou Volunteer. (2014). "Volunteers in Hangzhou and Public Service Organizations Promote Waste Separation Positively". Retrieved from http://www.hzva.org/article/othermenushow/id/957.html on Feb 12, 2017.

Hangzhou.com.cn. (2015). "Hangzhou 2014 Gdp Growth Picked up for the First Time in Five Years". Retrieved from http://hznews.hangzhou.com.cn/jingji/content/2015-01/28/content_5628520.htm on Feb 18, 2017.

Hangzhou.com.cn. (2013). "Methods for Household Waste Separation and Standard for Marks". Retrieved from http://z.hangzhou.com.cn/2013/2013ljfl/content/2013-05/08/content_4727012.htm on Feb 16, 2017.

Huang, Q., Wang, Q., Dong, L., Xi, B., & Zhou, B. (2006). "The Current Situation of Solid Waste Management in China". *Journal of Material Cycles and Waste Management*, *8*(1), 63-69.

Kenny, D. A. (2015). "Measuring Model Fit". Retrieved from http://davidakenny.net/cm/fit.htm on March 19, 2017

Kim, Y. G., Jang, S. Y., & Kim, A. K. (2014). "Application of the Theory of Planned Behavior to Genetically Modified Foods: Moderating Effects of Food Technology Neophobia". *Food research international*, *62*, 947-954.

Legal Affairs Office of Hangzhou Municipal Government. (2015). "Regulation on Household Waste Management in Hangzhou". Retrieved from http://www.hangzhoufz.gov.cn/details/gfwjdetail.aspx?id=2114 on Feb 16, 2017

Liska, A. E. (1984). "A Critical Examination of the Causal Structure of the Fishbein/Ajzen Attitude-Behavior Model". *Social Psychology Quarterly*, *47*(1), 61-74.

Miafodzyeva, S., Brandt, N., & Andersson, M. (2013). "Recycling Behaviour of Householders Living in Multicultural Urban Area: A Case Study of Järva, Stockholm, Sweden". *Waste Management & Research*, *31*(5), 447-457.

Ministry of the Environment of Japan. (2012). "Solid Waste Management and Recycling Technology of Japan: Toward a Sustainable Society. ". Japan Environmental Sanitation Center. Retrieved from https://www.env.go.jp/en/recycle/smcs/attach/swmrt.pdf.

Nunnally, J. C. (1978). *Psychometric Theory.* New York: McGraw-Hill.

Pakpour, A. H., Zeidi, I. M., Emamjomeh, M. M., Asefzadeh, S., & Pearson, H. (2014). "Household Waste Behaviours among a Community Sample in Iran: An Application of the Theory of Planned Behaviour". *Waste Management*, *34*(6), 980-986.

Solikhah, B. (2014). "An Application of Theory of Planned Behavior Towards Cpa Career in Indonesia". *Procedia-Social and Behavioral Sciences*, *164*, 397-402.

Wicker, A. W. (1969). "Attitudes Versus Actions: The Relationship of Verbal and Overt Behavioral Responses to Attitude Objects". *Journal of Social Issues*, *25*(4), 41-78.

Wuensch, K. L. (2016). "Conducting a Path Analysis with Spss/Amos". Retrieved from http://core.ecu.edu/psyc/wuenschk/MV/SEM/Path-SPSS-AMOS.pdf on March 18, 2017

Zheng, S. (2013). "Status Quo of Domestic Garbage Sorting in Hangzhou and Recommendations". *Economic & Trade Update*, (14), 132-133.

SPSD

Key factors of people's willingness to pay for green buildings in a less developed region in China: A pilot research effort in Shanxi Province

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Abstract: With the process of urbanization, China has entered into a booming of construction, and new buildings currently cost large quantities of natural resources and energy. Green Buildings are one of the approaches being implemented to help to mitigate the impacts of the building stock on the environment. However, the majority of green buildings are located in eastern region of China where the economies are more developed. For developing regions in the middle and western regions, green buildings are few. Low income is easily assumed to be the barrier, but research performed to test this assumption, is scarce. The authors of this paper chose Shanxi Province, a less developed region, as the area of investigation to investigate this issue. The authors developed a framework of consumer behaviour based on the Howard-Sheth model to find the key factors that affect people's willingness to pay (WTP), for which a questionnaire survey was conducted in the study area in Shanxi Province. The survey data were analysed by logistic regression and cross tabulation methods. The results revealed that rather than income, the knowledge related to green buildings and awareness of environmental protection had significant impacts upon green building WTP. Based on the analyses, several suggestions were developed, including: imposing certain demands on constructors of buildings to adopt green facilities, improving the publicity of green buildings, etc. This study investigated people's real attitudes toward green building and found a high WTP in the region, which deserves further attention from the relevant stakeholders in the future.

1.   INTRODUCTION

With the rapid industrialization and economic development, the energy situation is very serious in China and may threaten the stability and security of the country. In such a tense situation, according to the 2013-2017 China Intelligent Building Industry Market Prospects and Investment Strategy Planning Analysis Report, buildings account for 33% of the total energy consumption and 27.6% of coal use, and 25% of greenhouse gas emissions. This "33%" is only the proportion of energy consumed during the construction and use of buildings. If we add the energy consumption of building materials during the production processes, the total energy consumption related to buildings shares 49.7% of the Chinese Society. Prior to 2013, China's construction was 40 billion square meters, but since then 16-20 billion square

meters of new construction are being built every year (Mo, Chen, & Huan, 2013).

As a new attempt for reducing environmental impacts of buildings, by September 2016, there were 4,515 green buildings in China with a total construction area of 52,291 square meters (Ministry of Housing and Urban-Rural Development Centre of Technological Industrialization Development, 2017). As Amecke et al. (2013) stated, China's building stock is characterized by rapid new construction and demolition of older buildings and large scale urban expansion. As a result it is contributing negatively to a broad range of climatic conditions. But China is dedicated to developing and modernizing its technologies. Accordingly, China's foremost building energy efficiency priorities are designed to ensure that new buildings are built to high energy efficiency standards and are committed to improving the efficiency of heating and cooling and other equipment used in buildings. Hence, green buildings can be an effective path to sustainable development if properly designed, constructed and maintained.

Although green buildings are attracting attention in China, the distribution is unbalanced. As Ye et al. (2013) concluded "green building" labels cover a great number of provinces, autonomous regions, municipalities and Special Administrative Regions, within not only large cities, but also in a few small cities. However, the distribution of green buildings is mainly concentrated in the eastern region of China, which is the region with rapid economic development. A majority of the green buildings in China are in wealthy provinces, such as Shanghai, Jiangsu, Guangdong and Beijing. These four provinces together accounted for about 50% of the total number of green building certifications in China (Ye et al., 2013). Why are people living in west and middle regions of China reluctant to choose green buildings? Is it because of their low income or other factors? For development of green building, not only standard and policy play important role, citizens are also involved as consumers. Their willingness to pay (WTP) is considered to be an important factor that affects investments in green buildings. Most of the previous studies focussed upon green building standards, evaluation methods and indices, policies and development situations. For instance, Zhang et al. (2017) compared Chinese green building standards with western green building standards. Zuo and Zhao (2014) reviewed the current situation and future agenda of green buildings in China. Shi et al. (2013) identified the critical factors for green construction in China and analysed the barriers of development of green buildings. Ye et. al. (2015) reviewed all green building labels in China in detail. Although they noted the unbalanced distribution of green buildings in China, they did not discuss the reason. They gave little attention to the cause(s) of distribution differences or the reason(s) for low quantity of green buildings in China.

To fill this knowledge gap, the objective of this paper was investigating if people do or do not wish to invest in green buildings. The authors conducted a questionnaire survey to explore citizens' real attitudes toward green buildings. Then based on the analysis of the responses, suggestions and policy implications were developed to promote increased investments in green buildings in China.

Shanxi province, located in north and middle region of China, was chosen as the area of investigation. According to the National Ranking of GDP published by State Statistics Bureau of China in 2016, Shanxi ranked 24th among 31 provinces which means that compared with the developed regions such as Beijing or Shanghai, Shanxi province has an underdeveloped economy. As the most important coal base, throughout the ages, Shanxi

province made and continues to make a great contribution to China's energy supply and expansion of national economic development. However, at the same time, a series of environmental problems and hidden troubles have emerged. For instance, the open pit mining destroys the ground surface and causes landslides and collapse. Drainage from coal production sites and from processing locations causes extensive water pollution. Additionally, air pollution is caused during coal transportation to energy transformation centres. Coal combustion produces large quantities of harmful particulate matter and gases which exacerbate the greenhouse effect and release SO_2 which causes acid rain, causing harmful impacts upon agricultural, forest and aquatic ecosystems. Especially in winter, northern China burns huge quantities of coal, which results in serious smog with high rate of PM2.5 and related substances, causing dramatic increases in human death rates due to respiratory and cardiac diseases. Berkeley Earth (2015) stated that "air pollution kills an average of 4000 people every day in China". The air pollution is worsened due to the fact that the traditional heating modes waste much of the energy.

The contents of this article are organized as follows: in Section 2, the authors presented a brief review to development process of green buildings in China and Shanxi Province, followed by an introduction to green building evaluation standards in China, including the related technical green building measures. In Section 3, the authors introduced the methodology they used. The Haward-Sheth Model was used to analyse consumers' behaviour from four factors, and the authors clarified how those factors were used in their research for this article. The analysis and discussion of the questionnaire results are presented in Sections 4 and 5. To sum up this study, in Section 6, the authors summarised the implications of their findings for governmental policies and actions to promote increased investments in green buildings. They also developed conclusions and recommendations for the future of green buildings in China

2. BRIEF INTRODUCTION OF GREEN BUILDINGS

2.1 Development process of green buildings in China and in Shanxi Province

The U.S. EPA stated "Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from design to siting, to construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high-performance building." (US EPA, 2016) In 1990s, introduction of these concepts into China was initiated. Since the United Nations Conference on Environment and Development in Rio De Janeiro, Brazil in 1992, the Chinese government has promulgated a number of related outlines, guidelines and regulations, and has vigorously promoted the development of green buildings. In September 2004, Use the words first and then the acronym, launched the National Green Building Innovation Award, which signified that the development of green buildings in China had entered a stage of integrated development. In 2006, the official form of the green building evaluation standard was officially issued. Since then, green buildings

are being developed at an increasing rate in China as a result of strong national policies on energy conservation and emissions reduction (Shi et al., 2013). As the result of those efforts, the number of green buildings has steadily increased. In 2015, there were 1,098 new green buildings appeared which created a new record (Chinese Green Building Evaluation Label, 2017).

At the same time, in Shanxi province, investment in green buildings developed relatively late. Evaluation of the first group of green buildings was performed 2011. Since then until 2017, only 37 buildings including both public and residential buildings were evaluated by a professional judging panel and got the qualification to apply for the green building label certification (Ministry of Housing and Urban-Rural Development of Shanxi Province).

Green building label certification is applicable for both the design and operation stages. The evaluation at the design stage requires detailed blueprints and models as proof, and at the operation stage, the evaluation is applied for the building that has been operated for some years. However, a great amount labor and material resources are needed during both types of evaluations. The high costs of evaluations should be paid for by the developers, according to results of interviews with stakeholders in Shanxi Province. However, since some of those buildings have already been approved to be constructed as green buildings and the developers did not intend to get the certification. Consequently, to date, few residential buildings have been certified as 'Green Buildings" in Shanxi Province.

2.2 Green Building Evaluation Standards and Supportive Technical Measures

Various green building rating systems have been established globally such as: The Building Research Establishment Environmental Assessment Method (BREEAM), which was founded in the United Kingdom in 1990. It was the first and most widely used green building evaluation method in the world. Similarly, the Leadership in Energy and Environmental Design (LEED), another popular evaluation standard that was adopted by over 165 countries and territories, was launched in the U.S. in 2003 (U.S. Green Building Council, 2016). These two green building labels are the only two internationally recognised green building labels, which have been adopted to evaluate green buildings in China.

Although interest in green buildings developed a little late in China, they received increased attention during the Five-Year Plan from 2011 to 2015. In China, the first national Green Building Evaluation Standard GB/T50378-2006 was promulgated and implemented in 2006. Due to the rapid development of green buildings in China and throughout the world, evaluation standards of green buildings and related regulations are also being improved constantly. Based on the initial policies, Ministry of Housing and Urban-Rural Development (MOHURD) made amendments and supplements to improve the evaluation standard. For instance, compared with the previous version, it extended the standard scope of application to all types of civil construction. The evaluation is divided into design evaluation and operation evaluation. Each type of green construction and operation evaluation is indexed with separate sets of scoring criteria. Extra points were added to encourage innovation and improvement of green building technology and management. As the result, the new form – GB/T50378-2014 was implemented since January 1, 2015. It includes seven categories – land saving and outdoor

environment, energy saving, water saving, material saving, indoor
environmental quality, operations and management and innovations. A
number of specific and common measures for various categories are presented
in Table 1 (GBT50378-2014 Green Building Evaluation Standard):

Table 1. Six categories of China's updated green building evaluation standard, GB/T50378-2014.

Categories	Aim	Technical measures
Land saving and outdoor environment	Enhance the full use of land.	Green roof, rational exploitation, underground space, high greening rate and etc.
Energy saving	Improve the thermal insulation performance of the building's envelope and use renewable energy.	Venetian insulation, double glazing window, radiant floor heating, solar water heater, sound controlled light illumination and etc.
Water saving	Improve the utilization efficiency of water resources.	Collection of rainwater.
Material saving	Use local materials to reduce pollution caused by transportation.	Big windows (save wall materials).
Indoor environment quality	Pay attention to the indoor air quality	Sound absorption board.
Operations and management	Use technology controlled by computers and networks to make life more convenient.	Intelligent housing system, good security.

Some technical measures could become important proof of grading. The
authors selected eight technical measures as examples to introduce their
functions and incremental costs that people have to pay. The incremental costs
of technical measures of green buildings were sourced from the research of
Sun, D. M. et al. (2008). Since their data were gathered in 2003, the authors
of this paper adjusted the costs with updated current per square meter housing
prices (Table 2).

Table 2. Incremental cost of technical measures

Technical Measures	Location of application	Incremental cost (Yuan/㎡)
Venetian insulating glass (*save space, sunshade, preserve heat, sound proof*)	All bathroom windows	90
Double glazing windows (*save energy, keep warm, thermal insulation, sound proof*)	80% of the buildings	280
Radiant floor heating	60% of the buildings	620
Electrical radiant floor heating system	40 of the buildings (bathroom)	120
Solar water heater	25% of the buildings	20
Sound controlled light illumination	All buildings (100%)	0.6
Reclaimed water reuse and Water-saving appliances	All buildings (100%)	150
Elevator shaft and sound insulation	All buildings (100%)	195
Intelligent housing system, security and property	60% of the buildings	1050
Total		2505.6

Source: Sun, D. M. et al. (2008)

As Sun, D. M. et al. (2008) stated that if a building is certified with requirements (shown in Table 3), the building may be accredited as a three-star green building. Hence, if there is a building which equipped with the 8 technical measures (listed in table 2), although it may not reach the three-star level, its grade of green building evaluation could be high.

Table 3. The requirements of three-star green building

Category	Three-star standard
Energy efficiency of building envelope	Achieve 65% of energy saving standard
Radiant floor heating	50% of the building
Solar water heater	50% of the building
Solar PV	Constitute 10% of energy proportion
Reclaimed water reuse and Water-saving appliances	The utilization rate of non-traditional water sources is no less than 30%
Indoor Environment Control	Meet the requirements of heat, sound, light and ventilation
Intelligent building	Meet the requirements of intelligent buildings

Source: Sun, D. M. et al. (2008)

3. THEORETICAL FRAMEWORK

3.1 The Howard-Sheth Model

There are various theoretical frameworks to describe and analyze the factors that affect consumer's purchasing behaviors. For instance, Guo et al. (2018) reviewed the theories of social psychology in exploring residential electricity consumption behavior. Sun, C., Yuan, and Xu (2016) applied the Contingent Valuation method to estimate the public's WTP for reducing air pollution in urban areas. Shuai et al. (2014) adopted the Dunnett's T3 test approach for single factor variance analysis to find the differences in consumers' WTP for low-carbon products among different types of consumers. de Medeiros, Ribeiro, and Cortimiglia (2016) used a model proposed by Zeithaml (1988) to investigate the relationships between consumer's perceived value for green products and the price elasticity of their purchases/investments. Juan, Hsu, and Xie (2017) identified behavioral factors that may affect consumer purchases of green buildings by using Howard-Sheth Model as the theoretical basis.

The Howard-Sheth Model is used to consider consumer's purchase behavior from four major perspectives: stimulate or *input factors* (input variables), *external factors*, *internal factors* (internal process) and reflect or *output factors* (Howard & Sheth, 1969).

Input factors are the factors controlled by the sales department, for instance the cost of the goods. External factors such as character traits and financial status of the consumer do not influence purchase behavior directly, however, they have significant impacts on purchase behaviors. Internal factors, mainly explain how input factors and external factors play roles in the psychological activities, will lead to the purchase decision. Output variables are the purchasing behaviors caused by the purchase decision process, which includes three stages: cognitive responses (attention and understanding), emotional responses (an estimate of the relative ability of a purchaser to satisfy his or her motives) and behavioral responses (whether the customer will buy or not).

Because the model emphasises the importance of input to the purchase decision making process, the model is important and is the most frequently quoted (Prasad & Jha, 2014). Although the model is not perfect enough to explain all buyer behaviors, it has already become a comprehensive theory of consumer's behavior as a result of empirical research (Horton, 1984).

3.2   Application of Howard-Shath Model

Promoting development of green buildings needs not only evaluation standards and policies, but also the efforts of consumers. Dwaikat and Ali (2016) found that green buildings cost less than their conventional counterparts. If so, there was no reason for people to refuse green buildings. Understanding the real attitudes of prospective green building users and the reason why green buildings were not prevalent in the study area can be used to help the government to formulate better policies to encourage the planning, development and operation of green buildings.

Based upon the theoretical framework of the Howard-Sheth Model, a prerequisite of purchase decision making is that costumers have knowledge of green buildings from the sales staffs that produce the information about the attributes of the product or brand. As a customer, among all information such as quality, price, distinctiveness, service and availability, quality and life cycle cost and benefits of green buildings are the most important aspects; for this research, they were considered as the input variables.

The, external factors included: gender, age, educational level and annual income, which also affect costumer's purchase decisions. Due to the complex impacts of input variables and external factors, the internal factors, which mainly deal with psychological variables (the cognition knowledge of green building and environmental protection awareness) are all involved in the purchase decision-making processes. The eight factors shown in Figure 1 were further developed in questionnaire survey to investigate consumer behaviour and acceptable cost of green buildings.
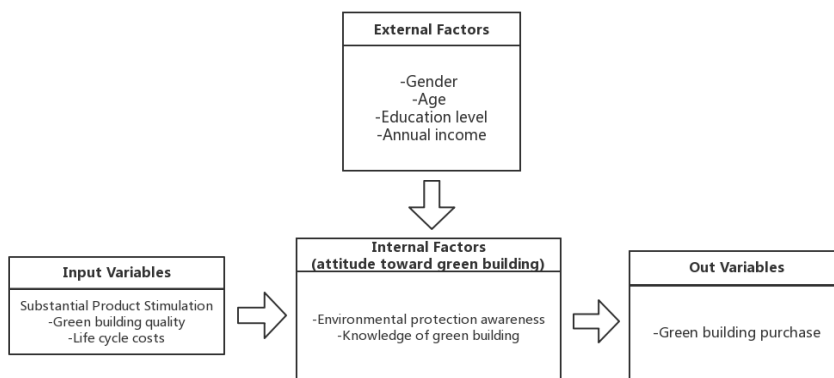

Figure 1. Application of Howard-Sheth Model

4.   QUESTIONNAIRE AND RESPONSES

4.1   Questionnaire survey design

This research was conducted by using random sampling survey. Shanxi citizens were selected as respondents, and they were randomly and voluntarily selected to complete the online questionnaire survey. After the first

questionnaire was developed the authors of this paper invited several people to fill in the questionnaire and to provide suggestions for improving the questionnaire. On the basis of their feedback, the questionnaire was revised. That version was used in the online questionnaire survey, which was shared by using the social software, called WeChat. A total of 491 valid responses were collected from June 27th to 28th, 2017. The average questionnaire answering time was 5 minutes 53 seconds. The number of people who successfully answered all questions accounted for 37% of the total number of visitors of the questionnaire site.

The questionnaire survey was divided into two parts. The first part included five questions for personal information, including age, gender, occupation, annual income and educational level. All these factors are likely to affect people's attitudes of green buildings. The second part, included twelve questions related to green buildings, mainly focused upon the respondent's knowledge about green buildings and their real attitudes about green buildings. They were asked to choose three categories they wish to have on the green building among the total six categories (shown in Table 1). The remainder of the questionnaire was focused on the incremental costs of technical measures of green buildings that not only bring economic returns but also help to protect the environment. The detailed data of incremental costs (Table 2) were listed for considering acceptance level of green buildings and the key factors that affect customers to choose green buildings.

4.2   Results of analyses of the questionnaire respondent's answers

The first four preliminary questions are about respondents' identity and about their personal message. Among the 491 responses, approximately 45% of respondents were between the ages of forty-one to fifty. Three 323 of the 491 respondents were female and 168 were male. For the annual income, the vast majority of respondents earned less than 100,000 yuan per year. There were more 76 respondents earn less than 200,000 yuan. Only five respondents earned more than 500,000 yuan/year, which stands for high income level. Therefore, high housing prices are or would be a burden for most of the respondents, not to mention that they should pay more money for the incremental cost of technical measures.

With regard to the respondent's educational level, the majority had obtained college degrees or above. Among all respondents, 55% of them heard about green buildings before and 45% did not. Hence, green buildings had been promoted and publicized but they still need more and perhaps different types of promotion. Most of respondents heard about green buildings from Internet. Other sources included work, media, education, radio programs, books and experiences of visiting a green building. Because only 2% of respondents heard about green buildings from realtors, education and policy support for land and built property agents are essential.

When respondents were asked to choose the definition of green buildings from three options, surprisingly, about 80% of respondents chose the right answer. There are perhaps two reasons. For those people who heard about green buildings before, the explanation of green buildings made an impression on them. Another reason was because the rudimentary knowledge of environmental protection helped them to choose the correct answer. After this question, an accurate explanation of green buildings was given. Then the respondents were questioned, now that you know more about the definition of

green buildings, do you wish to live in a green building? The data revealed that, 98% of them chose 'yes'. This indicates that people would love to and have enough enthusiasm to support environmental protection via investments in green buildings.

For those respondents who chose 'yes' for the last question, they were asked to choose three functions that must be fulfilled within a green building. The top two choices were water saving and energy saving (see Figure 2). In particular, the number of people who chose water saving is much more than the others. The reason for this selection may be due to the shortage of freshwater resources in Shanxi. Since water and energy saving could reduce their expenses directly, cost can be one of the factors that could affect respondent's choices for green buildings.
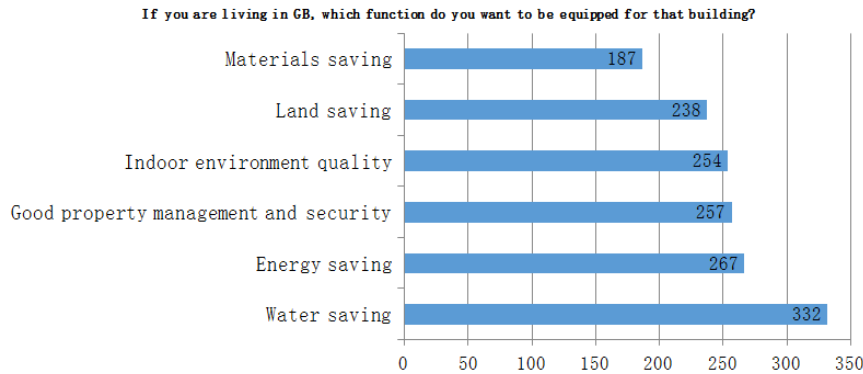
Figure 2. Respondents were asked choose three functions from all six categories

According to the six evaluation categories of green buildings, eight technical measures were listed and respondents were asked how much they were willing to pay for them (see Figure 3). There were approximately 100 respondents who were not willing to pay for the incremental costs of any of the technical measures. The price range that people were willing to pay was between 1-499 yuan. It was clear that WTP is sensitive to the costs. However, there were a few respondents who were willing to pay for technical measures with higher prices.
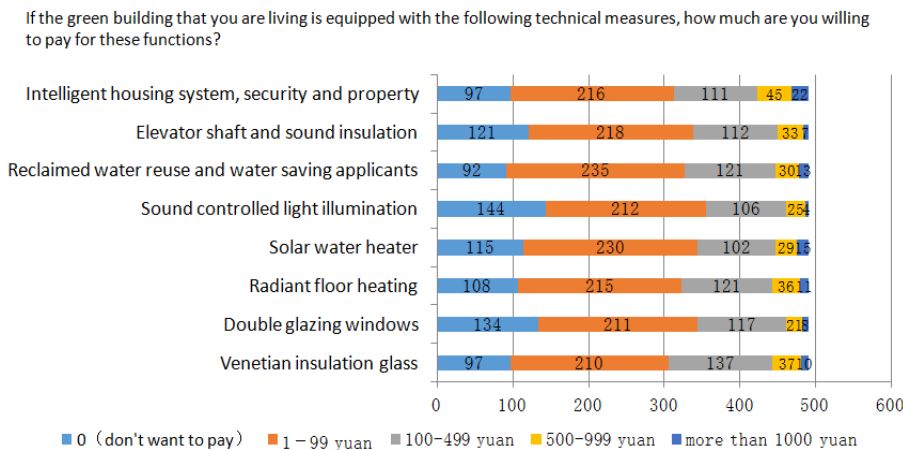
Figure 3. How much people are willing to pay for technical measures

After this, the exact price was given and the respondents were asked to decide whether they were still willing to pay for those technical measures. In the Figure 4, clearly the scope of the blue line (willing to pay) is bigger than the scope of green line (don't want to pay). Even for the technical measures with incremental costs higher than 500 yuan, about half of the respondents

who were willing to pay. Hence, the incremental costs of technical measures were affordable for those respondents, even if they may be reluctant.
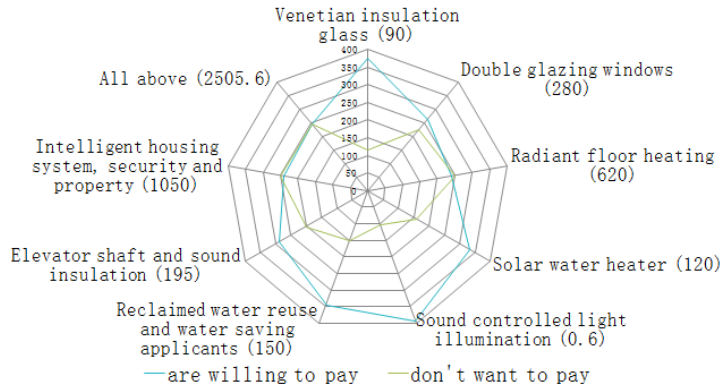
Figure 4. Number of people willing to pay (blue) vs not willing to pay (brown)

After the respondents were informed of the exact price for the technical measures, the last question was posed to them: "Do you want to live in a green building?" again. As shown in Figure 5, the number of respondents who chose "doesn't want to" increased by 72 respondents. For the respondents who wanted to live in a green building, the most common reason was "living in a green building could help to save energy and protect the environment" which is evidence of the respondents' environmental protection awareness (Figure 6). Hence, environmental awareness can potentially affect green building purchase decisions.
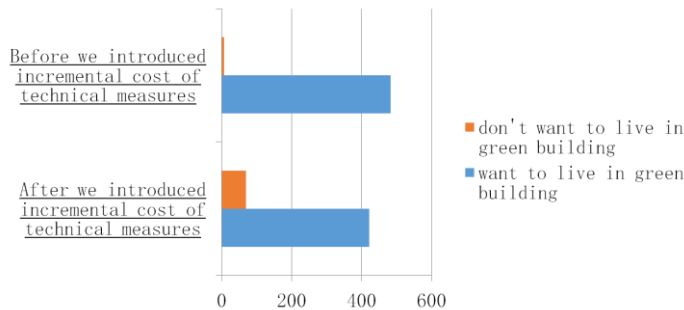
Figure 5. Comparison of the change in the quantity of respondents
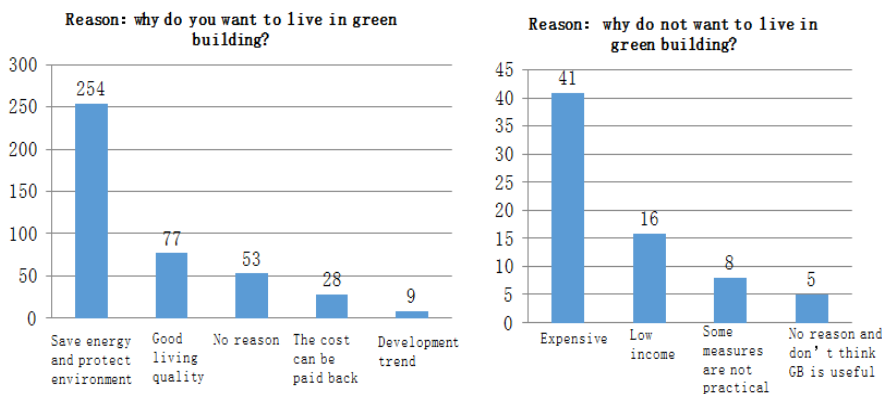
Figure 6. Reasons for respondents' choices

In conclusion, based on the questionnaire results and analysis, the income and environmental protection awareness, the knowledge of green buildings

and personal attributes, all affected the respondent's attitudes toward green building purchases. In order to confirm these initial conclusions, the authors of this paper performed the quantitative analysis presented in Section 5.

5.   QUANTITATIVE ANALYSIS AND RESULTS

5.1   Logistic regression analysis

Simple descriptive analyses provides researchers an overview of the variables but does not provide exact answers, hence statistical analyses are needed to verify whether the insights from the general observations are correct. Logistic regression is a probabilistic nonlinear regression model. It is a multivariate analysis method to study the relationships between nominal observations and influencing factors. Statistician D.R.Cox, developed this approach in 1958 as a statistical method; since then, it has been used widely in many fields, including medical and social sciences (Jin, Yan, & Zhu, 2015). With the advent of the information era, logistic regression is extensively used for many data mining applications. For example, credit risk models in the banking industry, customer preference models in retail, and for assessments of diverse segments of customers in all areas of business (Jin, Yan, & Zhu, 2015).

Based on the application of the Howard-Sheth Model for this research, except these four factors ("annual income", "gender", "whether people heard about green building before" and "environmental protection awareness"), we add more factors which be considered to influence respondents to choose green buildings. In the questionnaire, respondents were asked about the reasons they wanted to live in green buildings, by choosing their care level of good living environment, saving home expenses and high level, residential quality. It was essential to analyze whether their care level would affect their choice green buildings. In this study, logistic regression analysis was applied, with WTP of green buildings as the dependent variable, and the other seven factors as independent variables. The variables and results of the regression analysis are presented in Table 4. The significance of Omnibus Test of Model Coefficients was 0.007 and the results of use of the Hosmer and Lemeshow Test showed good model-fitting too. (The"B" refers to the partial regression coefficient). The analysis results showed that the regression coefficients of 'whether the respondent had heard about green buildings' and 'good environmental protection awareness' were 0.684 and 0.812, and the corresponding significance values were both less than 0.05. It means only these two factors had significant positive predictive decision-making impacts on the WTP of green buildings among the seven factors.

Table 4. Final fitting result of regression equation

	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
Annual income	-.168	.251	.446	1	.504	.846	.517	1.383
Gender	-.312	.288	1.171	1	.279	.732	.416	1.288
Whether heard about green building	.684	.280	5.948	1	.015	1.981	1.144	3.431
Caring about good living environment	.390	.307	1.619	1	.203	1.478	.810	2.696
Environmental protection awareness	.812	.355	5.244	1	.022	2.252	1.124	4.513
Caring about saving home expenses	-.350	.335	1.093	1	.296	.705	.366	1.358
Caring about the grade of the residential district	.066	.243	.074	1	.786	1.068	.664	1.720
Constant	-.610	.981	.386	1	.534	.543		

5.2   Cross tabulation analysis

A cross tabulation analysis was performed to learn whether annual income level would affect the respondent's WTP for the eight technical measures. In the light of the results, more than 80% of the respondents' annual income was less than 100,000. The questionnaire results in the previous part indicated that for these respondents, when incremental cost is less than 500 yuan, most of them were willing to pay. Even if the cost was higher than 500 yuan, still about 50% of them were willing to pay for the technical measures. On the contrary, for those respondents who earned more than 500,000 per year, there were only 40% of them who were willing to pay for the cheapest technical measure. However, for the most expensive technical measures (the intelligent housing system and the security of green buildings), all of them were willing to pay.

Desire, status and luxury have been explored for so many years. Veblen suggested the act of buying expensive things was a means for people to communicate their social status to others (Veblen, 1899). Purchasing expensive houses or luxury goods is an approach to flaunt their considerable wealth. These psychological factors coupled with the effect of annual income have brought about the above-mentioned proportions. However, how well the annual income affected the respondent's WTP must be analyzed further.

Here, the Chi square test, which is a very common hypothesis testing method, was used for testing the association between two categorical variables. Table 5 shows the Chi square independence test between annual income and WTP for incremental cost of technical measures. The results were opposite from the author's expectations; the Chi square test results were not significant (all p-values were more than 0.05). These results demonstrated that annual income and WTP for incremental costs of technical measures are independent of each other. However, even though, according to the Chi square test, there were no significant effects does not mean that there was no effect. Income more or less affected people's consumption behaviors. Whereas, income was not the most important barrier that make people refuse accept green buildings.

Table 5. Chi-Square test of whether annual income affects people's WTP

Green building technical measure (cost, Yuan per m2)	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Venetian insulation glass (90)	1.514[a]	3	.679	.734	.171	.049
Double glazing windows (280)	2.698[a]	3	.441	.456	.069	.021
Radiant floor heating (620)	2.496[a]	3	.476	.471	.196	.044
Solar water heater (120)	.837[a]	3	.841	.831	.507	.073
Sound controlled light illumination (0.6)	7.420[a]	3	.060	.055	.478	.083
Reclaimed water reuse and water saving applicants (150)	3.570[a]	3	.312	.305	.044	.016
Elevator shaft and sound insulation (195)	2.353[a]	3	.502	.516	.307	.059
Intelligent housing system, security and property (1050)	7.493[a]	3	.058	.050	.013	.005
All above (2505.6)	3.754[a]	3	.289	.299	.041	.013

5.3   Discussion

In accordance with questionnaire survey results, some assumptions were made based on the seven factors, and the quantitative analyses were performed, as stated in the last section, by using logistic regression analysis and cross tabulation analysis. The quantitative analysis results indicated that only "whether heard about green building" and "good environmental protection awareness" have significant impacts on WTP for green building purchases. Cross tabulation tests analyzed whether annual income affected respondent's WTP or not, for the incremental costs of technical measures. According to the respondent's answers, it is important to note that it may be the difficult to pay for both the housing and technical measures at the same time. This means that if someone wants to buy a one hundred square meter house, he/she needs to pay 250,560 yuan more for a green building than for an ordinary building. This may be a burden especially for respondents whose annual income is less than 100,000, although it could be paid back in the future. Possibly because of this, there were 72 respondents who changed their choices. However, for the last question, there were still about 85% of the respondents who chose green buildings. This suggests that although the higher initial costs are a burden for most respondents, the incremental costs were still affordable. Hence, low income actually was not a fundamental barrier for their potential investments in green buildings.

In regard to gender, the proportion of male and female respondents differed very little in regard to the proportions who were WTP or not WTP. For the educational level, as Coddington (1993) pointed out, higher income and more education would help to make people to have more tendency of green consumption. However, since many serious environmental problems are occurring in China and almost all Chinese are already concerned about environmental protection, our research results showed that education level was not a factor that affects people to choose green buildings. After all analysis of this research, the factors that affect people's WTP effectively are "knowledge related to green building" and "environmental protection building".

6. IMPLICATIONS, CONCLUSIONS AND RECOMMENDATIONS

In China, green building is a relatively new approach which helps to reduce pollution, energy wastage and to improve the health of the population. A number of improvements still need to be made. The most excellent green building could be traced back to the construction for the Beijing Olympic Games in 2008, which was mainly promoted by the government (Shi et al., 2013). Hence, the development of residential green buildings still need to be improved.

Analyses of the research results, revealed, that the factors that affected people's WTP to invest in green buildings was not income level but were more related to "knowledge related to green buildings" and "environmental protection awareness" in Shanxi Province.

The reasons for the small numbers of green buildings in Shanxi Province might be the lack of policies to promote green building construction. Government, industry association and enterprises should provide more support and guidance for construction and purchase of green buildings. In particular, government can play an increasingly pivotal role during the whole process, especially in the context of severe air pollution and the need to shift from the current societal system that is heavily dependent upon fossil-fuels to systems that are based upon renewable energy and improved energy efficiency.

Based on the questionnaire results, the authors of this paper propose that governments should expand their emphases upon green building in the following ways:

The government should promulgate relevant policies and laws to promote information dissemination about the urgent need for the transition to the Post-Fossil Carbon Society and that Green Buildings can be an integral part of the needed changes.

The government should provide policies and financial support to developers by establishing tax incentive measures, deficit subsidies, financial discounts, pre-tax loans and other methods to encourage them to become effective in planning and construction of green buildings.

The government should provide financial measures to stabilize the housing prices, and thereby reducing financial burdens for citizens to invest in the environmentally friendlier green buildings.

Government should encourage more enterprise and industrial construction to invest to green buildings by simplifying evaluation procedures and by reducing the evaluation fees.

Based upon the high WTP for green buildings found in this research, the authors suggest that governments may consider imposing certain green building standards on all new constructions. By using mandatory green building requirements, the evaluation procedure could be simplified and there will be no need to apply for the certification. Such measures can benefit the community with reduced prices for green buildings.

Greater environmental protection awareness could increase the focus on green consumption. The quantitative analysis result of this research found that expanded emphasis upon environmental education for citizen to enhance environmental protection awareness is an essential approach to affect people's WTP for green buildings.

There are 17 green building standards at the national level and more than 50 standards at the province level, which often cause confusion for industries

and citizens in general and for associations and enterprises, in particular, because standards are slightly different (Ye et al., 2015). For instance, in Taiyuan city, the capital city of Shanxi province, the evaluation standard for green building evaluations is known as DBJ04-255-2007. In its preface, there is a saying that "The principle of this standard is the localization of the national green building evaluation standard for construction (GB/T50378-2014). Some of the indexes have been embodied and extended." Hence there is the possibility that the same building gets different evaluation results depending upon how the evaluations are performed. Additionally, the developers may choose the more beneficial evaluation approach to obtain more benefits. Therefore, it is necessary to promulgate relevant laws and to unify the evaluation standard. In addition, simplifying the evaluation procedure to create easy and transparent accreditation is urgently needed.

The questionnaire adopted in this research was distributed by the authors by using a social media called WeChat, and asked their friends to fill in it voluntarily. Therefore, the problem remains that whether this sampling properly represents the Shanxi Province people. Further research is needed to overcome this limitation. Moreover, similar, comparative research should be done in developed regions to provide a more solid foundation to find solid answers to the author's research questions.

The results of this research illustrate one way of exploring the WTP, and the results represent at least a part of Shanxi people's attitude towards green building which indicated a high acceptance of green buildings. This finding deserves further research from relevant stakeholders throughout all provinces of China and in other countries.

REFERENCES

Amecke, H., Deason, J., Hobbs, A., Novikova, A., Yang, X., & Zhang, S. (2013). "Buildings Energy Efficiency in China, Germany, and the United States". *Climate Policy Initiative*. Retrieved from https://climatepolicyinitiative.org/wp-content/uploads/2013/04/Buildings-Energy-Efficiency-in-China-Germany-and-the-United-States.pdf.

Berkeley Earth. (2015). "Air Pollution Overview". Retrieved from http://berkeleyearth.org/air-pollution-overview/ on September 17,2017.

Chinese Green Building Evaluation Label. (2017). "Statistics of National Green Building Label". Retrieved from http://www.cngb.org.cn/index.action?sid=402888b74f68e52e014f696c7643000c on September 15, 2017.

Coddington, W. (1993). *Environmental Marketing: Positive Strategies for Reaching the Green Consumer.* . New York, NY: McGraw-Hill.

de Medeiros, J. F., Ribeiro, J. L. D., & Cortimiglia, M. N. (2016). "Influence of Perceived Value on Purchasing Decisions of Green Products in Brazil". *Journal of Cleaner Production*, *110*, 158-169.

Dwaikat, L. N., & Ali, K. N. (2016). "Green Buildings Cost Premium: A Review of Empirical Evidence". *Energy and Buildings*, *110*, 396-403.

Horton, R. L. (1984). *Buyer Behavior: A Decision-Making Approach.* Columbus, OH: Merrill Publishing Company.

Jin, R., Yan, F., & Zhu, J. (2015). "Application of Logistic Regression Model in an Epidemiological Study". *Science Journal of Applied Mathematics and Statistics*, *3*(5), 225-229.

Juan, Y., Hsu, Y., & Xie, X. (2017). "Identifying Customer Behavioral Factors and Price Premiums of Green Building Purchasing". *Industrial Marketing Management*, *64*, 36-43.

Mo, L., Chen, M., & Huan, Y. (2013). "A Brief Talk on the Current Situation and Development Trend of Green Building in China". *Sichuan Building Materials*, *39*(5), 5-7.

Prasad, R. K., & Jha, M. K. (2014). "Consumer Buying Decisions Models: A Descriptive Study". *International Journal of Innovation and Applied Studies*, *6*(3), 335-351.

Shi, Q., Zuo, J., Huang, R., Huang, J., & Pullen, S. (2013). "Identifying the Critical Factors for Green Construction–an Empirical Study in China". *Habitat International*, *40*, 1-8.

Shuai, C.-M., Ding, L.-P., Zhang, Y.-K., Guo, Q., & Shuai, J. (2014). "How Consumers Are Willing to Pay for Low-Carbon Products?–Results from a Carbon-Labeling Scenario Experiment in China". *Journal of Cleaner Production*, *83*, 366-373.

Sun, C., Yuan, X., & Xu, M. (2016). "The Public Perceptions and Willingness to Pay: From the Perspective of the Smog Crisis in China". *Journal of Cleaner Production*, *112*, 1635-1644.

Sun, D. M., Yuan, L., Li, J., & Cheng, K. (2008). "Investigation and Analysis on Construction Cost of Green Building in China". Retrieved from https://wenku.baidu.com/view/a1102709763231126edb11da.html?from=search on September 15, 2017.

U.S. Green Building Council. (2016). "What Is Leed". Retrieved from https://www.usgbc.org/help/what-leed.

US EPA. (2016). "Green Building". Retrieved from https://archive.epa.gov/greenbuilding/web/html/about.html on September 15, 2017.

Veblen, T. (1899). "Excerpt from the Theory of the Leisure Class". *Dictionary of American History.* Retrieved from http://www.encyclopedia.com/history/dictionaries-thesauruses-pictures-and-press-releases/excerpt-theory-leisure-class-1899-thorstein-veblen on September 15, 2017.

Ye, L., Cheng, Z., Wang, Q., Lin, W., & Ren, F. (2013). "Overview on Green Building Label in China". *Renewable Energy*, *53*, 220-229.

Zhang, Y., Wang, J., Hu, F., & Wang, Y. (2017). "Comparison of Evaluation Standards for Green Building in China, Britain, United States". *Renewable and Sustainable Energy Reviews*, *68*, 262-271.

Zuo, J., & Zhao, Z.-Y. (2014). "Green Building Research–Current Status and Future Agenda: A Review". *Renewable and Sustainable Energy Reviews*, *30*, 271-281.

Soft Power of Chinese Cities: Factors that Attract International Students to Study in Changchun City

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Abstract: More and more international students come to China for higher education, and their host cities become key platforms for demonstrating China's image and soft power. So far, many studies have analysed international students' language learning and cultural adaptation, however, very few focus on what factors attract international students to certain Chinese cities instead of others. This study aims to determine the key factors attracting international students to study in Changchun, a city in northeast China, from a qualitative approach. The authors apply both survey questionnaires and in-depth interviews to obtain insights and determine the underlying reasons influencing their selection. Results from a total of 190 questionnaires and 59 interviews are collected for analysis. The results indicate that certain factors, including economic factors, such as the cost of living and scholarships, political factors, such as government coordination, and sociological factors, such as religious tolerance, play dominating roles in their decision-making process. Additionally, the discussion and policy recommendations of each section offer useful insights for policy-makers for attracting and accommodating international visitors to cities like Changchun.

1.   INTRODUCTION

Changchun, the capital city of Jilin Province, is located in north-eastern China with a metropolitan area of 4,789 square kilometres and a population of 7.54 million (Changchun Municipal Government, 2017). Changchun city is regarded as China's cradle of movies, automobiles, optical instruments, pharmaceutical drugs and railway vehicles. Besides this, Changchun is also known as "the Forest City" and "the Science, Culture and Education City", and was awarded "China's Happiest City" from 2003 to 2013 (Antonicelli & Roman, 2014).

Historically, Changchun was taken over by Communists in October 1948 and, after a three-year recovery, the government began construction and various movements in order to rebrand Changchun as an industrial city. The Commission of the First Five-Year Plan (FYP) selected the outskirts of Changchun for the site of the First Automobile Works (FAW) (Liu & Wang, 2012), and it has since transformed the city into an industrial base. During

operation of the FAW, many grand industrial projects were built in the city and yielded profound achievements.

Currently, although beset by the economic slowdown and outbound migration, Changchun is still significant to north-eastern China. Under the guidance of the National Congress of the 18th Communist Party of China, Changchun has decided to pursue the revitalization of Jilin Province. Additionally, Changchun is also aiming to develop itself into a central, core city in Northeast Asia by building a wealthy society (Jilin Provincial Network, 2017). The municipal government of Changchun has also developed a six-part master plan that focuses more on hard power and economic fields to facilitate this goal (Changchun City News, 2017).

One equally important aspect is the soft power of a city, which is often neglected, but has gained more attention in recent years. The concept of soft power was originally developed by professor Joseph Nye of Harvard University, which, applied to international relations, describes the ability of actors to persuade and attract other parties towards certain goals, in place of more coercive, forceful measures. Soft power entails aspects of culture, political values, foreign policies, etc. that could influence foreign populations and actors. In this paper, soft power refers to any means of increasing a city's international influence or reputation, however, it is not our intention or purpose to offer a specific definition or discuss the legality of this terminology.

As China has become the second largest destination for international students, Chinese cities are the main platforms for attracting them to particular destinations and local hosts. However, north-eastern Chinese cities, with Changchun city as a typical example, are less attractive than "tier-one" cities or major eastern coastal cities. Although Changchun has received a large number of international students compared to the greater Jilin Province, or even the whole north-eastern region, it is still far less internationally recognised than cities like Beijing, Shanghai, Guangzhou and Shenzhen (BSGS).

This paper attempts to determine the major factors and underlying reasons international students choose Changchun for their studies. The main approach is through surveys and interviews with the international students studying at Jilin University. Through analysis of the results, a number of policy recommendations are offered that could improve Changchun city's international attractiveness and image. This could also shed new light on other regions' major central cities' international exposure in terms of policy, governance and management, and eventually contribute to China's grand strategy of boosting its soft power in general (Xi, 2017).

The remainder of this paper is arranged as follows: Section 2 reviews the relevant literature regarding factors that influence students' selection of overseas study destinations; Section 3 describes the methods for factor selection, survey questionnaire design and interview, as well as how the data is collected and analysed; Section 4 illustrates the analysis results and policy recommendations based on the analysis; and Section 5 brings a concluding remark to this study and points to potential directions for further study.

2.   LITERATURE REVIEW

There is abundant literature on the factors that influence students' selection of overseas study destinations. Most of these studies analysed the "pulling" or "pushing" factors for non-native English speaking students studying in English speaking countries, such as the UK, Canada, the US, New Zealand

and Australia (Phang, 2012). There are a few studies addressing international students studying in China, but mainly these are focused on educational disciplines. For example, Yu, Baohua (2008) studied the language acquisition and cultural adaptations of international students studying Chinese in China; Sumra (2012) analysed the faculty and staff perspectives on the problems that international students face in Beijing; Yu, Bin et al. (2014) examined the factors that lead to international students' accumulative stress levels at universities in Wuhan city. There is no study analysing why international students come to a particular city in China and their underlying reasons for doing so. Therefore, it is necessary to understand what factors influence their selection so that more cities in the less developed regions of China can develop policies to attract foreign students and the potential benefits they can bring.

When it comes to the students' selection of overseas study destinations, Chapman (1986) applied the consumer behaviour theory to explain their rationales. Three models explaining student choice were summarized by Ivy (2010) (cited in Phang, 2012, p. 14), namely, the economic, sociological, and information processing models: the economic model of student choice emphasises cost-related aspects; the sociological model of student choice emphasises issues like family influence, personal motivation and ability, as well as other influences; the information processing model combines both the economic and sociological model to determine the decision-making and selection process of students.

Two clusters of "push" and "pull" factors are identified as influencing international students' decisions (Mazzarol & Soutar, 2002; McMahon, 1992). Phang (2012) compiled a list of major influencing factors based on previous studies carried out by scholars across multiple countries. A total of 22 factors have been summarised based on Phang's review, addressing various aspects such as economic, social, political and cultural factors. It was observed that factors such as "education access", "career prospects", "costs", "culture", "environment", "family/network influence", "reputation", "competence", and "language (English)" are frequently mentioned, reflecting the common concerns for students going overseas for higher education.

However, there is an overlap between a number of factors and due to the lack of any specific definitions and the different circumstances under which these studies were conducted, it is less appropriate to use these factors directly. Therefore, a further screening and selection of these factors are needed before using them as inputs for survey design. Local conditions must also be considered as important criteria for factor selection.

3.   METHODOLOGY

Three major steps were followed in conducting this research: first, to screen and select accurate indicators, a group discussion with international students was conducted, based on which, a number of indicators were selected and finalised for survey questionnaires; second, a questionnaire was designed based on the previous inputs, and distributed to the target respondents in the form of closed-ended, self-administered surveys. After this, a total of 59 in-depth interviews were conducted to obtain qualitative insights and underlying reasons that influenced their choices; third, both survey data and interview content were collated. These are analysed for interpretation and discussion and a number of policy recommendations are proposed accordingly (refer to Figure 1).
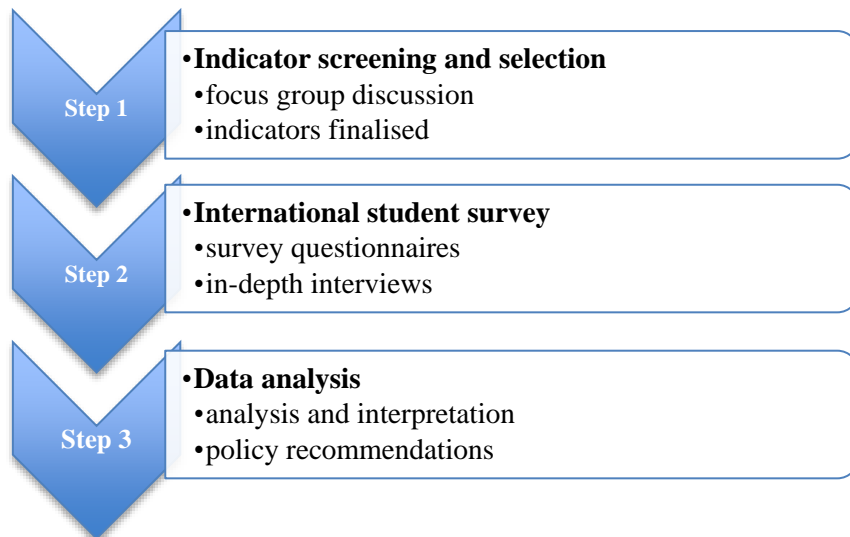
Figure 1. Reseach design: A three-step appraoch

3.1 Focus-group discussion

The study began with a discussion with 15 international students. The discussion aimed to discover the most relevant factors that led to their selection of Changchun as a study destination. These factors are then categorised and used in the survey questionnaire for quantitative analysis. These 15 students are in postgraduate courses at Jilin University. All of their answers are recorded and transcribed for content analysis and referenced for indicator selection. Table 1 entails a basic profile of the group members.

Table 1. Basic profile of the focus group members

Country	Gender	Student Description
Indonesia: 2 students	M (1) F (1)	Both have work experience, educational and official backgrounds, and will resume work after studying.
Ghana: 5 students	M (4) F (1)	All have work experience and governmental job backgrounds from different sectors. One male is a PhD student. They will all resume work after studying.
Russia: 2 students	F (2)	Both have part-time work experience, no job positions at home, and plan to work in China.
The Philippines: 1 student	F (1)	Has rich work experience, especially with ASEAN, and will resume their previous position after studying.
Laos: 1 student	F (1)	No working experience, Diplomat's child, no plan yet after studying.
Vietnam: 1 student	M (1)	Two years of work experience, business sector background, and no job planned after studying.
Venezuela: 1 student	F (1)	Years of work experience, worked as a diplomat, and will resume the position after studying.
Zimbabwe: 2 students	M (2)	Years of work experience, worked as government officials, and will resume work after studying.

Note: F – Female, M – Male, (#) denotes quantity of students.

As can be seen from the above table, these international students come from different continents and various work backgrounds. Most of them have governmental backgrounds. A few of them are fresh college graduates who came to Changchun to study immediately afterwards. During the discussion, they were asked why they chose Changchun as their study destination and the factors that influenced their decisions. They were also asked for suggestions

to make Changchun more attractive internationally, and their answers are integrated in the later questionnaire data analysis and policy recommendations.

Based on the discussion, a total of 15 influencing factors have been identified and finalized according to relevance and applicability. Despite some overlap, these factors can be categorized in three ways, namely, "Economic Factors", "Sociological Factors", and "Political Factors" (refer to Table 2 for details). These indicators are then used for the question design of the survey.

Table 2. Finalised factors that influenced international students' choice to study in Changchun

Economic Factors	Sociological Factors	Political Factors
Scholarship *(Including financial incentives like financial aid or loans)*	**Climate** *(Local climate and natural environment)*	**Government coordination** *(Government allocation and suggestions mandated by scholarship)*
Tuitions *(Local institute's tuition fees)*	**Host hospitality** *(Hospitality and accommodation of local host/institutes)*	**International reputation** *(Local city/host's international reputation)*
Living cost *(Local living costs)*	**Quality of Life** *(Local living conditions and quality of life)*	**Alumni recommendation** *(Recommendations from local city/host's alumni networks)*
Part-time job *(Local availability for doing part-time jobs during study)*	**Religious tolerance** *(Local tolerance towards their religion and cultures)*	**Geo-political proximity** *(Advantages of local city's geo-political proximity towards other regions)*
Employment *(Local opportunities for seeking full-time employment after graduation)*	**Curriculum** *(Local institute's provided curriculum, courses and programmes)*	**International access** *(Local city's access to various international resources)*

3.2   Survey and question design

The questionnaire consists of four major sections. The first section asks for general information from the respondents, such as their country of origin, gender, education level, and whether they had heard about Changchun city before. The next three sections are based on the previous summarised three categories (economic, sociological and political), each of which consists of five corresponding questions. Using the Likert Scale, the respondents are asked to give their opinions on the provided question by choosing from five options of "*Strongly Agree*", "*Agree*", "*Neutral*", "*Disagree*", "*Strongly Disagree*".

Next, the full questionnaire is transferred to a cloud-based software (SOJUMP or "Wenjuanxing" in Chinese) and output as an online self-administered survey for distribution. Due to the time constraints of holidays, the target respondents were surveyed via WeChat, and this software was designated particularly for this purpose. According to the international student office of Jilin University, between 250 to 300 international students graduate from Jilin University each year, so an estimate of 275 is taken as the intended respondent number. Over two weeks, a total of 190 valid survey results were obtained, reaching a response rate of over 69%, which is considered significant for valid analysis and conclusions.

3.3   In-depth Interviews

To obtain more qualitative insights, in-depth interviews were then conducted. Students were asked why they chose Changchun as their study destination instead of other Chinese cities, what facilitated their decisions, as well as asked for their evaluation and suggestions for making Changchun more internationally attractive. A total of 59 valid, in-depth interviews were conducted, with most of the conversations recorded upon consent and transcribed by student assistants (refer to Appendix for the list of interviewed international students) for later analysis.

3.4   Data analysis

The contents of the survey and interview results were then qualitatively analysed. No statistical analysis is applied due to the nature of these surveys. Combining the inputs from the interviews, the underlying reasons are summarised and the possible reasons that led to these results is discussed. Next, suggestions for policy recommendations are proposed for improving the identified issues, with the aim of increasing and enhancing Changchun city's attractiveness to international students.

4.   FINDINGS AND POLICY RECOMMENDATIONS

4.1   General information from respondents

As shown in Figure 2, there are a total of 190 valid results obtained. Among the respondents, about 60%[1] are male and 40% are female. Most of them are in post-graduate courses, with almost half (49%) of them Master's students and one third (33%) of them PhD students. This indicates that, currently, most international students in Changchun are coming for post-graduate studies, and comparatively fewer of them are starting at undergraduate level.
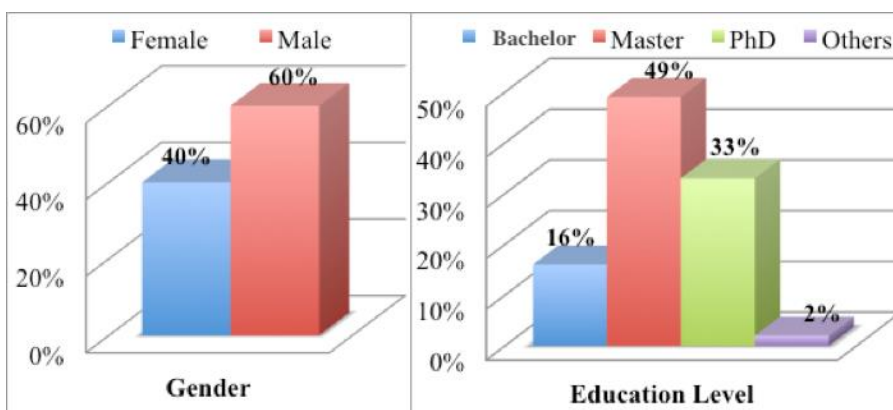
Figure 1. Gender and education level of the respondents (n =190)

More than half (54%) of the responding international students had not heard of Changchun city before they came (in Figure 3), which indicates that Changchun is comparatively less well-known overseas. This also reveals a

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[1] The percentage has been rounded up with no decimal for the purpose of easier comprehension, and the exact percentage of each can be seen from Table 3 to Table 5.

problem with Chinese cities' international exposure in that cities such as Changchun are not competitive with the internationally renowned ones like Beijing, Shanghai, Guangdong, and Shenzhen. This suggests branding the city and promoting its identity to an international audience could raise the city's profile overseas.

Additionally, the majority (81%) of the students are scholarship recipients, sponsored by different governmental bodies (i.e. Chinese Ministry of Education or Chinese Ministry of Commerce), while merely one fifth (19%) of them are self-financed. This suggests that unlike the US or the UK, China still devotes large funds to attract international students.
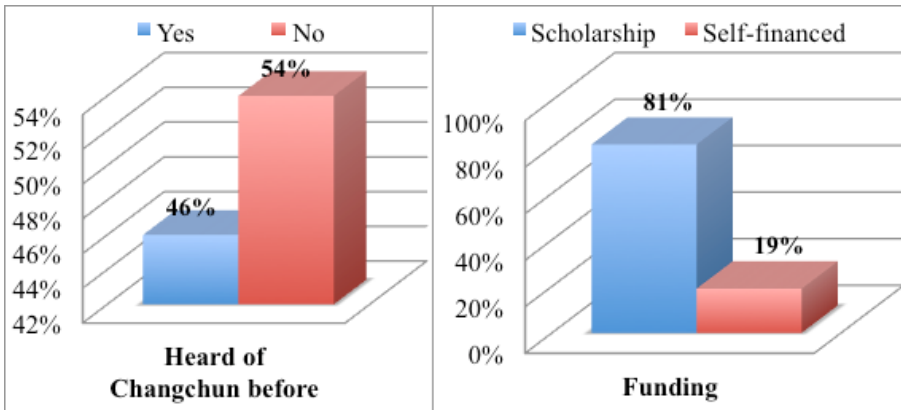
Figure 2. General information of the survey respondents (n = 190)

4.2   Economic Factors

There are five economic factors examined in this section of the survey, namely, "scholarship", "tuition fees", "living cost", "part-time job", and "employment", as shown in Figure 4 (refer to Table 3 for the detailed percentages of each factor). A dominating 75% of the respondents agree with the notion that scholarships or other financial incentives are the major influencing factor for their selection of Changchun as a study destination. This result confirms the common notion that financial incentive plays a key role in their decision-making process.

Figure 3. Economic factors survey results (n = 190)

Table 3. Individual Survey Results for Economic Factors (n = 190)

Item	Strongly Agree	Agree	Neural	Disagree	Strongly Disagree
Scholarship	31.1%	44.2%	17.9%	2.6%	4.2%
Tuition fees	16.8%	42.1%	34.7%	6.3%	0.0%
Living cost	61.1%	33.7%	2.1%	3.2%	0.0%
Part-time job	11.6%	17.9%	32.6%	24.2%	13.7%
Employment	12.6%	21.1%	43.2%	17.9%	5.3%

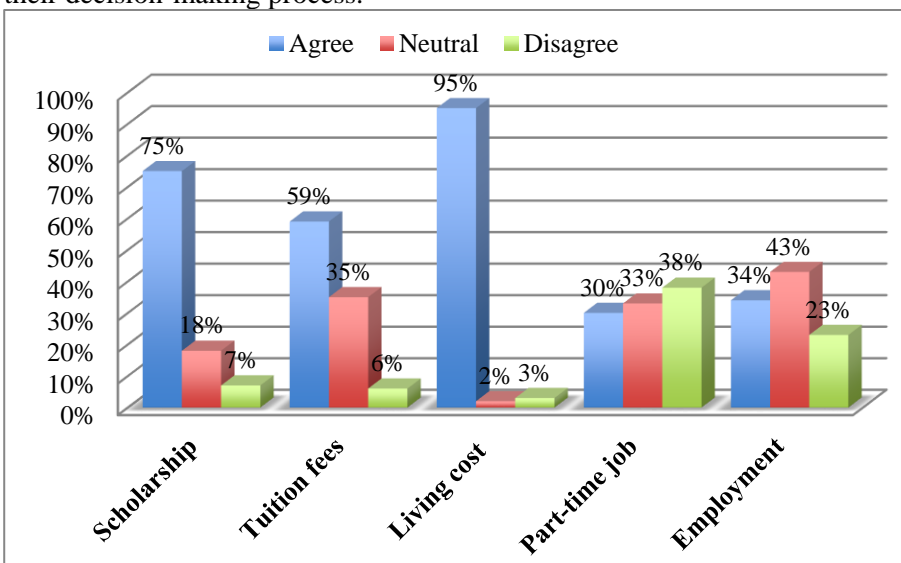Slightly more than half of the respondents (59%) agree that local tuition fees are an important factor for choosing Changchun for their studies. This is mainly because of the largely standardized Chinese public university tuition fees, which do not vary much between different cities. Top Chinese universities not only charge standard tuition fees, which are heavily subsidized by the Chinese government, but they also have opportunities for various scholarships, particularly for overseas students who want to study in China. Therefore, the local institutions' tuition fees are comparatively less restrictive.

Local living cost receives the largest share of agreement, with only a very small percentage of the respondents thinking otherwise (3% disagree or strongly disagree). It is concluded from this that the local living cost is the most important or most influential. It reveals that for cities like Changchun to be more internationally attractive, the local affordability is a selling point for international branding.

Opinions vary most regarding the other economic factors, namely, part-time jobs and employment. More respondents (Neutral – 33%, Disagree – 38%) do not think access to part-time jobs helped them in choosing Changchun as a study destination. There are similar results for the employment factor, with less than one third (34%) in agreement. As is shown previously, the majority of these students have job positions back home and intend to resume work after their studies in China. Another possible reason is that they see fewer opportunities for working in Changchun after graduation due to various sociological barriers, such as language, culture or religion, which was mentioned in some of the interviews.

4.2.1   Summary and policy recommendations

For the five listed economic factors, living costs and scholarships are the most influential factors for international students to consider. Tuition fees are important, but not as determining or influential as the previous two factors, as indicated by the data results. The other two factors, part-time jobs and employment, weigh significantly less in comparison, suggesting that the international students might find less motivation from these two aspects in their decision-making process.

There are a number of reasons for this: many government scholarship recipients are required not to take any additional part-time work; access to proper part-time jobs for them is limited for multiple reasons, such as the language barrier, and ethnic and religious concerns; similar reasons could also explain their lack of motivation in seeking employment in Changchun after graduation. Therefore, addressing these two aspects could increase Changchun city's international attractiveness.

Based on the analysis, the authors put forward the following policy recommendations to increase Changchun's international attractiveness for overseas students:

- Promote international branding of Changchun as an affordable city with low living costs and a good quality of life;
- Continue financial incentives, such as government scholarships and other forms of financial aid or student loans; and
- Improve access to part-time jobs and employment opportunities after graduation, making Changchun city more competitive in attracting international talent to settle in the city.

4.3   Sociological factors

This section examines the influence of five sociological factors, "climate", "host hospitality", "quality of life", "religious tolerance" and "curriculum" (as are shown in Figure 5). Less than half (47%) of the respondents consider "climate" as a major influencing factor in coming to this city (refer to Table 4 for detailed percentages of each factor). Although Changchun is literally translated as "ever spring" in English, some of the interviewed students, particularly those from Southeast Asian or African countries, find it too cold in winter. Despite the initial excitement during their first few encounters with snowfall, the harsh cold does present some challenges to those who are not accustomed to such temperatures. It can be concluded that local climate does affect students to a certain extent.
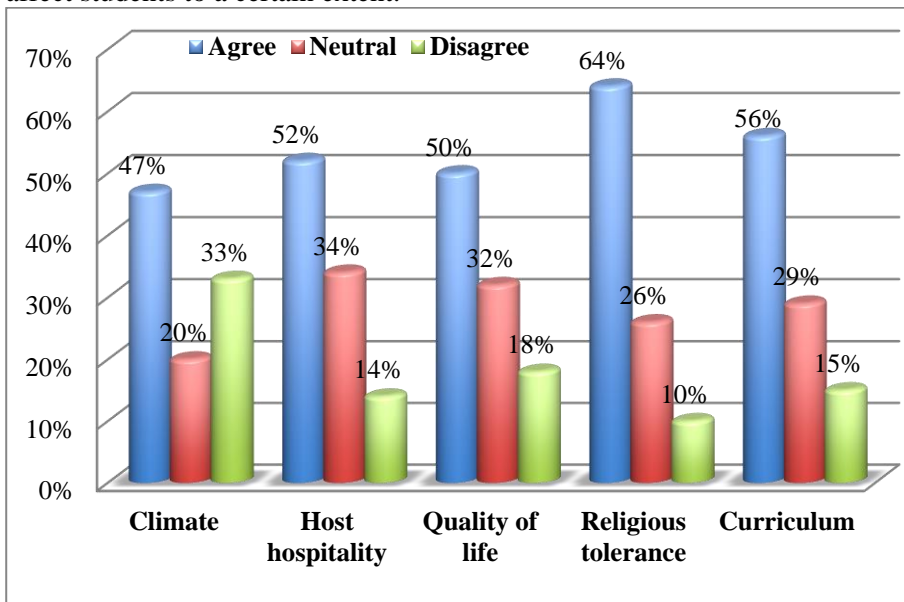
Figure 4. Sociological factors survey results (n = 190)

Table 4. Individual Survey Results for Sociological Factors

Item	Strongly Agree	Agree	Neural	Disagree	Strongly Disagree
Climate	15.8%	30.5%	20.0%	27.4%	6.3%
Host hospitality	18.9%	32.6%	33.7%	12.6%	2.1%
Quality of life	14.7%	34.7%	31.6%	16.8%	2.1%
Religious tolerance	23.3%	41.1%	25.6%	6.7%	3.3%
Curriculum	10.5%	45.3%	29.5%	11.6%	3.2%

Changchun city has been selected as "the most accommodating Chinese city" for seven years in a row, indicating the city's hospitality towards its residents and visitors (Antonicelli & Roman, 2014). The survey result for host hospitality consolidates this impression with slightly more than half (52%) of the respondents in agreement. This suggests that their local hosts or institutes

are sufficiently caring and accommodating. There is, of course, room for improvement as nearly half of them do not hold strong affirmative opinions.

As the capital of Jilin province, Changchun's living expenses and housing prices are lower than Tier 1 cities like BSGS, which makes it more affordable. In terms of quality of life, half (50%) of the respondents agree that Changchun's living quality is attractive. Different from the local cost factor in the economic domain, their definitions of quality of life are influenced not only by living costs, but a number of other reasons, such as religion, ethnicity, culture, and habits. This is why there is a considerable percentage gap between these two factors.

Another major influential factor reflected in this part of the survey is religious acceptance, which received the highest share (61%) of affirmative votes amongst the five factors in this section. This result shows the importance of religion for the majority of international students coming to study in China. Changchun is a multi-racial city due to geo-historical reasons, Han being the major ethnic group, with multiple large minority groups, such as Korean and Manchu; this possibly contributes to a more racially and religiously tolerant culture. Changchun should embrace and enhance this local feature and competitive edge.

Regarding the curriculum, or courses offered in their host institute, more than half (56%) of the respondents agree with its importance in their selection. This indicates, to some extent, that good curriculums would indeed attract certain groups of students. Jilin University, as China's largest university with the most disciplines and schools, could contribute to offering such incentives to an international audience.

4.3.1   Summary and policy recommendations

Generally speaking, all five factors in this part of the survey influence students' selection. Religious tolerance remains one of the most influencing factors suggested by the survey result. Climate could potentially become a pushing factor that hinders or concerns certain groups of international students. Local hospitality, quality of life and the curriculum play a certain positive role in influencing their selections.

The influence from weather and regional climate in Changchun is not as relevant to policy-makers, however, it can be used as an advantage particularly for those students from tropical areas who have never experienced snow. Many of the African and Southeast Asian students were excited to first experience snow in Changchun, but less so through the peak of a harsh winter season. Of course, more can be done to enhance the already positively received local hospitality, particularly regarding the religious aspects, as suggested during some of the interviews.

Based on the survey results and interview contents, a number of policy recommendations could be amended or proposed:

- Repackage Changchun's local climate features as selling points or make it appealing to certain groups of international students;
- Continue strengthening the local hospitality and liveability at home and on campus, and build feature slogans for promoting Changchun city; and
- Create a more culturally accepting, religiously tolerant atmosphere and living conditions to accommodate international students with diverse cultural, religious and ethnic backgrounds, to make

Changchun not only the most hospitable city for domestic residents, but also for international visitors, both short-term and long-term.

4.4   Political factors

The five sociological factors included in this session are "government coordination", "international reputation", "alumni recommendation", "geo-political proximity" and "international access" (refer to Table 2 for detailed descriptions of each factor). It is clear that the most influential factor is the government coordination, with the highest votes of 70% in this group. The other four factors are considered by the respondents as "less important" since none of them received more than 50% of the affirmative votes, as is indicated in Figure 6 (refer to Table 5 for detailed percentages of each factor).
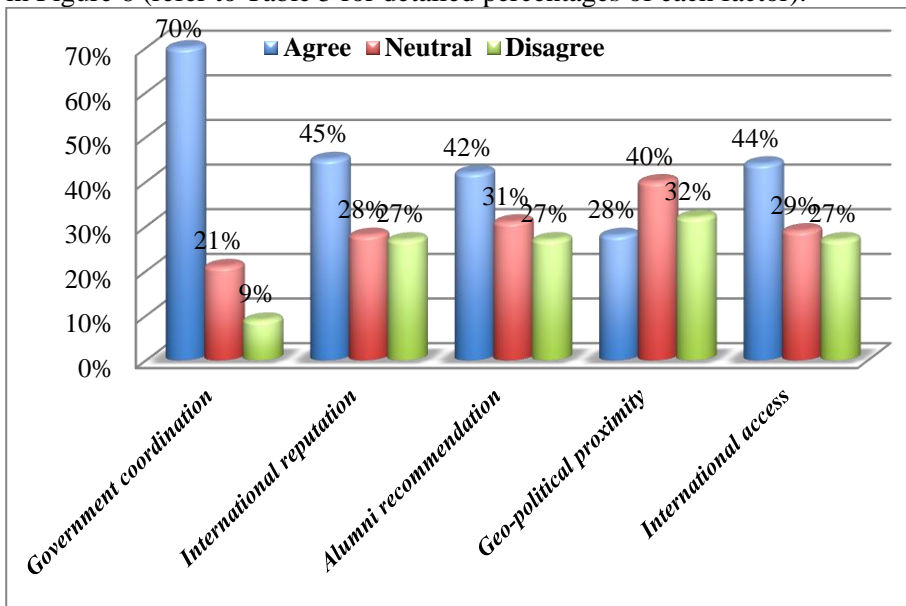

Figure 5. Political factors survey results (n = 190)

Table 5. Individual Survey Results for Political Factors

Item	Strongly Agree	Agree	Neural	Disagree	Strongly Disagree
Government coordination	23.2%	46.8%	21.1%	7.9%	1.1%
International reputation	7.4%	36.8%	28.4%	18.9%	8.4%
Alumni recommendation	12.6%	29.5%	30.5%	23.2%	4.2%
Geo-political proximity	7.4%	21.1%	40.0%	23.2%	8.4%
International access	10.5%	32.6%	29.5%	23.2%	4.2%

As mandated by the Chinese government scholarship providers (such as the Ministry of Education (MoE) or Ministry of Commerce (MoC)), international students are asked to register for their desired institutes and locations, which might not always guarantee their selection. Many of the non-BSGS cities are lesser-known to those who have never set foot in China before. Therefore, government coordination became one the determining factors in the selection of Changchun city. According to some of the students, they had never heard of Changchun before their scholarship sponsors sent them to Jilin University. If not for the scholarship, they would likely have gone to cities

like BSGS or other internationally renowned cities. This confirms the role of governmental administration in resource allocation to cities like Changchun.

In contrast to the previous question, although more respondents (44%) agree that international reputation plays a key role in attracting them than those who disagree (26%), the affirmative rate does not surpass the 50% benchmark for a majority. This again reflects the fact that cities like Changchun are less competitive when compared to those more internationally renowned cities, suggesting the necessity for Changchun to extend its overseas influence and reputation.

Slightly more than one third (42%) of the surveyed students agree that the host institute's alumni or network recommended them to study in Changchun. This, on the one hand, strengthens the previous notion of Changchun city's lower international recognition; on the other hand, it indicates a possible lack of endorsement from graduates of institutes in Changchun, and possibly China. From a broader perspective, this also reflects the state of China's soft power in general. While the Chinese government has made continued effort to improve its international image and soft power, the results may not yet have followed.

Another obstacle or disadvantage that impairs Changchun's international attractiveness is the geo-political proximity factor. Less than one-third (28%) of the respondents consider it influential for their choices; however, for some groups, such as the South Korean, Japanese or Russian students, Changchun is a good place to study due to his geographical proximity. This, in turn, could be an advantage for Changchun if marketed properly.

Following this, more students agree (43%) that Changchun provides more access to international connections than those who disagree (27%). One possible explanation is that most of the international students are embedded within international communities through their classrooms, dormitories or student groups. They have high exposure to their peers from other countries, but relatively less exposure to their Chinese peers. Some of the interviewed students said they spent some time with a few Chinese language volunteers, but comparatively little with Chinese graduate students. This is both good and bad news for the administration when designing their study and living configuration. More interaction with local Chinese communities would give students more opportunities to develop a positive impression of Changchun city and Chinese people.

4.4.1   Summary and policy recommendations

From this section of the survey results, it can be concluded that government coordination is the most influential factor determining the choice of Changchun city. Other factors did not have as much influence over its attractiveness, and, in some cases, they led to concerns or obstacles that had the opposite effect. Therefore, several policy recommendations are proposed based on this part of the analysis:

- Strategically coordinate for more international students to relocate to north-eastern cities like Changchun to study;
- Strengthen international branding and increase Changchun's overseas reputation via professional marketing or alumni networks; and
- Promote more local geo-political advantages to target geographically closer countries.

Changchun city, in order to become a major city of Northeast Asia, needs to increase its international soft power. Increasing its international attractiveness is crucial for the development of its image. Compared with other mega cities like Beijing. Shanghai, Guangzhou and Shenzhen, Changchun faces the challenges of a second-tier city: it requires multi-level governmental support in a number of areas to become more competitive, as suggested in the analysis. The Chinese central government is, without any doubt, the most important impetus for injecting financial incentives and mobilising international student resources; local government and institutes also need to play their part in accommodating international students with proper consideration for their social and political needs, in order to promote the local image and nurture the appeal of China in the future.

5.   CONCLUSION

China is now the second largest economy in the world and has become increasingly involved in global affairs; there is a growing need to match this growth with soft power. As China becomes the second largest destination for international students, Chinese cities, especially lower-tier cities, should become more internationally attractive to cope with these rising global demands, and more importantly to compete for the potential resources brought by hosting these foreign students. For policy makers and urban researchers, while continuing infrastructure construction, urban planning and engineering, it is of some significance to develop aspects such as local culture, hospitality and international exposure.

For Changchun city, a tier-two capital city in north-eastern China, it is very challenging to compete with tier-one mega cities like Beijing, Shanghai, Guangzhou and Shenzhen for multiple reasons. By conducting interviews and surveys of the international students in Changchun, some determining factors and their underlying reasonings can be summarised and interpreted as the following:

- Financial incentives, such as living costs and scholarships are the dominating factors that influence their choice of Changchun. Without scholarships, most of them would likely not have come, since they would have applied for other countries' scholarships.
- Local tuition fees, living quality and curriculum design are important factors for their consideration of Changchun over other cities (like Beijing, Shanghai, Guangzhou, Shenzhen), because they could have better quality of life with similar financial benefits.
- Other forms of incentives, such as part-time or full-time employment opportunities are less import factors in determining their choice of Changchun, since they found it less promising or even difficult sometimes to obtain access during or after their study.
- Changchun's climate features are somehow perceived negatively, due to the rather extreme climate conditions in summer and winter, for some students. On the other hand, some consider it quite pleasing due to this change of setting compared to their home countries.
- Religious tolerance is an important factor from a sociological perspective, though favourably received by the interviewed international students, more consideration should be given in this regard.

- Government coordination, like the financial incentives, is a dominating factor for the selection of Changchun city. This can be regarded as one of the most influential for prospective students.
- Jilin city's geo-political proximity, international reputation, alumni recommendations and the accessibility it provides to international resources are less important factors as reflected by the survey results, which also indicate a potential for improvement.

Based on the previous analysis, the four most important factors are local costs, scholarships, religious tolerance, and government coordination, all of which offer major incentives across different aspects. The other factors also influence either favourably or negatively to a certain extent, but not as significantly as these four. To address the revealed problems and improve Changchun city's international soft power, several policy recommendations are summarised below:

- The central government should offer more financial incentives and policies encouraging more international students to come to Changchun (or other similar cities);
- The local government and institutes should create more part-time or full-time employment opportunities for international students to settle in these cities;
- By promoting religious tolerance, cultural and racial friendliness, lesser-known cities could obtain a more competitive edge with students with religious backgrounds;
- Local governments also need to improve their city branding towards international audiences and respect the potential of existing foreign students to be future alumni ambassadors who would become the spokespeople for host cities or institutes; and
- Additionally, local governments should consider turning negatively perceived local geo-political features into their advantage through awareness campaigns targeting specific student groups that emphasise Changchun as a central Northeast Asian city.

Needless to say, to implement these policies requires an integrated effort from all levels of government, institutes and involved stakeholders.

ACKNOWLEDGEMENT

REFERENCES

Antonicelli, A., & Roman, R. (2014). "The Changchun Guide". Retrieved from http://www.changchunlive.com/magazine/changchunguide/TheChangchunGuide-1.6.pdf.

Changchun City News. (2017). "Implement "Seeking Oppurtunities, Development Innovation" Goal and Develope Changchun into Central City of Northeast Asia". Retrieved from http://www.ccnews.gov.cn/ztbd/qm/ on July 21, 2017.

Changchun Municipal Government. (2017). "Changchun City Profile". Retrieved from http://221.8.13.155:8099/zjzc/ccts/cccsmp/sqjj/index.html. on July 21, 2017.

Chapman, R. G. (1986). "Toward a Theory of College Selection: A Model of College Search and Choice Behaviour". *Advances in Consumer Research*, *13*, 264-250.

Jilin Provincial Network. (2017). "Significance of Developing Changchun into Central City of Northeast Asia". Retrieved from http://www.jlxy.gov.cn/news.aspx?id=129055 on July 21, 2017.

Liu, Y., & Wang, X. (2012). "A Pictorial History of Changchun,1898-1962". *Cross-Currents: East Asian History and Culture Review*, (5), 190-217.

Mazzarol, T., & Soutar, G. N. (2002). "Push-Pull Factors Influencing International Student Destination Choice". *International Journal of Educational Management*, *16*(2), 82-90.

McMahon, M. E. (1992). "Higher Education in a World Market: A Historical Look at the Global Context of International Study". *Higher Education*, *24*(4), 465-482.

Phang, S. L. (2012). "Factors Influencing International Students' Study Destination Decision Abroad". (Master in Communication Thesis), University of Gothenburg, Gothenburg, Sweden.   (2012:087)

Sumra, K. B. (2012). "Study on Adjustment Problems of International Students Studying in Universities of the People's Republic of China: A Comparison of Student and Faculty/Staff Perceptions". *International Journal of Education*, *4*(1), 107-126.

Xi, J. (2017). "Report of the 19th National Congress of Chinese Communist Party ". *Xinhua News*. Retrieved from http://news.xinhuanet.com/politics/19cpcnc/2017-10/27/c_1121867529.htm.

Yu, B. (2008). "Cross Cultural Adaptation and Second Language Acquisition: A Study of International Students in Universities of the People'S Republic of China". (Ph.D), The University of Hong Kong, Pokfulam, Hong Kong.

Yu, B., Chen, X., Li, S., Liu, Y., Jacques-Tiura, A. J., & Yan, H. (2014). "Acculturative Stress and Influential Factors among International Students in China: A Structural Dynamic Perspective". *PLOS ONE*, *9*(4), e96322.

Appendix List of In-depth Interviewed International Students

Student NO.	Country of Origin	Sex	Major	Influence Factors Summary
1	Turkey	F	Chinese	Scholarship, curiosity about Changchun;
2	South Korea	F	Literature	Network recommendation, Geopolitical proximity;
3	Mali	M	Economy	Cheap cost for living;
4	Maldives	F	Medicine (Ph.D.)	Not expensive to live, local hospitality;
5	Pakistani	M	Engineering	Network recommendation;
6	Mali	M	IR	Institutional reputation;
7	Laos	F	Chemistry	Network recommendation;
8	Tajikistan	M	Chinese	Network recommendation;
9	India	M	IR (Ph.D.)	Scholarship;
10	Singapore	F	N.A.	Climate (winter);
11	Canada	M	N.A.	Self-financed, Culture attraction;
12	Ethiopia	F	Public Diplomacy	Institutional reputation;
13	India	F	Medicine	Network recommendation, Scholarship;
14	Yemen	M	Medicine	Network recommendation;
15	Pakistan	F	IR (M)	Scholarship;
16	Japanese	F	Chinese	Access to study resources;
17	South Korea	M	Economy	Partner uni. Network;
18	South Korea	M	Economy	Partner uni. Network;
19	South Korea	M	Economy	Partner uni. Network;
20	India	M	Medicine	Institutional reputation, curriculum, local hospitality;
21	Nigeria	M	Chinese	Climate (winter), quality of life;
22	Somalia	F	Medicine	Network recommendation;
23	Japanese	M	Pharmacology	Local cost, hospitality, partner uni. Network, geo proximity;
24	Kazakhstan	F	Business	Climate, geo proximity, curriculum;
25	Ukraine	M	Business	Scholarship, government coordination;

26	Mongolia	F	Business	Scholarship, government coordination, employment;
27	Kyrgyzstan	F	IR (M)	Scholarship;
28	Tajikistan	F	IR	Network recommendation, her brother is studying here;
29	Papua New Guinean	M	IR (M)	Government coordination, scholarship;
30	Nepal	M	IR (M)	Government coordination, scholarship;
31	Kenya	M	Medicine	Scholarship, Network recommendation;
32	South Korea	M	IR (M)	Institutional reputation, geopolitical proximity, cost of living;
33	Nepal	M	IR (M)	Institutional reputation, Geopolitical proximity;
34	Mali	M	Pharmacy	Local hospitality, Network recommendation;
35	Nigeria	F	Chinese	Climate (winter), quality of life;
36	Russia	F	Business	Geopolitical proximity;
37	Russia	F	Chinese	Network recommendation (parent's work);
38	Japan	M	Sinology	Partner uni. Network (exchange program);
39	Japan	M	Humanities	Network recommendation (his Chinese friend);
40	Iraq	M	Medicine	Network recommendation (his brother is here;
41	Tajikistan	M	IR	Government coordination, scholarship;
42	Argentina	F	Linguistics	Partner uni. Network, quality of life, network recommendation;
43	South Korea	M	Engineering	Government coordination, low cost of living;
44	Tajikistan	M	Chinese	Climate (winter), quality of life, religion tolerance;
45	Ukraine	F	Chinese (M)	Partner uni. Network, local hospitality;
47	Libya	M	Diplomacy (M)	Network recommendation (his Chinese friend), scholarship;
48	Algeria	M	Diplomacy (M)	Scholarship;
49	Kuwait	M	English	Institutional reputation, network recommendation;
50	India	M	Medical Science	Network recommendation (his friends);
51	Mo Zambia	F	Medicine	Scholarship, quality of life, urban hardware;
52	Zambia	F	Medicine	Network recommendation, her brother is studying here
53	India	F	Medical Science	Government coordination, scholarship;
54	South Korea	M	Public Diplomacy	Family reasons;
55	South Korea	M	IR (Ph.D.)	Institutional reputation, Geopolitical proximity;
56	India	M	Medical Science	Institutional reputation, girlfriend;
57	Sudan	M	Engineering	Alumni (he used to study here), local culture;
58	India	F	Medicine	Local hospitality;
59	Mali	M	IR	cost of living, potential careers;

Note: "IR" stands for "International Relations", "(M)" denotes Master's study; "(Ph.D.)" denotes PhD study; "N.A." stands for "Not Available"

SPSD

Mapping and Quantifying Variations in Ecosystem Services of Urban Green Spaces: A Test Case of Carbon Sequestration at the District Scale for Seoul, Korea (1975–2015)

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Abstract: Urban ecosystem services (ESs) can moderate many common environmental issues in cities that are caused by the land use transformation central to urbanization. However, quantitative knowledge of historical changes in ES provisioning at various urban scales is limited. In this research, it is proposed to identify ESs, especially those generated by urban green space (UGS), and quantify their spatiotemporal variations at the regional scale in the southern part of Seoul City, Korea. Changes are first detected in landscape patterns, then one ES indicator — carbon sequestration (CS) — is chosen as a test case, and its spatial pattern explored using the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) model. Total potential CS decreased by 41.2% from 1975 to 2015, with loss and fragmentation of landscapes occurring and patches becoming smaller and simpler in shape in the urban area, as indicated by landscape metrics. Moreover, strong decreases in urban forest and agricultural areas were the primary causes of loss of CS. On the other hand, a 120% increase in the grassland area somewhat offset these two factors. It is hoped that these results will contribute to cognizance of the potential of historical processes to inform future policy decisions related to green infrastructure and land-use planning.

1. INTRODUCTION

The concept of ecosystem services (ESs) has developed rapidly over the past two decades. Hundreds of projects and groups are currently working toward better understanding, modeling, valuation, and management of ESs (Costanza et al., 2014). However, previous studies have generally focused on quantifying the ESs of natural and rural landscapes at regional or national scales (Byrd et al., 2015; Martínez-Harms & Balvanera, 2012), while less than 10% of all ES publications deal with urban ESs (Derkzen, Teeffelen, & Verburg, 2015; Gómez-Baggethun & Barton, 2013; Haase, 2013). Urban ESs can moderate many common environmental issues in cities, such as air pollution, biodiversity loss, and heat stress, as caused by the land-use transformation that occurs during urbanization (Larondelle & Haase, 2013; Li, Y. et al., 2018).

As a central component of cities' "green infrastructure" (Tratalos et al., 2007; James et al., 2009), urban green space (UGS) provides critical urban ESs for local residents (Wolch, Byrne, & Newell, 2014). UGS includes many types of space, ranging from high-maintenance urban parks to natural areas and buffer spaces between noisy infrastructure and other land-use types (Panduro & Veie, 2013). These diverse types of UGS are important for the delivery of social and environmental goods (Young, 2010; Ricard & Bloniarz, 2006), providing a great benefit to the urban environment; thus, more attention should be paid to UGS.

Previous studies have evaluated the benefits derived from UGS in cities. These studies often estimated the economic value of UGS (Abbott & Klaiber, 2010; Morancho, 2003), as well as the aesthetic (Southon et al., 2017), environmental (Yang et al., 2017; Sandström, Angelstam, & Mikusiński, 2006) and social value (Chan, 2017; Dennis & James, 2017; Barbosa et al., 2007). Several studies have also investigated UGS directly based on ES theory. For example, Derkzen, Teeffelen, and Verburg (2015) quantified the ES of UGS in Amsterdam and Niemela et al. (2010) addressed the most important ES in functional urban regions in Finland through measurement of UGS. However, studies investigating ESs at various urban scales are still limited.

Comprehensive spatiotemporal analyses of the landscape can offer a powerful tool for uncovering historical relationships between human activities and the environment (Fuchs et al., 2016; Grecchi et al., 2014; Li, S., Wang, & Zhang, 2017; Shahraki et al., 2011; Han et al., 2017), and also provide evidence for urban ecosystem conservation and restoration through analysis of urban ESs from a historical perspective.

This study proposes to identify an indicator of ESs at the regional scale in the metropolitan area of Seoul, Korea, and to quantify spatiotemporal variations therein from 1975 to 2015. The potential for urban habitats to capture and store atmospheric carbon is increasingly important amid growing concerns over the role played by anthropogenic CO_2 in global climate change (Grafius et al., 2016; Lee, Lee, & Lee, 2015). Thus, in this research carbon
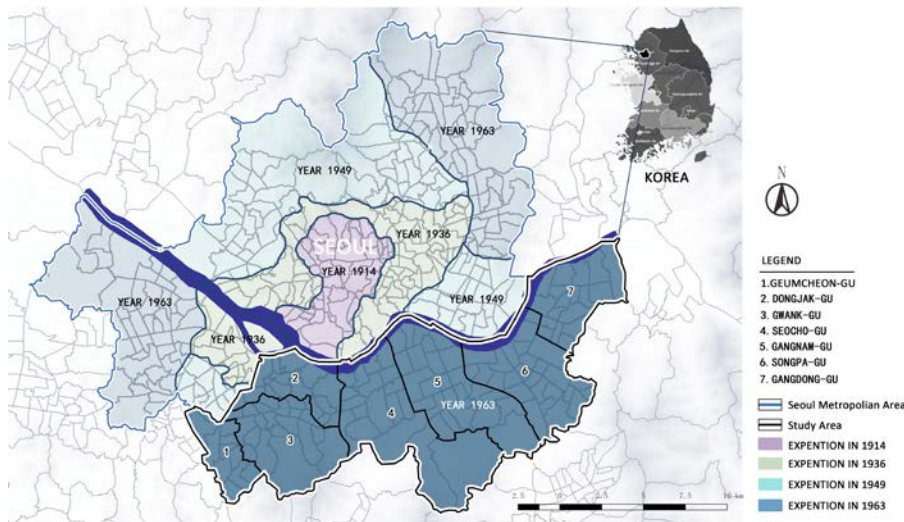

Figure 1. Research site

sequestration (CS) is chosen as a test case, and the response of CS to landscape changes is explored. The study aims to answer three questions: 1) How did the historical landscape change from 1975 to 2015?; 2) What were the

characteristics of these landscape changes?; and 3) What was the response of CS to historical landscape changes?
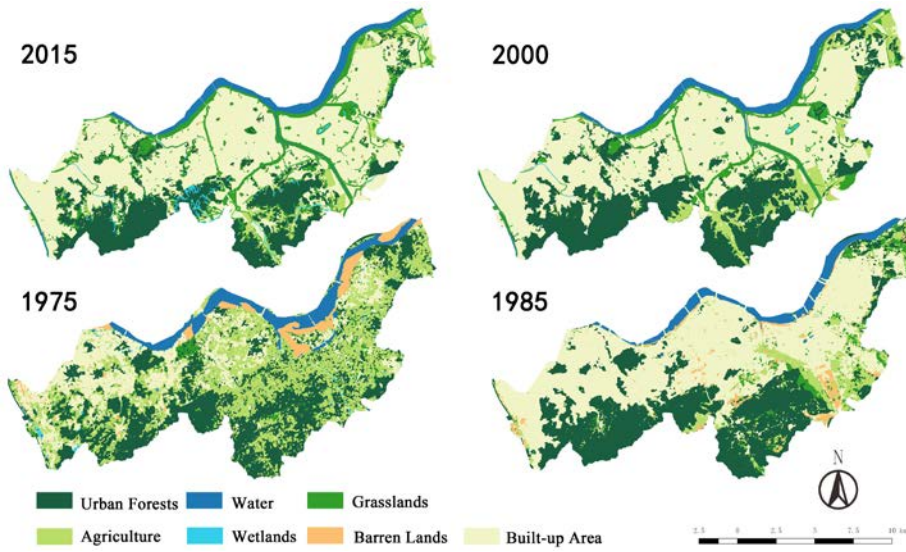

Figure 2. Maps of landscape types from 1975 to 2015

Table 1. Re-classified landscape types classification.

NO.	Landscape class	Class description
01	Urban forests*	Forests or parks with clustering trees in urban areas; orchards.
02	Agriculture*	Cultivated fields, open agricultural lands.
03	Water	Broad-scale rivers and streams.
04	Wetlands	Wetlands, lakes, pools, or irrigation.
05	Grasslands*	Tombs, creamery parks, golf playgrounds, children's parks, or grasslands of waterfront areas, parks, and communities.
06	Barren lands	Barren lands, heath, or undeveloped areas without vegetation.
07	Built-up area	Urban residential, commercial, industrial areas, transportation, or mixed-use areas.

*Urban green space (UGS) includes landscape types of urban forests, agriculture, and grasslands by referencing to the official land use classification of Seoul.

2.   METHODS

2.1   Research site

This study investigates historical changes in a region that has been expanding and developing since the 1960s in southern Seoul City. Land use in this urban region showed significant changes from the 1960s to 2000s, largely due to the urbanization of peri-urban areas. The study region is approximately 20,430 km2 in area, including Gangdong-gu District, Songpa-gu District, Gangnam-gu District, Seocho-gu District, Gwanak-gu District, Geumcheon-gu District, and Dongjak-gu District (*Figure 1*).

2.2   Data

A time series of land use/cover maps was derived from historical aerial photographs taken in 1975, 1985, 2000, and 2015 containing land cover

information. The maps for 1975 and 1985 had resolutions of 60 m and 30 m, respectively, and were created by the Water Management Information System (WAMIS, www.wamis.go.kr). The maps for 2000 and 2015 were provided by the Seoul Metropolitan Government, with 5m resolution (www.gis.seoul.go.kr/SeoulGis/). All maps were converted to 5m resolution using ArcGIS 10.2.2 software. We then standardized the significant landscape types represented in the maps according to a common classification scheme. The seven re-classified landscape types were: urban forests, agriculture, water, wetlands, grasslands, barren lands, and built-up area (*Figure 2, Table 1*). Of these newly classified landscape types, three included areas of UGS: urban forests, agriculture, and grasslands.

2.3   Data analysis

2.3.1   Landscape patterns analysis

Table 2. Landscape metrics using in this study

Acronym	Landscape Metric	Class Level (UGS)	Landscape Level	Description
TLA	Total Landscape Area	√		The area of each landscape type
NumP	Number of Patch	√	√	Degree of spatial fragmentation of landscape type; complexity
MPS	Mean Patch Size	√	√	Average patch size for a landscape/ a class
MSI	Mean Shape Index		√	Spatial complexity of a patch's size; artificial (geometric forms) versus irregular natural forms
AWMSI	Area-Weighted Mean Shape Index	√	√	An average shape index of patches, weighted by patch area so that large patches are weighted higher than smaller ones
SDI	Shannon's Diversity Index		√	SDI increases as the number of different patch types increases and/or the proportional distribution of area among patch types becomes more equitable.

To study how landscape changes affect urban ESs, landscape pattern analysis was applied. Landscape metrics have been used previously to analyze spatial characteristics at both the landscape level (i.e., of an entire region) and the class level (of individual UGS) using FRAGSTATS version 4.2.1, a comprehensive software package for analysis at the patch, class, and landscape levels (McGarigal et al., 2002). FRAGSTATS includes a large number of spatial metrics, classified as area and edge metrics, shape metrics, and aggregation metrics. A specific subset of these three categories was selected for this study (Deng et al., 2009). Several landscape metrics, including number of patches (NumP), mean patch size (MPS), mean shape index (MSI), area-weighted mean shape index (AWMSI) and Shannon's diversity index (SDI) were applied herein to clarify changes in overall

landscape loss and fragmentation trends at the landscape level. At the class level, landscape metrics were useful and directly relevant to correlated changes in UGS. The landscape metrics were calculated for each year and examined, as shown in *Table 2*.

2.3.2 Calculating carbon sequestration using InVEST model

Table 3. Indexes used for carbon model in InVEST software.

NO.	Landscape type	C_ABOVE	C_BELOW	C_SOIL	C_DEAD	Total
1	Urban forest	53.59	17.36	47.22	11.79	129.96
2	Agriculture	0	0	66.05	0	66.05
3	Water	0	0	0	0	0
4	Wetland	0	0	88.00	11.00	99
5	Grasslands	0.33	0.89	88.20	0.20	89.62
6	Barren lands	0	0.33	0.33	0	0.66
7	Built-up area	0	0	0	0	0

* The unit is t C/ha

The amount of CS during four historical periods in the study area was assessed using the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) model. InVEST was developed as part of the Natural Capital Project (www.naturalcapitalproject.org) by Stanford University, he University of Minnesota, The Nature Conservancy, and the World Wildlife Fund. InVEST uses maps of landscape types, which also detail the amount of carbon stored in carbon pools, to estimate the net amount of carbon stored in a given parcel of land (see InVEST user's guide for further details on this method) (Sharp et al., 2014).

The CS module requires an estimate of the amount of carbon in at least one of the four fundamental carbon pools: above-ground biomass, below-ground biomass, soil organic matter, and dead organic matter. Aboveground biomass comprises all above-soil living plant material; belowground biomass encompasses the living root systems attached to the aboveground biomass; soil organic matter, the largest terrestrial carbon pool, is the organic component of soil; dead organic matter includes litter, as well as lying and standing dead wood (Sharp et al., 2014). All four fundamental pools were examined in this study. The CS index was derived from previous studies (Chung, Kang, & Choi, 2015; Tomasso & Leighton, 2014; National Institute of Forest Science (NIFoS), 2015; Korea Environment Institute (KEI), 2016)(*Table 3*); Based on the input parameters, the total CS for each period examined was quantified.

3. RESULTS AND DISSCUSSION

3.1 Detection of historical changes in urban landscape

Seoul experienced rapid urbanization between the 1960s and the 1990s, with landscape changes occurring as a result of numerous projects, and with little consideration for the natural environment (Hong et al., 2003). Data on the areas covered by each landscape type in the four years examined in this study are presented in *Figure 3*. The most significant change was in the large

areas of natural landscape that were lost with the dramatic increase in construction area ([Han et al., 2017](#)). Built-up area covered approximately 19,384 ha in 2015, compared with 6,365 ha in 1975 (*Figure 3*). The second most significant change occurred in the agricultural landscape: the proportion of agricultural land decreased by 90% over the 40-year period and (*Figure 3*), by 2015, only a small amount of agricultural land remained on the outskirts of the district (see *Figure 2*).
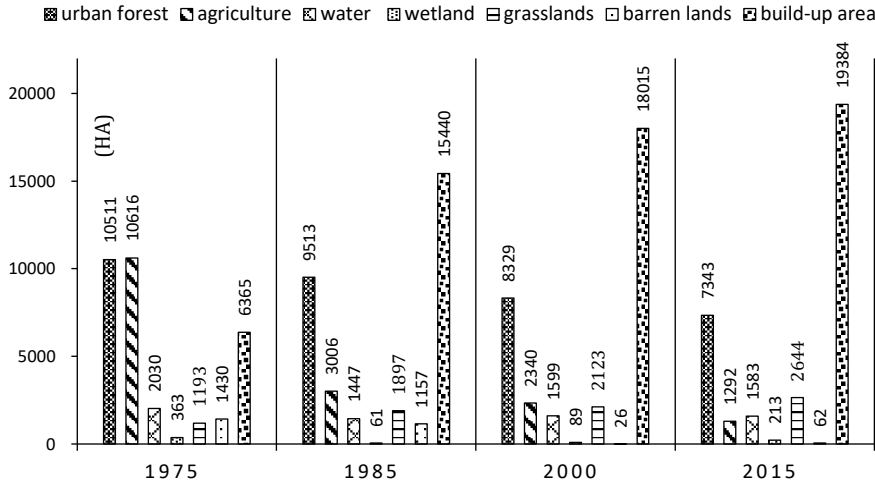

Figure 3. The total landscape area（TLA) of each landscape type from 1975 to 2015

Significant changes in landscape type occurred during the period 1975–1985. The agricultural landscape declined in extent by approximately 72%, while the amount of built-up area increased significantly (*Figure 3*). Most of the rural landscape was urbanized during this period. In addition, after the 1990s, although the process of urban transformation slowed, forest area still decreased between the years of 2000 and 2015, while the built-up area increased steadily.

UGS in the study area changed significantly, as indicated by the proportions of the urban forest, agriculture, and grassland landscape types. The area covered by urban forests decreased by about 30%, while that covered by grasslands increased by approximately 120%; most of the grasslands had previously been forest and agricultural lands (*Figure 3*). This shift may be attributable to the "Parks Act", enacted in the 1980s, which had the goal of enhancing urban greenness via park-related laws, and which transformed cultural and historical sites into neighborhood parks.

In addition, a trend toward urban landscape fragmentation was indicated by the NumP and MPS values. At the landscape level, the overall NumP increased from 7,127 in 1975 to 8,832 in 2015. MPS showed its highest value (7.096) in 2000, but this decreased by approximately 50% (3.682) by 2015 (*Figure 4*). The fragmentation trend can also be explained by reference to the
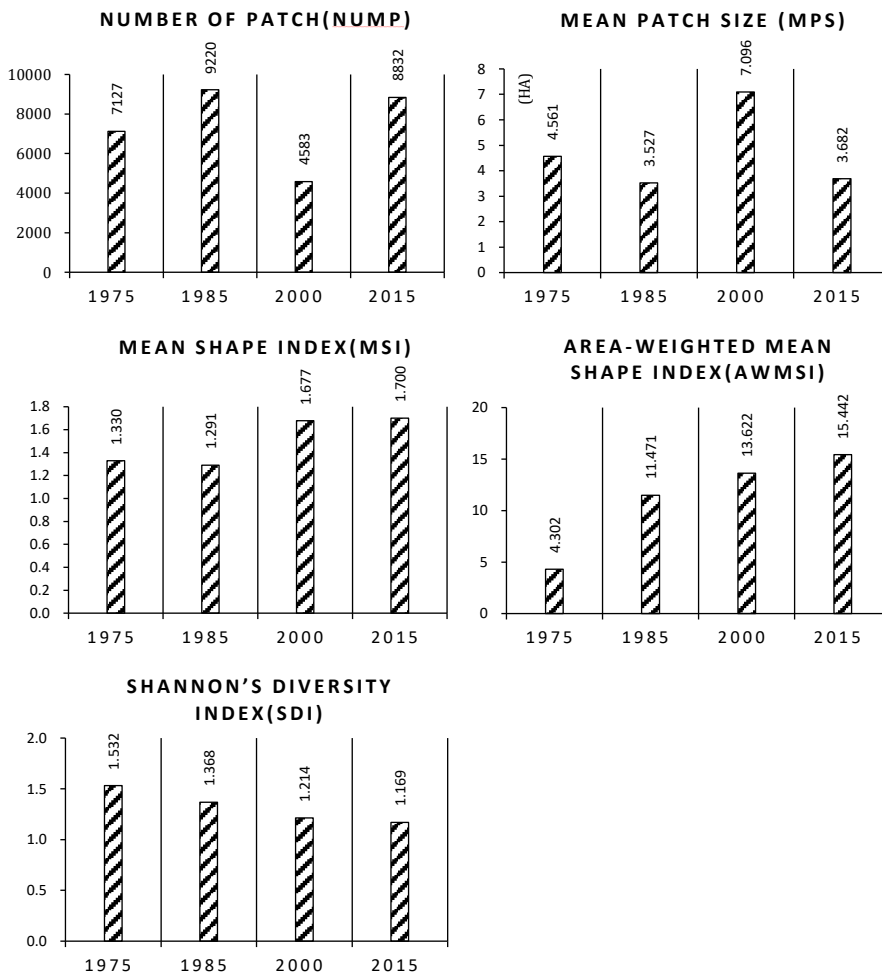
Figure 4.The results of examined landscape metrics at landscape level from 1975 to 2015

spatial metrics of UGS at the class level (*Figure 5)*. Urban forests were present in only 2,188 patches in 1975, compared with 4,844 patches in 2015. The NumP of agriculture decreased steadily, from 2,037 patches in 1975 to 744 patches in 2015, except in 1985(2,557), when it increased slightly. Meanwhile, the NumP of grasslands increased from 920 in 1975 to 3,431 in 1985, but then decreased to 1,498 in 2000, before finally increasing again to 2,798 in 2015.

Moreover, the diversity of patch types decreased, while the shapes of patches became simpler, and the patch size smaller. At the landscape level, AWMSI increased from 4.302 in 1975 to 15.442 in 2015, and SDI decreased from 1.532 in 1975 to 1.169 in 2015 (*Figure 4)*. However, UGS at the class level shows different results, both in terms of landscape types and year of study. For example, a previous study reported that forest patches decreased during the period 1988–1999 and patch shapes became smaller and simpler (Hong et al., 2003), as indicated in this study by the sharp declines in MPS and AWMSI from 1985 to 2000; however, AWMSI showed a contrary trend for the period 2000–2015, with a slight increase from 1.669 to 2.025 (*Figure 5)* .

3.2 **Historical changes of carbon sequestration (CS)**

Land use transformation affects the CS capability of urban areas. The total potential CS in the study area decreased by 41.2% from 1975 to
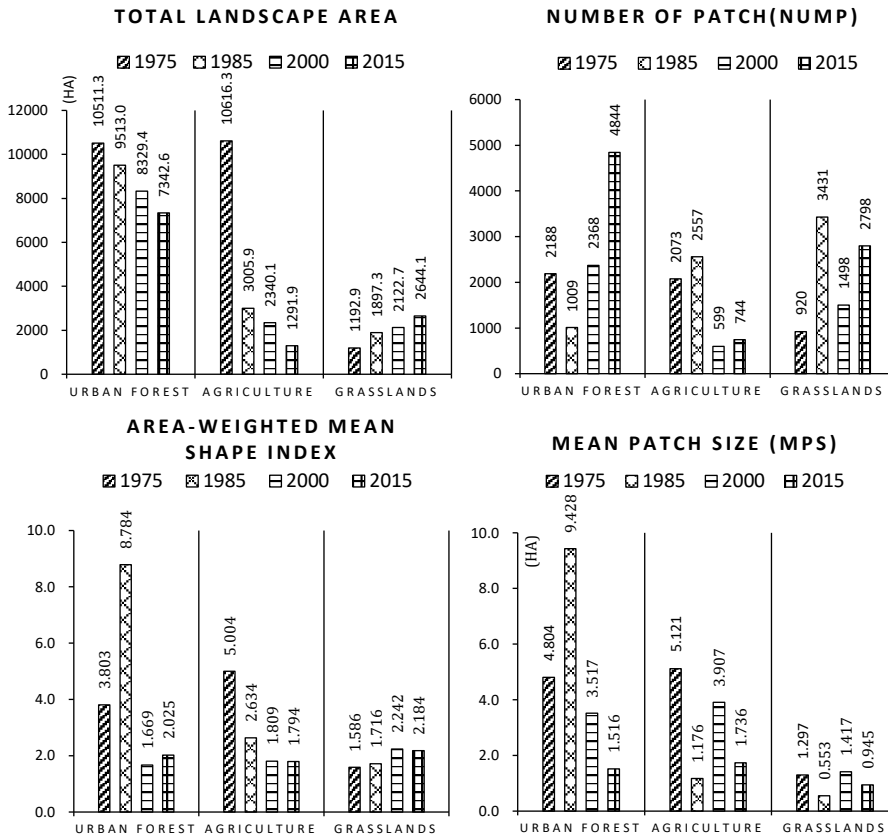
*Figure 5.*The results of examined landscape metrics of UGS (urban forest, agriculture, grasslands) at class level from 1975 to 2015.

2015(*Table 4)*. UGS provides important ecosystem-related goods and services at the city level, and plays a particularly critical role in CS. Thus, in this study, the decline in the area of UGS was the main cause for the loss of CS. The proportion of UGS relative to the total study area decreased from 95.5% in 1975 to 81.6 % in 2015(*Table 4)*. Urban forests decreased by 30%, which was the main reason for the decrease in CS, as urban forests and urban soils can significantly increase CO_2 sequestration and storage (Pulighe, Fava, & Lupia, 2016). Urban agriculture contributed to storage of CO_2 in gardens, and could decrease greenhouse gas production in relation to the distance over which food is transported to reach consumers. Our results show that the agricultural landscape in the study area decreased by 90% from 1975 to 2015. Lee, Lee, and Lee (2015) explored the area available for urban farming in the metropolitan area of Seoul, and concluded that urban agriculture in a 51.15 km^2 area within Seoul City could reduce CO_2 emissions by 11.67 million kg annually.The 120% increase in the area of grasslands, which somewhat offset the decreases in agriculture and urban forests, was mainly in the form of urban green infrastructure, such as parks and community gardens.

Table 4. The historical changes of carbon sequestration

Year	1975	1985	2000	2015
Total CS (ton)	1387427.88	1012851.47	902769.47	815535.81
CS of UGS	1317770.62	904879.89	782688.05	665533.74
Proportion	95.5%	89.3%	86.7%	81.6%

3.3   The role and applications of UGS in ecosystem services (ESs)

For certain ESs, the spatial arrangement of UGS is a key determinant of whether a service is actually supplied (Andersson et al., 2015). The type, size, and location of UGS affect ESs supply in different ways. For example, whether a city has a few large or many small habitat areas does not matter in terms of CS, although long and continuous vegetation strips are optimal for noise reduction (McGarigal et al., 2002).

Through mapping the landscape patterns in the research area, the fragmentation of natural habitats was shown to be due mainly to the process of urbanization. CS in the study area decreased by 41.2% from 1975 to 2015(*Table 4)*. Natural habitat was found to be the UGS type playing the most crucial role in CS. Thus, consideration of the potential for UGS to capture and store atmospheric carbon in urban areas is essential (Darren et al., 2016).

It is also important to differentiate among UGS types when quantifying ESs in an urban area (Pulighe, Fava, & Lupia, 2016). Although urban forests play an active role in most ecosystem functions, artificial green spaces, such as parks and community gardens, could support several ESs when the forested area shows a sharp decrease. Thus, the importance of careful UGS design during city planning initiatives for the provision of ESs should be highlighted. Moreover, further consideration should be given to enhancing the CS capability of UGS during urban planning and policy making. It's hoped that this study will contribute to a greater understanding of the potential of historical processes to inform future policy decisions related to green infrastructure and land-use planning.

4.   CONCLUSION

Based on historical changes in landscape types, variations in ESs can be quantified. However, the number of studies clarifying and characterizing ES variations at various urban scales is still limited. Using CS as a test case, we historical changes in ESs were analyzed at the regional scale in Seoul based on changes in landscape patterns from 1975 to 2015. Our results reveal that total potential CS in the study area decreased by 41.2% between 1975 and 2015, with loss and fragmentation of landscapes and smaller and simpler patch shapes appearing in the urban area, as indicated by landscape metrics. UGS played a crucial role in CS at the city level; thus, a sharp decrease in urban forest and agriculture areas was the main cause of CS loss, although a 120% increase in the area of grasslands in part offset these two decrease. The size, shape, and spatial arrangement of UGS, especially in the grassland landscape type, affected ESs in different ways, which should be considered in future policy-making and green infrastructure planning initiatives. These findings contribute to the evidence that historical maps are useful for analyzing temporal dynamics and the trajectory of landscape changes, and provide important insights for the conservation of natural habitats in the central urban area of Seoul. However, limitations to the CS model used in this study remain, including an oversimplified carbon cycle, the assumption of linear change in CS over time, and potentially inaccurate discounting rates (Sharp et al., 2014). Further studies should explore the relationship between changes in landscape patterns and multiple ESs.

ACKNOWLEDGMENTS

REFERENCES

Abbott, J. K., & Klaiber, H. A. (2010). "Is All Space Created Equal? Uncovering the Relationship between Competing Land Uses in Subdivisions". *Ecological Economics*, *70*(2), 296-307.

Andersson, E., McPhearson, T., Kremer, P., Gomez-Baggethun, E., Haase, D., Tuvendal, M., & Wurster, D. (2015). "Scale and Context Dependence of Ecosystem Service Providing Units". *Ecosystem Services*, *12*, 157-164.

Barbosa, O., Tratalos, J. A., Armsworth, P. R., Davies, R. G., Fuller, R. A., Johnson, P., & Gaston, K. J. (2007). "Who Benefits from Access to Green Space? A Case Study from Sheffield, Uk". *Landscape and Urban planning*, *83*(2), 187-195.

Byrd, K. B., Flint, L. E., Alvarez, P., Casey, C. F., Sleeter, B. M., Soulard, C. E., . . . Sohl, T. L. (2015). "Integrated Climate and Land Use Change Scenarios for California Rangeland Ecosystem Services: Wildlife Habitat, Soil Carbon, and Water Supply". *Landscape Ecology*, *30*(4), 729-750.

Chan, C.-S. (2017). "Health-Related Elements in Green Space Branding in Hong Kong". *Urban Forestry & Urban Greening*, *21*, 192-202.

Chung, M. G., Kang, H., & Choi, S. U. (2015). "Assessment of Coastal Ecosystem Services for Conservation Strategies in South Korea". *Plos One*, *10*(7), e0133856.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., . . . Turner, R. K. (2014). "Changes in the Global Value of Ecosystem Services". *Global Environmental Change*, *26*, 152-158.

Darren, D. S. A., Petruccelli, D., Patton, S. J., Winemaker, M., & de Beer, J. (2016). "From "Surgical Gatekeepers" to "Patient Navigators": Examining Perceptions and Practices of Hip and Knee Osteoarthritis Management among Primary Healthcare Physicians". *Current Orthopaedic Practice*, *27*(1), 46-55.

Deng, J. S., Wang, K., Hong, Y., & Qi, J. G. (2009). "Spatio-Temporal Dynamics and Evolution of Land Use Change and Landscape Pattern in Response to Rapid Urbanization". *Landscape and Urban Planning*, *92*(3-4), 187-198.

Dennis, M., & James, P. (2017). "Evaluating the Relative Influence on Population Health of Domestic Gardens and Green Space Along a Rural-Urban Gradient". *Landscape and Urban Planning*, *157*, 343-351.

Derkzen, M. L., Teeffelen, A. J., & Verburg, P. H. (2015). "Review: Quantifying Urban Ecosystem Services Based on High-Resolution Data of Urban Green Space: An Assessment for Rotterdam, the Netherlands". *Journal of Applied Ecology*, *52*(4), 1020-1032.

Fuchs, R., Schulp, C. J., Hengeveld, G. M., Verburg, P. H., Clevers, J. G., Schelhaas, M. J., & Herold, M. (2016). "Assessing the Influence of Historic Net and Gross Land Changes on the Carbon Fluxes of Europe". *Global change biology*, *22*(7), 2526-2539.

Gómez-Baggethun, E., & Barton, D. N. (2013). "Classifying and Valuing Ecosystem Services for Urban Planning". *Ecological Economics*, *86*, 235-245.

Grafius, D. R., Corstanje, R., Warren, P. H., Evans, K. L., Hancock, S., & Harris, J. A. (2016). "The Impact of Land Use/Land Cover Scale on Modelling Urban Ecosystem Services". *Landscape Ecology*, *31*(7), 1509-1522.

Grecchi, R. C., Gwyn, Q. H. J., Benie, G. B., Formaggio, A. R., & Fahl, F. C. (2014). "Land Use and Land Cover Changes in the Brazilian Cerrado: A Multidisciplinary Approach to Assess the Impacts of Agricultural Expansion". *Applied Geography*, *55*, 300-312.

Haase, D. (2013). "Synthesizing Different Perspectives on the Value of Urban Ecosystem Services". Retrieved from http://sendzimir.org.pl/sites/default/files/Urban%20Ecosystem%20Services%20Lodz%20Poland%2015_16%20July%202011%20book%20of%20abstracts%205.pdf.

Han, Y., Song, Y., Burnette, L., & Lammers, D. (2017). "Spatiotemporal Analysis of the Formation of Informal Settlements in a Metropolitan Fringe: Seoul (1950-2015)". *Sustainability*, *9*(7), 1190.

Hong, S. K., Song, I. J., Kim, H. O., & Lee, E. K. (2003). "Landscape Pattern and Its Effect on Ecosystem Functions in Seoul Metropolitan Area: Urban Ecology on Distribution of the Naturalized Plant Species". *Journal of Environmental Sciences*, *15*(2), 199-204.

James, P., Tzoulas, K., Adams, M. D., Barber, A., Box, J., Breuste, J., . . . Thompson, C. W. (2009). "Towards an Integrated Understanding of Green Space in the European Built Environment". *Urban Forestry & Urban Greening*, *8*(2), 65-75.

Korea Environment Institute (KEI). (2016). "An Integrated Approach to Environmental Valuation, Sejong-Si, Korea".

Larondelle, N., & Haase, D. (2013). "Urban Ecosystem Services Assessment Along a Rural–Urban Gradient: A Cross-Analysis of European Cities". *Ecological Indicators*, *29*, 179-190.

Lee, G. G., Lee, H. W., & Lee, J. H. (2015). "Greenhouse Gas Emission Reduction Effect in the Transportation Sector by Urban Agriculture in Seoul, Korea". *Landscape and Urban Planning*, *140*, 1-7.

Li, S., Wang, Z., & Zhang, Y. (2017). "Crop Cover Reconstruction and Its Effects on Sediment Retention in the Tibetan Plateau for 1900–2000". *Journal of Geographical Sciences*, *27*(7), 786-800.

Li, Y., Kang, W., Han, Y., & Song, Y. (2018). "Spatial and Temporal Patterns of Microclimates at an Urban Forest Edge and Their Management Implications". *Environmental monitoring and assessment*, *190*(2), 93.

Martínez-Harms, M. J., & Balvanera, P. (2012). "Methods for Mapping Ecosystem Service Supply: A Review". *International Journal of Biodiversity Science, Ecosystem Services & Management*, *8*(1-2), 17-25.

McGarigal, K., Cushman, S. A., Neel, M. C., & Ene, E. (2002). "Fragstats: Spatial Pattern Analysis Program for Categorical Maps". Retrieved from http://www.umass.edu/landeco/research/fragstats/fragstats.html.

Morancho, A. B. (2003). "A Hedonic Valuation of Urban Green Areas". *Landscape and Urban Planning*, *66*(1), 35-41.

National Institute of Forest Science (NIFoS). (2015). "Increased Reliability in Statistics on Forest Carbon Pools of Korea".

Panduro, T. E., & Veie, K. L. (2013). "Classification and Valuation of Urban Green Spaces—a Hedonic House Price Valuation". *Landscape and Urban planning*, *120*, 119-128.

Pulighe, G., Fava, F., & Lupia, F. (2016). "Insights and Opportunities from Mapping Ecosystem Services of Urban Green Spaces and Potentials in Planning". *Ecosystem Services*, *22*(Part A), 1-10.

Ricard, R. M., & Bloniarz, D. V. (2006). "Learning Preferences, Job Satisfaction, Community Interactions, and Urban Forestry Practices of New England (USA) Tree Wardens". *Urban Forestry & Urban Greening*, *5*(1), 1-15.

Sandström, U. G., Angelstam, P., & Mikusiński, G. (2006). "Ecological Diversity of Birds in Relation to the Structure of Urban Green Space". *Landscape and Urban Planning*, *77*(1–2), 39-53.

Shahraki, S. Z., Sauri, D., Serra, P., Modugno, S., Seifolddini, F., & Pourahmad, A. (2011). "Urban Sprawl Pattern and Land-Use Change Detection in Yazd, Iran". *Habitat International*, *35*(4), 521-528.

Sharp, R., Tallis, H., Ricketts, T., Guerry, A., Wood, S., Chaplin-Kramer, R., . . . Olwero, N. (2014). "Invest User's Guide".   The Natural Capital Project, Stanford.

Southon, G. E., Jorgensen, A., Dunnett, N., Hoyle, H., & Evans, K. L. (2017). "Biodiverse Perennial Meadows Have Aesthetic Value and Increase Residents' Perceptions of Site Quality in Urban Green-Space". *Landscape and Urban Planning*, *158*, 105-118.

Tomasso, L. P., & Leighton, M. (2014). "The Impact of Land Use Change for Greenhouse Gas Inventories and State-Level Climate Mediation Policy: A Gis Methodology Applied to Connecticut". *Journal of Environmental Protection*, *5*(17), 1572-1587.

Tratalos, J., Fuller, R. A., Warren, P. H., Davies, R. G., & Gaston, K. J. (2007). "Urban Form, Biodiversity Potential and Ecosystem Services". *Landscape and urban planning*, *83*(4), 308-317.

Wolch, J. R., Byrne, J., & Newell, J. P. (2014). "Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities 'Just Green Enough'". *Landscape and Urban Planning*, *125*, 234-244.

Yang, J., Sun, J., Ge, Q., & Li, X. (2017). "Assessing the Impacts of Urbanization-Associated Green Space on Urban Land Surface Temperature: A Case Study of Dalian, China". *Urban Forestry & Urban Greening*, *22*, 1-10.

Young, R. F. (2010). "Managing Municipal Green Space for Ecosystem Services". *Urban Forestry & Urban Greening*, *9*(4), 313-321.

Editorial introduction
Spatial planning system integration

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Spatial planning is a term with ambiguity because there is no generally agreed definition (Kai, 2007). "Spatial planning system" is still a complex topic strongly related to the context of administrative systems. As long as there are urbanization and development around the world, those topics will stay important along with the changing socio-economic situations. Right now there is a common phenomenon in many countries/regions where numerous layers of spatial plans are formulated by different stakeholders or governing bodies. Therefore, to avoid spatial policies overlapping or contradicting with each other, some countries/regions are promoting new ways to coordinate spatial plans, making integral spatial policy frameworks. Thus, this special issue focuses on several reviews of spatial planning system reform, as well as some relevant case studies.

Since the signing of the European Spatial Development Perspective (ESDP) in 1999, European regions and member states have reached agreements on territorial co-operation responsible for spatial planning (Kai, 2007); member states' spatial policies and spatial planning of their respective territories are also inevitably influenced. The first paper of this issue, "Coordination through Integration: A critical review on French spatial policy and spatial planning systems", aims to contribute several key facts and to inspire the coordination of various spatial plans formulated by different planning bodies, by reviewing the latest framework of French spatial policy, spatial planning system, as well as the implementation of both (Liu, 2018). In its review, it can be seen that France, as a typical decentralized administrative nation, shapes a multi-faceted spatial policy framework and a multi-layered spatial planning system, meaning many plans with their policies will be formulated by various entities or stakeholders. In spite of that, with the consensus goals of achieving well-balanced, sustainable development and social diversity, the system can function with coordination thanks to integrated policy framework under corresponding jurisdictions, as well as many cooperation policies in implementation through a number of multiple projects bounded by the agreements between different governments, authorities and stakeholders. French experience can serve as inspiring reference for developing countries like China that are engaging in restructuring an integral spatial planning system.

Nowadays, China has been promoting a spatial planning system reform named Integration of Multiple Planning to integrate the various sectoral

policies from four principal spatial plans. Based in this context, the following three studies are presented. The paper "Co-exist or Integration? Reviewing the Spatial Planning Reform of China from the Perspective of Central-Local Relationships" makes a contribution pointing out that the nature of "integration of multiple spatial plans" lies in the differences of governance orientation between central and local government (Hu & Zhou, 2018). As is stated in the paper, China's central government has raised the proportion of revenue from local authorities, which in turn leads to local authorities largely relying on land sales for funding and providing the engine of city development, of which the typical policy-making tool is a City Master Plan. In cases of massive urban sprawl by land sales, however, the central government still asserts its control on local development by the tools of a National Main-function Plan or National Land-use Plan. It is the conflict of the orientation of two spatial policy modes that brings about the discoordination between multiple spatial plans. The paper suggests that other than some innovations in spatial planning tools or instruments, promoting reform is fundamental to re-establishing the relationships between central and local government, such as reducing the constraints of planning censorship systems, and rebalancing responsibilities and the public finance of local government on planning matters.

A consensus is building on integration becoming a shaper of spatial planning systems. It seems that in some aspects spatial planning is aimed at handling "the problem of coordination or integration of the spatial dimension of sectoral policies through a territorially-based strategy" (Cullingworth & Nadin, 2006). There are still discussions on how to achieve planning integration in practice in China, and as such, the third paper, "An Exploration on How to Lead the Transformation of Small and Medium-Sized Cities by Integration of Multi-Planning: Case Study of Jieshou City, Anhui Province, China", shows a method of integrating multiple spatial plans with a practical planning case (Wan, Li & Tan, 2018). The authors pay attention to small and medium-sized cities, for they are faced with limitation of spatial resources in the course of development, and integrated spatial planning can help to make the most of the resources to achieve a better development goal.

The fourth paper, "Review on Practice of Provincial Spatial Planning: Case of a Western Less Developed Province", contributes a new spatial planning system framework and integral spatial plan-making method based on the administrative territory of province rather than that of municipality (Lian, 2018). To integrate a current fragmented spatial planning system as well as ensure the sustainable development of Ningxia, the author introduces a two-level framework, in which the provincial level spatial plan mainly focuses on strategic spatial policy-making, whereas the city level delimits "3 zones and 3 lines" (namely ecological zone, agricultural zone, urban zone; ecological red line, urban development boundary line, and permanent basic farmland red line). The author develops a five-step planning process to demonstrate a two-level spatial planning framework, and also develops a Land Development Suitability Evaluation to support the delimiting of "3 zones and 3 lines".

Other than spatial planning system integration, there are also papers which contribute supporting instruments to spatial plan-making and spatial policy-making with empirical study. On the regional scale, the hierarchy and distribution of urban systems is also vital knowledge in the making of spatial planning such as how to model the regional structure by city size and function. The fifth paper, "Triangle Law or Power Law? City Size

Distribution in Sub-national Levelled Administrative Areas in China", introduces a new pattern of city size distribution within China, which is called Triangle Law (Li & Zhang, 2018). The authors argue that in China, power law distribution, which is the commonly acknowledged city size distribution law, does not fit the city size distribution in sub-national administrative regions, instead, a newly-introduced Triangle Law could provide a better fit. The phenomenon means the city administrative system has shed light on the city size distribution in sub-national China, as the result, institutional influence was the main influence factor of the city size distribution law.

In addition, newly emerging technology, methodology and database systems will also support the improvement of spatial plan-making. The sixth paper, "Determining Non-Passenger Data from WiFi Scanner Data (MAC Address), A Case Study: Romango Bus, Obuse Town, Nagano Prefecture, Japan", contributes a data processing technique via a transportation survey of spatial planning (Hidayat, Terabe, & Yaginuma, 2018). The authors developed a data processing procedure to combine raw WiFi data and GPS log data into non-passenger data. The proposed method is appropriate for the long-term data collection of daily variations, and there is no need to communicate with human or object when collecting data.

This special issue is one of the outputs of the (virtual) Workshop on Urban Planning and Management held on 6th February in 2018 at Kanazawa University in Japan. We hope that the perspectives, approaches and solutions being acquired from the spatial planning research in these cases provide good inspiration for similar work of other cities and regions globally. Finally, we would like to express our sincere gratitude to all the authors and reviewers for their efforts in their research, submissions and the hard work throughout the publication process.

REFERENCES

Cullingworth, B., & Nadin, V. (2006). *Town and Country Planning in the UK. Fourteenth edition*. Routledge, London.

Hidayat, A., Terabe, S., & Yaginuma,H. (2018). "Determine Non-Passenger Data from WiFi Scanner Data (MAC Address), A Case Study: Romango Bus, Obuse Town, Nagano Prefecture, Japan", *International Review for Spatial Planning and Sustainable Development*, *6* (3), 154-167. doi: http://dx.doi.org/10.14246/irspsda.6.3_154.

Hu, T & Zhou, J. (2018). "Co-exist or Integration? Discussing the Spatial Planning Reform of China from the Perspective of Central-Local Relation", *International Review for Spatial Planning and Sustainable Development*, *6* (3), 168-184. doi: http://dx.doi.org/10.14246/irspsda.6.3_168.

Kai, B. (2007). "European Spatial Policy-Making", 8 pages.
http://commin.org/upload/European_Spatial_Policy/European_Spatial_Policy-Making.pdf.

Li, W., & Zhang, Y. (2018). "Triangle Low or Power Law? City Size Distribution in Sub-national Levelled Administrative Areas in China", *International Review for Spatial Planning and Sustainable Development*, *6* (3), 203-215. doi: http://dx.doi.org/10.14246/irspsda.6.3_203.

Lian, X. (2018). "Review on Advanced Practice of Provincial Spatial Planning: Case of a Western, Less Developed Province", *International Review for Spatial Planning and Sustainable Development*, *6* (3), 185-202. doi: http://dx.doi.org/10.14246/irspsda.6.3_185.

Liu, J. (2018). "Coordination through Integration: A critical review on French spatial policy and spatial planning system", *International Review for Spatial Planning and Sustainable Development*, *6* (3), 125-140. doi: http://dx.doi.org/10.14246/irspsda.6.3_125.

Wan, J., Li, Y., & Tan, Z. (2018). "Exploring on How to Lead the Transformation of Small and Medium-Sized Cities by Integration of Multi-Planning: Case Study of Jieshou City, Anhui Province, China", *International Review for Spatial Planning and Sustainable Development*, 6 (3), 141-153. doi: http://dx.doi.org/10.14246/irspsda.6.3_141.

Coordination through Integration

A critical review on the spatial policy and spatial planning system of France

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Abstract: In this template file as introduction for the format of this journal. As a country with a long history of spatial development, France is distinguished in the world by its profound tradition of spatial planning. Since the mid-20th century, a multi-dimensional spatial policy framework and a multi-layered spatial planning system have been established and developed successively, for the purpose of guiding comprehensive and well-balanced spatial development all over the country. They help promote balanced regional development and urban-rural development, implement special management over specific areas, and encourage the cooperation of governments and departments at various levels. As a critical review on the spatial policy framework and the spatial planning system of France which have been in force since the 2000s, this paper analyses in a systematic way the structure of the policy framework and the planning system respectively, as well as the interrelation between spatial policies with spatial plans, elaborates the hidden logic of coordination through an integrated spatial planning system for the purpose of a well-balanced spatial development all over the country, and summarizes some key facts that guarantee the efficiency of coordination through integration, such as cooperation among governments and departments, presenting integration in urban plans, and the active role of central government. It concludes that the French experience of coordinating various spatial plans formulated by different stakeholders at different levels through an integral spatial planning system based on an integral spatial policy framework can serve as inspiring reference for developing countries like China that are facing the urgency of structuring an integral spatial planning system to deal with the disconnection or even conflict among different departmental plans concerning spatial development.

1. INTRODUCTION

Up to now in China, since its reforms and opening-up in the 1980s, there has been the co-existence of multiple spatial planning systems, including but not limited to Five-Year Socio-Economic Development Planning, Urban-Rural Planning, Land Use Planning, and Environmental Protection Planning. They are under the jurisdiction of different governmental departments and intervene in the country's spatial development simultaneously from different perspectives. However, due to the lack of efficient coordination resulting

from departmental independence, there is often the problem of disconnection or even conflict among them, which leads to not only unnecessary confusions but also low efficiencies in practice. When this problem, as well as its consequences, becomes more and more significant along with the acceleration of China's urbanization, efforts are made by different parties in different ways to promote the coordination of various spatial planning systems, such as the institutional reform of governmental departments, the technical innovation of planning practices, and the theoretical exploration of the planning profession (Huang, 2012; Lai et al., 2013; Luo & Mao, 2015). Amid this process, more focus is paid to structuring an integral spatial planning system (Xie & Wang, 2015; Zhu, Deng, & Pan, 2015), with regard to which the experience of developed countries are often taken as reference, such as that of the Netherlands (S. Zhang, Feng, & Liu, 2014; J. Zhou, Hu, & Gu, 2017), Germany (Z. Zhang & Huang, 2007; Y. Zhou, Pu, & Zhang, 2006), the UK (Yang, 2016; S. Zhou, Zhai, & Shi, 2017), France (Liu, 2011; Zhuo & Liu, 2004), and so on.

As a country with a long history of spatial development, France is distinguished in the world by its profound tradition of spatial planning. Since the 20th century, particularly after the Second World War, a multi-dimensional spatial policy framework and a multi-layered spatial planning system have been established and developed successively, for the purpose of achieving comprehensive and well-balanced spatial development all over the country (Bertrand, 2005; Ecrement, 2002; Gambino, 2010; Geppert, 2015; Ministère des Affaires étrangères, 2006). They help promote balanced regional development and urban-rural development, implement special management over specific areas, and encourage the cooperation of the governments and departments at different levels. The French experience of coordinating various spatial plans formulated by different stakeholders at different levels through an integral spatial planning system based on an integral spatial policy framework can serve as valuable reference for developing countries like China that are facing the urgency of structuring a spatial planning system to deal with the disconnection or even conflict among various departmental plans concerning spatial development.This paper is a critical review on the spatial policy framework and the spatial planning system of France which have been in force since the 2000s, with specific concern regarding coordination and integration to guarantee well-balanced nationwide spatial development. It analyses in a systematic way the structure of the policy framework and the planning system respectively, as well as the interrelation between spatial policies and spatial plans, elaborates the hidden logic of coordination through an integrated spatial planning system for the purpose of a well-balanced spatial development, and summarizes some key facts that guarantee the efficiency of coordination through integration, such as cooperation among governments and departments, presenting integration in urban plans, and the active role of central government. It concludes that the French experience of coordinating various spatial plans formulated by different stakeholders at different levels through an integral spatial planning system based on an integral spatial policy framework can serve as a model for developing countries like China to structure an integral spatial planning system to face the need of coordination.

2.   RESEARCH APPROACH

In France, spatial development and planning refers to the action and practice of distributing the population and their activities, as well as the facilities and communication modes they might use, on the territory of the country in a prospective vision, while taking into account the constrains of nature, humans, economy and strategy (Merlin & Choay, 1988). As guidance to achieving a comprehensive and well-balanced spatial development in the country, the French spatial policy framework and spatial planning system cover all the national territory, concern all the territorial levels, and involve all the aspects of socio-economic development. At the turn of the new millennium, in response to the new challenges of sustainable development, economic globalization and European unification, and under the circumstance of administrative decentralization, which tends to transfer some decision-making and administrative powers of the State to local territories, including those of spatial planning, according to the Defferre Act of 7 January 1983 relative to competence distribution, remarkable amendments were made with the French spatial policy framework and spatial planning system, according to the Pasqua Act of 4 February 1995 (LOADT) and the Voynet Act of 25 June 1999 (LOADDT), two important acts relative to spatial development and planning. In spite of that, the goal, the structure and the characters of the French spatial policy framework and spatial planning system never change.

Based on mainly literature work, this paper tries to elaborate the hidden logic of coordination through integration for the purpose of promoting well-balanced spatial development in France. In the following sections, it firstly outlines the French spatial policy framework by clarifying its compositional structure, application scope, and expression form and commenting the specific policies of each category from the aspects of objectivity and responsibility. It then reviews the multi-levelled French spatial planning system, from macro to micro, as concrete expression of the spatial policies, in terms of mission, coverage, contents, and responsibility, as well as the interrelationship between various plans. It goes further to articulate the implementation of the above mentioned spatial policies and spatial plans within the structure of the French administration system, highlighting the mechanism of collaboration and cooperation, based on different kinds of contracts, among the governments and their departments of different levels. Finally, it summarizes the key elements of the successful French experience of coordinating various spatial plans formulated by different stakeholders at different levels through an integral spatial planning system based on an integral spatial policy framework.

3.   SPATIAL POLICY FRAMEWORK OF FRANCE

The current French spatial policy framework is composed of three kinds of policies, i.e. comprehensive policy, special policy and sectoral policy, with the latter two being the complement and extension of the former one. Aimed at guaranteeing the sustainable development of the country and the common interests of the society, they function together to guide the actions or practices of spatial development that take place all over the country or in certain areas of the country, involving all the territorial levels of State, Region, Department, Commune, and Inter-Communality and concerning all the socio-economic aspects of economy, housing, transportation, culture,

education, and so on (*Table 1*). According to the Constitution Amendment Act of 2003, there are three kinds of local territories in France, i.e. Region, Department and Commune. This administrative division system is characterized by a large number of small Communes, without distinction among cities, towns and villages. Due to the large number of small Communes, the Inter-Communal administration system has been in a developed state for a long time, in order to facilitate administration and governance. In reality, there are several kinds of Inter-Communal Associations, such as the Public Agency of Inter-Communal Cooperation (EPCI). Currently in France, there are 18 Regions, 101 Departments, and 36,658 Communes, plus 9,711 EPCIs and about 2,800 other kinds of Inter-Communal Associations. Moreover, for the purpose of promoting and coordinating regional development that crosses administrative boundaries, there are more and more Inter-Regional and Inter-Departmental Associations in France.

From the 2000s, the French spatial policies were mainly oriented to strengthening the attractiveness and competitiveness of the national economy by fostering the growth of new industries and new industry agglomerations and supporting the development of new local economies, so as to promote economic restructuring, and strengthening the social solidarity and regional balance of the country through the implementation of large-scale projects, the construction of transportation facilities and digital communication facilities, and the modernization of public service facilities, so as to promote the development of the area's difficulties and disadvantages.

Table 1. The current spatial policy framework of France

Policy category	Policy sub-category	Applicability	Policy expression
Comprehensive spatial policy		Jurisdiction area of the State, Regions, Departments, Communes and Inter-Communalities	Comprehensive spatial plans formulated respectively by the central and the local governments
Special spatial policy	Urban policy	Urban area	Special spatial plans formulated through the collaboration between the central and the local governments concerned
	Policy for living areas	Basin area of daily living	
	Policy for rural areas	Rural area	
	Policy for mountain and coastal areas	Mountain and coastal areas	
Sectoral spatial policy	Economic policy Housing policy Transportation policy Culture policy Higher education and research policy Health policy Energy policy Information and communication policy Natural and rural area conservation policy Others	Jurisdiction area of the State, Regions, Departments, Communes and Inter-Communalities	Sectoral spatial plans formulated respectively by the central and the local governments

3.1   Comprehensive spatial policy

The comprehensive spatial policy refers to the comprehensive strategies of spatial development which are formulated respectively by the central and the local governments and are applicable to the corresponding jurisdiction areas. Being the main body of the French spatial policy framework, they concern the multiple aspects of society, economy, environment, culture, and urban construction, etc. and are elaborated through the comprehensive spatial plans of various levels.

Table 2. The comprehensive spatial policy expressed through the comprehensive spatial plans in France

Spatial planning system	Title of spatial Plan	Applicability	Organizer	Planning permit management
National planning	*National Sustainable Development Plan (SNADT)*	National territory	State	None
	Collective Services Blueprint (SSC)			
Regional planning	*Regional Spatial Planning and Development Blueprint (SRADT)*	Jurisdiction area of Regions	Region	None
Regional urban planning	*Spatial Planning Directive (DTA)*	Jurisdiction area of Regions and/or Inter-Regional or Inter-Departmental Associations	State or Region, in collaboration with the Regions and/or Departments concerned	None
	Territorial Cohesion Blueprint (SCoT)	Jurisdiction area of Departments, Inter-Departmental Associations, or Inter-Communalities	Department, Inter-Department Association, or Inter-Communality	None
Local urban planning	*Local Urban Planning Map (PLU)*	Jurisdiction area of Communes or Inter-Communalities	Commune or Inter-Communality	Commune or Inter-Communality
	Communal Map (CC)	Jurisdiction area of Communes	Commune	Commune
	National Urban Planning Regulations (RNU)	Jurisdiction area of Communes without either a *Local Urban Planning Map* or a *Communal Map*	State	State

Since the 2000s, these comprehensive spatial plans have included the National Sustainable Development Strategy (SNADT) or Collective Services Blueprint (SSC) at the national level, the Regional Spatial Planning and Development Blueprint (SRADT) at the Regional level, the Spatial Planning Directive (DTA) and the Territorial Cohesion Blueprint (SCoT) at the Inter-Regional, Inter-Departmental and/or Inter-Communal levels, and the Local Urban Planning Map (PLU), Communal Map (CC), and National

Urban Planning Regulations (RNU) at the Communal and/or Inter-Communal levels, all of which compose the main body of the French spatial planning system (*Table 2*). Although these plans are formulated by different territorial authorities, i.e. the State, Regions, Departments, Communes and Inter-Communalities, representing different interests and elaborating different objectives, they are all integrated into the unique spatial policy framework and spatial planning system, with the superior level plans being compulsory to the inferior level plans.

3.2   Special spatial policy

In some sense, the special spatial policy is a kind of comprehensive policy, but it concerns only four kinds of areas delimited according to specific statistical criteria. They are urban areas, living areas, rural areas, and mountain and coastal areas, with regard to which, the central government collaborates with the local governments concerned to work out special spatial plans in view of the local conditions and needs, which are then included in the contracts between the central and the local governments. The special spatial plans must accord with the comprehensive spatial plans of the superior levels, as well as those of the same level.

According to the definitions issued by the National Institution of Statistics and Economics Studies of France, an urban area (aire urbaine) refers to a group of Communes on a continuous territory without enclave which is composed of an urban center (pole urbain, the center of an urban unit (unite urbaine) which is a Commune or a group of Communes with a continuous built-up area, i.e. no more than 200 meters between two buildings, accommodating a population of no less than 2,000) offering more than 1,500 jobs, as well as a number of rural Communes (Communes rurale) belonging to no urban units, or urban units as suburban ring (couronne), where at least 40% of the local residents have a job in the urban center or in the Communes attracted by it (Institut National de la Statistique et des Études Économiques). A living area (bassin de vie) refers to the smallest scope where people have access to the most common equipment and services of personal services, commerce, education, health, sports, culture and leisure, and transportation (Institut National de la Statistique et des Études Économiques). and where urban, suburban and rural areas meet with each other, ignoring the administrative boundaries. The rural area refers to all the small urban units and rural Communes (commune rurale) that do not belong to any urban centers, suburban rings, and multi-centered Communes (commune multipolarisee), where no less than 40% of the local resident labor force working in several urban areas and which, together with these urban areas, form a continuous territory.

The special policy for urban areas concerns respectively the metropoles as engine of the national economy, the conurbations as agglomeration of urban Communes, the medium-sized cities as employment and service centre for rural areas, and the needy neighbourhoods in the above-mentioned urban areas. That for metropoles was firstly carried out in 2003 in the areas with a population over 500,000, except Paris Region, which includes at least one urban area of over 200,000 residents, in hope of strengthening the international competitiveness of the metropoles by promoting the internal cooperation and integration and the growth of new urban centres as well. That for conurbations was firstly applied in the late 1990s to the Inter-Communalities that comprise several Communes forming a continuous territory, without enclave, and centred on a Departmental capital or one or

more central Communes of more than 15,000 residents, with a population over 50,000, aimed at reducing the disparity and promoting the integration between the Communes through internal collaboration. That for medium-sized cities was implemented in 2006 in the urban areas with populations varying between 30,000 and 200,000, in order to revitalize the local economy by improving the accessibility to railways and aviation and the public services of education, culture and healthcare. That for the needy neighbourhoods in the above-mentioned urban areas was enforced since the early 1980s, for the sake of promoting the urban regeneration and social integration of the urban neighbourhoods' difficulties and disadvantages, due to socio-economic transition, by way of rehabilitating old houses, upgrading public services, and providing more job opportunities.

The special policy for living areas was put into effect in 2003 in the legally designated living areas, i.e. the areas where the residents share common geographical, cultural, economic or social interests within the same catchment area for work and leisure. Based on the long tradition of Inter-Communal cooperation and the support of local civil societies, it is for the purpose of promoting the coordination among the Communes concerned and between the urban and rural areas, with a focus on the issues of public transportation, personal services for aging and kids, medical care service, and health care facilities, etc.

The special policy for rural areas classifies rural France into three categories, i.e. the rural areas' neighbouring cities, the new rural areas with tourism potentiality, and the traditional rural areas far from cities. It was carried out from 2005 for the purpose of maintaining the economic vitality, improving the living conditions, and protecting the natural environment of the rural areas through the implementation of a number of projects, such as Excellent Rural Centre (PER), Rural Revitalization Area (ZRR), and Regional Natural Park (PNR). As the three kinds of rural areas face different problems and challenges due to the differences in geographic location and socio-economic development, the policy tries to tackle them through different countermeasures, addressing challenges such as the conflict between real estate development and natural site protection for the rural areas' neighbouring cities, the weakened role of ecological protection due to the continuous inflow of migrants to new rural areas with tourism potentiality, and the dilemma of low revenue, decreasing population and stagnating economy for the traditional rural areas far from cities (Liu, 2010).

The special policy for mountain and coastal areas concerns the nine mountain areas of France, accounting for 29% of the national territory, and the littoral along the coastline of 7,200 kilometres. It was implemented in the 1980s with the objective of promoting ecological sustainability through limited urban development, diversified economic development, and integrated governance.

It should be noted that, as the four kinds of special areas are delimited according to statistical criteria, their scopes may change whenever a locality fails to meet the criteria. There is also the phenomena of one kind of area overlapping with other ones, especially between living areas and rural areas, which often results in confusion and difficulties in the implementation of special spatial policies.

3.3   Sectoral spatial policy

The sectoral spatial policy is an important complement to both the comprehensive and the special policies, which concerns the sectors of

economy, housing, transportation, education, public services, and so on, in response to the actual needs of the socio-economic development. It is expressed through a series of sectoral plans which are formulated either by the central and the local governments respectively or through the collaboration between them, within the scope of their respective authorities, and are applicable to the corresponding jurisdiction areas.

For example, as higher education is an authority of the central government, the sectoral plan for higher education development is formulated by the central government and applicable to the whole country. As economic development is the authority of the local governments at all levels, but with different focuses one from another, the sectoral plans for economic development are formulated respectively by the local governments at various levels and applicable to the corresponding jurisdiction areas. For the economic development of any of the four special areas, such as the rural areas, the sectoral plan is then formulated through the collaboration between the central and the local governments concerned and applicable to the specific areas concerned. However, no matter who is in charge and what are the contents of the plans, the sectoral plans must accord with the comprehensive plans of both the superior and the same levels, as well as the sectoral plans of the superior levels.

4.   SPATIAL PLANNING SYSTEM

As carrier of comprehensive spatial policies, the comprehensive spatial plans constitute the main body of the French spatial planning system which is an hierarchical system including SSC as the national plan, SRADT as the regional plan (Regional), DTA and SCoT as strategic urban plan at the regional level (Inter-Regional, Inter-Departmental, Departmental and Inter-Communal), PLU, CC and RNU as regulatory urban plan at the local level (Inter-Communal and Communal) (Table 2), and the Plan of Protection and Enhancement (SPMV) and the Plan of Concerted Development Zone (PAZ) as operational urban plan at the neighbourhood level (Secrétariat Général du Gouvernement, 2018). All these plans are formulated respectively by the central and the local governments and play the role of guiding the actions and practice of spatial development taking place on the corresponding territories. Among them, the national plans, Regional plans and regional-level urban plans play the role of strategic guidance, while the local urban plans, i.e. the regulatory and operational urban plans, have a normative effect. All the superior level plans are compulsory to the inferior level plans while all the inferior level plans should respect the regulations of the superior plans.

4.1   SSC as strategic national plan

SSC was instituted by the Voynet Act of 25 June 1999 to play the role of national plan in place of SNADT which was instituted by the Pasqua Act of 4 February 1995, but never formulated under the circumstance of administrative decentralization. It refers to a series of reference planning documents concerning the collective services of higher education and research, culture, health, information and communication, transport, energy, natural and rural space and sport, all of which are thought strategic for the sustainable development of the country. Being a sectoral spatial plan covering the whole national territory, these planning documents are

formulated by the central government for the purpose of assuring the strategic role of the State in spatial development and facilitating the formulation of SRADT which shapes the contents of the contract between the State and the Regions over a long-term period of 20 years. They are approved by a decree of the State Council after consultation at the Regional scales.

4.2   SRADT as strategic regional plan

SRADT was instituted by the Pasqua Act of 4 February 1995 which later on, as sustainable development became a primary concern in French society, was renamed the Regional spatial Planning and Sustainable Development Blueprint (SRADDT). After France restructured the administrative division of Regions in 2016, SRADDT was required to be integrated with other sectoral plans at the Regional level, into the Regional Spatial Planning, Sustainable Development and Equity Blueprint (SRADDET).

SRADT was formulated by the Regional government, in collaboration with certain local governments and Inter-Communalities, Regional Natural Parks, living areas, and civil societies, and approved by the Regional Council. Being a comprehensive spatial plan for a Region without normative effect, it is meant to set up the guidelines for the Region's sustainable development over a long-term period of 20 years and to shape the contents of the contract between the State and the Region concerned, with respect to SSC. It deals with the issues of the location of major facilities, infrastructure and services of general interest, the development of economic projects, the harmonious development of urban, suburban and rural areas, the protection and conservation of environment, landscape and natural heritage, the rehabilitation of derelict areas, the incorporation of Inter-Regional or cross-border planning, and the infrastructure program and the organization of regional transportation, more specifically, rail transport.

4.3   DTA and SCoT as strategic urban plan at the regional level

DTA, renamed as Spatial Planning and Sustainable Development Directive (DTADD) according to the Grenelle II Act of 12 July 2016 to show the considerations on environment, targets the specific areas with strategic significance, including those where it is hard to lay out major transportation infrastructure and social service facilities due to geographical constrains, as well as those that are facing demographic pressures, land shortage, and ecological risks, such as the coastal areas, mountain areas and urban peripheries. It aims at strengthening the coherence and coordination of various national spatial policies concerning the above-mentioned areas, controlling the actions of local governments in spatial development, and specifying the special spatial policy for mountain and coastal areas, so as to balance development and preservation and to maintain social mix and urban diversity. It sets out from the national or regional perspective the objectives of governing and balancing the development, preservation and utilization of territory, as well as the principles for laying out large-scale transportation infrastructure and public service facilities and preserving natural spaces and historic sites. The formulation of DTA is at the initiative of either the State or the Region and is conducted by the central government in association with the local authorities concerned, including Regions, Departments,

Communes and Inter-Communalities. Thus, the formulation itself is a process of negotiation for common views among the stakeholders, which favours a partnership among them. It is approved by a decree of the State Council after a consultation with the Inter-Ministry Committee of Spatial Planning and Development (CIADT) and is compulsory to SCoT and inferior level urban plans.

Transformed from the Master Plan of Spatial and Urban Development (SDAU) instituted in the 1960s, SCoT was instituted by the Urban Solidarity and Renewal Act of 13 December 2000 (SUR) for the purpose of coordinating the sectoral policies relating to urban planning, housing, transportation and commercial facilities. Targeting the specific area of conurbations on a continuous territory without enclave, it is formulated by either the Departmental government or the Inter-Communality concerned, following the principles of balanced development, urban renovation, land use efficiency, social mix and environmental preservation. It sets out the general guidelines of spatial planning over the long-term to maintain a balance between the built-up, natural, farming or forest areas, as well as the objectives for balancing housing, social mix, public transport, and commercial and business facilities. In line with the SRDAT concerned, as well as the DTA concerned in case of existence, it is based on a Spatial Planning and Sustainable Development Proposal to show due considerations on environment. It is reviewed every ten years to ensure its actual efficiency.

4.4   PLU, CC and RNU as regulatory urban plan at the local level

Both PLU (including PLUI for Inter-Communalities) and CC are instituted by the Urban Solidarity and Renewal Act of 13 December 2000, replacing the previous regulatory urban plan, Land Use Plan (POS). They target large- and medium-sized Communes / Inter-Communalities respectively and are formulated by the Communal / Inter-Communal governments for purpose of zoning the Commune / Inter-Communality into four areas, i.e. general urban area, urban facility area, urban green area, and natural and forestry area, and set out the planning regulations of building and land-use, as the basis for urban planning management. They are also based on a Spatial Planning and Sustainable Development Proposal to show due considerations on environment.

As the French administrative division system is characterized by a large number of small Communes, there are always the Communes / Inter-Communalities that are not able to formulate even a CC due to various reasons, such as the lack of technical force, the insufficiency of financial support or the too small scale of population. In these cases, the RNU formulated by the agencies of the central government will take place of CC as the regulatory urban plan. Following the principle of limited construction, that is to prohibit any new constructions outside any actual urbanized areas, it aims at restraining disordered urban sprawl and protecting natural spaces and landscape. Taking into consideration the actual situation of existing constructions and their relationship with the surrounding environment, it delineates the actual urbanized areas and sets out the planning regulations of building and land-use on the commonly agreed constructible lands.

4.5　PSMV and PAZ as operational urban plans at the local level

Targeting historic neighbourhoods and urban renovation or new development areas respectively, PSMV and PAZ are formulated and approved by the local government of Communes / Inter-Communalities, for the purpose of defining the planning and design of the construction projects on the territory concerned, so as to regulate the actions of construction and development. In the case that an urban renovation or new development project is nominated as an Operation of National Interest (OIN), the PAZ can also be formulated by the agencies of the central government (Liu, 2013a, 2013b).

5.　IMPLEMENTATION OF SPATIAL POLICIES AND SPATIAL PLANS

As French spatial policies are embodied in a series of comprehensive, special and sectoral spatial plans that involve the multiple territorial levels of State, Region, Department, Commune, and Inter-Communality, the specific areas crossing the administrative borders of Regions, Departments, Communes and Inter-Communalities, and the multiple aspects of economy, transportation, culture, education, and so on, the implementation of these spatial policies and plans is inevitably a participatory process by all the central and the local governments, as well as their departments concerned. This process can be simplified as "one region, one strategy and one contract", with "one region" referring to the jurisdiction area of a certain authority to which specific spatial policies and plans are to be applied, "one strategy" referring to the spatial policies and plans to be implemented, and "one contract" referring to the cooperation contract between the central and the local governments to implement the specific spatial policies and plans. In detail, for the spatial development of a certain area, the central and the local governments, as well as their departments concerned, should formulate respectively the spatial plans within their respective authority and take their responsibility to implement the spatial plans respectively within the framework of a cooperation contract between them. In France, the contractual approach of inter-governmental cooperation was established in the 1960s and 1970s, for the purpose of promoting cooperation between the central and the local governments in the field of spatial development, by specifying the goals, actions and financial terms of the spatial development projects which they will respectively or jointly implement.

5.1　Planning Contract between Central and Regional Governments

The Planning Contract between Central and Regional Government was instituted by the Act of 29 July 1982 as part of the regional planning process. It outlines the strategic priorities for a Region which are a focal point for discussions between the central and Regional governments. Based on the discussions, the two parties agree on an action plan of spatial development in the Region, covering the subjects of major infrastructure for transportation or higher education, regional industry or agriculture, and research, health, culture, etc., as well as the financing program for the

actions. The contract consists of three sections, dealing with the Regional, the local, and the Inter-Regional projects respectively.

In 2006, based on a series of consultations, the contractual approach was transformed into the Project Contract between Central and Regional Government, focusing mainly on three priorities. The first is local competitiveness and attractiveness, with support to competitive industrial clusters, research and higher education, urban facility construction, agricultural development, and transport network upgrading and expansion, excluding the expressways and rail transport. The second is the environmental dimension of sustainable development, including the fight against climate change, the comprehensive and balanced management of water resources, the increasing awareness of natural and technological risks, and the maintenance and enhancement of biodiversity. The third is social and spatial integration, concerning employment and vocation training, economic change, urban renewal, and the specific problems of overseas Departments and mountain areas.

5.2   Local Project Contract

As one of the three sections of the Planning Contract between Central and Regional Government, the Local Project Contract is applicable to certain areas within a Region, such as conurbations, living areas, and Regional Natural Parks, regarding which the localities concerned can sign a contract with the central government and the Regional or Departmental government, within the framework of the Planning Contract between Central and Regional Government, on the implementation of the spatial development projects of transportation, education, economy, urbanization, urban renewal, and so on. The existing Local Project Contracts mainly deal with the sustainable development policies for conurbations, the construction of local digital networks to enhance economic competitiveness, the local strategies for coping with climate change, the prevention of natural risks, the adaptation of public services, and the initiation of innovative personal services, etc.

5.3   Diversity of Contracts

In practice, the contractual approach is quite flexible and diverse, leading to the coexistence of different types of contracts. Each Regional or Departmental government can implement one or more types of contracts relating to specific areas within the Region or Department. The central government can sign a wide range of contracts besides the Planning Contract between Central and Regional Government and the Local Project Contract, for example, the site contracts introduced in 2003, such as City Contract and Urban Social Cohesion Contract, to help the areas struggling with industrial restructuring to revive the economy and create new jobs, and the contracts with large state-owned enterprises, such as the Post Office of France, Electricity of France (EDF), and Gas of France (GDF), to set out the objectives of spatial development for these enterprises.

guarantees the authority of the central government in spatial development and planning to achieve the goal of balanced spatial development over the whole country, while respecting and meeting the specific demands of the localities.

6.4   Presenting Integration in Urban Plans

The French spatial planning system prescribes that regional planning is compulsory to urban planning and superior level urban planning is compulsory to inferior level urban planning. This makes the local urban planning at the bottom of the spatial planning system become the ultimate embodiment of all the superior level spatial policies and the ultimate collection of all the superior level spatial plans (*Figure 1*). Being a kind of regulatory spatial plan regarding a Commune or an Inter-Communality, it concretizes the spatial development projects, proposed by the superior level spatial plans according to the spatial policies of the superior level governments, in the regulations of land use and spatial layout, so as to ensure the integration and the realization of the superior level spatial policies and plans.

6.5   Active Role of Central Government

According to the Constitution Amendment Act of 2003 and as result of the administrative decentralization since the 1980s, the local governments of France are endowed with different authorities and powers and they operate independently following the principles of free administration, no oversight of one over another, financial autonomy, and central government supervision after the fact. This institution gives the local governments full autonomy of spatial planning within the scope of their respective authority. In spite of that, the central government still retains the right of direct or indirect intervention on the local spatial development and planning through top-level design and plays an active role in spatial policy-making and spatial planning, so as to guarantee a comprehensive and well-balanced spatial development across the country. For example, on the one hand, it may prescribe the powers and responsibilities of spatial development and planning of the local governments by structuring the spatial planning system, issue spatial policies to show the national orientations on spatial development and planning, and set up contracts with the local governments to join the implementation of spatial plans; on the other hand, it may formulate DTA in collaboration with the local governments concerned for some strategic areas, such as socially and ecologically vulnerable areas, formulate regulatory urban plans for the Communes or Inter-Communalities that are incapable of accomplishing the mission, and formulate operational urban plans and conduct planning permission management for the major development areas which are significant to the national economy and people's livelihoods, especially those representing national competitiveness.
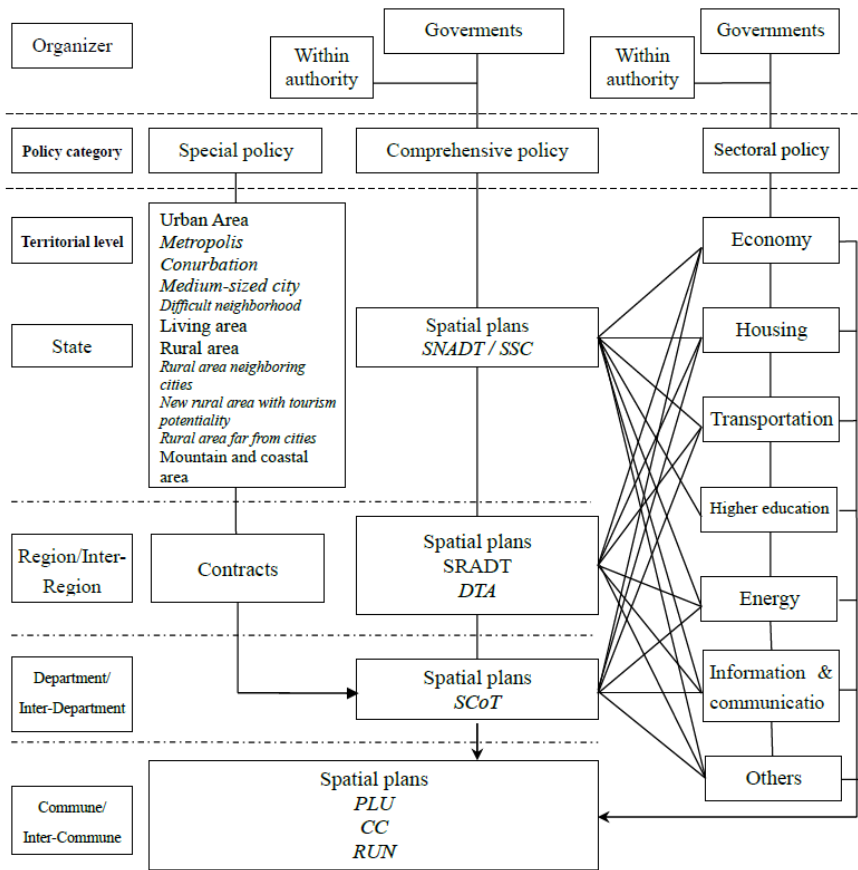
Figure 1. Interrelation between spatial policies and spatial plans in France

REFERENCES

Bertrand, F. (2005). "Aménagement du territoire et développement durable", La documentation française.

Ecrement, B. (2002). "Urbanisme, habitat, déplacement: l'expérience de la France (1950-2000)", *Texte Disponible En Ligne Sur Le Site Du Centre de Documentation de l'urbanisme*.

Gambino, M. (2010). "Politique d'Aménagement du Territoire, Agriculture Energie 2030", Ministère de l'Agriculture, de l'Alimentation, de la Pêche, de la Ruralité et de l'Aménagement du Territoire, Centre d'Etudes et de Prospective-Service de la Statistique et de la Prospective.

Geppert, A. (2015). "Planning without a spatial development perspective? The French case", *Planning for States and Nation/States: A TransAtlantic Exploration.* 381–410.

Huang, Y. (2012). "Institutional reform and plan integration: Observation and thinking of domestic Three Plans' Integration", *Modern Urban Research*, *27*(2), 10–14. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTotal-XDCS201202005.htm

Institut National de la Statistique et des Études Économiques (INSEE). https://www.insee.fr/fr/metadonnees/definition

Lai, S., Huang, H., Chen, J., & Chen, X. (2013). "From technical innovation to institutional innovation: Three-Plan-Coordination practice in Heyuan, Yunfu and Guangzhou", *Urban Planning Forum*, *210*(5), 63–68. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTotal-CXGH201305009.htm

Liu, J. (2010). "Rural development and its planning management in France: An experience in line with the principle of balanced urban-rural development", *Urban Planning International*, *25*(2), 4–10.

Liu, J. (2011). "Policy framework and planning system of territorial development in France: Characteristics and inspirations", *City Planning Review*, *35*(8), 60–65. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-CSGH201108015.htm

Liu, J. (2013a). "Practice of historic preservation in France: A case study on Paris", *Beijing Planning & Construction*, *27*(3), 22–28.

Liu, J. (2013b). "Urban renovation through holistic creation in France: The planning mechanism of ZAC and its implementation in Paris", *Urban Planning International*, *28*(6), 57–66.

Luo, Y., & Mao, D. (2015). "Progress on study about planning coordination and merge in China", *Journal of Urban Studies*, *36*(2), 77–81. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTotal-YYSZ201502015.htm

Merlin, P., & Choay, F. (1988). "Dictionnaire de l'urbanisme et de l'aménagement",.

Ministère des Affaires étrangères, D. générale de la C. internationale et du D. (2006). "Spatial Planning & Sustainable Development Policy in France", Mediatys / Groupe Corlet, Paris.

Secrétariat Général du Gouvernement (SGG). (2018). "Code de l'Urbanisme". Retrieved from https://www.legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000006074075

Xie, Y., & Wang, W. (2015). "From multiple-plan coordination to the reform of the spatial planning system", *Urban Planning Forum*, *223*(3), 15–21. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTotal-CXGH201503003.htm

Yang, D. (2016). "Reconstructuring sustainable spatial planning system: Innovation and relevant debates of the UK government since 2010", *City Planning Review*, *40*(8), 91–99. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTotal-CSGH201608018.htm

Zhang, S., Feng, C., & Liu, C. (2014). "Progress of Dutch Spatial Planning System", *Urban Planning International,* *29*(5), 89–94. Retrieved from http://www.upi-planning.org/EN/Magazine/Show.aspx?ID=45434

Zhang, Z., & Huang, D. (2007). "The enlightenment of German experience of spatial planning system reform to the Chinese counterparts", *Modern Urban Research*, *22*(6), 11–18. Retrieved from http://en.oversea.cnki.net/kcms/detail/detail.aspx?QueryID=16&CurRec=1&dbCode=CJFD&filename=XDCS200706002&dbname=CJFD2007

Zhou, J., Hu, T., & Gu, Y. (2017). "National spatial planning and coordination system in the Netherlands", *Planners*, *33*(2), 35–41.

Zhou, S., Zhai, G., & Shi, Y. (2017). "Spatial Planning Experience in England and Its Implications to China", *Urban Planning International*, *32*(4), 82–89. https://doi.org/10.22217/upi.2016.520

Zhou, Y., Pu, L., & Zhang, F. (2006). "Spatial planning in Germany with its implication in China", *Resources and Environment in the Yangtze Basin*, *15*(4), 409–414. Retrieved from http://caod.oriprobe.com/articles/10865221/SPATIAL_PLANNING_IN_GERMANY_WITH_ITS_IMPLICATION_IN_CHINA.htm

Zhu, J., Deng, M., & Pan, A. (2015). "Three planning in one: Exploring the order and regulation capacity of spatial planning", *City Planning Review*, *39*(1), 41–47/97. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTotal-CSGH201501009.htm

Zhuo, J., & Liu, Y. (2004). "Urban planning decentralization policy in France: A brief review on the evolution of urban planning system in France from 1919 to 2000", *Urban Planning International*, *19*(5), 7–16. Retrieved from http://www.upi-planning.org/EN/Magazine/Show.aspx?ID=43966

Exploring how to Lead the Transformation of Small and Medium-Sized Cities by Integration of Multi-Planning:

Case Study of Jieshou City, Anhui Province, China

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Abstract: This paper focus on the integration of multi-planning in the widespread small and medium-sized cities in China, which are now facing embarrassment in the process of urbanisation. As the basic executors within the three-level administrative system, small and medium-sized cities are being trapped in the multifaceted dilemma of population loss, constrained spatial and natural resources and less positive policies. In order to find an optimized approach to achieve urban transformation while responding to these practical problems, this paper proposes spatial planning that collates and integrates all of the current plans completely, eliminating their discrepancies and forming one blueprint for the city. This is a new approach leading the transformation of small and medium-sized cities. This approach must be comprehensive, multi-tasking, highly exercisable and localised, and balanced between economic growth and environmental improvement in order to better the urban and rural life of these numerous small and medium-sized cities.

1.   INTRODUCTION

Spatial planning, or multi-planning integration, has been a hot topic in China in the past few years. While big cities have been the main focus of this trend, there are still numerous small and medium-sized cities which have been neglected (Neo & Pow, 2015). As spatial planning is introduced into these cities, planners have observed huge differences, beyond that of scale, between big cities and small cities. Compared to big cities, small and medium-sized cities are at a much lower level of economic development, and they face more limits and restrictions, especially on their spatial resources. Spatial planning in these cities requires more work at the local and foundational levels, where it may be used as a tool to solve practical problems.

This paper focuses on how to promote spatial planning in one such small city and to lead the city's transformation by reorganising the spatial resources through the integration of dozens of current plans. To plan the city

holistically, as a whole, rather than separating it into divided areas, will provide a more efficient approach for the city's development.

1.1　　Spatial planning system as a national strategy: the origin of spatial planning and its characteristics

In 2013, Xi promoted the "spatial planning system" at the Central Work Conference on Urbanization, (2013). This event was significant in recognising that the spatial planning system has become an important tool for reforming the urban and rural planning system, regulating spatial resource management and promoting the urbanisation process in an orderly manner. Spatial planning is the integration of urban and rural planning, land use planning and all the other current planning. Therefore, it has been the focus of close attention from the central government departments, such as the Ministry of Housing and Urban-Rural Development (referred to as MOHURD), the National Development and Reform Commission (referred to as NDRC), and the Ministry of Land and Resources (referred to as MLR). "One plan, one blueprint" is considered to be more efficient to implement.

Based on the experience of multiple-plan integration in Guangdong, Shanghai and Zhejiang, the MOHURD, NDRC and MLR selected 28 pilot cities/counties and two pilot provinces for spatial planning.

One thing should be noted, that the ongoing spatial planning system is very different from traditional spatial planning in western countries. The latter is attempting to bridge land-use models and planning with new approaches, tools, and techniques (Albrechts, 2006; Couclelis, 2005), whereas in China, several administrative plans coexist and conflict with each other. Spatial planning is designed to change this situation, and in some cases spatial planning also overlaps with strategic planning.

1.2　　The practical problems: Small and medium-sized cities are facing more dilemmas

The multiple-plan integration has been a focus area since 2010. Both the big cities, such as Guangzhou, and the coastal developed cities, such as Yunfu and Deqing have been working on how to integrate urban and rural planning, land use planning and other plans related to urban, social and economic development. In general, the big cities enjoy a high level of civilization and a good planning foundation. More importantly, these cities have precise knowledge of their goals and strategies, which have already become common views around the city. Therefore, the multiple-plan integration — in other words, the spatial planning in these cities — mainly works on the comparison of different plans and the elimination of discrepancies through a negotiation system and agreed principles. Spatial planning in other coastal developed cities, which are close to and have advantages similar to those of the big cities, would benefit from a similar experience to big cities.

In China's vast interior, there are hundreds of small and medium-sized cities and counties. Spatial planning in these areas is more demanding and challenging than in the developed cities. First of all, limited by their stage of economic growth, they lack planning experience, where the concept of planning is often misunderstood beyond the basic meaning of the arrangement and management of urban activities. Therefore, the future development of these cities would benefit from clarification. The current

plans, especially the plans which focus on the counties and towns, are more difficult to integrate. Secondly, one aspect of spatial planning is a process of forming and popularising the urban development consensus. Making this planning easily understandable is as important as making it insightful. Third, these cities have more restrictions than the developed cities. Their available land resources are restricted by their higher-level government, however, they are under equivalent time pressure to complete all of the prescribed tasks. The population in these cities is continuously being attracted to big cities, making it relatively more difficult to strengthen their economies. How to find a way through all of these constraints is the essential question for spatial planning in these cities.

The numerous small and medium-sized cities are the most important parts of Chinese cities. The case city of Jieshou is a typical small city in central China, which this study uses as a lens to provide answers to this essential question during the planning formulation process, and a representative and propagable conclusion.

2. METHODOLOGY: REGIONAL PERSPECTIVE AND HOLISTIC PLANNING

2.1 The 'Survey-Analysis-Plan' work pattern is the main framework for spatial planning

In the planning process of this case city, the classical 'Survey-Analysis-Plan' work pattern, promoted by Sir Patrick Geddes (Geddes, 1915), is applied. This method, which is widely used in regional planning, is appropriate in spatial planning.

Since spatial planning aims to integrate all of the current plans and potential projects, it is very important to thoroughly investigate throughout the city to discover a wide range of possible factors that may impact the city's construction. The survey is used to gain a deep understanding of the city's situation, while the analysis of the investigation materials presents and selects amongst the possibilities in order to make the plan.

2.2 Problem-oriented

The case city is now facing several severe problems. Its industrialisation requires more land and labour, but land shortage is the main constraint. Roads, rivers and green land need to be improved, but because of the conflicts between different plans, the infrastructure has not been built yet. The towns also have their own development strategies, which do not coincide with the city's. These problems are urgent. Therefore, the spatial planning in this city is expected to be a problem-oriented one.

2.3 A necessarily regional perspective

The process takes a regional perspective to research the city's characteristics. Based on a comprehensive understanding of the city, it is evident that planning the city holistically, as a whole, is the best method, not only because spatial planning requires the planners to consider all aspects of the city simultaneously, but also because the small city is highly restricted by its land resources and it has limited options. The following parts of this

paper will analyse the city's situation, including its foundation in the past, problems at present and its opportunities in the future. Then the planning strategies aiming to lead the transformation of the city by spatial planning are introduced. Three conclusions are drawn from this case and it is hoped they would be useful in the spatial planning of other small and medium-sized cities

3.   THE CURRENT OPPORTUNITIES AND CHALLENGES OF JIESHOU CITY

3.1   The city's status and opportunities

Jieshou lies in the northwest of Fuyang city, and it administers three urban districts and 15 towns with a total area of 668.69km^2 and a population of 0.8 million. With mild climate and clear seasons and more than 60% of the land used as farmland, the city is a major grain producing area.

The past decade was a critical period for the city's economic development. In recent years, the recycling economy has become the main industry of the city and brought more than 10 national recognitions. Recycled plastic, reused lead batteries and other recycling have created a 10.5% annual economic growth and a 13.5% annual industry growth. After 20 years' absence, Jieshou re-entered the top 10 industrial economies in China.
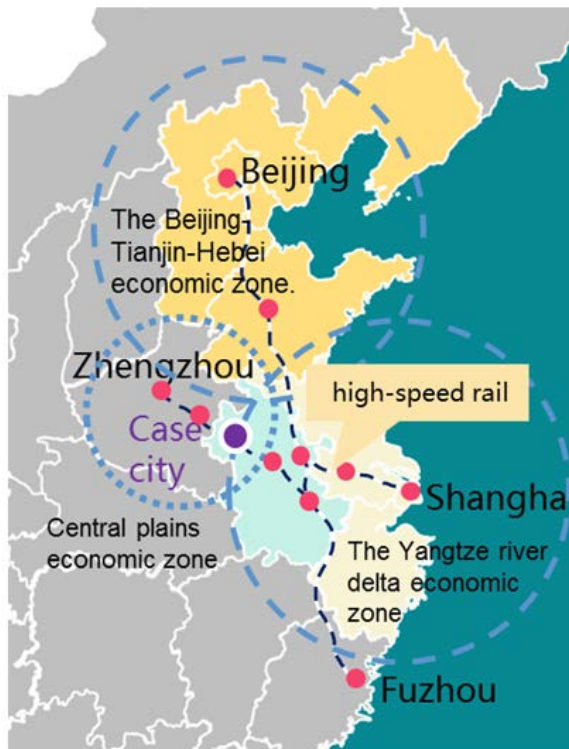

Figure 1. The location of the case city

The alteration of China's macroeconomy has created more opportunities for the city. The city is located at the junction of several economic zones, including the Yangtze River Delta Economic Zone, the Beijing-Tianjin-Hebei Economic Zone, and the Central Plains Economic

Zone (*Figure 1*). In 2012, the State Council responded to the Planning of the Central Plains Economic Zone (referred to as PCPEZ), signifying the inclusion of the central plains city clusters as part of the national strategy. Jieshou city was proposed as a node city of Zhengzhou-Hefei urban belt. The new high-speed railway along the belt being built will enhance its connection to Shanghai and Beijing.

3.2 Limitation and challenges

3.2.1 The constraint of land shortage

The land resources in Jieshou city are highly restricted. The small administrative area is only 1/3 to 1/4 of the size of the neighbouring county's area. Although land resources are scarce, 88% of the farmland was classified as basic farmland by the MLR and its subordinate administration, which means land available for development was made much scarcer (*Figure 2*). However, although the economic strength of Jieshou and the size of the urban population is greater than its neighbours, the following urbanisation and modernisation, including environmental enhancements, increasing public spaces and infrastructural improvements, is currently limited by the land shortage.
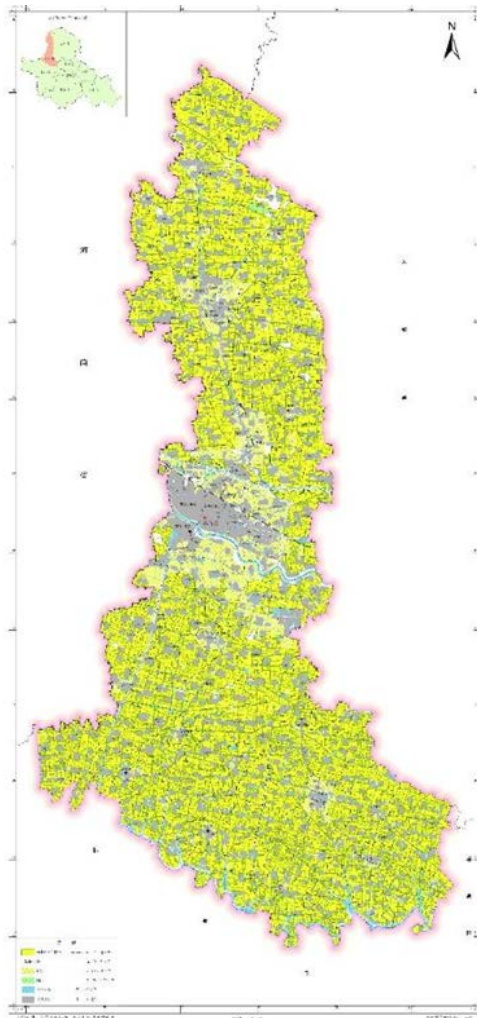

Figure 2. The farmland (yellow) in Jieshou city

3.2.2   Insufficient and unbalanced distribution of well-built spaces

Although Jieshou has a relatively high urbanisation rate, the quality of its urbanisation is at the average level for central China. Little of the urban area is of high quality, including public spaces along the streets, waterfront spaces along the river and the green spaces near the forest. The well-built spaces are all located in the central urban area or the comparatively well-built township, which coincides with the spatial structure of the whole city.

Jieshou has two major rivers flowing through the city, which benefits the central urban area, and four towns along the rivers. Other towns and counties have extremely little waterfront space, and even the current pools and streams are under pressure due to lack of maintenance. The forest and green parks are also concentrated in the central urban area.

3.2.3   Lack of guidance or constraints on land use

One result of the unconstrained land use is that the farmland is very inefficiently used. Although the ratio of farmland in Jieshou is quite high, the land is badly segmented by the villages, which makes it more difficult for the small city to promote mechanized farming. In 2012, there were 1,106 villages scattered across the city and some of them had already become disused (*Figure 3*). The superfluous villages caused another problem because many of them were built along the national highway and provincial roads. From the comparison of the villages and the roads, it is evident that more than half of the roads had over 20% of their length occupied by villages without planning. Some of the roads were even occupied along more than 40% of their length. The current chaotic development pattern should be transformed into smart and efficient growth in order to best utilise the limited resources of Jieshou city.
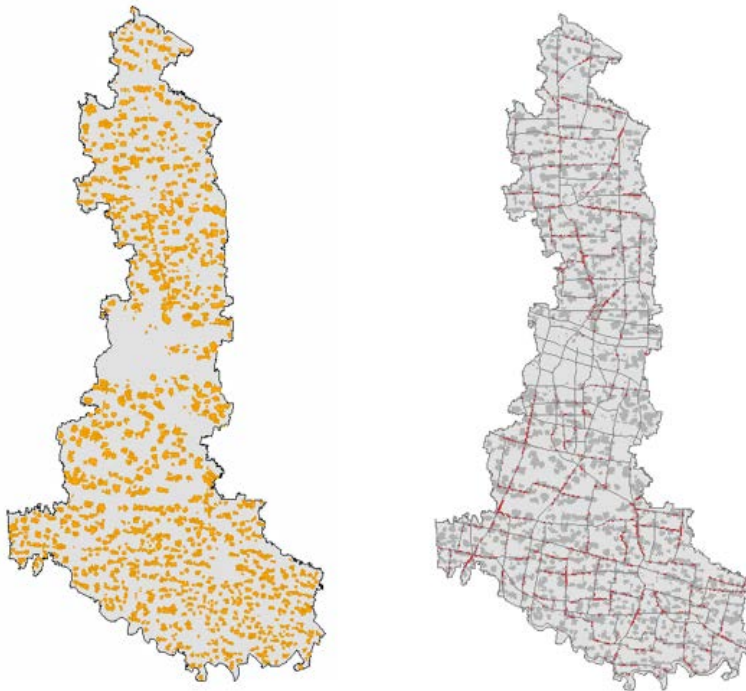

Figure 3. The villages in Jieshou city and their relations to the roads

3.2.4 Integration of development concepts with existing plans

There are problems with the existing planning for Jieshou. First, the planning goals of towns and counties do not match the city's planning. The population and urban size are the main points of conflict. The towns have all planned to become bigger and stronger, but the strategies and routes are very similar to each other, so they are in competition. Secondly, the development plans of the various departments are not unified, which can be clearly observed in their spatial overlap. For example, the water system planning conflicts with the forest planning as well as the road planning, and almost every plan conflicts with land use planning. Therefore, these plans are difficult to execute, and one unified blueprint is necessary to integrate the concepts of both the towns and the higher-level departments.

4. PLANNING STRATEGIES: HOW TO LEAD THE TRANSFORMATION

From a historical perspective, the urban population percentage of China has just passed 50%. Broadly, at the national scale, populations and resources are accumulating in big cities and the cities' clusters. At the regional scale, people prefer to live and work in urban areas rather than small towns and villages. According to the macro trends and current situation of Jieshou city, the four major strategies and the framework of spatial planning are determined.

4.1 Take the whole situation into account and concentrate on the dominant resources

4.1.1 Plan the entire city holistically and clarify the targets

Given the constraints on land resources, the city needs to coordinate its spatial resources through unified planning of the city in order to achieve a significant outcome. In recent years, the industries in Jieshou have made continuous progress and the population has also reversed the trend of outward population flow, with both the permanent and registered populations recovering. These vibrant industries and the population need to be supported with sufficient space, which is the main constraint.

Therefore, in terms of the city's identity, its foundation and favourable conditions have been reassessed and the city's position and several development goals suitable and realisable for the city have been prioritised.

The city will be defined as a strong industrial city with recycling as the dominant industry, a featured commercial city in the Central Plains Economic Zone, and a liveable garden city on the riverside. Correspondingly, the goals of urban development would be building a national identity as a city with a strong recycling economy, a demonstration of new industrialization in the Central Plains Economic Zone and be one of top ten comprehensive competitive economies in the province's counties.

4.1.2 Integrated access to land condition

A comprehensive evaluation of the city's land condition was made, based on the landform, the important farmland, population distribution, road

accessibility and other natural and social factors. The suitable development area is mainly concentrated in the central urban area and the 15 towns and counties, with a total area of 210 km^2, within which the basic suitable development area is mainly concentrated in the surrounding area of the towns, with a total area of 132 km^2. The rest are restricted development areas, including important agricultural areas, wetland parks and major river systems. This spatial distribution is the basis of the division of the production space, living space and the ecological space, and forms the basic urban space framework.

4.1.3   Concentrate the dominant resources to form primary and secondary urban systems

Based on the above urban space framework and the characteristics of present urbanisation, the main functional area is clarified in order to make full use of the spatial resources. The central urban area and the township of Tianying is the core of the integrated urban space, which will have the most important function of urbanization. The synchronous development of the industrial park of Tian Ying Town and the central city is one effective measure for balancing jobs and housing. The two town-level cities and their clusters form the two subcentres and the central areas of urbanisation on either side of the central urban area. On the northern side, the pillar industry is recycling, while the south is mainly a commercial economy. There should be a provincial road, which runs north and south through the city, connecting the main core and two subcentres. This provincial road would form the economic development zone, with other towns, counties and villages ensuring a convenient connection with the main core and subcentres and forming their own characteristic industries and culture. The main core and two subcentres comprise the main (primary) area of urbanisation, while the other areas would be small but with excellent, distinctive features and fill out the urban spatial network with local characteristics (secondary).

4.2   Optimise spatial resources and equalise according to demand

Corresponding to the insufficient and unbalanced spatial development mentioned above, a two-step solution is proposed. The first step is to improve spatial quality by creating more high-quality spaces, and the second step is to determine the distribution principle of these public spaces in streets, waterfront spaces along the river, and the green spaces near the forest. Citizens of central urban areas, towns and villages would have equal access to these high-quality spaces. Road traffic, forest ownership and water surface area are selected as three core factors to assess spatial quality.

4.2.1   Improve the road network and the quality of roads

The total length of existing roadway is 911 km, but only 10.7% of it is secondary roads or grade one highway. The external capacity is deficient and the traffic pressure is concentrated on highway entries and exits. The provincial roads within the city have not been connected to the neighbouring provinces. The internal roads are fishbone shaped, rather than connected as a network. Combining this present condition and the rapid transport system planning from the Department of Transportation, the plan improves 38.8% of the current roads over the next 20 years. Transportation planning, urban and

rural planning, and central village planning should be integrated, and the conflicts eliminated to make sure that the road network is designed in accordance with the urban settlement system. The central urban area is at the core of urban transportation. There are at least two provincial roads intersecting in the key towns. All towns and counties are connected with the surrounding residential areas through at least one provincial road. All central villages should be located in the transportation network formed by county roads, and all villagers are within 30 minutes of the central urban area, forming a half hour urban life circle.

4.2.2 Reconsidering the water system

The present water volume per capita in Jieshou is 300 m^3, which is far below the average of 2,500 m^3 in China. Although the city has surrounding rivers and several rivers and streams through it, the present water system is too poor and fragmented to conserve water; it particularly suffers from the encroachment of cultivated land. Due to the small surface area of water, only two rivers are available for citizens to enjoy. The existing water system plans aiming to solve this problem are in conflict with the basic farmland operations.

Therefore, the current water system should be reserved as much as possible to preserve the city's unique characteristics. The rivers, pools and wetland, which were occupied by the farmland, should be recovered, forming a stronger water network. The towns and villages are connected to the Shaying River and Quanhe River, ensuring that there are more than five trunk rivers in the central urban area and more than 10 waterfront parks. The two town-level cities would have more than two trunk rivers and more than one waterfront park. There should be more than one trunk river and more than one waterfront park in the key towns. All towns or counties should have at least one waterfront park and every central village at least one river. The riverside spaces would be reserved for public spaces, open to all citizens, in order to enhance the urban value of the water (*Tabel 1*).

Table 1. The water system planning principles

	Number of trunk rivers	Number of waterfront parks
Central urban area	≥5	≥10
Town level city	≥2	≥4
Key towns	≥1	≥1
Towns	——	≥1

4.2.3 Increase the forested area

According to statistics from the forestry department, the forest coverage rate of Jieshou city has reached 20.66%, but the forest and garden land from the land and resources department is merely 26 km^2, which means the forest coverage rate is only 4%. The conflicts between the forest planning and the land use planning are striking.

In order to take full advantage of all of the forest in the city, a forest ecological network should be constructed, relying on both the water and traffic corridors. The existing forests south of Shaying River are planned to

be the core of this network and the main forest park of the whole city, while the forest resources would be arranged with full consideration of balance. The central urban area would have more than two forest parks and more than 30 gardens and street squares, while the town-level cities would have at least one forest park within 500 m and more than 10 gardens and five squares. The key towns should be less than 1 km away from forests and have more than five gardens and two squares. No town or county is farther than 2 km away from forests and they should all have more than two gardens and one square. The central villages should all be located within 2 km of forests (*Table 2*).

Table 2. The forest network planning principles

	Number of Forest parks	Distance from the forest	Numbers of green parks	Numbers of public spaces
Central urban area	≥2	——	≥30	≥30
Town lever city	≥1	≤500m	≥10	≥5
Key towns	≥1	≤1000m	≥5	≥2
Towns	——	≤2000m	≥2	≥1

4.3   Analyse the current land use and reorganise more efficiently and intensively

The distribution and organization of land use in Jieshou City is relatively poor and land use efficiency is not evident. In order to reorganize the land use in a more efficient and intensive way, three aspects are considered.

First, the current proportion of construction land is high, accounting for 22.52% of the total area of the city, with wasteful land use. Judging by the current population of Jieshou city, by the trend of the population growth, and by the capacity for better land use efficiency in the future, the proportion of construction land could be limited up to 18%. Therefore, the key concept for Jieshou land use is "reduction", and urban land uses should be reorganised in an intensive manner.

Secondly, the proportion of land used for different types of construction is not well-balanced. The ratio of the central urban construction area to town construction area to rural construction area is 1: 0.66: 4.36. The rural construction land area accounts for 72.46% of the total construction land area, which is 4.36 times larger than the central urban construction land area and 6.64 times the town construction land area. This ratio is not only contradictory to Jieshou's urbanisation rate, but also does not match the urban system, showing the low efficiency of land use. The urbanisation rate of Jieshou city is 50.22%, exceeding the average level of the cities and provinces where it is located.

In rural construction areas, many unauthorised village developments are located close to the prefectural highway (mentioned above). At the same time, there are lots of "hollow villages" where few people live. Therefore, in combination with the urban system planning and the future population distribution, the scale of land for construction in central urban areas, towns and central villages is adjusted so that the central city, the towns and the central villages meet the future needs of their populations respectively. The proportion of these lands has been adjusted to a ratio of 1: 0.85: 0.67, as a

guide for land area for future construction concentrated in the central city, towns and other areas of intensive development. After the prevention of unauthorised construction and the removal of "hollow villages", and the repurposing of this land for farmland, the scattered farmland can also be linked together as one, which is conducive to building a better agricultural landscape system and avoiding the vicious cycle of unauthorised village developments on occupied farmland and the encroachment of farmland on forest and water areas.

Thirdly, the share of land use for transport facilities, rivers, lakes and forests in the city is considerably low. In combination with the planning concept, the proportions of these land use types have been increased through this spatial planning to create a better living environment. By considering and planning all the important spatial elements and factors within the entire city area, a city-wide traffic system, waterway system and forest garden system could be achieved.

4.4　Integrate concepts of development and use one plan for all spatial elements of the city

A unified classification of land use is used (Department of Housing and Urban-Rural Development of Anhui Province, 2017), putting the land use plan (which used to be classified by independent standards made by MOHURD, (Ministry of Land and Resources, 2017), the urban and rural master plan (which used to be classified by independent standards made by MLR 2011 edition (Ministry of Housing and Urban-Rural Development, 2011), and many other plans (made by towns and other departments, etc.) on the same data platform with shared coordinates. Through this, there are a large number of discrepancies, each of which shows that there are different planned uses on the same land. For two major plans, due to the differences in planning period and editing dates, the number of discrepancies reached 7,489, amounting to 43.4 km^2, and accounting for 6.5% of the total area of Jieshou. Other important spatial plans also have major conflicts with basic farmland.

The discrepancies can be classified as follows: discrepancies occupying small areas or discrepancies only caused by different land use standards are an immaterial discrepancy; discrepancies caused by different planning concepts or occupying larger areas that need to be coordinated, are considered substantive discrepancies. Based on this planning strategy, three principles for dealing with discrepancies have been identified.

The first principle is to incorporate holistic planning (something that is not easy to accomplish in China), long-term planning and rational coordination. Improving the urban-rural system is the fundamental basis for handling discrepancies. In turn, the demand for construction land in central urban areas, key towns, and other towns and central villages will be guaranteed to promote intensive development and to support the construction of beautiful villages. For the discrepancies that are difficult to achieve in the near future, long-term control and guidelines are introduced to manage these areas and an effective collaborative management platform is established to ensure long-term control.

The second principle is to ensure that the total amount of basic farmland must not decrease and that its spatial distribution is more contiguous. There is great pressure on the protection of basic farmland in Jieshou. Given unified allocation of spatial resources, the total amount of basic farmland

must be retained as a precondition, and the current scattered basic farmland should be adjusted to be as contiguous as possible.

The third is to ensure ecological security while forming urban and rural characteristics. Following guidance from defining urban, rural and ecological spaces, the space within the ecological red line must be strictly protected from construction, while the water system, important ecological network construction and important infrastructure construction in the whole region should be promoted.

These three principles underlie the final land use plan for Jieshou's spatial planning.

5.   CONCLUSION

In summary, three main points and characteristics of the spatial planning in this paper are summarised, providing reference for the spatial planning of other small and medium-sized cities.

5.1   Activate spatial resources through holistic planning

Compared with mega-cities or large cities in China, the characteristics of small and medium-sized cities are limited in three ways - limited resources, limited space and limited policies. In such a situation, to make a breakthrough in urban development, limited resources of the whole city should be pooled to form large-scale agriculture and ecology, broad landscapes, and large-scale industrial parks, creating an overall advantage for the city.

5.2   Propose intensive development of high efficiency and rational reduction of developing areas

Due to the late start of urban planning in parts of China, it has been common to have disorderly and wasteful development and construction in small and medium-sized cities. Land use in villages is dominated by farmland, which also affects the country landscape. Considering these conditions, land use in the construction areas (except for characteristic or historical villages, which should be preserved) should be intensive and efficient, which would be not only beneficial to the management of urban land but also to forming large-scale agricultural land.

5.3   Equalise high-quality spatial recourses in the city

Compared with big cities, the infrastructure and urban landscapes of the small and medium-sized cities is relatively poor quality. High-quality resources are concentrated in a few areas, such as the central urban area, which makes towns and villages less competitive, causing the loss of population in less-developed areas. In this plan, the distribution of high quality resources, including transportation facilities, rivers, parks, schools and other public utilities, is balanced and equalised across the entire area of the city. By enhancing overall quality and competitiveness, the city can not only forms its unique characteristics, but also enable the residents to enjoy the benefits of city development.

REFERENCES

Albrechts, L. (2006). "Bridge the gap: From spatial planning to strategic projects", *European Planning Studies*, *14*(10), 1487–1500. https://doi.org/10.1080/09654310600852464

Coucelis, H. (2005). ""Where has the future gone?" Rethinking the role of integrated land-use models in spatial planning", *Environment and Planning A*, *37*(8), 1353–1371.

Geddes, P. (1915). *Cities in Evolution: An Introduction to the Town Planning Movement and to the Study of Civics*, Ernest Benn, London.

Neo, H., & Pow, C. P. (2015). "The weight of small cities: Development and the rural–urban nexus in Jinghong, Southwest China", *The Professional Geographer*, *67*(4), 555–563. https://doi.org/https://doi.org/10.1080/00330124.2015.1053880

中央城镇化工作会议(The Central Work Conference on Urbanization) (2013). "会议于12月12日至13日在北京举行，习近平提出建设空间规划体系，守住城市开发边界和生态红线. (The conference was held on December 12nd and 13rd. Xi Jinping came up with the spatial planning system in order to restrict the urban growth boundary and establish the urban ecological red line.)", Retrieved from http://npc.people.com.cn/n/2013/1215/c14576-23842750.html

住房和城乡建设部(Ministry of Housing and Urban-Rural Development) (2011). "城市用地分类与规划建设用地标 (Classification on Urban and Rural Land-use and Standards for Land-use in Construction). 该标准编制于2011年，并从2012年1月1日开始实施。该标准于2018年修订，目前正在征求意见中。(The standard was published in 2011 and applied on January 1st in 2012. In 2018 a new edition on the ", Retrieved from http://www.mohurd.gov.cn/wjfb/201805/t20180522_236162.html

国土资源部(Ministry of Land and Resources) (2017). "土地利用现状分类 (Classification on Current Land-use) 该分类标准批准于2010年，于2017年11月1日修订后实施 (The original version was published in 2010, and was edited and applied on November 1st in 2017.)", Retrieved from http://www.mlr.gov.cn/xwdt/jrxw/201711/t20171103_1670738.htm

安徽省住房和城乡建设厅(Department of Housing and Urban-Rural Development of Anhui Province) (2017). "安徽省市县空间规划编制标准（Standard of city and county spatial planning)", 25–26.

SPSD

Determine Non-Passenger Data from WiFi Scanner Data (MAC Address), A Case Study: Romango Bus, Obuse, Nagano Prefecture, Japan

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Abstract: WiFi is one of the most useful technologies that can be used for detecting and counting MAC addresses. Many previous studies have interpreted MAC address data into other forms for use in infrastructure development and urban transport. This study uses onboard WiFi scanners, circulated on the "Romango Bus", a hop-on-hop-off bus that has nine bus stops with roaming time from 09.50 to 17.50. The method uses WiFi and GPS MAC addresses as raw data from WiFi devices, collected during the time the bus goes around the route. WiFi scanner devices are placed on two different buses for comprehensive monitoring of the route's operating hours. Raw data obtained in the form of WiFi data and GPS data is combined and processed through five steps to produce non-passenger data. The results are displayed on a map that contains MAC address data, and that specifies non-passenger data categorized into pedestrians, vehicles, and buildings. Obuse is a tourist area that has many tourist attractions, and the results of WiFi at stopover locations shows a high number of pedestrians, especially at Obuse Park and Obuse Station.

1.   INTRODUCTION

This is the era of big data, the latest development in information technology. Technological progress and innovation have made it easier to manage and calculate future infrastructure and transportation needs. Recently, technological advances have required faster data retrieval and processing. The technology currently being developed to address this is WiFi, which is presently widely used in the field of transportation. There is an increasing amount of research on the development of WiFi, with some of it primarily concerned with transportation, and mostly focusing on origin-destination movement. Up until this point, the research has been interested in the behavior of travel, origin-destination, travel time, waiting time, and other aspects. This paper analyses bus-related data both from on-bus field observations and WiFi data, which contains all travel data for bus passengers (Hidayat, Terabe, & Yaginuma, 2018) and non-passengers. Non-passenger data is non-bus user data detected by WiFi. The raw WiFi data is simply a count of media access control (MAC) addresses, the unique alphanumeric identifiers for WiFi and Bluetooth (BT) devices. Some

researchers have applied Bluetooth and WiFi sensors to get the position of people and vehicles. However, this is usually considerably costly, and suffers from time restrictions with high maintenance levels; with such costs, these methods of collecting data are difficult to apply to further research. WiFi is widely used during use of smartphones, laptops, tablets and other portable devices that are currently in high demand around the world. A MAC address can be detected when people are looking for an access point (AP), and every single networking device is equipped with this globally unique hardware address (Al-Husainy & Fadhil, 2013; Asija, 2016; Freudiger, 2015; Takahiko & Yaginuma, 2017). They are used for such devices as smartphones, tablets, laptops, WiFi routers, car and motorcycle GPS, as well as others. As such, WiFi is now one of the most useful options for getting movement or MAC address data. WiFi tracking data provides an excellent approximation of crowd densities because WiFi has an extended detection range, and so a large area is covered by each sensor (Dunlap et al., 2016) and every year WiFi is being increasingly detected from portable devices (Nishide & Takada, 2013).

The advantage of using WiFi to detect MAC addresses in the field of transportation is that it not only reduces the cost of data collection, but it is easier, more accessible, and more energy efficient. For data retrieval, live experiments were conducted by placing WiFi scanners inside the bus. The collected data is categorised into two groups, travel data, and non-passenger data. This paper focuses on non-passenger data, as travel data is already explained in more detail in other research papers (Hidayat et al., 2018). This study attempts to develop a further interpretation of this data, dividing non-passenger data into three groups, namely pedestrian, vehicle and building data.

2. LITERATURE REVIEW

2.1 WiFi and Bus Experiment

Previously, a study related to the on-bus use of WiFi calculated the Origin/Destination (OD) bus passenger matrix (Dunlap et al., 2016). The study attempted to compare the results of WiFi and Bluetooth usage and develop a raw data filtering procedure (WiFi data and Bluetooth data) into an estimation of passenger numbers. Similarly, in research of travel data in Obuse, Japan, passenger estimation is predicted using a speed indicator as well as the MAC address positional filtering procedure (Hidayat et al., 2018). Previous research on passenger behavior using on-bus WiFi data revealed that MAC addresses that do not change location on the same bus could be understood as a passenger (Jiang et al., 2016). Data filtering is essential for identifying passengers and non-passengers. Other research measured bus passenger loads by monitoring WiFi transmissions from mobile devices, revealing insights into the patterns of travel as well as pick-ups and drop-offs (Fukuda et al., 2017; Oransirikul et al., 2014). This research applies a filtering process to interpret and justify the raw non-passenger WiFi data obtained in the experiment process.

2.2 WiFi and Non-Passenger Data Experiment

Recently, there has been a lot of research into pedestrians and technology-based methods of collecting pedestrian data. Research using WiFi and Bluetooth as tools for counting non-motorized travel users confirm this (Böhm, Ryeng, & Haugen, 2016; Nishide & Takada, 2013; Poucin, Farooq, & Patterson, 2016). There are significant benefits and challenges to the use of WiFi and Bluetooth data for analysis of spatiotemporal dynamics of human movement. Crowd data collection and monitoring (Abedi, Bhaskar, & Chung, 2013), and combining data from both sensor types (WiFi and Bluetooth), results in useful insights into pedestrian dynamics (Heuvel, Ton, & Hermansen, 2016). Previous research has also used WiFi and Bluetooth data of pedestrians inside terminals (Shlayan, Kurkcu, & Ozbay, 2016). This research attempts to detect moving pedestrians and their behavioral patterns within the terminal and to create an origin-destination motion matrix. Similar research on WiFi systems for traffic monitoring focuses on pedestrians, vehicles, and bicycles (Jackson, Lesani, & Moreno, 2014). The study used WiFi and placed it on street lights to capture MAC address data, identifying and estimating numbers of pedestrians, bicycles, and vehicles from the speed of each traveling MAC address. Initially, pedestrians were identified by filtering for MAC addresses that could be captured across a distance of 100 meters (Malinovskiy, Saunier, & Wang, 2012). One study detects vehicles using WiFi and Bluetooth devices installed in the car (Ahmed et al., 2008) as well as vehicle detection, with a focus on travel time (Mai et al., 2017). The process captures and reads the MAC address installed on the vehicle and estimates how long it takes from the starting point to the end point using static WiFi placed in several places. The data is interpreted as vehicles following previous research that used the indicators of further mileage and longer travel time. This paper uses a different approach, interpreting the data based on the movement of WiFi in a bus, and filtering for passenger data and non-passenger data.

The principle method uses multiple sensors to record the different Bluetooth or WiFi MAC addresses for each wireless communication device (Dunlap et al., 2016; Petre et al., 2017). WiFi MAC addresses can be used to identify mobile devices, and they can be used to determine the location of mobile devices when combined with received signal strength at multiple locations (Xu et al., 2013). Android is also widely used to detect pedestrian movements. While it depends on the device, most smartphones usually send probe request frames to associate with a WiFi access point, which includes the MAC address (Fukuzaki et al., 2014). In this study, MAC address data was traced to determine the position of the pedestrian with a probabilistic method consisting of a set of candidate lists of destinations, with the probability of each record of targets being the true one (Hamacher, Heller, & Ruzika, 2010). Using another method, a penetration ratio is calculated by combining tracking and count data from WiFi. This rate describes the ratio between the number of counts and the number of tracked data points (Heuvel et al., 2016). Pedestrian data can be estimated with the system to detect unknown MAC addresses of devices at short distances at fixed locations (Jackson et al., 2014) and the performance of the BT-WiFi method evaluated to identify these unknown MAC addresses (Lesani & Moreno, 2016). Lastly, the research uses WiFi devices paired permanently in strategic locations (Lesani et al., 2016), and the use of software installed on smartphones; it should be noted that most pedestrians do not make use of this software (Shlayan et al., 2016). This research will describe and explain

WiFi scanner data in Obuse, a tourist spot in Japan. The research makes use of WiFi scanners as a detector of MAC addresses. This WiFi scanner is placed on the bus as a moving detector. An explanation is given for the process of filtering raw data WiFi scanner (MAC address) data into non-passenger data, using simple, battery-powered equipment. This paper provides a novel solution for using moving detectors to estimate non-passenger data.

3.   METHODS

3.1   Field Experiment

The location for this study is Obuse, Kamatakai District, Nagano Prefecture, in October 2016. Obuse (小布施町 /Obuse-machi) is a town in the Chūbu region of Japan. As of 1 October 2016, the town had an estimated population of 10,698 and a population density of 560 persons per km². Its total area was 19.12 square kilometers (7.38 sq mi). The city of present-day Obuse was part of ancient Shinano Province. The modern village of Obuse was created with the establishment of the municipalities system on April 1, 1889. It was elevated to town status on February 1, 1954. Obuse annexed the neighboring village of Tsusumi on November 1, 1954 (Wikipedia, 2008).

Obuse is one of the top tourist destinations in Japan (Nagano Prefecture Government, 2016). The town has a shuttle bus called Circle Bus, or "Romango." The Romango bus is a hop-on-hop-off bus. It has seven circulation journeys from bus stop one to bus stop nine, running from 09:50 until 17:50. One-day tickets cost 300 yen, and group tickets (10 sheets) 2,000 yen. Obuse town operates two circular buses every Saturday and Sunday. The circular route is approximately 15 km long, and it takes 50 minutes for a round trip. Buses start every 30 minutes from 09:00 to 16:00. There are two types of Romango bus, no.1 and no.2, shown in *Figure 1*. The Romango bus traverses seven segments in its circulation from bus stop no. 1 (BS1) to bus stop no. 9 (BS9) and passes nine bus stops: BS1 (Obuse Highway Oasis Park), BS2 (Obuse Station), BS3 (Hokusai Museum), BS4 (Obuse Museum), BS5 (Matsumura Town Parking), BS6 (Obuse Hot Springs) BS7 (Floral Garden), BS8 (Jyokoji Temple) and BS9 (Ganshoin Temple). Refer to *Table 1* for more detail. The circular route is approximately 15 km, and the overall route length is 8.8 km. The longest leg is 2.7 km (2675.92m) from BS1 to BS2, and the shortest is 0.3 km from BS4 to BS5 (304.59m). The total route length is 8805 metres. Refer to *Figure 2* for more detail.

Figure 1. "Romango Circle Bus" No.1 and No. 2

Table 1. Obuse Bus Stop

Number of Bus Stop	Bus Stop Name/Famous Destination Near Bus Stop	Figure
1	Obuse Highway Oasis Park	
2	Obuse Station	
3	Hokusai Museum	
4	Obuse Museum	
5	Matsumura Town Parking	
6	Obuse Hot Springs	
7	Floral Garden	
8	Jyokoji Temple	
9	Ganshoin Temple	
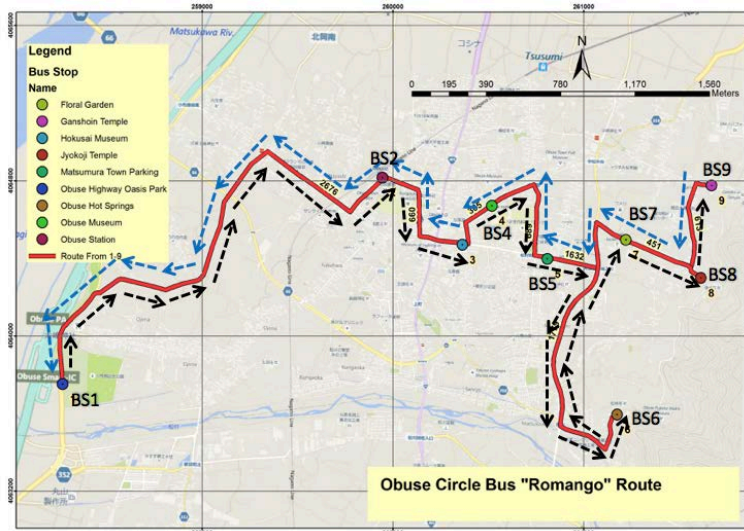
Figure 2. "Romango Bus" Route

3.2   WiFi Equipment

WiFi technology periodically transmits a signal, called WiFi, to all information devices around it. When a device receives a WiFi signal, it sends a query, called a probe request, and the access point returns a reply, called a probe response, which includes the Service Set Identifier (SSID). The probe request can be made in as short as 15 seconds or as long as several minutes (and is on the order of one minute on average), and also includes the media access control (MAC) address that identifies the transmitting device.

This study used a WiFi Scanner to acquire data. This Scanner uses the minicomputer Raspberry Pi 2 B V1.1 (Raspberry., 2015) as a WiFi scanner, GPS tracker, and micro USB power source to save the data. A mobile battery keeps the WiFi scanner on for 12 hours. From collecting and analyzing data, it is possible to grasp patterns, such as the spatial flow and distribution of information device users. The WiFi scanner was placed as per *Figure 3* on the bus. The scanner collected MAC addresses which were interpreted as non-passenger data from the bus.
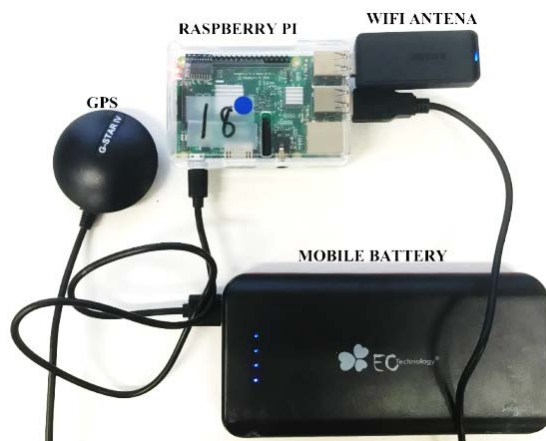
Figure 3. WiFi scanner, GPS, and Mobile Battery

3.3   Experiment

The WiFi Scanner was mounted on bus no. 1 near the left window and on bus no. 2 above the driver between 09:50–17:50 on Sunday, October 30th, 2016 (*Figure 4*). The device installation was simple, and it was placed so that it did not interfere with the bus driver and passengers. No appropriate place could be found to install the scanner above the driver's seat in bus no. 1, which was a different model from bus no. 2. Due to the differences in the internal layouts at the front of the bus, the scanner was unable to be placed in the same position. Therefore, the WiFi scanner was installed near the front-left window on bus no. 1 and above the driver's seat on bus no. 2. The difference in position did not influence the detection results as the differences were negligible concerning WiFi-scanner coverage. It can detect WiFi devices within an approximate 200-300 metre radius (*Figure 5*). This scanner records the unique identification code (MAC address) of mobile devices (Hidayat, Terabe, & Yaginuma, 2017a; Hidayat, Terabe, & Yaginuma, 2017b; Hidayat et al., 2018; Terabe, Hidayat, & Yaginuma, 2017)

Figure 4. Installing WiFi Scanner on Bus No.1 and Bus No.2

Figure 5. WiFi scanner's Approximate Range.

4. RESULTS

4.1 Processing Data

The result of this experiment is a GPS log and WiFi log as raw data. The GPS log contains the time, latitude and longitude data. The WiFi log contains the time and MAC address. The GPS log shows the bus position along the bus journey in the form of data X (longitude) and Y (latitude). The time data for each area also appears in the GPS data. The WiFi data contains time data for each MAC address recorded on the WiFi scanner,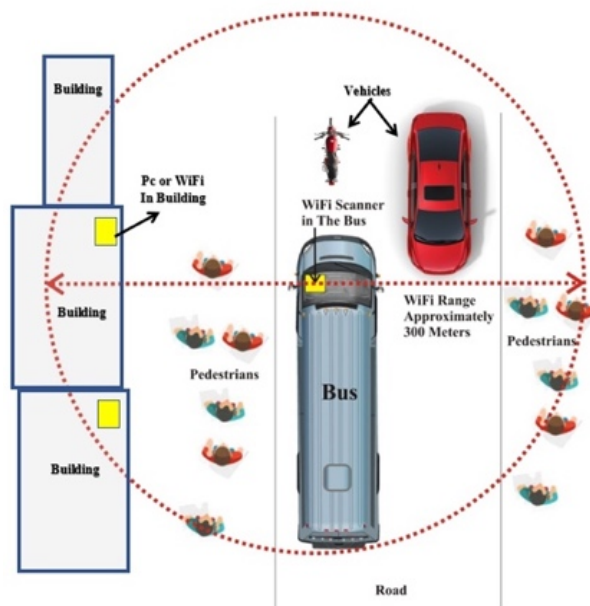 its type, and the WiFi signal strength in decibels. This data was then translated into non-passenger data. The data structure for WiFi and GPS is shown in *Table 2*.

Table 2. Structure of WiFi and GPS Data

GPS Data Structure	Day
	Time
	Latitude
	Latitude compass direction
	Longitude
	Longitude compass direction
WiFi Data Structure	Day
	Time
	type
	dB
	Mac Address

The MAC address is the unique ID assigned to each network device to be used as an identification code (Asija, 2016; Senthil Kumar, 2016). There are five steps from processing to mapping the MAC address data and distinguishing non-passenger data;

a. The first step is to combine raw data from the WiFi and GPS logs to get WiFi data containing latitude and longitude. During this step, the "Time" data is combined. This step is necessary for determining the position of each MAC address, so that they have XY data combined from the GPS and WiFi data. Unused information is deleted or eliminated from the combined data.

b. The second step is to eliminate errors in the data using loop and pivot data to retain only unique data. This stage reduces failure or duplication of MAC addresses, time and XY. A lot of data has a lot of mistakes or repetition due to the per second reading interval of WiFi scanning. From this step, we get unique data ready to be processed in the next stage.

c. The third step is to convert the coordinate system in the raw GPS data from the geodetic system of latitude and longitude to universe transverse mercator (UTM) to be more easily processed.

d. The fourth step is to import data to a Geographic Information System (GIS), show the point location, and make a map of MAC addresses. This step processes the data in the GIS so that the initial data is entered into the GIS to be selected using GIS tools.

e. The fifth step is to identify the MAC address that appears by dividing into two groups, fixed and mobile. The fixed group is defined as a static location and can be interpreted as a building and the mobile group is determined as a non-static location, and divided into pedestrian and vehicle, according to the rule as follows;

1) If there are more than six identical MAC IDs in the same location, then it can enter into the fixed category and is interpreted as a building, such as a store, a house, or a convenience store.
2) For MAC IDs appearing between 2-6 times with different locations, it can be classified as moving data. 2-3 MAC IDs are categorized as pedestrians and 4-5 are categorized as vehicles.

All of the processing was done with Anaconda 1.5 Jupiter Notebook 5.0, Python 2.7, Microsoft Excel 2010 and QGIS software. There were 71,630 MAC addresses collected from 09:00 to 18:00. Filtering the result reduced the amount by about 92.05% from the initial data to 5,691 non-passengers data logged along with the bus route. The point data on the map shows the MAC address data with the position located in the field. The flowchart for data processing and the mapping of MAC addresses is shown in *Figure 6*.
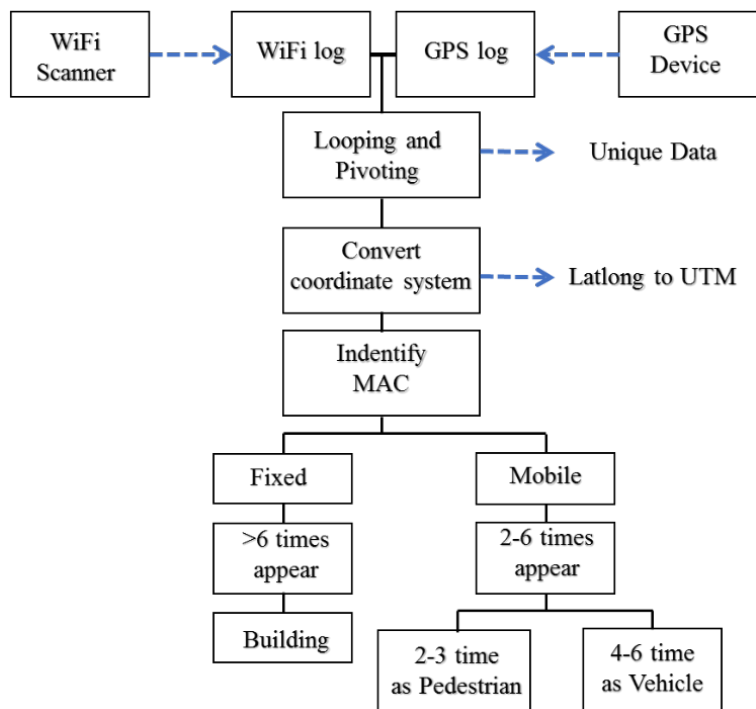
Figure 6. Flowchart of Processing Non-Passenger Data

4.2   Estimate Non-Passenger Data

Based on the processing of the distribution of MAC addresses in the map, *Figure 7* shows them regularly located around the bus route. The points on the map indicate a direction or a line following the bus route, which demonstrates the accuracy of the GPS detectors and devices and success of the field study. This raw data has been analysed into non-passenger data such as pedestrian, vehicle, and building data.

The results are obtained from the process of filtering raw data into non-passenger data from both buses. For bus no. 1 there are as many as 2,649 MAC IDs and for bus no. 2, there are as many as 3,042 detected MAC IDs, which could be rated as non-passenger (*Table 3*). The distribution of non-passenger data based on the results of the filtering process is shown in *Figure 8*.

The number of buildings, such as shops, convenience stores and others that have WiFi devices, comes to 58 units on bus no.1 and 35 units on bus no.2. For the classification of vehicles (cars and motorcycles using WiFi devices) as many as 320 units from buses no. 1 and 197 units from bus no. 2 were identified. There were 2,271 people on bus no. 1 and 2,810 persons on bus no. 2. These results show that WiFi data can be used in the process of counting field data, especially non-passenger data. The difference between the data for bus no. 1 and bus no. 2 is not significantly large, because the two buses differ only by 30 minutes along the same route. This estimate comes from the processing of data and may require more trial and error in testing.

Figure 7. Mapping of MAC Address
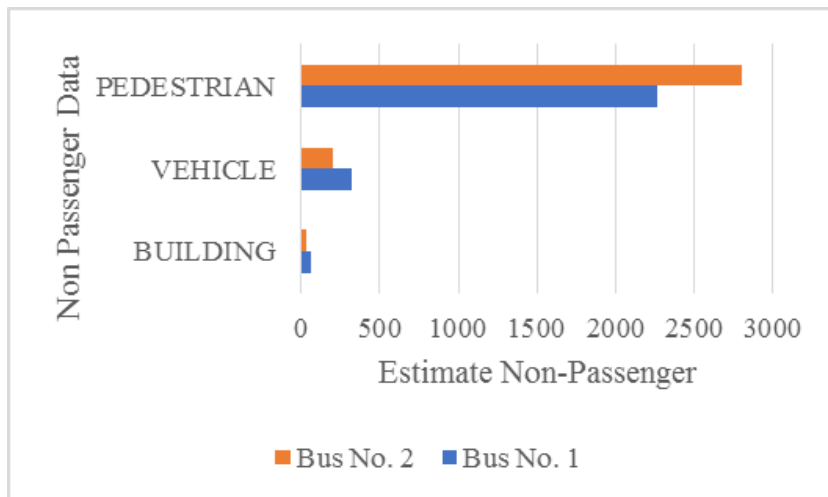
Figure 8. Estimate Non-Passenger Bus Data

Table 3. Estimate Non-Passenger Data

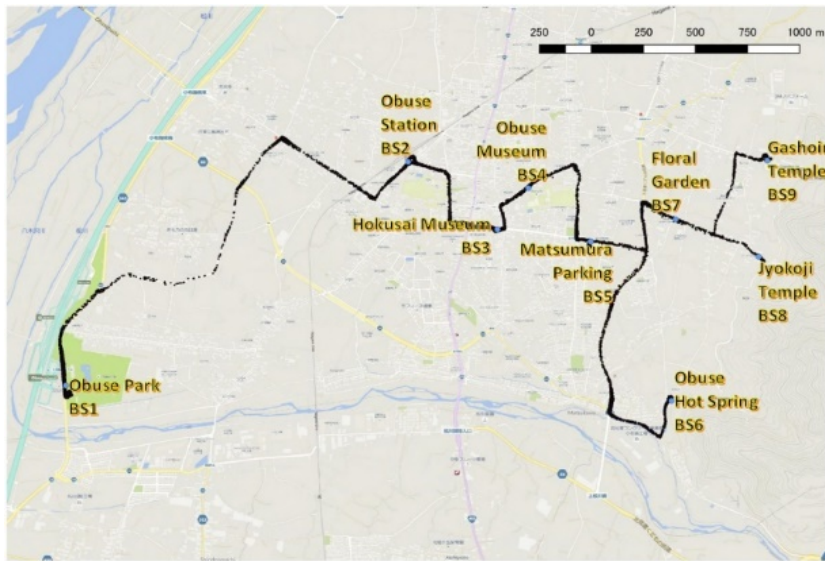| Bus	Building	Vehicle	Pedestrian	Total
Bus No. 1	58	320	2271	2649
Bus No. 2	35	197	2810	3042
Total	93	517	5081	5691

4.3   Spatial Distribution

Pedestrians are detected in more densely packed areas of pedestrian movement around Obuse Park and Obuse Station. Obuse Park is the entrance area to Obuse and is a heavily utilized recreation park on Saturdays and Sundays. The WiFi scanner will detect the pedestrians around Obuse Park. The area where most pedestrians were identified was Obuse Station, bus stop no. 2. Obuse Station is a bustling area for walkers, due to the many people who use the train in the morning and evening and becomes one of the busiest nodes in Obuse. Vehicles were detected when they were unidirectional or in line with a bus where the speed of the vehicle was equal to that of the bus; parked vehicles were not detected. Buildings were detected along Obuse Park to Matsumura Town Parking.

5.   CONCLUSION AND FUTURE WORK

The results of this paper are:
a. This article developed a data processing procedure to combine WiFi raw data, and GPS log data into non-passenger data.
b. MAC addresses can be processed as non-passenger data by several methods and interpreted as pedestrian, vehicle, and building data.
c. WiFi scanners are simple and powerful for reading and capturing MAC address data and can be used for transportation surveys.
d. Composition analysis and data processing will be suitable for analyzing big data in the future

The results of the conducted experiments indicate not only the benefits of the developed equipment but also the challenges to be addressed in future work. WiFi scanners could be used for several other purposes:
1) The proposed method is appropriate for long-term data collection with daily variations.
2) There is no need to communicate with people or objects when collecting the data.
3) The WiFi-scanner data can provide information about busy areas such as bus stops, shops, parking lots and bus terminals. If the WiFi scanners detect an area that has many visitors, this data could inform operators about the need for increased capacity. For local governments, WiFi-scanner data could be used to improve the ability of facilities and provide input to urban planning related to transportation facilities and public transportation and could also be used to enhance the marketing of tourism support facilities in towns and cities.

The results of the conducted experiments indicate not only the benefits of the developed equipment but also the challenges to be addressed in future work. However, at present, there are several limitations. The WiFi scanner can produce inaccurate results when there is less use of WiFi-enabled mobile devices; there are false WiFi readings because the devices are out of range, the MAC address changes (when upgrading system devices), or because of slight GPS inaccuracies. As there have been few case studies, the technology needs to be tested in several different places with larger survey areas and longer survey times to improve the analysis and procedure.

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REFERENCES

Abedi, N., Bhaskar, A., & Chung, E. (2013). "Bluetooth and Wi-Fi MAC Address Based Crowd Data Collection and Monitoring : Benefits , Challenges and Enhancement", In: *Australasian Transport Research Forum 2013 Proceedings 2*, 1–17. Retrieved from http://www.patrec.org/atrf.aspx

Ahmed, H., El-Darieby, M., Morgan, Y., & Abdulhai, B. (2008). "A wireless mesh network-based platform for ITS", In: *Vehicular Technology Conference, 2008. VTC Spring 2008. IEEE*, IEEE., 3047–3051. https://doi.org/10.1109/VETECS.2008.329

Al-Husainy, D., & Fadhil, M. (2013). "MAC Address as a Key for Data Encryption", *International Journal of Computer Science and Information Security* 83–87. Retrieved from http://arxiv.org/abs/1311.3821

Asija, M. (2016). "MAC Address Monika", *IRA-International Journal of Technology & Engineering*, *03*(01), 41–60. Retrieved from https://research-advances.org/index.php/IRAJTE/article/view/125/138

Böhm, M. F., Ryeng, E. O., & Haugen, T. (2016). "Evaluating the Usage of Wi-Fi and Bluetooth Based Sensors for Pedestrian Counting in Urban Areas", In: *European Transport Conference 2016Association for European Transport (AET)*, 24p–24p. Retrieved from https://trid.trb.org/view/1442384

Dunlap, M., Li, Z., Henrickson, K., & Wang, Y. (2016). "Estimation of origin and destination information from bluetooth and Wi-Fi sensing for transit", *Transportation Research Record: Journal of the Transportation Research Board*, (2595), 11–17. Retrieved from https://doi.org/10.3141/2595-02

Freudiger, J. (2015). "How talkative is your mobile device?: an experimental study of Wi-Fi probe requests", In: *Proceedings of the 8th ACM Conference on Security & Privacy in Wireless and Mobile Networks-WiSec '15*, ACM Press, New York, 1–6. Retrieved from https://doi.org/10.1145/2766498.2766517

Fukuda, D., Kobayashi, H., Nakanishi, W., Suga, Y., Sriroongvikrai, K., & Choocharukul, K. (2017). "Estimation of Paratransit Passenger Boarding/Alighting Locations Using Wi-Fi based Monitoring: Results of Field Testing in Krabi City, Thailand", *Journal of the Eastern Asia Society for Transportation Studies*, *12*, 2151–2169. https://doi.org/10.11175/easts.12.2151

Fukuzaki, Y., Mochizuki, M., Murao, K., & Nishio, N. (2014). "A pedestrian flow analysis system using Wi-Fi packet sensors to a real environment", In: *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct Publication-UbiComp '14 Adjunct*, ACM Press, New York, 721–730. https://doi.org/10.1145/2638728.2641312

Hamacher, H. W., Heller, S., & Ruzika, S. (2010). "Pedestrian and Evacuation Dynamics 2008", In: *PED 2010 Conference Proceedings*, Springer Berlin Heidelberg, Berlin, Heidelberg. Retrieved from https://doi.org/10.1007/978-3-642-04504-2

Heuvel, J. van den, Ton, D., & Hermansen, K. (2016). "Advances in Measuring Pedestrians at Dutch Train Stations Using Bluetooth, WiFi and Infrared Technology", In: V. L. Knoop & W. Daamen (Eds.), *Traffic and Granular Flow ' 15*, Cham: Springer International Publishing, Switzerland, 11–18. https://doi.org/10.1007/978-3-319-33482-0_2

Hidayat, A., Terabe, S., & Yaginuma, H. (2017a). "Mapping of MAC Address with Moving

WiFi Scanner", *International Journal of Artificial Intelligence Research*, *1*(2), 34–39. https://doi.org/10.29099/ijair.v1i2.27

Hidayat, A., Terabe, S., & Yaginuma, H. (2017b). "WIFI SCANNER FOR OBTAINING PEDESTRIAN DATA", *Plano Madani: Jurnal Perencanaan Wilayah Dan Kota*, *6*(2), 128–136. Retrieved from http://journal.uin-alauddin.ac.id/index.php/planomadani/article/view/3224

Hidayat, A., Terabe, S., & Yaginuma, H. (2018). "WiFi Scanner Technologies for Obtaining Travel Data about Circulator Bus Passengers: Case Study in Obuse, Nagano Prefecture, Japan", *Transportation Research Record: Journal of the Transportation Research Board* 1–10. Retrieved from https://doi.org/10.1177/0361198118776153

Jackson, S., Lesani, A., & Moreno, M. L. F. (2014). "Towards a WIFI system for traffic monitoring in different transportation facilities", Transportation Research Board, 93rd Annual Meeting., 1–19. Retrieved from https://trid.trb.org/view/1290003

Jiang, M., Fan, X., Zhang, F., Xu, C., Mao, H., & Liu, R. (2016). "Characterizing On-Bus WiFi Passenger Behaviors by Approximate Search and Cluster Analysis", In: *7th International Conference on Cloud Computing and Big Data (CCBD)*, IEEE., 31–36. https://doi.org/https://doi.org/10.1109/CCBD.2016.017

Lesani, A., & Moreno, M. L. F. (2016). "Development and Testing of a Real-Time WiFi-Bluetooth System for Pedestrian Network Monitoring and Data Extrapolation", In: *Transportation Research Board, 95th Annual Meeting*, 1–13. Retrieved from https://trid.trb.org/view/1394097

Mai, V. H., Kusakabe, T., Suga, Y., & Oguchi, T. (2017). "Travel Time Estimation in Mixed Traffic Using Wi-Fi Detector Based Data.", In: *ISCTSC 11th International Conference on Transport Survey Methods*, ACM Press, Canada. Retrieved from http://www.isctsc2017.ca/workshops/isctsc2017_workshop_b3.pdf

Malinovskiy, Y., Saunier, N., & Wang, Y. (2012). "Analysis of pedestrian travel with static bluetooth sensors", *Transportation Research Record: Journal of the Transportation Research Board*, (2299), 137–149. https://doi.org/https://doi.org/10.3141/2299-15

Nagano Prefecture Government (2016). "Obuse Tourist Guide", Nagano. Retrieved from http://www.obusekanko.jp/download/pdf/english_s.pdf

Nishide, R., & Takada, H. (2013). "Detecting Pedestrian Flows on a Mobile Ad Hoc Network and Issues with Trends and Feasible Applications", *International Journal on Advances in Networks and Services*, *6*(1), 108–117. Retrieved from http://www.iariajournals.org/networks_and_services/tocv6n12.html

Oransirikul, T., Nishide, R., Piumarta, I., & Takada, H. (2014). "Measuring Bus Passenger Load by Monitoring Wi-Fi Transmissions from Mobile Devices", *Procedia Technology*, *18*, 120–125. https://doi.org/10.1016/j.protcy.2014.11.023

Petre, A.-C., Chilipirea, C., Baratchi, M., Dobre, C., & van Steen, M. (2017). "WiFi tracking of pedestrian behavior", In: *Smart Sensors Networks*, Elsevier., 309–337. Retrieved from https://doi.org/10.1016/B978-0-12-809859-2.00018-8

Poucin, G., Farooq, B., & Patterson, Z. (2016). "Pedestrian activity pattern mining in wifi-network connection data", In: *Transportation Research Board, 95th Annual Meeting*, 20p. Retrieved from https://trid.trb.org/view/1394184

Raspberry. (2015). "Raspberry Pi 2 Model B",. Retrieved from https://www.raspberrypi.org/products/raspberry-pi-2-model-b/

Senthil Kumar, S. (2016). "An Analytical Study of MAC Address Spoofing", *International Journal of Scientific Development and Research (IJSDR)*, *1*(11), 123–125. Retrieved from http://www.ijsdr.org/viewpaperforall.php?paper=IJSDR1611021

Shlayan, N., Kurkcu, A., & Ozbay, K. (2016). "Exploring pedestrian Bluetooth and WiFi detection at public transportation terminals", In: *2016 IEEE 19th International Conference on Intelligent Transportation Systems (ITSC)*, IEEE., 229–234. https://doi.org/https://doi.org/10.1109/ITSC.2016.7795559

Takahiko, K., & Yaginuma, H. D. F. (2017). "Estimation of Bus Passengers Waiting Time at a Coach Terminal With Wi-Fi MAC Addresses", In: *11th International Conference on Transport Survey Methods*, 11th International Conference on Transport Survey Methods, Estérel, Québec. Canada. Retrieved from http://www.isctsc2017.ca/workshops/isctsc2017_workshop_b3.pdf

Terabe, S., Hidayat, A., & Yaginuma, H. (2017). "WiFi Sensing Technologies for Affordable

Travel Data Collection from Bus Passengers", In: *11th International Conference on Transport Survey Methods*, Quebec, 1–11. Retrieved from http://www.isctsc2017.ca/workshops/isctsc2017_workshop_a4.pdf

Wikipedia (2008). "The free encyclopedia, Obuse, Nagano.",. Retrieved July 1, 2017, from https://en.wikipedia.org/wiki/Obuse,_Nagano

Xu, Z., Sandrasegaran, K., Kong, X., Zhu, X., Zhao, J., Hu, B., & Chung Lin, C.- (2013). "Pedestrain Monitoring System using Wi-Fi Technology And RSSI Based Localization", *International Journal of Wireless & Mobile Networks*, *5*(4), 17–34. https://doi.org/10.5121/ijwmn.2013.5402

Co-exist or Integrate?

Reviewing the Spatial Planning Reform of China from the Perspective of Central-Local Relations

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Abstract: A multiplicity of spatial plans in a planning system can have different ways of co-existing under different institutional organizations. Having a highly centralized government like China, the phenomenon of a multitude of national-level plans dominating at the same time has its own unique characteristics. Much literature emphasizes only the lacking of coordination between governmental institutes. However, this research finds that the current constitution of the Chinese planning system profoundly reflects the relations between central and local governments. This paper first examines the characteristics of the Chinese political system, briefly reviewing the iterative process of "centralization-decentralization-selective centralization", showing the rise and fall of spatial planning as an administrative tool of local governments. Especially since the 1990s, the central government has raised revenue from the local level, which leads to local governments depending more on selling land for quick money. But as the urban expansion accelerates, the state asserts its control on local development by the National Main-function Plan and National Land-use Plan, which seriously impedes the coordination of spatial plans at different levels. Therefore, this study argues that spatial planning reform in China requires not only generating integrated information platforms and technical standards, but more importantly, establishing new relations between central and local government. In the end, some suggestions are made on central authorities reducing the constraints of a planning censorship system and rebalancing the responsibility and the public finance of local government on planning matters.

1. INTRODUCTION

In China, planning is an administrative tool of the government. There are quite a number of and types of spatial plans. At least 83 types of plans are authorized by laws or regulations, of which 22 are spatial plans, and 25 are spatially-related planning tools utilized by various government departments (Liu, Shi, & Xiang, 2017) Among them, city master planning, land use planning and major function-oriented zones' planning are the three most comprehensive spatial plans, which make an important component of the spatial planning system of China.

City master planning, managed by Ministry of Housing and Urban-Rural Development, is to determine the city's future scale and direction of development, to set up goals, to reasonably deploy urban functions, and to clarify specific spatial layout. The history of city master planning is the longest in the country. A matured system of planning techniques has formed due to this (Li, 2011; Gu, 2015) Land use planning, organized by the Ministry of Land and Resources Management, is to formulate overall arrangement and layout in time and space for the function, scale and intensity of land development for a certain region. It is a tool of the central government to practice land supply regulation and to control the overall aggregation of land for construction purposes (Gu, 2015; J Lin, Zhou, & Zhang, 2017). Major function-oriented zones' planning, supervised by the National Development and Reform Commission, is to divide the country or region into spatial and functional zones with specific development positions, based on comprehensive analysis of resources and environment carrying capacity, the existing development density and potential and other factors. The major function-oriented plan first appeared in 2007 with the purpose of forming a framework for coordinating regional development (Shi, 2008; Wang, 2009).

Other than the three major spatial planning types, environmental plan and the national five-year plans (Wang & Shen, 2014) also have the tendency to develop into more comprehensive national overall plans with the purpose of effectively coordinating the contradiction between "development" and "protection" through scientifically arranging all spatial resources (Gu, 2015). However, these spatial plans are fragmented, lacking cohesion, and conflicting with each other, which has brought about the problem of increasing inefficiency and waste of resources, which has also weakened the legitimacy and executive efficiency of spatial planning.

In recent years, these problems have become a hot topic in China's planning circles. Many scholars have discussed how to standardize the technical standards of various planning to integrate the multiple spatial plans (Xiao, 1998; Lu, Yang, & Li, 2004; Cai, 2009; Huang, et al, , 2016). These studies avoid the institutional background of the coexisting phenomenon. Some other scholars emphasize solving the problem from the relations between government departments, by establishing a collaboration platform (Harbers et al., 2017; Yejun Huang, 2012; Y. Wang, 2009; Zhu & Yin, 2016). A multitude of spatial plans of similar spatial scales coexisting has been and is now still the case in some countries with long-standing planning traditions, such as the Netherlands (Faludi & Van der Valk, 1994; Zhou, Hu, & Gu, 2017). It is easy to simply accuse the lack of horizontal coordination between government departments as the reason for the overlap, crossing-over of and conflicts of spatial plans, regardless what socio-economic system the planning system is embedded in.

There are few articles that try to explore the reasons for the coexistence of the multiple spatial plans and the significant meaning of planning integration from the angle of intergovernmental relations, especially the relation between the central and local governments. The relationship between the central government and local governments is an important issue in the construction of a major power system, which has a profound impact on the coordination of spatial development as well as on the planning system. Before China's decentralization reform in 1978, spatial planning was not widely seen in China, and urban planning was in a state of stagnation for a long time. But since the local government received more discretion from the central government, especially in the most recent 20 years, the types of

spatial plans organized by the central government department increased dramatically. For this reason, this article tries to understand the correlations between the phenomenon of the multiple-plan coexistence and the decentralization of state power.

In China, the planning system is grounded in an all-around government management system. Under the "strong government and weak society" mechanism (A. D. Z. Wang, 2005), direct government control on spatial development has a more profound influence than that of countries with a market economy. Among the over 80 types of spatial plans, many, especially plans for relatively large scales, are in fact a tool of the central government making use of the administrative power of formulating and implementing spatial plans to guide and contain lower-level governments (Oi, 1992).

This article first attempts to summarize the characteristics of the central and local relations in China, including the evolution of these relations and its impact on spatial development. Then, the nature and development of city master planning, land use planning, and major function-oriented zones' planning will be analyzed, to reveal the need of the central government to control and regulate local development in different socio-economic development phases. This study argues that the phenomenon of coexistence of multiple spatial plans stems from the conflicts of interest of the lateral government departments only from the surface. But in fact, the conflict deeply reflects the vertical relations of different government levels, especially the logic between the central and local, during the gradual socio-economic reform process. It is based on this theory, that the direction of "integration-of-multiple-spatial-plans" is discussed.

2.   RESEARCH APPROACH

Much research has emphasized the low efficiency of the current planning system in China and thus has been eager to give suggestions on technical integration of different urban plans. But this article focuses on the fundamental reasons for the co-existence of multiple urban plans. It tries to reveal the reason why the central government put forward Land Use Planning and Major Function-oriented Zones' Planning when the City Master Plan had been already in use before them. This study argues that the main reason lies in the desire for control from the central government to local government that causes the co-existence phenomenon.

In that regard, this article focuses on the perspective of central and local relations since it is important to understand that the spatial planning system of China is deeply rooted in the country's political system, under the background of "Strong Government and Weak Society" in China. Rooted in the planned economy system of past times, the central and local government relation is the most important feature of the nation's institutional structure, so it is the main field of political system reform. This relation profoundly influences the spatial development and the spatial planning system of China.

In the following sections, firstly a literature review is carried out to show the discussions on the central and local relations. The focus is on the land development driven by the local government following fiscal reform, and the consequences and pressure that the central government faces. Then, a systemic analysis is made for the main types of spatial planning in China that is the city master planning, land use planning, and the major function-oriented zones' planning. The orientation and main contents of the three plans are explained to reveal the purpose as to why the central government

is eager to introduce multiple types of comprehensive spatial plans. In conclusion, this study argues that the purpose of the planning system reform happening at the moment should again be to reflect the interests and demands of the central government, as it continues to assert control on local governments.

3. TRANSITION OF RELATIONS BETWEEN CENTRAL AND LOCAL GOVERNMENT

3.1 The relations of central and local during the planned-economic period

In 1949, China began to establish a strict centralized planned-economic system. The fiscal, economic, financial and administrative power of the whole country was centralized in the hands of the central government. In this period, local governments worked only as agencies for the central government at lower levels. The institutional setup was organized in such a way to correspond to that of the central departments for social and economic management. In other words, the supervision and management systems were formed from top to bottom by departments and sectors, namely in "straps" - the vertical management system. Correspondingly, "blocks" - the horizontal structure - indicates management organization subordinated to the level of province, city, and county and so on. These kinds of "straps" and "blocks" formed the structure of a subordinated government system where responsibilities could be distributed in vertical manner from top to bottom, but also leading to the formation of complex central and local relations (Z. Zhou, 2009).

In this strict central planning system, the central government was responsible for collecting and spending the budget. The budget for construction was for a long time formulated by the former National Planning Commission (current National Development and Reform Commission), and then distributed to and executed by the provinces. The corresponding funds were issued by the Ministry of Finance. Other than that, local governments had very few financial resources. Local enterprises were mostly state-owned enterprises, whose profits were ought to be collected by the central government. Therefore, local governments were not motivated to develop their own economy and could only play the role of implementers of the central government's plan. Urban planning matters that were supposed to be within the scope of local government responsibilities, such as the scale and pace of urbanization and the provision of public service, were also to obey the overall order of the central economic plan, controlled by the centrally-planned instructions.

This centralized system was able to promote massive social production, avoiding the waste of resources caused by local competition, and ensuring an equalized allocation of social resources. However, the highly-centralized system led to a lack of an incentive mechanism. Thus, under the strict central planning system, sometimes small-scale decentralization was empowered to local governments. For example, the responsibility and financial resources to provide public services. It was hoped that local governments would shoulder more burdens of local development, making up for the differences between the "one-size-fits-all" policy of the central government and the actual needs of local areas, increasing their economic

vitality. However, while local governments actively involved themselves in pursuing local economic growth, it brought about the problem of stability for the macro-economy, which again made the central government compelled to increase discretion granted to local governments. Between 1949 and 1977, China's institutional model saw the iteration of "decentralization and centralization" (Z. Zhou, 2009).

3.2   Central and local relations in transition

From 1978, China begun with its economic reform process, the central government started to decentralize more power and financial resources to local governments. The financial contracting system was adjusted to ordinate with the new central and local relations. In 1980, the fiscal revenue-sharing system was carried out, which formed a financial relation based on the division of income and expenditure and self-balancing. In 1994, the central and local tax distribution system was adjusted. Local economic growth was further linked to local revenue. At the same time, administrative power was also decentralized. For example, local governments can formulate local development policies and spatial plans according to the actual situation of local regions, most of which did not require approval by the state. Under the gradual decentralization process, local governments have become a stakeholder with their own range of powers and responsibilities, and relatively independent financial discretion. They are no longer executive agencies of the central government under the traditional planned economic system, following hierarchical order. L. Zhou (2008) argues that the vertical hierarchy governmental system is a level-to-level agency system, where the upper-level government decentralizes the management powers (security, employment, economic development, to provide public goods, etc.) as a package delivery to the next lower level government. But the appointment of lower-level government officials, evaluation and management are entrusted to their direct superior departments.

In addition, the central government meant to stimulate the local governments to become the main bodies responsible for developing local economies, by offering more supportive policy and opportunities for those local regions that had better-developing momentum. At the same time, an evaluation index system was established for the selection and appointment system of government officials. Although indexes are diverse, city GDP (gross domestic product) growth and the scale of local economies are always the most important evaluation indexes, as the key reference for promotion.

Although the direction of China's reform was to establish a market-oriented system, the government's direct intervention of microeconomics was to gradually decrease, with the leading role of the government in guiding and controlling economic development resulting in no fundamental change. Only through the decentralization of powers, the dominator of local development has shifted from the central government to local governments. The divisions of central government departments at local levels, in the vertical "straps", work as main bodies driving local economic growth (Caulfield, 2006). Tending to get actively involved in their economy, local governments usually make use of the state-owned land resources to attract private investment, promoting economic growth and city construction. But it has also brought about macroeconomic problems, such as overheating investment, low investment efficiency, and similarity of industrial structure. The excessive speed and scale of land development is especially troubling.

4. LOCAL GOVERNMENT-LED LAND DEVELOPMENT

Due to the ambiguity of land property rights, the land has become an essential resource that local governments can easily grasp (Jieming Zhu, 2002). After the reform of the tax sharing system in 1994, local governments began to use the monopoly of local-level development to transfer a large amount of agricultural land into commercial development, forming an upsurge of enclosures. Initially, local governments were keener to engage in the construction of development zones, implemented the strategy of "building nests and attracting phoenixes", and attracted investment through infrastructure construction and cheap land rents, thereby expanding the local government tax source. With the large-scale promotion by governments at all levels, development zones were hot across the country. In the past decade or so, with the gradual saturation of the manufacturing industry, warming of real estate, and the enthusiasm of the municipal government for land finance, the municipal government has acquired huge revenue from land sales by accumulating large amounts of construction funds. The revenue from land sales accounts for more than 50% of the individual urban fiscal revenue.

These government-led developments have brought about some serious problems: (1) Widening income differences and social differentiation: Most local governments did not respect the wishes of farmers and forcibly requisitioned rural collective land. Economic compensation was not in place; the auction price of land in some mega cities continued to rise, and real estate prices also rose, which increased the living cost and business costs for new urban residents; most of the land revenue was concentrated. In cities, the gap between urban and rural disparities had been widened. (2) The green land and cultivated land were greatly reduced, causing an ecological crisis. (3) There is a structural disorder in land use: There are many high-tech parks, creative industry parks, new urban districts, big squares and wide roads, many of which are idle lands and "ghost towns". (4) In recent years, the real estate market in many places has become saturated, and borrowing has become a new and compelling choice for local governments: Since the late 1990s, local governments have begun to establish local financing platforms to solve the shortfall in expenditure. In particular, after the financial crisis of 2008, the Central Government launched a fiscal investment of 4 trillion RMB, and local governments launched a corresponding supporting plan of nearly 10 trillion RMB. The scale of local investment and financing platforms and local government debt began to expand rapidly. In recent years, great threats to macroeconomic stability have been formed.

The over-supply of land caused by land development has triggered territorial politics to emerge (Rithmire, 2013) and controversy over excessive "incentive mechanisms" of the central government to localities and the lack of "restraint mechanisms", which has also made spatial planning a focus (L. Wang & Shen, 2014).

4.1 Coexistence of spatial plans: a reflection of the failure of traditional planning?

In general, local governments need to have discretion in providing local public services and promoting local economies. In the process of

decentralization and economic transition, the expansion of the discretionary power of Chinese local governments, while contributing to economic growth, has also led to a series of problems such as the overlarge scale of spatial development. For this reason, the central government will raise doubts about whether "the discretion of the local government is excessive". Therefore, the central government will inevitably need to strengthen the restrictions on local governments and control the discretion of the local governments in the development of urban land and space resources. Due to the lack of legal, judicial, and fiscal constraints, and the failure to establish a set of power supervision mechanisms to adapt to the market economy, higher levels of government often rely on administrative measures to achieve supervision of local governments. In administrative measures, the role of administrative directives in the traditional planned economy has weakened, and spatial planning and performance evaluation indicators have replaced traditional administrative directives to a certain extent. Among them, to ensure that spatial planning effectively constrains the spatial development behavior of local governments, the central government will strengthen the restrictive content of spatial planning.

Before the decentralization reform, there were only a few types of planning such as city master plan in the spatial planning system, and the urban plans belonged to the scope of the municipal government's authority. The restrictive role of the urban planning was only for the society and the lower levels of government, and it lacked constraints on the municipal government itself. For this reason, a new type of spatial planning with the main purpose of constraining local government emerged to make up for the inadequacy of the central government's local control measures.

4.2   City Master Planning: administrative tools of municipal government

In all kinds of spatial planning in China, the history of city master planning is the oldest. Contemporary city master planning in China emerged in the 1950s. At that time, in order to coordinate with the construction of key national projects and coordinate the relations between key projects and the development of urban space, the "city master plan" system was initially established, and planning was carried out in several key industrial cities. The "master plan" at this stage is seen as a continuation of the economic and social development plan, with a focus on urban functional zoning, site selection of industrial projects, and infrastructure construction, and direct development of material space. During the Great Leap Forward in 1958, local governments were allowed to coordinate the resources of their jurisdiction and develop the local economy, which led to a nationwide investment boom. New industrial lands appeared in cities. Urban planning was also active at that time. In order to adapt to the Great Leap Forward in industrial construction, some cities proposed unrealistic planning goals. For instance, the urban planning of Yinchuan and Xiangfan put forward the development targets of 1 million and 1.2 million people respectively based on the original population of 100,000. However, in the subsequent rectification of the economic order, the discretion of the local government was constrained, and the city planning as an administrative tool for the municipal government was required to be suspended for three years, but it was actually a long-term stagnation (K. Wang, 1999).

The urban planning system was restored in 1978, transformed from serving plans and projects of upper levels to serving the local government

for comprehensively allocating spatial resources (Ng & Tang, 2004). By 1990, a legal planning system centered on the "Urban Planning Law" was essentially formed. Urban planning belonged to the scope of a local government's authority. Through urban planning, it would conduct "building arrangements" for space, and then integrate the resources within its jurisdiction, and meanwhile coordinate the appeals of various departments. It was based on the physical form of urban space, guided by the goals of economic and social development for a certain period of time, and through the determination of the nature, scale and development direction of the city, spatial arrangements were made for the road systems and other infrastructure, buildings, industries and other urban functional units involved in the urban physical development pattern, in order to coordinate arrangements for the spatial layout of various functions of the city, realize the rational use of urban land, and promote the development of urban space in an orderly manner.

From the perspective of planning technology, urban planning has weak constraints. The technical standards for urban planning are provided by the Ministry of Housing and Urban-Rural Development to provide technical standards. According to the "Urban and Rural Planning Law", the "local government shall, before compiling the city master plan, make a summary of the implementation of the current general city plan and the implementation of various special plans, and evaluate the supporting capabilities and construction conditions of the infrastructure." "Based on regional planning and urban-rural integration, forward-looking studies on strategic issues such as the city's orientation, development goals, urban functions, and spatial distribution should be conducted." But these legal provisions lack rigidly binding content. For example, the scale of future urban development in the planning period, despite the existence of per capita land use standards and other restrictions, due to the lack of strict validation of the "population size forecast", urban planning is often based on deliberately increasing the size of the population forecast, and then making the scale of urban construction exceed actual needs. Some urban planning even often reverses the predicted size of urban population through the scale of construction land needed by local governments to achieve the legitimacy of the planned scale of urban construction land in the future.

In addition, for a long time, there has lacked upper-level macro planning in the urban planning system to guide the overall urban planning. Although the Ministry of Housing and Urban-Rural Development and the Provincial Office of Housing and Urban-Rural Development have compiled national and provincial urban system plans, most of them are guidelines and have few restrictions. Moreover, the preparation time and specific requirements for these macro-scale plans all have differences between each other, lack coordination and convergence between the top and bottom, and the authority and operability are also limited (X. Li & Men, 2004)

Although urban planning needs to be approved by local people's congresses, local people's congresses as the highest authorities are not always able to perform their due functions and roles. Although the power of local government officials is fundamentally given by the Municipal People's Congress, it is more directed by the higher authorities. The position of the local people's congressman is mostly taken over by local officials, so the role of local people's congresses is largely blurred. In the process of urban decision-making, the procedural rules for the Municipal People's Congress to participate in decision-making are not specific and are unclear, making the role of the Municipal People's Congress greatly limited.

Although the "Urban and Rural Planning Law" has established a "hierarchical examination and approval" method, it also stipulates that the "city master plans" of some important cities need to be reported to the central government for approval. However, the main approval content lacks major and minor differences. Moreover, excessive approval content and department involvement have exceeded the authority of the higher-level government. These have also resulted in that the duration and efficiency of the approval cannot be guaranteed. Some approval procedures are frequently 3-5 years, sometimes eight years. Although it was not always possible to obtain approval promptly, the planning prior to the approval process was still implemented to ensure the timeliness of the plan. Therefore, the low efficiency in the approval process not only reduces the guiding role of the examination and approval, but also reduces the binding significance of the approval, which provides an excuse for planning violations and illegal activities (Zhao & Hao, 2012).

City master planning has gradually progressed toward standardization and legalization. Till 1990 a legal planning system based on the Urban Planning Law had been only basically formed. A judicial accountability system in urban planning was also missing. A city master plan as a normative legal document, although directly affecting the allocation of public resources and regulating the public interest, in its preparation and results, is regarded as an abstract administrative act and does not fall within the scope of administrative litigation regulated by the Administrative Litigation Law of China. It is considered with non-litigating nature. For the concrete administrative behaviors of the implementation of urban planning, the scope of procedures and jurisdictions that the government should follow is more of a principled provision. In practice, administrative regulations or orders are often used in place of legal restrictions, thereby reducing judicial accountability. As the vulnerable group of urban planning games, the public cannot safeguard their rights and interests through more deterrent judicial relief. Regardless of the old version of the "Urban Planning Law" or the existing "Urban and Rural Planning Law", the specific applicability of relevant laws and regulations depends on the local government's adaptation to local conditions. This is a practice that has been delegated authority but is not clearly regulated, which causes the legislators to inadvertently give the local government too much discretion, and the judicial system that abuses the discretion of the municipal government has not yet been established.

Due to the lack of restraint mechanisms for upper-level governments and the lack of inherent social restraint mechanisms, urban planning has become an administrative tool or growth tool for local governments, constantly expanding the scale of cities and pursuing "leap-forward development" (Wu, 2015). Sometimes urban planning even serves the major personal achievements of the municipal government's leaders. With the beginning of the new leadership term cycle, the government frequently compiles or revises the "master plan" in order to meet the new leadership's need to pursue short-term performance. In this case, "urban planning" starts by reflecting the intention of the administrative officials. What is more, local governments often use the image of city planning "technical rationality" to persuade the superiors to circumvent the limitations of other types of spatial planning (such as the subsequent land use planning).

In short, since urban planning authority belongs to the municipal government, and the planning approval, implementation, supervision systems and the technical content of planning are all lacking in effective constraints, urban planning shows "expanding" characteristics. This has also

led to the difficulty of urban planning in implementing the central government's regulatory requirements for the municipal government in urban development.

4.3   Land Use Planning: restrictive on the total amount of land for development

China's land-use planning began in the 1950s, focusing on the planning of state-owned farms, people's communes and irrigated areas, with the aim of serving agriculture. The National Land Administration was also affiliated with the Ministry of Agriculture at that time. The planning experts were mainly soil experts. In the 1980s, land use planning at the county level began to appear. The first "Land Administration Law of the People's Republic of China" was issued in 1986, being clearly required for general land use planning. It regulated that "urban planning and general land use planning should be coordinated; in a planned urban area, land use shall conform with city planning". The first round of general land use plans focused mainly on rural agricultural areas outside urbanized areas. They emphasized research on the bearing capacity of land, the development and governance of cultivated land, the prediction of urban land, index adjustment and partitioning. They become the main content of general land use planning. The suitability of certain types of land for certain functions, the allocation of resources among different industries, sectors, and regions and the spatial organization of land use functions have been paid much attention to (J Lin et al., 2017) . However, the social status and juridical power of the general land use planning under the market economy had not reached the height it should have. The planning was lacking an effective regulative mechanism on urban constructed land, constraint methods on the transition of farmland to non-agricultural functions, protection regulations on cultivated land, as well as control on the development of township enterprises.

Since the 1990s, there has been a boom in "land enclosure" activity, especially in 1992 and 1993, when the "real estate boom" and "special economic zone" wave swept through China. The speed that the agriculture land was diminishing at reached a record high. The phenomenon let the central government recognize the importance of implementing restriction on spatial development. In 1997, the No. 11 files issued by the Central Committee of the Communist Party of China, "Notice on Further Strengthening Land Management and Protecting Arable Land", emphasized that "according to China's specific conditions, the land management in our country, especially the measures for protecting cultivated land, must be very strict, and must be implemented stringently". It required strictly that the total amount of cultivated land of provincial governments could only be increased, must not be reduced, and be based on a dynamic balance manner, and additionally, that efforts were to be made to improve the quality of cultivated land. The policy also called for careful preparation, revision and implementation of general land use planning. This was during the reform of decentralization, a power control tool by the central government to manage the development scale of local levels, when other directive control methods over the local governments were decreasing (Gu, 2015; J Lin et al., 2017).

To this end, the status and usefulness of the general land use planning had been significantly promoted. Land use planning was endowed with the function of restricting the total amount of land for development. The core meaning of the land use planning had shifted to improving the land use

efficiency, and to the compensation principle of linking the decrease of cultivated land for development with reclamation for new arable land elsewhere. General land use planning was purposed to secure national land for national economic and social development by applying overall management and planned allocation of various types of land functions for development based on the coordination of various governmental departments with land demand. The plan made every effort to make full and reasonable use of limited land resources, according to the determined land use type. On the planning content, away from the single agricultural land planning in the past, its planning scope was expanded to all urban and rural land within the territory of the overall arrangement. It shifted from focusing on only utilizing land for development into a comprehensive theme for land development, protection and renovation; from focusing on the micro-scale land-use organization, to more macro-control and policy guidance; from emphasizing on production and development, to promoting the coordinated economic, social, resource and environmental development by master planning.

The legal status of the general land use plan had also been greatly improved. Once approved, the plan would become legally binding and incorporated into the five-year plan and annual plan of the national economic and social development and shall be strictly implemented. By the end of 2000, land use planning at five levels, from the national to the town level, had basically been completed around the country and implementation started, following a step by step top-down control through the five hierarchies. To this point, the system has been established for the general land use planning, based on the central control of land supply constraints.

The second round of the general land use plan, that of 1997, emphasized too much on agricultural land, especially the protection of cultivated land and permanent farmland, with the aim to "strictly restrict the conversion of agricultural land into construction land, controlling the total amount of construction land", "to ensure no decrease on the total amount of cultivated land". As a result, construction land necessary for national economy development was not planned for well enough, and the impact and demand on the ecological environment did not have sufficient research support. The plan had been violated again and again in actual operation, for it was against the logic of economic and social development. Thus, it did not really show positive effects of land use planning. The third round of the land use plan was formulated in 2006, which set up the rationale of being "global, flexible and dynamic". A land use evaluation index system was created for the economical and intensive use of land, from the economic, ecological and social points of view. Space-time and potential analyses would be performed for the land use of specific areas, providing a base for the control index decomposition in the land use functional plan and spatial layout of construction land (J Lin et al., 2017).

Henceforth, general land use planning is on the path to becoming a regional comprehensive planning strategy because of its core role of implementing control of land use and development for the central government. In contrast to the city planning, land use planning emphasizes restriction in quantity of land development from the national strategic point of view to that of local governments. The "land rules" and "land indicators" formulated in the land use plans must be strictly complied with by city plans. The city planning departments are often in a relatively weak position when coordination is needed between it and the land-use planning department. The comprehensive long-term development goals and visions of

city plans are subject to the fixed amount of land available as established in the land use plan. Interestingly, city plans have become a tool of local government to bargain for more land for development from provincial and higher levels.

The emergence of land use planning has profoundly affected the relations between central and local governments in China. Due to the commonly-seen discrepancies between local demand of land for social and economic development and the amount of land predicted and restricted in the land use planning, the plan has become a straightjacket of local growth, just like in a period of a planned economic system with a tight control of supply of resources (Gu, 2015). The principle of dynamic balance of the increase of construction land in the urban area and compensated with the reclamation of new arable land elsewhere has become the basis of local governments lobbying for more policy support.

4.4   Major Function-oriented Zones' Planning: hierarchical top-down plan

The central government tends to pursue the macroscopic benefits, advocating differentiated growth, opposing the one-hive growth model. However, due to the emphasis on the effectiveness of policy and the lack of effective mechanisms in coordinating local interests, the central government's control policy often works as a "one size fits all". This kind of policy is often made by a certain central ministry or committee from its own perspective and is oriented towards a single goal. For example, the second edition of the national general land use plan ignored the comprehensive goal of social development, neglected the influence of efficiency and social justice, and resulted in high social costs. Therefore, it is difficult to ensure monitoring and management of spatial plans, if only relying on the policy and plans made by the central government.

In order to frame reasonable targets that fits local situations, the eleventh five-year plan in 2006 put forward a new type of spatial plan - Major Function-oriented Zones' Planning, intending to clarify the prioritized functions suitable for a certain region in the country, re-arranging the pattern of regional development before the relations of various types of spatial planning is settled. It had the ambition to become the foundation of decision-making for various types of spatial planning, and therefore forming a coordinated system through four governmental levels (national-provincial-municipal-county) and between different government sectors (Shi, 2008).

The document "Opinions on the Preparation of Major Function-oriented Zones' Plan" ('the Plan') by the State Council of 2007 put forward that, the Plan is strategic, fundamental, and legally binding in nature, and is the overall basis for national economic and social development and a variety of spatial planning in spatial development and arrangement. Traditional development plans in China can be seen as being based on the plans and interests of a vertical "straps" system (central department's) plan. It mainly gave priority to the balance of man-power, financial power and material resources, and determined the allocation proportion between departments and regions. But major function-oriented zones' planning is based on the logic of regional comprehensively matched development and transverse comparability, emphasizing balanced and coordinated development among regions in the country in the long-term.

The main intention of promoting this new type of spatial plan is to clarify the development direction, intensity control, to standardize the order

of development, to improve the development policy, and to form a sustainable national spatial development pattern. Resources and environment carrying capacity, and existing building density and development potential are objective differences between regions and are also the foundations in determining the main and prioritized functions for that specific region. By further referencing to factors like population distribution, economic layout, land use functions and the urbanization development pattern, reasonable arrangements can be made with comprehensive considerations for the overall development tasks for different regions in the national development framework. Optimized development zones, key development zones, restricted development zones and prohibited development zones are the four types of land regions used by the Plan. The main drive is to constrain irrational development impulses, using development intensity as a single coordinate to determine the type a region belongs to. The central government hopes to use this plan as a base to achieve regional harmonious development, promoting orderly and planned urbanization, and overall coordination of the spatial development pattern (Gu, 2015; Shi, 2008).

Major function-oriented zones' planning requires the higher-level government to base local land use and development plans on obeying the farmland protection line, the principle of ecological construction and environmental protection, and economic and social development demands. According to the types of main functional zone assigned to the region, local governments are given access to different land development rights or construction permissions (Jian Lin & Xu, 2014), and are accompanied with different evaluation criteria for local officials. Compared with the general land use plan, the National Major Function-oriented Zones' Plan is performing the central planning of national economic and spatial development from the perspective of the central government. It is more comprehensive, macroscopic and strategic.

5.   DIRECTION OF INTEGRATING SPATIAL PLANS

To promote the integration of multiple spatial plans is the reform direction of the Chinese government in recent years, with the aims to reduce repetitive planning and improve planning efficiency, to improve the rationality and comprehensiveness of planning through department cooperation; to promote the planning and management of docking through coordinated control, to improve the national macro-control system based on planning, to strengthen the seriousness and authority of planning, and implement the rules and regulations (D. Li, 2011).

Therefore, for improving the spatial planning system and government efficiency, the spatial plans in the vertical system could already have basic cohesion regarding planning objectives, statistics caliber, spatial control method and planning sequence, etc. But for the overlapping and conflict in the horizontal system, it is necessary to calibrate and coordinate three key factors in spatial planning (i.e. targets, indicators and coordinates), content and scope of planning, standard statistical caliber, land use types, planning period, and restrictive index. Much workload is on re-standardization and building information platforms. However, it is not the "oneness" of planning technology that is the key issue here. The concept of "technology supremacy" needs to be reconsidered. More importantly, the "oneness" system mechanism should be established for achieving real integration.

To effectively control urban expansion, it is necessary to rationalize the relations among all kinds of spatial planning and re-build a planning system. City planning which is organized by local governments should pay attention to national policy guidance and constraints, especially those binding targets such as "newly-increased construction land", combining local "expansion-oriented" planning with the "control-oriented" planning logic of the central government. On the other hand, the General Land Use Plan should be able to respect the actual local needs when allocating the land index. Increasing elasticity in the supply system can also help to avoid land provision deviation from the real need. Major function-oriented zones' planning is above all other types of spatial planning. It is a kind of strategic policy planning that can provide a fundamental basis for city planning, general land use planning and environmental planning, transportation planning and other kinds of spatial planning. It is a long-term, strategic and fundamental framework plan, useful to establish cooperation among all kinds of spatial planning rather than replacing any of them. After formulating the main functions for strategic zones in the country, it is then possible to implement spatial management through city master plans and land use plans. Therefore, the new spatial planning system should base itself on major function-oriented zones' planning, and then include land use planning and city planning.

Due to the decentralization reform, the restrictive mechanism of local governments had been weakened. New types of spatial planning were therefore strengthened to assert control from central to local governments. Therefore, it is possible to reduce dependence on restrictive planning, by reasonably increasing the level of central control of other aspects. Existing decentralization reform has remained focused on administrative and fiscal decentralization. A clearer functional division of different governmental levels should be established. That is to differ from the past reform, which attached great importance to the power division but not the function division. This study suggests further decentralizing much public management and public service powers to the local government, to strengthen the autonomy of local government management responsibility, and to make them bear more of the cost of management and service provision. And some functions such as economic adjustment shall be borne by city governments, or at a higher level, so that county governments and lower-level authorities can focus on providing better quality public services, as their main responsibility. Further, it is necessary to adjust the performance evaluation systems of local government officials, from a formerly pure economic index to a more comprehensive appraisal index. For example, taking social satisfaction as the main indicator in evaluating and appointing local government leaders.

In addition, although all kinds of spatial planning emphasize the function of public policy, they reflect only the government's "responsibility". Because of the different functions and rights, cohesion problems arose due to different interests and starting points of different levels of governments. If planning is based on real public interest, it can avoid disputes brought about by different responsibilities. For this reason, the integration of multiple plans needs to review the formulation and implementation path of various spatial planning from the perspective of interest coordination in future periods, involving the perspectives of different stakeholders in the planning, introducing societal supervision mechanisms to the government, and expanding citizens' participation in depth and breadth to the processes of public management activity. Finally, local development plans should be

placed under the multiple supervisions of higher-level government, the people's congress of the same level, and of the people themselves.

6.   CONCLUSIONS

The decentralization reform provides local governments more and more autonomy and resources of their own, making local governments the main bodies developing their local economies. They indeed are playing a crucial role in enhancing the local competitiveness and promoting economic growth. In recent years, urban expansion has been the most important strategy by local governments to accelerate capital accumulation. The rapid expansion has brought the problem of inefficient land use, which calls for the needs of macroeconomic regulation and control. The planning game in this sense is about land development rights.

City master planning as a traditional type of spatial planning leads to weak control and regulation and has become a tool of expansion by local governments. To control the disordered urban growth, the central government must use alternative spatial planning tools to restrain local city plans. For example, raising the legal status and functional scope of national land use plans to control the expansion of urban construction at the local level by setting up rigid limits for total yearly amount of land differing in scale level for different regions. In addition, the major function-oriented zones' plan gives instructions for the development direction, development intensity, order and development policy guides for regions, based on comparison of macro-regional development conditions, to form a sustainable national spatial development framework, and further guide and constrain city master plans and land use plans. The emergence of highly regulative types of spatial plans has also deeply affected the relations between the central and local governments. A new bargaining over land development rights between the central and local has therefore been triggered. The key issue of local governments is to persuade the central government to grant more amounts of land for development.

Currently, both the central and local governments welcome plan integration reform with their own considerations. The central government considers that "integration" will bring more control and a tighter grip over bringing all the spatial factors together under one single organization, while resolving conflicts between different spatial plans shall bring local governments clarity about how much more land is to become available for construction. For both sides, the obscurity has severely hindered development.

The key to "the-integration-of-multiple-spatial-plans" is not the coordination of planning techniques of different plans, but to establish a system that can coordinate the relations between the central and local governments. It must be able to reflect the state policy for spatial development, but also be specific and pertinent to local demands. All new spatial plans should be guided by the Main Functional Zoning Plan, and be based on the city plan, and integrate the restrictive content of a National Land Use Plan.

In addition, the adjustment of the central and local relations can also bring opportunities for the "integration-of-multiple-plans". The division of functions between governments at different levels and the strengthening of the division of powers can reduce the constraints between local

governments, increasing social participation, and forming more constraints on spatial planning.

REFERENCES

Cai, Y. (2009). "Exploration on coordination of four types of planning in the new era", *Planners*, *1*, 22–25.

Caulfield, J. L. (2006). "Local government reform in China: A rational actor perspective", *International Review of Administrative Sciences*, *72*(2), 253–267.

Faludi, A., & Van der Valk, A. J. (1994). "Rule and order", *Dutch Planning Doctrine in the Twentieth Century, Dordrecht*.

Gu, C. L. (2015). *Spatial Planning Based on the Integration of Multiple Plans*, *International review of administrative Sciences*, Tsinghua University Press, Beijing.

Harbers, A., Evers, D., Dassen, T., & Al, E. (2017). *Innovating Spatial Planning in China: Drawing Lessons from the Dutch Experience*, *International review of administrative Sciences*, PBL Netherlands Environmental Assessment Agency, The Hague.

Huang, Y. (2012). "Institutional Reform and Plan Integration-Observation and Thinking of Domestic Three Plans' Integration", *Modern Urban Research*, *2*, 10–14.

Huang, Y., Zhou, S., Wang, L., Luo, C., & Ni, Y. (2016). "Basic Theory And Technique Of Multi-plans Integration", *Planners*, *3*, 13.

Li, D. (2011). "Local government three Plans integration efforts and innovation", *Planners*, *30*(9), 65–69.

Li, X., & Men, X. (2004). "Study on the Reform of Management System of Urban and Rural Planning", *Planners*, *20*(3), 5–8.

Lin, J., & Xu, C. (2014). "Land development rights, space control, and synergetic planning", *City Planning Review*, *1*, 26–34.

Lin, J., Zhou, L., & Zhang, Y. (2017). "30 Years' Review on Land Use Planning", *Land Sciences*, *31*(9), 24–33.

Liu, C., Shi, J., & Xiang, Z. (2017). "Research on the pilot innovation of multiple-plan integration", *Land and Resources Information*, *10*, 27–34.

Lu, W., Yang, L., & Li, Y. (2004). "Analysis on urban master planning and land master planning", *City Planning Review*, *28*(4), 58–61.

Ng, M. K., & Tang, W.-S. (2004). "Theorising urban planning in a transitional economy: the case of Shenzhen, People's Republic of China", *Town Planning Review*, *75*(2), 173–203.

Oi, J. C. (1992). "Fiscal reform and the economic foundations of local state corporatism in China", *World Politics*, *45*(1), 99–126.

Rithmire, M. (2013). "Land politics and local state capacities: The political economy of urban change in China", *China Quarterly*, (216), 872–895. https://doi.org/10.1017/S0305741013001033

Shi, Y. (2008). "Research on the relationship among major function zoning, urban planning and land use planning", *Macro-Economy Study*, *8*, 35–40.

Wang, A. D. Z. (2005). *China Local Public Finance and Urban Development*, *China Economy Press*, China Economy Press, Beijing.

Wang, K. (1999). "The changes and influences of guiding ideas in Chinese urban planning from 1949 to 1999", *Planners*, *15*(4), 23–26.

Wang, L., & Shen, J. (2014). "Changing spatial planning in China's five-year planning system", *Proceedings of the Institution of Civil Engineers-Urban Design and Planning*, *67*(5), 189–195.

Wang, Y. (2009). "Institutional reasons of conflicts between master plan and land use plan: causes of land expropriation of local government", *City Planning Review*, *10*, 53–59.

Wu, F. (2015). *Planning for growth: Urban and regional planning in China*, Routledge, New York.

Xiao, C. (1998). "Study on relationship of urban planning and land use planning", *Urban Planning Forum*, *1*, 29–33.

Zhao, M., & Hao, J. (2012). "The Paradoxes and Solutions of Urban Comprehensive Planning Practice in China [J]", In: *Urban Planning Forum*, (Vol. 3) 1–9.

Zhou, J., Hu, T. X., & Gu, Y. T. (2017). "Study on the Vertical and Horizontal Coordination Mechanism of Dutch Planning System", *Planners*, *2*, 35–44.

Zhou, L. (2008). *Local Governments under Transformation: The Incentive of Government Officials and Governance*, *Truth & Wisdom Press*, Shanghai.

Zhou, Z. (2009). *Research on the relationship between the government functional departments and local government in contemporary China (Dangdai Zhongguo zhen fu "tiaokuai guanxi" yanjiu, 当代中国政府"条块关系"研究)*, Tianjin People Publishing House, Tianjin.

Zhu, J. (2002). "Urban development under ambiguous property rights: A case of China's transition economy", *International Journal of Urban and Regional Research*, *26*(1), 41–57. https://doi.org/10.1111/1468-2427.00362

Zhu, J., & Yin, X. (2016). "Integrating all sides and coordinating mechanism of city space planning", *Shanghai Urban Management*, *4*, 58–61.

Review on Advanced Practice of Provincial Spatial Planning: Case of a Western, Less Developed Province

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Abstract: Since the establishment of a unified spatial planning system was introduced at the Central Urban Work Conference, 2015, a number of cities across China have introduced "multiple-plan integration" planning practices. In 2016, the Meeting of the Central Leading Group for Deepening Overall Reform approved a proposal in Ningxia Autonomous Region, China to carry out a province-wide multiple-plan integration and spatial reform pilot. With a total territory area of 664,000 km2, Ningxia is suitable for exploring a new theoretical mode for multiple-plan integration. This paper first reviews the policy from "multiple-plan integration" to the reform of the spatial planning system, which has become the principal means for conducting spatial governance and land use control. The paper will introduce the basic logic and framework of the Ningxia example based on the project study. Mainly focused on the compilation of spatial planning systems, this research derives from planning of functional zones, and key and core content of technology integration, so as to enrich the current research findings and provide new insights for the practice of spatial planning at the provincial level.

1.   INTRODUCTION

During the past 15 years, as China's urbanisation and industrialisation have entered a transitional period of development, a huge focus has been the multi-planning system integration at the state level. With passing time, the general approach has moved away from technical integration to the integration and reformation of government departments. The existing "multiple planning segregation, overlapping and contradiction" is a characteristically Chinese phenomenon, and came out of its particular historical context. Spatial planning at the provincial level is key to the integration of national and local level spatial regulation and planning. Promoting provincial spatial planning, and innovating theories and technical approaches is quite an important issue in Chinese eco-civilisation reform and spatial planning reform. It remains important for China to continue to explore appropriate mechanisms to fulfil the protection and development needs within its territory.

Multiple planning integration has been a typical topic of Chinese research since 2000. It is understood that the relationship between socioeconomic development and the regulation of land use has been changing over the past few decades, but the transformation of the planning formulation system and planning management system has not matched its pace. Ever since the 1950s, urban planners have used Western planning theories and methods, but there is a fundamental difference in the governing systems.

The term "spatial planning" is used in many countries to refer to their current planning systems. It is used to describe national and regional planning, as well as aspects of planning (Tewdwr-Jones, Gallent, & Morphet, 2010). The forms of spatial planning systems correlate broadly with the national conditions and cultural traditions of each country, where they are tied to historical development, socioeconomics, and political and cultural values (Stead & Meijers, 2009). In 1997, the Summary of the European Union Spatial Planning System proposed that spatial planning mainly be used by the public sector to influence the spatial distribution of future activities, with aims to create a more rational territorial organisation for land use and functional relations, to balance the protection of the environment and development needs, and to achieve the overall goals of social and economic development (Luxembourg: Office for Official Publications of the European Communities, 1997). Salet, Thornley, & Kreukels (2003) conclude that the three elements of spatial planning are space, function and departments, and that spatial planning can be divided into the national, regional, and metropolitan areas and regional level or local levels).

Newman & Thornley (1996), looking at different legal and administrative systems, divide the European spatial planning systems into four main types: the British system (mainly Great Britain), Nordic planning system (Denmark, etc.), the Germanic system (Germany and Austria) and Napoleonic system (Belgium, France, etc.). The British spatial planning system is a guiding system based on common law. Characterized by compromise and negotiation, it is used widely. In England, the central government has strong control and the local government also has a high degree of autonomy. The Planning and Compulsory Purchase Act was enacted in 2004, marking their formal entry into the era of spatial planning. Britain's urban and rural planning system includes land use, development strategies and action plans. After several transition rounds of centralisation and reform to decentralisation, the current planning system is divided into the National Plan, Regional Plan, Structure Plan and District Planning (Haughton et al., 2009). In accord with the intentions of the new law, British planners are reaching beyond narrow land-use regulation to develop a more coordinated and consensus-based approach to planning practice (Shaw & Lord, 2009).

The formation and evolution of western spatial planning systems is closely related to their political and economic systems, economic development stages, and other factors (Tewdwr-Jones et al., 2010). Decentralised countries usually do not have unified management of spatial planning, nor do they emphasize regional coordination (Jingquan et al., 2017). The United States is the most typical example of this decentralisation, as the federal government does not really govern the macro, regional, or state planning and local government planning. In most western countries, the planning and management system is a comparatively comprehensive structure, especially in countries with centralised

bureaucratic traditions, such as Japan, Singapore, Germany, Netherlands and France (Alterman, 2001). Land is mostly owned by the state. Even if the land is private, the state retains the right to develop and control it. These countries have relatively complete spatial planning systems. In Germany, the spatial planning system is divided at the levels of federal, state, regional and local, called *bundesraumordnung*, *landesplanung*, regional *planung*, and *ortsplanung*, where *landesplanuge* is considered the provincial level territory planning. In 1993, the Framework of Policy Measures for Spatial Planning was established, which emphasised the following development tasks: improving the structure of national settlements, establishing a network of urban systems, expanding the links between cities and surrounding areas, protecting the diversity of ethnic cultures in agricultural areas and ensuring the sustainability of the basic natural survival territories (Bndesministerium Fuer Raumordnung, Bauwesen Und Staedtebau, 1996; Braam, 1996). Regarding Germany, the specific name for this style of planning is not as important as the reliance on planning, and the national, central government attaching importance to the rational planning and control of the utilization of national spatial resources (Zhiqiang, 1999). The legal basis of the spatial planning system in the Netherlands is the *Wet op de Ruimtelijke Ordening* (WRO), which was promulgated in 1965. The law declares that spatial planning is a coordinated activity (Evers & Zonneveld, 2014). This system belongs to the hierarchy regulatory planning system and can effectively coordinate state departments to work together. Planning has been widely understood as an integrated part of Dutch society (Shetter, 1987). The international academic community defines the Dutch planning system as a "comprehensive and integrated approach" (Alexander, 1992; Bing & Yaowen, 2017). Though it is not a mandatory provision for planning to be undertaken by provincial or municipal governments, the Dutch provinces have created their own regional strategic planning (*Streekplan*) for the comprehensive deployment of spatial structural elements and their layout, water management, environmental protection and heritage protection (Bing et al., 2017; Faludi & Van der Valk, 1994). Most of them are instructive, and only a few specific decisions have been mandatory.

In 1974, Japan promulgated the Land Use Planning Law, which highly restricts land use planning systems from top to bottom, consisting of the three levels of government at the national, county and prefectural, and city and village level. In Japan, after 2001, the Land Department was revoked, and the Ministry of Transportation and other departments formed the Ministry of Land and Transportation. The operations for all kinds of planning were integrated into the ministry, which actually strengthened the leading position of the cabinet; additionally, with the revision of the Comprehensive Land Development Act, the planning level was reduced from three levels to two (Quanrun, 2004). In some developing Asian countries, the establishment of spatial planning regarding economic and social development is also under discussion. For example, in Indonesia, the interaction between institutional-cultural forces and globalizing neo-liberal ideas has influenced the formulation of the draft of their new Spatial Planning Act. The neo-liberal ideas fragment the system and conflict with the existing institutional-cultural forces. The idea of legislation and decentralisation, as promoted by neo-liberalism, has been encouraged in order to develop a more effective planning system (Hudalah & Woltjer, 2007).

China, traditionally, has had a centralised political system, but with a decentralised planning and government system. What is more, different

government departments each have some land development rights. China's current spatial planning and governance systems have achieved remarkable results since the Reform and Opening Up Policy in 1978, supporting the rapid growth of over 40 years with relatively scarce resources. On the other hand, China still faces many problems, especially in ecology and natural resources protection. The development is limited by such problems as the natural resource endowment constraints, inefficient use of land among local governments and industries, sharpening contradictions between construction and conservation, coexistence of regional economic isomorphism and spatial disorder, and serious environmental damage. The inherent contradictions in these mechanisms cause separation and contradiction between different planning systems. In China, even though researchers have conducted a lot of studies on planning coordination and integration (Jingquan et al., 2017; Li, Tang, & Lu, 2017; Lin, Chen, & Wei, 2011, and others), the question of how to form a spatial planning system, from regional domains to local land regulation control, is still scarcely discussed. Additionally, the question of what kind of value system should be introduced for the restructuring of the spatial planning system has still not been adequately analysed. Therefore, this paper attempts to answer the following questions: what is the appropriate structure of the spatial planning system in China, especially at the provincial level? How should the operation mechanism be incorporated in a planning scheme to allocate natural resources and space? And what is the best probable, functional and useful approach to solve multiple planning segmentation and contradictions? To answer these questions, this study contributes a basic theoretical framework for a unified provincial planning system and technical methods by introducing the case of Ningxia Hui Autonomous Region Provincial Spatial Planning (Multiple Planning Integration).

This project is funded by the Ningxia Hui Autonomous Region Planning and Management Committee (Multiple Planning Integration, 2016-2035), with the cooperation of Guangzhou City Planning and the Surveying Design Institute. Also, the Planning Institution of China, Centre for Urban Development conducted provincial spatial planning research for the National Development and Reform Commission (NDRC). In this paper, the exploration and thoughts from both the Ningxia practice and the NDRC research program are combined.

2.   METHODOLOGY

The basic framework is to figure out a feasible mechanism for implementing the central governmental spatial policy through local authorities' spatial planning. In the following sections, a policy transformation is reviewed. The status and function of provincial spatial planning in the reform of the whole planning system is clarified. Following this is the case study of the Ningxia practice: from a problem-oriented and goal-oriented perspective, the study proposes five main highlights regarding the aspects of transitioning ecological civilisation, spatial planning system formulation, top design schemes, land use regulation, and working mechanisms for multiple planning integration.

As for technical analysis and evaluation, the database includes mainly three types of data. 1) The first type comes from a database of various plans, including regional plans, and spatial plans at the national, provincial and city-county (district) level. Provincial level spatial plans include plans such

as the Ningxia Overall Land Use Development Plan, Industry Layout Spatial Plans, the Woodland Protection and Utilization Plan, Traffic Planning, and the Zoning of Permanent Protection of Basic Farmland Red Line. Those plans are either released or still in the period of validation. 2) The second is spatial resource status and changing data: all kinds of natural resource distribution, and data reflecting the current state of its utilization, which mainly includes land use status data, the latest land use change data, cultivated land quality information, woodland and forest resources, grassland and wetland resources, degraded land (including desertification and desertification of land), hydrology and water resources, and mineral resource distribution. 3) The third type is statistical data of populations, and economic and social development. Specifically, the second type of data is mainly applied to evaluations modelling the availability of land space development suitability, as well as evaluations of environmental resource carrying capacity. The analysis of situational characteristics in Ningxia and Ningxia planning contradictions mainly use the first and third types of data.

3.   POLICY REVIEW: FROM "MULTIPLE-PLAN INTEGRATION" TO THE REFORM OF THE SPATIAL PLANNING SYSTEM

3.1   Policy Transformation

In 2004, the National Development and Reform Commission (NDRC) proposed a pilot program to integrate three planning systems in six cities. The Opinion on Main Tasks of Deepening Economic System Reform in 2014 (State Council No. 18/2014), proposed by the NDRC, proposed the tasks of "implementing new national urbanisation planning, promoting the 'integration' of socio-economic development planning, land use planning, urban-rural planning, eco-environmental protection planning, and carrying out a pilot reform of city (county) spatial planning and boosting the integrated socio-economic development in urban and rural areas."

While there has been a substantial response since August 2014, at that time, the NDRC, the Ministry of Land and Resources, the Ministry of Housing and Urban-Rural Development, and the Ministry of Environmental Protection, jointly issued the Notice on Conducting the pilot work for "Multi-Planning System Integration" in Cities and Counties (NDRC Plan No. 1971/2014; (Jingquan & Chi, 2015). In this pilot notice file, 28 counties and cities were chosen as experimental regions. During this time period, many governments conducted bottom-up multi-planning integration, with the purpose of increasing tight restrictions over land resources for construction. Many forms of integration appeared, such as "Two-Plan Integration", "Three-Plan Integration", "Four-Plan Coordination" and so on. Generally speaking, all integration was done to resolve contradictions among spatial plans in a technical way, under the current framework of the political management system and operation mechanisms. Local governments enthusiastically promoted this to free up new construction land. The legal hurdles and institutional obstacles, which fundamentally influenced the outcome of the reform, were ignored.

In fact, the clear-cut promotion has been acknowledged by the Central Government since the 18th National Congress of the Communist Party of China (CPC), the Third Plenary Session of the 18th National Congress of

CPC, and the Urbanization Work Conference of the CPC Central Committee. The reform of the spatial planning system and multi-plan integration practices should be considered in the scope of the state's reform of the ecological civilisation system to improve governance capacity. With the deepening of the state reform, the guiding ideology of dealing with contradictions among plans has changed tremendously.

In September 2015, the Integrated Reform Plan for Promoting Ecological Progress (State Council No. 18/2014) was printed and distributed by the CPC, the Central Committee, and the State Council. The plan was formulated for putting systematic and complete systems for improving the ecosystem in place more quickly, achieving faster ecological progress, and reforming ecological progress to make it more systemic, holistic and better coordinated. In this state level design, a spatial planning system was considered one of the eight systematic and complete institutional frameworks for promoting ecological progress and modernising China's governance systems and relevant capacity for governance and ushering in a new era for socialist ecological progress. In December 2015, at the Central Urban Work Conference, based on the planning of functional zones, president Xi Jinping proposed explicitly combining different types of plans into a single spatial plan, such that gradually there would be one plan, or blueprint, per province, city or county. Thus, a clear path is proposed for promoting the planning system reform.

Other than full technical integration, spatial planning at the provincial level should take place prior to all other departmental plans, integrate the spatial policy and land use regulation of all sectors, and be easy to complement with a feasible operation mechanism.

3.2   National-level planning of functional zones

National-level planning of functional zones was distributed in 2007, and it is the only national level spatial plan that has been approved legally by the CPC, Central Committee and the State Council since 1949. Although NDRC, the Ministry of Land and Resources, the Ministry of Housing and Urban-Rural Development, the Ministry of Environmental Protection, the Ministry of Forestry, the Ministry of Transportation and the Ministry of Water Resources all have their own vertical planning system, this is the only legal national territory development plan since the founding of the People's Republic of China.

As a blueprint of territorial and spatial development with emphasis on humanism and harmony with human-nature, this plan exists as a guideline for the government to implement spatial governance and a platform for integrating the related resources for spatial planning. It is also the scientific basis on which the regulatory roles of both government and market can be fully realised, regionally coordinated development can be boosted, and the whole society governed, leading to a more accurate understanding and rational construction of people's living space.

On the basis of this plan, the national territory was divided into different major function zone types – urban areas, primary production areas for agricultural products, and key ecosystem service areas (see *Figure 1*). Regarding development, there is another division into four types, including development zones to be optimised, key development zones, limited development zones, and prohibited development zones. It is important to note that the smallest spatial unit at this national level is the county, which is a very strong political entity in the Chinese political hierarchy system. Since

2007, this plan has become the fundamental legal basis of regional, city and county level spatial planning, and thus affected the technological path for how spatial land regulation will be implemented.

Figure 1. Territory spatial divisions of national level major function-oriented zoning
(Source: Outline of the thirteenth-year plan for the national economy and social development
in the People's Republic of China, 2016-2020)

Under the overall strategic scheme of ecological civilization reform, in December 2016, the Experimental Scheme of Spatial Planning at the Provincial Level was printed and distributed (Ministry No.51/2016). This file puts forward the main task, supporting measures and work requirements for the pilot work of provincial spatial planning in 2017. Nine provinces, including Hainan, Ningxia, Jilin, Zhejiang, Fujian, Jiangxi, Henan, Guangxi and Guizhou were chosen as experimental provinces to conduct provincial spatial planning pilot work.

3.3　Provincial spatial planning

Provincial spatial planning should correspond with the level of government power and the scale of provincial space. Its status and function are mainly reflected in the following aspects. As the top-level design, it is the blueprint for the sustainable development of provincial space, which is the basis of the department planning and the city and county spatial planning. At middle level territory planning, provincial spatial planning should play a key role in both implementing the national strategy in the spatial planning system and in guiding the city and county spatial planning. The coordination of resources should promote the efficient allocation of provincial space resources, optimise the spatial pattern of the whole region and guide the implementation of regional infrastructure. For effective control, it should meet the needs of macro management and the cities and counties' micro control at the provincial level. With national spatial use control and the control index of construction, provincial spatial planning is complemented to reduce the institutional trading costs, promote national spatial governance ability, and improve the efficiency of government management.

At present, China's social and economic development situation is complex, and the resource and environmental constraints are becoming increasingly serious. Provincial spatial planning should be guided by the concept of ecological civilisation construction, focus on solving the problem of the tension between land space development and environmental preservation, and promote the modernisation of the national governance system and governance capability. The top-level design should strengthen control to form a unified pattern of spatial development and protection, and to build a community of common destiny for the whole region.

4.   NINGXIA PRACTICE AND EXPERIENCES

In April 2016, the 23rd Conference of the Central Deep Reform Group discussed and approved the adoption of the Ningxia spatial planning pilot program, with the requirement that Ningxia should strengthen the leadership to boldly innovate, and that the central government departments should support the follow-up and summary experience. This means that Ningxia has become a provincial-level pilot and experimental province in reform and innovation. A new stage has begun. With almost two years of hard work, and with massive support from the Ningxia Hui autonomous Region Planning Management Committee Office, vigorous cooperation with the Guangzhou Urban Planning Survey Design Institute, technical collaboration from the Geographical Science and Resources Institute, the Chinese Academy of Sciences in Heilongjiang province, and the Geographic Information Bureau of the Surveying and Mapping Institute of Science, the Ningxia Hui Autonomous Region Provincial Spatial Planning (2017-2030) was formulated successfully. Following this, the situation characteristics and problems of Ningxia are analysed, and the main practice and key features of this experimental work explained.

4.1   Situation characteristics and problems of Ningxia

4.1.1   Situation of development and preservation

Ningxia, officially the Ningxia Hui Autonomous Region (NHAR), is an autonomous region of the People's Republic of China located in the northwest of the country. Ningxia was reconstituted as an autonomous region for the Hui people, one of the 56 officially recognised nationalities of China. 20% of China's Hui population lives in Ningxia. Ningxia is bounded by Shaanxi to the east, Gansu to the south and west, and Inner Mongolia Autonomous Region to the north. Present-day Ningxia is one of the nation's smallest provincial-level units with an area of around 66,400 km2, and with a population of 6,680,000, the third lowest in the country, at the end of 2015. There are large differences between the natural environments of the northern, central and southern territories. In the north of the Yellow River flood plains is a large oasis, one of the few rich land resources in north-western China, where urban construction conditions are much better, while the central and southern areas are relatively dry, desert-like regions, facing quite fragile ecological problems.

The ecological system is sensitive and fragile, and the pressure to protect the environment is great. Soil erosion is serious, and the difficulty of governance has increased gradually. The quality of the ecosystem and ecological system services are comparatively low. Resource constraints are

tight, and there is increasingly limited carrying capacity of water resources. The shortage of water resources and the unbalanced allocation of space, and the contradiction between supply and demand is outstanding. Ecological space is squeezed as the fragmentation intensifies.

Economic development is lagging behind and the primary pressure comes from development. The structure of industry remains unreasonable as the proportion of heavy industry is too high, and the high energy consumption industry is still the main body of growth. Innovation from science and technology ranks low in ability. Overall, the provincial domain competitiveness ranking is backward. In 2014, it ranked 27th in the national comprehensive provincial competition rankings. In the surrounding provinces of northwest China, the new state-level districts are located in the economic zone of Xi'an and Lanzhou, and there are only two national economic zones in the Ningxia autonomous region.

Spatial development features are different from north to south. Currently, Ningxia just entered the intermediate stage of industrialization, and its whole spatial development pattern also corresponds to this. In the northern area along the yellow region (including Yinchuan municipal districts, Yongning, Helan, Lingwu, Shizuishan city, Pingluo, Wuzhong city, Litong, Qingtongxia and Zhongning) are at a pivotal point in their early development, with populations accounting for 65% of the whole municipality, creating nearly 90% of the GDP in the region. This has primarily had an accumulative effect. Central and southern urban development is insufficient, with the average per capita GDP of the southern nine counties at only 36.8% of the average provincial level. Only 10.6% of the counties are financially self-sufficient. The southern area is still in the separate central scatter model, and there are some comparatively obvious polar nuclei in the southern region.

4.1.2   Present problems of planning contradictions in Ningxia

It is difficult to effectively form a joint directive because of serious planning contradictions. There are several kinds of top spatial plans for Ningxia at the provincial level (*Table 1*), including planning of functional zones, urban system planning, the overall plan for land utilisation, short and long term strategic development planning, environmental functional district planning, ecological protection and construction planning, forestland protection and utilisation planning, strategic planning of integrated transportation systems, planning of soil and water conservation, and so on. These are each drawn up by different departments.

The contradictions between these works and their management exist in many areas, such as different views between central authorities and localities in terms of content and planning areas. They mainly manifest in contradictions in the layout structure, in the land use regulation control zone, and in the land use. As to land use, the layout of urban construction land is mainly different between urban planning and land resource planning. The differences for non-construction land are mostly due to the contradiction between forestland and farmland grassland. The contradiction between urban-rural construction land and important ecological factors is also obvious. Plans for construction land occasionally overlap with the water source preservation areas, the ecological public welfare forests, resulting in difficulty with implementation and placing the ecology under threat. Another contributing factor is that there are discrepancies in the basic utility information for these territories between different government

systems, such as the Department of Land and Resources and the Department of Surveying and Mapping.

Table 1. Different priority plans regarding territory of Ningxia at the provincial level

	Name of plan	Issuing institution
1	Planning of functional zones of the Ningxia Hui Autonomous Region (2014-2020)	Development and Reform Commission
2	Strategic planning of space development of Ningxia (2014-2030)	Department of Housing and Urban Rural Development
3	Overall plan for land utilization of the Ningxia Hui Autonomous Region (2006-2020)	Provincial Department of Land and Resources
4	Urban system planning: Urban hierarchical planning of the Ningxia Hui Autonomous Region (2015-2030)	Department of Housing and Urban Rural Development
5	Environmental functional district planning of Ningxia (2014-2030)	Department of Environmental Protection
6	The ecological protection and construction planning of Ningxia (2015-2030)	Department of Environmental Protection
7	Forestland protection and utilization planning of the Ningxia Hui Autonomous Region (2010-2020)	Department of Forestry
8	Strategic planning of integrated transportation system of Ningxia (2016-2030)	Provincial Department of Transportation
9	Planning of soil and water conservation of the Ningxia Hui Autonomous Region (2014-2030)	Department of Water Resources

These contradictions are obstacles in the process of planning legislation, which negatively impact planning directives and implementation. The main reasons for the contradictions include the following: 1) the focus of the departments' macro specialist resources allocation and coordination is different; 2) different technical methods and standards cause different spatial layouts; 3) the planning base years and target years are different; 4) The difference of control method leads to the difference in management effectiveness, which leads to unclear management responsibilities.

4.2   Ningxia practice and key features

The spatial planning of Ningxia Hui Autonomous Region focuses on exploring the following aspects and forming key features. As a provincial spatial planning pilot approved by the central government, this program has made great efforts to formulate reform highlights and innovation, so as to form a series of replicable experiences from Ningxia.

4.2.1   Bottom-line thinking and ecological priority

Bottom-line thinking, adherence to ecological priorities and the balance between development and protection, have been considered essential. The plan aims to fulfil the comprehensive implementation of the central government's strategic requirements for Ningxia, and the reform is a major step towards coordinating the socioeconomics, ecology, population, resources and environment. Based on the scientific judgment that lack of sufficient development is still the most important problem in Ningxia, the plan aims to solve practical problems for Ningxia's development and ecological protection, and to promote clear development goals and strategies, leading the spatial development.

In Ningxia, a new system was built based on this spatial planning, drawing on regulation as the main approach, with the purpose of ending the

over-use of quality cropland and ecological space, ecological damage, and environmental pollution caused by disorderly, excessive, and scattered development.

The goal was to protect the ecological environment to the maximum extent, delineate ecological space, and strictly observe the red line of ecological protection and the red line of permanent basic farmland protection. The demarcation of the Ningxia ecological protection red line accounts for 24.76% of the total land area. The ecological space of Ningxia occupies 65.4% of the total area. To ensure ecological and agricultural security, it is important to regulate the behaviour of all kinds of spatial development. From the earliest stages, basic evaluation, including evaluation of resource and environment carrying capacity, and land space development suitability evaluations, must be carried out for every inch of land, to ensure that all spatial development activities are supported by the resources and environment carrying capacity.

4.2.2   Proposing a two-level spatial planning system

Spatial planning systems should be coordinated according to the scale of space or administrative hierarchies, with each administrative authority having only one comprehensive spatial plan (Huien, 2004). Otherwise, it will cause problems for implementation. In Ningxia practice, to fulfil the reform goal, a spatial planning system will be designed, with the main purpose of strengthening the spatial governance and improving its structure, which is regionally unified and better connected between different departments of government, and according to which management is divided between governments at multiple levels, in an effort to eliminate overlapping and conflicting spatial plans, the overlap and duplication of responsibilities between departments, and the issue of local authorities frequently changing their plans.

In Ningxia, a two-level spatial planning system has been formed, from macroscopic to microcosmic and coordinated to a specific layout. The core content for spatial planning at all levels is set up as shown in *Figure 2*.
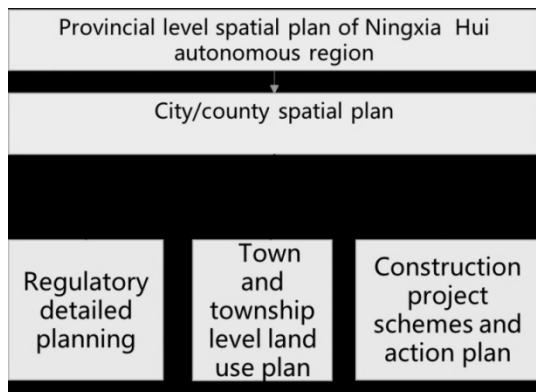

Figure 2. Framework of local spatial planning system

The plan is the blueprint to ensure the sustainable development of the autonomous region, and the top-level design with the key contents of the development goals, tasks, technology path, planning content, collaboration mechanisms, and upper and lower linkage working method, and system of laws and regulations. The provincial plan focuses much more on spatial policy, a unified spatial strategy, unified development goals, unified index

system, unified policy regulation zone partition, and unified resources allocation. The provincial plan should strengthen the protective bottom line control.

Municipal or county spatial planning should classify land use with a unified standard, and, in accordance with the relevant functional zoning and the requirements of the provincial-level spatial plan, should delineate production space, living space, and ecological space, and demarcate the development boundaries of urban construction areas, industrial areas, and rural living areas, as well as the boundaries of protected areas of arable land, woodlands, grasslands, rivers, lakes, and wetlands, and strengthen coordinated planning for urban subsurface space. More effective guidance will be given to cities and counties regarding their trials for plan integration.

4.2.3   Design of spatial resource coordination and allocation

The technical arrangement and main contents of the design of spatial resource coordination and allocation for the plan are outlined in *Figure 3*, below.
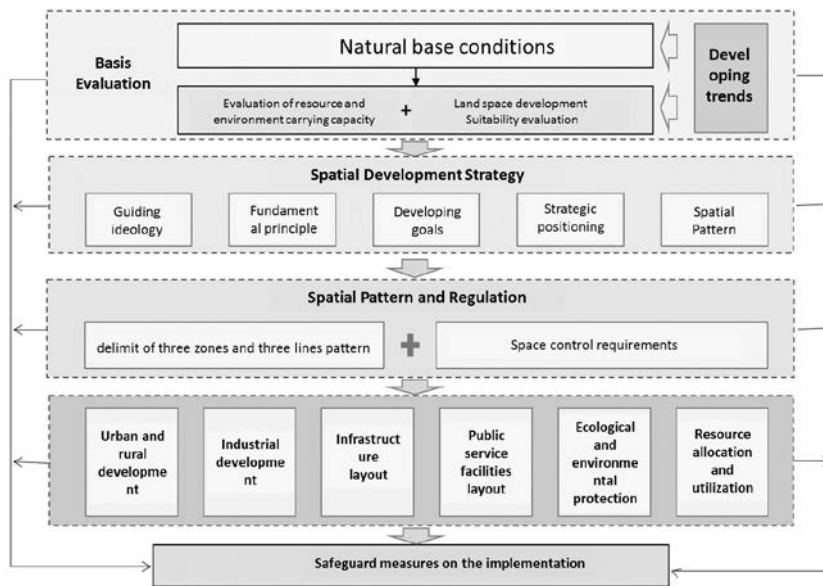

Figure 3. Technical route and main contents

4.2.3.1 United spatial planning for departments and cities/counties

A top-level structure of planning content was designed to solve the planning contradictions addressing the underlying causes. All types of current spatial plans formulated by different departments at the provincial level will be integrated into unified spatial plans, which will be all-encompassing. The new spatial planning will guide provincial development with spatial blueprints for sustainable development; it will be the fundamental basis for all types of development and construction programs.

Within China's administrative framework, the relationships of China's spatial planning system in both the vertical and horizontal dimensions are organised into a comprehensive plan for urban spatial development, which accommodates the demands of urban construction, village development, ecological protection, farmland preservation, and industrial development, and gives it a statutory status.

All-in-one innovation is embodied in the following aspects: in the content system, the core content of all kinds of planning is integrated; in the index system, the core control index of spatial class is strengthened; the construction includes the index system of 28 indicators of the four major sectors, covering the land use for economic and social development, the environment of ecological protection, and the construction of urban and rural areas. On the basis of the technical method, beginning from each inch of land, a double evaluation system is conducted, which then forms a united control line plan, and land use regulation plan.

4.2.3.2 Based on the planning of functional zones

The main national functional zoning plan identified the yellow economic zone as one of the 18 state-level key development zones. According to the requirements of the strategy of development priority zones, on the basis of national spatial analysis and evaluation, combined with administrative boundaries and natural boundaries, and using various cities and counties as the basic unit, urban farming is divided into three kinds of spatial layout and adjusted for optimisation. Finally, the overall blueprint is created for provincial development.

4.2.3.3 Guidance with strategic spatial development pattern

During the planning process, to implement the national policies effectively and differentiate the aims and values for improving territorial spatial structure, a united strategic planning structure named "One nuclear, three regions; one polarity, two poles", is determined (see *Figure 4*). Throughout the spatial development strategy, there is a focus on both regional harmonious development and the required function of the cities and counties in the main body. All kinds of spatial development and layout as a whole, in the global scope of internal allocation of public resources and production factors that guide further the urban agglomeration of population and economy, maximise agglomeration and strengthen south-central radiation.
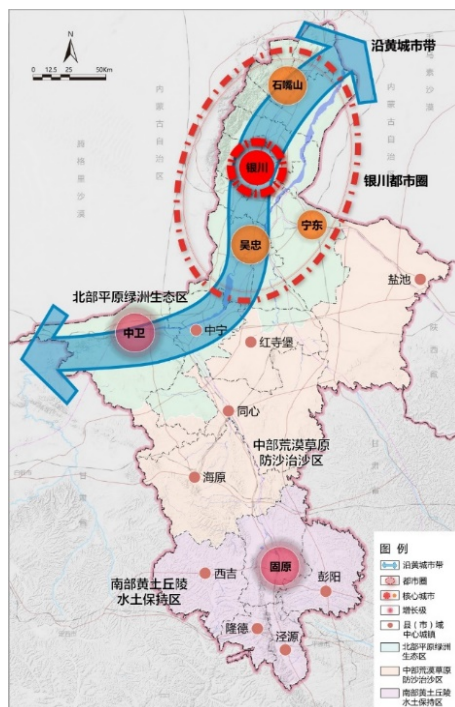

Figure 4. Spatial strategic plan of Ningxia

4.2.4   Forming the regional wide-domain land use control scheme

The main work of moving from basic double-evaluation to three zones and three lines is to carry out the basic double-evaluation, including evaluation of resources and environment carrying capacity, and land space development suitability evaluation, on the basis of the evaluation contents, indicators and standards, and then delineate the three zones and three lines (ecological zone, agricultural zone, urban zone; ecological red line, urban development boundary, and permanent basic farmland red line). This is strategically important for optimising the land space development pattern and urban-rural spatial distribution, in order to ultimately form one map for spatial planning.

According to the NDRC technical approach of Monitoring and Warning of Resource and Environment Carrying Capacity, the specialist evaluation and integrated evaluation of the basic evaluation is carried out in each county to identify the carrying capacity and to analyse the causes of overloading. Based on the land use change survey and other results, the comprehensive multi-index evaluation is carried out according to the suitability index and binding index. The evaluation result is superposed with the current surface area data, and the spatial development suitability evaluation result is formed, which is the basic premise of the Ningxia spatial planning (sees *Figure 5* and *Figure 6*). Based on the basic unit of the county administrative region, the scientific evaluation comprehensively reflects the carrying capacity and development suitability of the resource environment.
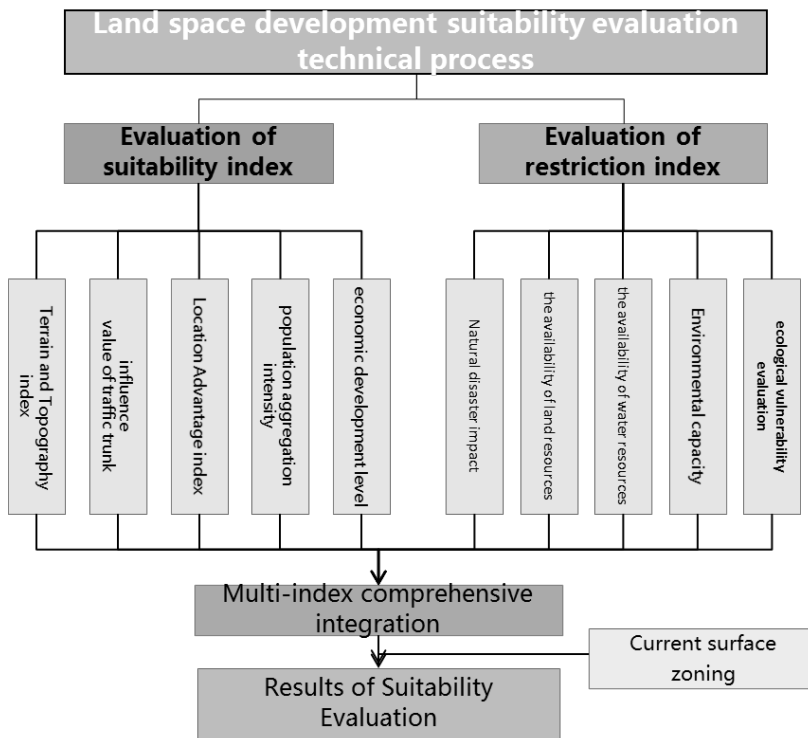

Figure 5. Land space development suitability evaluation technical process

From the perspective of planning regulations, the three zones and three lines can take the place of current multiple spatial regulations in different plans, such as three zones (forbidden construction, limited construction, pro-construction) and four lines (blue, green, yellow, and purple lines) in the

urban plan. The three zones cover every inch of the territory of Ningxia and are not interlaced with each other. With the control and regulation principle, the development intensity and the protection boundary are determined by the spatial factors of the ground control regulations.
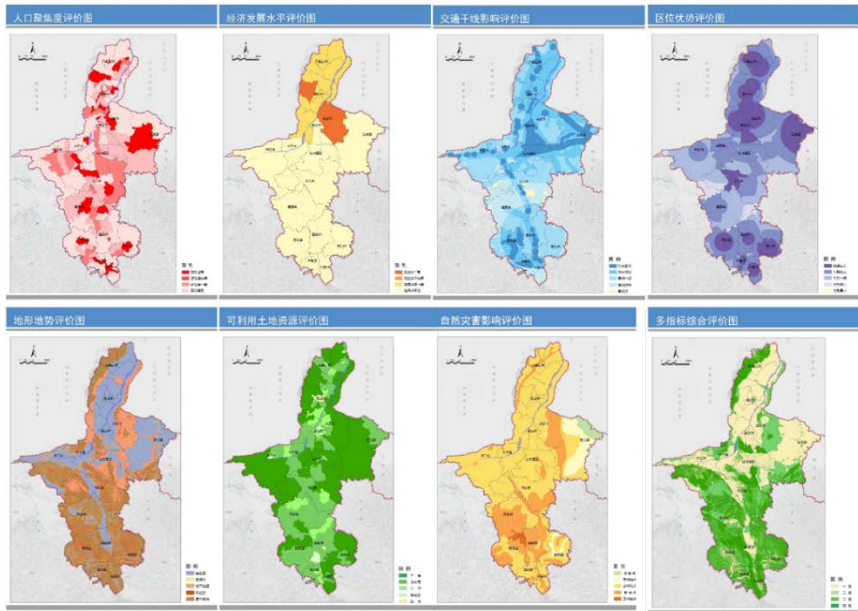

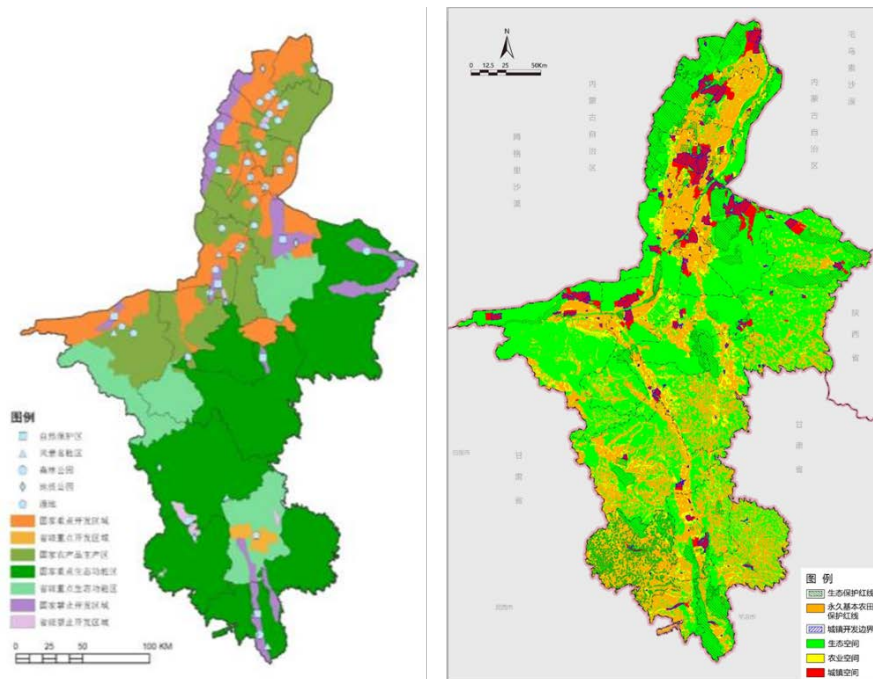*Figure 6.* Land space development suitability evaluation of Ningxia provincial region

Figure 7. From functional zones plan to whole territory spatial use control regulation

In setting the regulation rules, control regulation and operation mechanisms cannot be underestimated. Following target, strategy, spatial regulation, and policy logic, the target strategic spatial integration is integrated with policy coordination (see *Figure 7*). Thus, provincial spatial planning is an important measure and tool for urban spatial governance in

the future. To deal with conflicts and problems of land property in current various kinds of planning, the study formulates measures to deal with the differences in construction land and non-construction land, determine unique properties of the land, and clarify the planning and management of each plot.

Contradiction in technological standards is one of the most critical causes of planning contradictions. In practice, the root cause is the focus, and 10 technical standards are formulated from the range of provincial spatial plan content, classification of land use, space management and control mode, and the examination and approval system. In this way, a systematic set of technical regulations for a provincial spatial plan to strongly promote pilot work and enrich the theory of spatial planning is formed.

4.2.5   Top-bottom combined coordination and working mechanism

A shared work path is configured, combining top to bottom and bottom up. While conducting the provincial spatial planning, all counties in the five cities of Ningxia began local level spatial plan making. Cities and counties are an important foundation for spatial planning at the provincial level. There is no one-way, top-down decomposition or split relationship from bottom to top; they are unified.

For autonomous regional planning in counties and cities as units, based on basic evaluation results and measurement of autonomous regional spatial development control indicators, three lines of three counties are drawn according to the actual development. This demonstrates the content of the autonomous region through checks and feedback by mutual checking between the upper and lower linkages, with superpositions forming autonomous regional spatial development and protection controls, with a general layout across the upper-to-lower linkage. The provinces exercise macro and micro control of provincial cities and counties through overall coordination with specific requirements and do this organically with cities and counties.

5.   CONCLUSIONS AND SUGGESTIONS

After nearly two years of exploration and practice, the pilot project of Ningxia has achieved a series of staged achievements, which has provided theoretical research and practical exploration for the reform of China's spatial planning system, and accumulated experience. On August 29th, 2017, the General Secretary of the CPC central committee chaired the 38th Meeting of the Leading Group on Comprehensively Deepening Reform, and the report on the pilot work of the Ningxia Hui Autonomous Region on spatial planning (multi-level integration) was considered. The meeting pointed out that Ningxia has explored a series of experiences that can be copied and promoted for aspects of the formulation of spatial planning, clear protective development patterns, exploration of land and resource regulation systems, building spatial management information platforms, etc. Next, Ningxia should continue to formulate and improve spatial planning, deepen institutional reform, and ensure the implementation of its spatial planning.

A pilot project of spatial planning reform promoted at the provincial level is a regional exploration of the Central Government's "authorized reform" to deepen the institutional reform of planning and upgrade the

efficiency of governmental administration. To promote the pilot work of provincial-level spatial planning, the reform of institutional innovation must be carried out, and the spatial plan implemented through system design. With respect to planning reform and multi-plan integration, this paper puts forward reform experiences and suggestions from Ningxia practice at each level of planning and governance, guiding ideology, evaluation methods, technical routes and depth, land use control regulation of spatial resources, and provincial-local government coordination mechanisms. This reform also offers recommendations on the reform of provincial spatial planning systems, the legislation of relevant laws and the integration of supporting institutions.

ACKNOWLEDGMENTS

REFERENCES

Alexander, E. R. (1992). *Approaches to planning: Introducing current planning theories, concepts, and issues*, Taylor & Francis.

Alterman, R. (2001). *National-Level Planning in Democratic Countries: A Comparative Perspective*, Town Planning Review Book Series,. https://doi.org/10.5949/liverpool/9780853238454.003.0001

Bing, Z., & Yaowen, H. (2017). "A Study On the Scientific Spatial Planning: Hainan Province Example", *Urban Planners*, (2), 19–23.

Bndesministerium Fuer Raumordnung, Bauwesen Und Staedtebau, (Federal Spatial Planning, C. A. U. P. D. (1996). "Raumordnung In Deutschland (Spatial Planning In Germany)", Bonn.

Braam, W. (1996). "Stadtplanung: Aufgaben- Beriche, Planungsmethodik, Rechtsgrundlage (Urban Planning: Task, Method and Legal Basis), Duesseldorf, Werner-Verlage.".

Evers, D., & Zonneveld, W. (2014). "Dutch national spatial planning at the end of an era", In: *Spatial Planning Systems and Practices in Europe: A Comparative Perspective on Continuity and Change*, Routledge., 81–102.

Faludi, A., & Van der Valk, A. J. (1994). "Rule and order", *Dutch Planning Doctrine in the Twentieth Century, Dordrecht*.

Haughton, G., Allmendinger, P., Counsell, D., & Vigar, G. (2009). *The new spatial planning: Territorial management with soft spaces and fuzzy boundaries*, Routledge.

Hudalah, D., & Woltjer, J. (2007). "Spatial Planning System in Transitional Indonesia", *International Planning Studies*, *12*(3), 291–303. https://doi.org/10.1080/13563470701640176

Huien, N. (2004). "National Planning, Regional Planning and Urban Planning: How to Coordinate them in China", *City Planning Review*, *11*, 42–46. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-CSGH20041100A.htm

Jingquan, X., & Chi, S. (2015). "Objective System and Coordination Mechanism Design for "Multi-Planning System Integration"", *China City Planning Review*, *24*(4).

Jingquan, X., Chi, S., Tianxin, H., Shu, D., & Xiaoming, Z. (2017). "General Concept and Main Tasks of Building Spatial Planning System in China", *Urban Planners*, (2), 5–11.

Li, H., Tang, Y., & Lu, S. (2017). "Exploration and Practices of County Spatial Planning Compilation: A Case Study of Spatial Planning in Yuanzhou District, Guyuan City", *Development of Small Cities & Towns*, 8, 25. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-XCJS201708025.htm

Lin, J., Chen, X., & Wei, X. (2011). "Coordination Problems of Spatial Planning in China: International Lessons and Experiences", *Modern Urban Research*, *12*, 15–21. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-XDCS201112007.htm

Luxembourg: Office for Official Publications of the European Communities (1997). "Commission of the European Communities (CEC) The Compendium of Spatial Planning Systems and Policies, Regional development studies".

Newman, P., & Thornley, A. (1996). *Urban planning in Europe: International competition, national systems, and planning projects*, Psychology Press.

Quanrun, H. (2004). "Transition of Regional Development Policies in Japan, Wang Yu translated", *Foreign Urban Planning*, (3), 5–13.

Salet, W. G. M., Thornley, A., & Kreukels, A. (2003). *Metropolitan governance and spatial planning: comparative case studies of European city-regions*, Taylor & Francis.

Shaw, D., & Lord, A. (2009). "From land-use to "spatial planning": Reflections on the reform of the English planning system", *Town Planning Review*, *80*(4–5), 415–436.

Shetter, W. Z. (1987). *The Netherlands in perspective: the organizations of society and environment*, Walters Noordhoff Pub.

Stead, D., & Meijers, E. (2009). "Spatial planning and policy integration: Concepts, facilitators and inhibitors", *Planning Theory & Practice*, *10*(3), 317–332.

Tewdwr-Jones, M., Gallent, N., & Morphet, J. (2010). "An Anatomy of Spatial Planning: Coming to Terms with the Spatial Element in UK Planning", *European Planning Studies*, *18*(2), 239–257. https://doi.org/10.1080/09654310903491572

Zhiqiang, W. (1999). "German Spatial Planning System and Its Development Dynamic Analysis", *Urban Planning Management*, *4*, 2–5.

Triangle Law or Power Law？
City Size Distribution in Sub-national Levelled Administrative Areas in China

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Abstract： Studies have shown that the city size distribution is in line with the power law distribution. By testing the city size distribution of cities in certain administrative levels in sub-national administrative areas in China, it was found that compared with power law distribution, the triangle law distribution put forward can better fit the city size distribution characteristics. The triangle law means the city size distribution structure is shaped like the city administrative division structure. That is, cities of the highest administrative level have far bigger size than other cities, and the city size distribution law of cities in the next administrative level is in accordance with the normal distribution. The triangle law hypothesis is put forward by the analysis of city size growth logic in China, and the institutional influence was considered as the main influencing factor. The results show that the city administrative system has probably shed light on the city size distribution. Further analysis shows the triangle law is more applicable in areas with higher population and fewer next levelled cities. Lastly, by new parameters extracted from the triangle law, the city size distribution characteristics of different regions in China are analysed.

1.   INTRODUCTION

City size distribution is always a core topic in urban studies. This paper tests the city size distribution laws in sub-national level administrative areas in China, where cities are selected by their administrative levels. The distribution of city size takes a similar shape to the hierarchical administrative structure, and it follows the proposed triangle distribution law more closely than the power law distribution that is commonly made use of in the field of urban size distribution.

Since the beginning of the 20th century, China has experienced rapid urbanisation and all Chinese cities have increased in size dramatically. To bring order to the rapid spatial development, it is important to measure and evaluate the current city size distributions and make spatial plans for the future. In recent decades, the study of city size distribution in China has attracted a lot of attention from both economists and planners.

The definition and classification of cities vary, and this paper observes cities from the perspective of administrative management. In China, cities

are divided into different administration levels and then given different administrative rights: some are important central cities with special economic and political policies, and some are small-sized counties or towns under the strict management of upper level local governments. This kind of hierarchical administrative division is not unique to China, but also commonly used in other countries. Chinese cities are greatly influenced by their institutions (Chan & Zhao, 2002; Fan, 1999; Wei, 2015), more so than market forces (Xiao, 2016). According to the Chinese administrative regime, administrative areas are the foundational geographical units for managerial affairs, for example, the implementation of top down policies and local regulations, as well as the allocation of financial resources and task indicators. Cities at different administrative levels have hierarchical development rights over competing resources, which most likely influences city size distribution. According to the analysis of the city administrative management system above, if the target cities are included based on the hierarchical administrative system, the distribution may be institutionally shaped. Also, the standing research of city size distribution law is varied, but very little of it has connected the hierarchical administrative management system with city size distribution law.

On the other hand, the city size distribution in sub-national level regions may result from the power law distribution, but it is still not certain. In the field of city size distribution, the Pareto law and Zipf's law (also known as Rank-size law) are the most well-known regulations, and both the Pareto law and Zipf's law are based on the power law distribution. In empirical studies, Zipf's law has been repeatedly proven in different countries (Fujita, Krugman, & Venables, 1999; Mills & Hamilton, 1994; Rosen & Resnick, 1980) to accord with the city size distribution in national units. Nevertheless, the power law distribution is theoretically a kind of non-scale distribution, so mathematically the distribution form in any subdivision of the series will be the same. Therefore, in this study, as commonly recognised, city size distribution may follow the power law distribution as well, however, some empirical studies in subnational level areas have shown that the applicable geographical areas of these laws have limited scale, so further studies should be done to discover the city size distribution law in sub-national China.

The paper is organized as follows. Firstly, the city administrative division in China is introduced. Secondly, according to the analysis of the city size growth logic and its relationship to city administrative level, a hypothesis is proposed regarding city size distribution regulations in China, called the tringle law. Thirdly, the studies on the applicable area for Pareto's law and Zipf's law are reviewed, in order to prove the limitation that there are no appropriately and universally used methods for studying subnational level city size distribution. Fourth, the city population and built-up city area data is used as the city size to test whether the city size distribution law is consistent with both Pareto's and Zipf's law, and also the triangle law. This reveals that for most of the sub-national areas, the triangle law is better at describing city size distribution. Finally, there are further findings shown, such as the socioeconomic characteristic analysis of the results and the city size distribution analysis of the triangle law.

2.   LITERATURE REVIEW

2.1   City administrative divisions in China

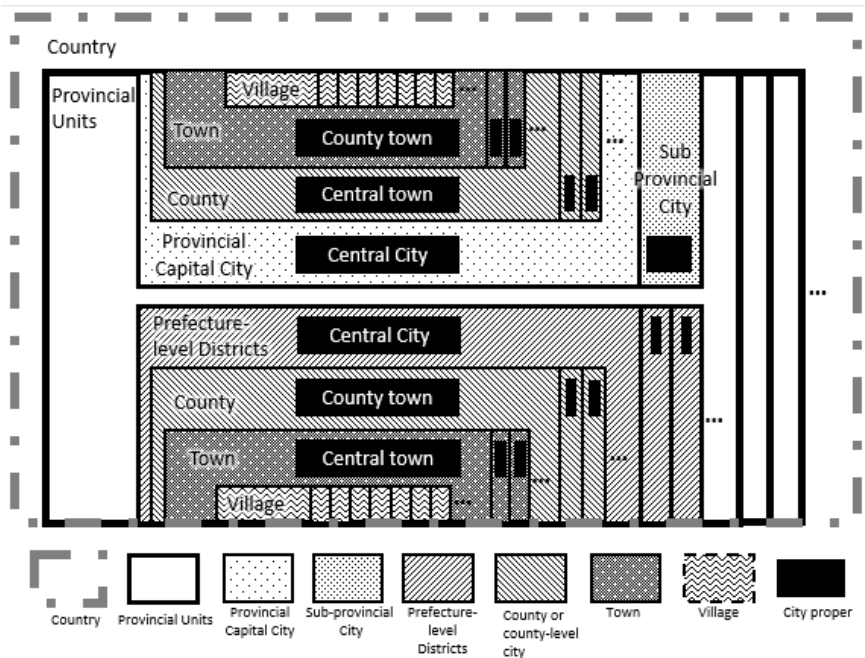*Figure 1*. Urban administrative divisions in China

[Figure 1] shows the urban administrative divisions in China. The country is divided into several provincial units, which includes 27 provinces or autonomous regions and four municipalities. Different provinces and autonomous regions have similar city hierarchy systems. In general, each provincial unit is spatially divided into several prefecture level districts, where some are cities, others are districts, and one is the provincial capital city. In fact, the provincial capital city is not a legal city administrative level. According to the administrative system in China, 10 of the 27 provincial capital cities are more specifically sub-provincial cities. They are in a higher administrative level than prefecture-level city, although both provincial capital cities and the normal prefecture-level cities are spatially divided in the same layer, meaning they are units next to each other. More specifically, in some provinces (Shandong, Zhejiang, Fujian, Liaoning and Guangdong), there are two sub-provincial cities (where one of them must be the provincial capital city). For the other 17 of the provincial units whose capital cities are among the prefecture level cities, the residents are governed by provincial local governments, and the city has some special administrative rights and special advantages in their economic activities. Above all, the city administrative hierarchy system in China is complex. In order to simplify it, this research takes the provincial capital city (regardless of administrative level) and the sub-provincial cities as level-two cities, and prefecture level cities as the level-one cities.

In more subdivided layers, the prefecture-level cities and provincial capital cities are divided into counties or county-level cities, and then the county units are further divided into towns and the towns into villages. Each city administrative unit spatially represents two concepts: one is the city proper, which is the concentrated urbanised area (the black squares in

Figure 1); and the other is the administrative area of the whole region, which includes both urbanised and non-urbanised parts (the striped space in *Figure 1*). Specifically, the city proper of prefecture-level city *A* would be the administrative centre where the local government of city *A* is located. The area outside the centre of city *A*, inside region *A*, is made up of the lower county-level administrative units that are to some extent governed by city *A*. As is shown in *Figure 1*, counties or county-level cities and towns have similar urban and rural integrated structures, but their lower-level units are towns or villages. Cities and towns in this research refer to the city proper or the central settlement rather than the whole administrative area.

2.2   Hypothesis of city size distribution triangle law

Economists interpret the city size distribution from the perspective of economics and geography, supported by many famous theories, including the central place theory from Christaller, (1966), the spatial economic theory from Fujita, Krugman, & Venables, (1999), and the new classical economics from (Yang & Zhang, 2000), which relate city size distribution to the total population, the total spatial range, the transaction efficiency, division of labour, the urban function, the urban connection and so on.

However, City size distribution in China is also closely related to institutional factors (Anderson & Ge, 2005; Chan & Zhao, 2002; Fan, 1999). In the wake of the rapid urbanisation since the 1990s, China's urbanisation rate has doubled, and the population and land use size of Chinese cities has grown. After the tax sharing reform in 1994, "land development has not functioned simply as a passive outcome of urbanisation but has been actively pursued by local governments as a means of revenue generation to finance local economic growth" (Lin & Yi, 2011). What's more, economic achievement is a main factor in the promotion of local government officials, so land development rights that are managed through different kinds of spatial planning have become a very competitive indicator for local governments. Local government at different administrative levels have different rights in competing for the development resources; for example, some urban plans made by governments in lower levels must be approved by higher government bodies; on the other hand, the land use plan in lower level cities is mainly decided by the branch of Ministry of Land and Resources in higher level administrative units. As a result, the city proper in higher level administrative areas has better land development opportunities, while inside the whole administrative area, central cities in the lower administrative areas have poorer but similar land development needs. These institutional factors influence the city land use size distribution. The imbalance of resource allocation in different city levels also reflects certain aspects, such as the quality of public services and infrastructure, and the standard of enterprises (Wei, 2015). The differences in land development rights are similar to the differences in the population concentration for cities at different levels.

Thus, it is evident that the city land use size distribution, as well as the city population size distribution, obeys a triangle law. The triangle law hypothesises that the highest-level city in an administrative area, such as the level two cities in a provincial unit, have the biggest size, and the other lower level cities, such as the main city area of prefecture-level cities in a provincial unit, have similar sizes obeying the normal distribution because

they have similar political opportunities in competing for the city's growth resources and the economical and geographical factors work against them. Such structures can be described in a triangle shaped structure in *Figure 2*, where the top of the triangle represents the size of the highest-level city inside the administrative area, and the bottom line represents the size of other lower level cities. In *Figure 2*, the *y*-coordinate is the measurement of urban size, and the *x*-coordinate is the cities ranked by name.
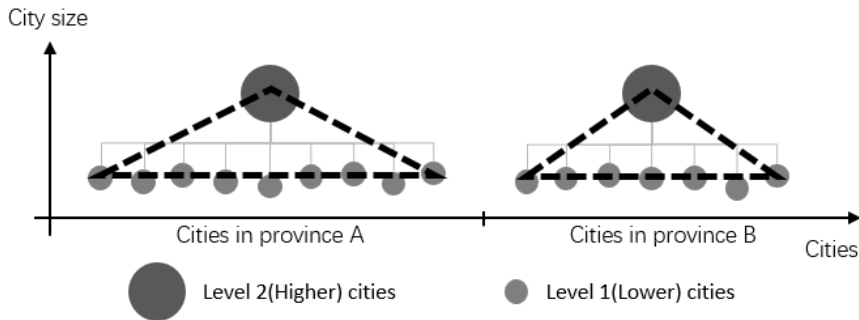

Figure 2. Pattern diagram of city size distribution triangle law

2.3 Theories of city size distribution power law

Pareto's law (Auerbach, 1913) and Zipf's law (Zipf, 1949) are two of the most commonly used theories for describing city size distribution. Though the two theories have different equations, they can transform from each other mathematically and Zipf's law is equal to when the Pareto exponent is equal to 1. Thus, Pareto's law and Zipf's law are "two different ways of looking at same things" (Adamic & Huberman, 2002). Both Pareto law and Zipf's law are based on the power law distribution.

There is a discussion in the existing research over whether the city size distribution in sub-national areas follows the power law distribution. Some studies provide positive evidence. The scale invariance is the main property of the power law distribution, which means there is a self-similarity agglomeration regulation existing across many spatial levels, and the size distributions in small areas are similar to those in large areas (Batty, 2008). Furthermore, Giesen & Südekum, (2011) have proven through empirical research that Zipf's law can be used at not only the national level, but also for subnational administrative areas and random selected areas, however, the actual situation and the theoretical assumptions are not always exactly the same. The research of Giesen and Südekum has some limitations in answering this question because they used the Pareto exponent at different area scales without testing whether the power law distribution is suitable for the city size distribution. Their research is mainly concerned with whether to reject the hypothesis that the Pareto exponent equals 1. However, if the series is not a power law distribution, it can also be used to estimate the Pareto exponent, so their research is mainly useful in demonstrating that city size distributions at different scales have similar degrees of dispersion. Such fear is warranted because, recently, scholars have found that log-normal distributions or double Pareto distributions, instead of power law distributions, can provide better approximations of the empirical urban size distribution in China by comparison to statistical methods (Anderson & Ge, 2005; Deng & Fan, 2016). Also, according to Schaffar & Michel Dimou, (2012),

whether the city size distribution belongs to Zipf's law is largely determined by a study's definition of city and its research area. Furthermore, Ioannides & Skouras, (2013) found that only the upper tail of US city size distribution obeys Pareto's law robustly. There is still no research to test whether the power law distribution is applicable to subnational areas in China, especially for the cities selected at the administrative level. Because of this gap, this study necessarily includes the statistical test of power law distribution at the subnational level.

3.   DATA AND METHODLOGY

3.1   Data and Study Area

Sub-national level units in this article refer to provincial units. City size distribution in other smaller administrative spatial units, such as prefecture-level cities and counties, are not considered in this paper as this research is only an exploration. Shown in *Figure 2*, level-two cities refer to the city proper of sub-provincial cities and provincial capital cities, and level-one cities are other prefecture-level cities. The city proper of the county and towns as well as other non-city prefecture-level districts are excluded. The study area includes 22 provincial units in China that have more than five prefecture-level cities; if there are too few cities, the results of the statistical test is insignificant. Thus, all four municipalities and five provincial units (Xinjiang, Xizang, Hainan, Ningxia and Qinghai) are not included, as they lack prefecture-level cities.

The data used in this research is from the China Urban Construction Statistical Yearbook 2015. For city land use size, the value is taken from 'Area of Built District', and for population size, the value is taken from 'Urban Population'. According to the yearbook, 'Area of Built District' refers to "large scale developed quarters within city jurisdiction with basic public facilities and utilities", and the urban population is the population of the urban area. In provincial cities and prefecture-level cities, the two indicators are both calculated from the city proper.

3.2   Methodology

The methodology of this research is shown in *Figure 3*. Both the urban population size and urban land use size data are used to do the statistical test. Firstly, for each provincial unit, the sizes of all the cities are taken into the power law test. The power law package in python is used as the tool to do the test. This is one of the most advanced tools for judging whether the data is in a long-tail distribution, and to distinguish what kind of distribution it fits best (Alstott, Bullmore, & Plenz, 2014). Secondly, the data is tested for normal distribution. The statistical analysis software SPSS can provide the Shapiro-Wilk test (s-k test) to test this. Compared with the Kolmogorov–Smirnov test, which is also packaged in SPSS and frequently used in normal distribution tests, the s-k test is better for small sample cases. It must be noted that for the normal distribution test, the provincial capital city, and the sub-provincial city, which are both from level two (see *Figure 2*) are not taken into consideration. Thirdly, according to the test results, urban size distribution can be divided into four types. If the provincial unit can pass just one test, it obeys either the

power law or the triangle law, and if it passes both tests, the result obeys both laws; likewise, if it fails both tests, the result obeys neither law. Finally, the results are analysed from two perspectives: firstly, the socioeconomic characteristics of the provincial units in each results group are analysed to explore their possible impact factors to the results; second, certain parameters are proposed to analyse the city size distribution structure of the provincial units that obey the triangle law in order to describe the city size distribution in sub-national level administrative areas in China using this new theory.
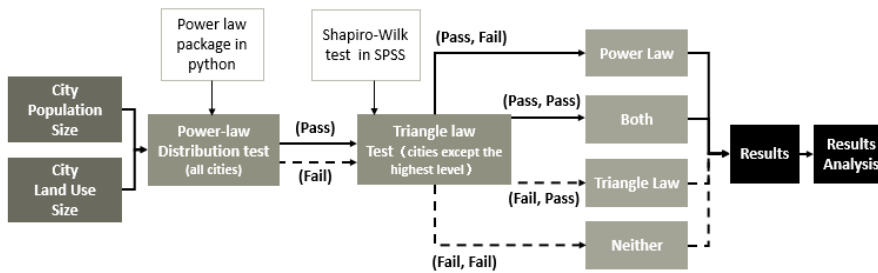

Figure 3. Schematic diagram of the research methodology

4.   RESULTS

4.1   Overview of the results

   Table 1 and *Figure 4* are overviews of the test results: the former is the specific test results of each provincial unit, while the latter shows the proportion of each result type. Firstly, it was found that the two laws can cover most of the distribution regulations. In terms of both the land use and population size, very few of the provincial units obey neither law; most of them fit one law or both. Secondly, the triangle law hypothesis is better for describing the city population size distribution than the power law, because the triangle law can be used in most situations and is rejected in very few cases. To be specific, according to *Figure 4*, for the land use size, half of the provincial units obey the triangle law, while about one fifth of the provincial units obey both laws, and another one fifth obey the power law. For the population size, 59 percent of them obey the triangle law and one third of them obey both laws, while only one provincial unit obeys the power law. Furthermore, as shown in *Table 1*, only Guangdong province strictly obeys the power law distribution, but 10 provincial units strictly obey the triangle law on both sides. Thirdly, many of the provincial units obey both laws. *Table 1* shows that in each provincial unit, the number of normal prefecture-level cities (except for the provincial capital cities) is no more than two dozen; therefore, because of the small number of samples in each provincial unit, the proportions of the results for "both" is not inconsiderable for either perspective.
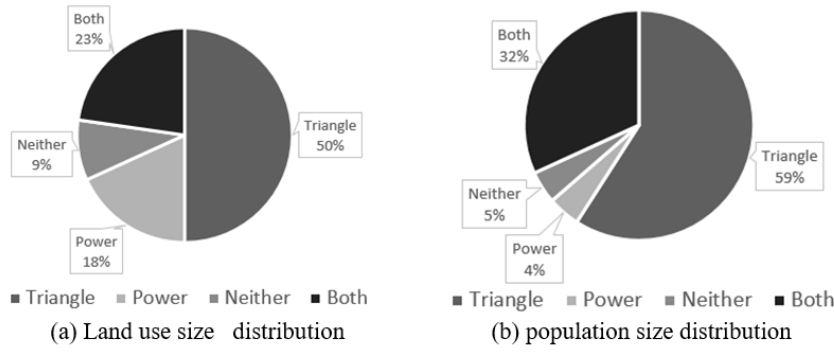
(a) Land use size distribution

(b) population size distribution

Figure 4. Overview of the statistical test results

Table 1. Overview of the statistical test results

Name of Provincial Units	Administrative Division		City Land Use Size Distribution			City Population Size Distribution		
	Number of Normal P-L-Cities	Number of Sub-Provincial Districts	Power-Law Distribution Test	Normal Distribution Test	Results	Power-Law Distribution Test	Normal Distribution Test	Results
Hebei	10	10	Fail	Pass	Triangle	Fail	Pass	Triangle
Shanxi	10	10	Pass	Fail	Power	Fail	Pass	Triangle
Neimenggu	8	11	Fail	Fail	Neither	Fail	Pass	Triangle
Liaoning	13	13	Fail	Pass	Triangle	Fail	Pass	Triangle
Jilin	7	8	Fail	Fail	Neither	Pass	Pass	Both
Heilongjiang	11	12	Fail	Pass	Triangle	Fail	Pass	Triangle
Jiangsu	12	12	Fail	Pass	Triangle	Fail	Pass	Triangle
Zhejiang	10	10	Fail	Pass	Triangle	Fail	Pass	Triangle
Anhui	17	17	Pass	Pass	Both	Fail	Pass	Triangle
Fujian	8	8	Fail	Pass	Triangle	Fail	Pass	Triangle
Jiangxi	11	11	Fail	Pass	Triangle	Fail	Pass	Triangle
Shandong	16	16	Fail	Fail	Triangle	Fail	Pass	Triangle
Henan	16	16	Pass	Fail	Power	Fail	Fail	Neither
Hubei	11	12	Pass	Pass	Power	Pass	Pass	Both
Hunan	13	13	Fail	Fail	Triangle	Pass	Pass	Both
Guangdong	22	22	Pass	Pass	Power	Pass	Fail	Power
Guangxi	13	13	Fail	Pass	Triangle	Fail	Pass	Triangle
Sichuan	12	12	Pass	Pass	Both	Pass	Pass	Both
Guizhou	5	8	Fail	Pass	Triangle	Fail	Pass	Triangle
Yunnan	7	15	Pass	Pass	Both	Pass	Pass	Both
Shaanxi	10	10	Pass	Pass	Both	Pass	Pass	Both
Gansu	11	13	Pass	Pass	Both	Pass	Pass	Both

4.2 Socioeconomic characteristic analysis of the results

For the provincial units, the different statistical test results may be caused by their social economic characteristics. According to factors of the city size distribution in the literature review, *Table 2* summarises the social-economic characteristics of the provincial units in different result groups, taking the GDP per capita, the total population, and the number of normal prefecture-level cities into consideration, where the average value of these indexes is calculated for each group. *Table 2* shows that, on the

one hand, regardless of the population or land use size, provincial units that obey the power law have bigger populations and more prefecture-level cities, but the ones that obey the triangle law are the opposite; on the other hand, the provincial units with higher average GDP per capita are more likely to obey the triangle law in terms of city land use size distribution and the power law in terms of city population distribution.

Table 2. Social-economic characteristic analysis of provincial units in results

Data Type	Distribution Type	Average GDP Per Capita (yuan)	Average Total Population (1,000,000 persons)	Average Number of Normal P-L-Cities
Land Use Size Distribution	Power + Both	26957.94	59.26	12.89
	Triangle + Both	27435.35	54.08	11.19
Population Size Distribution	Power + Both	26726.57	51.44	11.63
	Triangle + Both	25658.84	49.99	10.75

4.3 City size distribution analysis by triangle law

The Pareto exponent is commonly used as an index to describe the city size distribution structure, but the mathematical model of this parameter uses the power law distribution. As many of the provincial units obey the triangle law, this part focuses on these triangle law units and analyses their city size distribution structure within the parameters of the triangle law. The triangle law distribution consists of a special value (sizes of level 2 cities) and a normal distribution (sizes of level 1 cities). Certain normal distribution parameters are selected, including the average value, the standard deviation, the skewness and the kurtosis (calculated by SPSS) to describe the city sizes at level 1, and calculate the ratio of the average level 2 to level 1 city size to describe the relationship between the two levels. *Table 3* shows detailed results for each provincial unit.

Furthermore, China has a very large area and the regional differences are reflected in both economic vitality and political force; ultimately, these differences are reflected in the features of the city size distribution. The bottom of *Table 3* summarises the results by location, and divides China into four geographic regions: east, northeast, middle, and west, as shown in *Figure 4*. The east includes Hebei, Shandong, Jiangsu, Zhejiang, Fujian Guangdong; the middle includes Shanxi, Henan, Hubei, Hunan Jiangxi, Anhui; north-eastern China includes Heilongjiang, Jilin, Liaoning and Neimenggu; and the west includes Gansu, Shaanxi, Sichuan, Guizhou, Yunnan, Guangxi. Municipalities and provincial units with less than five prefecture-level cities are not included. The east is coastal with the highest level of economic development, while the west is the lowest region, and the middle and northeast are intermediate transition regions.

Table 3 shows the results of the analysis. First, the city size distribution shows gradual regional differences. For both the land use and population size, the values of the level 2 average to the level 1 average, from the maximum to the minimum, are distributed as west, middle, northeast then east, which is the same order as the value of level 1 standard deviation. Second, the results show that the distribution structure is shaped like a heavy tail distribution, though it failed the power law test. In *Table 3*, the skewness is between 0.5 to 1, which means the right tail of the distribution is longer than the left one, and meanwhile the kurtosis results are all from 1 to 2 (bigger than 0), which means they have stronger peaks and heavier tails than a normal distribution. Third, the difference between city land use

size and the population size appears mainly in two aspects, the ratio of level 1 to level 2 and the level 1 average standard deviation, while the value of the other two parameters for the same provincial units is always similar. *Table 3* shows that the land use size difference between level 2 cities and level 1 cities is smaller than that of the population size, and the standard deviation is bigger.

Table 3. Analysis of triangle law distribution structure

| Provincial Units	City Land Use Size				City Population Size			
	Level 2 Average/ Level 1 Average	Level 1 Average Standard Deviation	Skewness	Kurtosis	Level 2 Average/ Level 1 Average	Level 1 Average Standard Deviation	Skewness	Kurtosis
Hebei	2.38	61.33	0.69	1.33	2.79	51.85	0.69	1.33
Shanxi					5.87	25.88	0.69	1.33
Neimenggu					2.44	38.34	0.75	1.48
Liaoning	4.54	31.55	0.64	1.23	4.77	32.52	0.64	1.23
Jilin					6.18	30.24	0.79	1.59
Heilongjiang	4.27	61.41	0.66	1.28	6.52	28.78	0.66	1.28
Jiangsu	3.67	101.63	0.64	1.23	4.43	54.73	0.64	1.23
Zhejiang	3.57	62.75	0.69	1.33	3.74	38.31	0.72	1.4
Anhui	5.14	33.02	0.55	1.09	3.8	25.98	0.56	1.09
Fujian	3.84	56.56	0.79	1.59	4.18	25.21	0.79	1.59
Jiangxi	4.12	28.89	0.69	1.33	4.65	18.94	0.69	1.33
Shandong	2.91	62.78	0.58	1.12	3.1	38.09	0.6	1.15
Henan								
Hubei					7.83	24.19	0.66	1.28
Hunan	3.98	27.35	0.64	1.23	5.48	24.35	0.64	1.23
Guangdong								
Guangxi	4.42	42.97	0.62	1.19	5.08	28.88	0.62	1.19
Sichuan	8.15	27.84	0.55	1.06	8.36	24.19	0.55	1.06
Guizhou	5.32	14.57	0.91	2	5.08	15	0.91	2
Yunnan	12.22	15.1	0.79	1.59	14.54	14.89	0.79	1.59
Shaanxi	9.11	21.55	0.72	1.4	9.48	24.71	0.72	1.4
Gansu	7.12	17.48	0.66	1.28	6.85	13.64	0.66	1.28
Affiliated areas								
East China	3.27	69.01	0.68	1.32	3.65	41.64	0.69	1.34
Northeast China	4.4	46.48	0.65	1.26	4.98	32.47	0.71	1.39
Middle China	4.41	29.75	0.63	1.22	5.53	23.87	0.65	1.25
West China	7.72	23.25	0.71	1.42	8.23	20.22	0.71	1.42
China	5.3	41.67	0.68	1.33	5.76	28.94	0.69	1.35
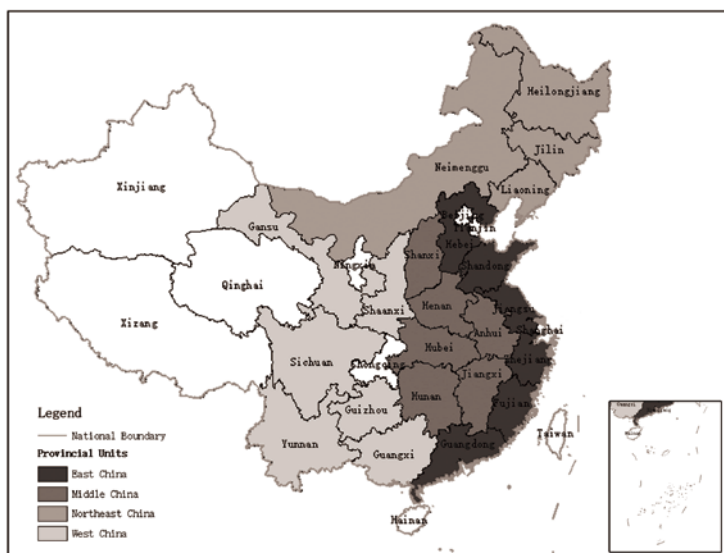
Figure 4. Division of geographic regions in China

5.   DISCUSSION

5.1   Significances

The most significant point of this paper is the proposal of the triangle law hypothesis and the remarkable results showing that most provincial units cannot reject the triangle law hypothesis, while many of them do reject the power law distribution test. To some extent, this means that the hierarchical administrative division, together with the administrative system, financial system, and spatial planning system, have shaped the city size distribution in sub-national areas.

However, as the Pareto exponent is the most commonly used method for measuring the characteristics of city size distribution, this research cannot deny the applicability of the Pareto law and Zipf's law. Because many provincial units obey both the power law and the triangle law, and with results showing that the city size distribution follows the triangle law, the value of skewness and kurtosis means that the normal distribution of level 1 city sizes always have a biased shape. Importantly, the new parameters from triangle law can be used to understand the urban size distribution structure; as the normal distribution is the foundation of many statistical research methods, whether or not city size distribution of level 1 cities surpass the normal distribution is significant for enabling statistical methods in further urban size studies.

5.2   Implications

To summarise the results above, there are many interesting implications. It is thought that the smaller the size differences of level 1 cities and the bigger the size differences between cities of the two levels, the clearer the triangle structure is. Compared with the city land use size, the city population size distribution has a clearer triangle law structure. The possible reason may be that the resource allocation factor contributes more than the spatial planning factor in shaping the city size distribution

triangle law. Furthermore, areas further east, with better market forces and economic development levels, always show less clear triangle shapes. This result could mean that with the development of regional economies, the size gap between cities of different levels will be narrower, and the characteristic city size distribution of the power law will gradually appear.

5.3   Limitations

This research about the city size distribution in sub-national China is only a primer, admitting some limitations. For example, city size data is limited to 22 provincial units in the year 2015, and the samples are to some extent insufficient. To better prove the triangle law hypothesis in provincial units, future research should use extended time series. This research has raised some related research questions that can be explored in the future. For the further subdivided layers, for instance the prefecture-level cities and the counties, does the city size distribution have a similar triangle law? And how about in foreign countries? The secret of city size distribution has only been slightly revealed, and future work is still very much needed.

REFERENCES

Adamic, L. A., & Huberman, B. A. (2002). "Zipf's law and the Internet", *Glottometrics*, *3*(1), 143–150.

Alstott, J., Bullmore, E., & Plenz, D. (2014). "Powerlaw: A python package for analysis of heavy-tailed distributions", *PLoS ONE*, *9*(1), e85777. https://doi.org/10.1371/journal.pone.0085777

Anderson, G., & Ge, Y. (2005). "The size distribution of Chinese cities", *Regional Science and Urban Economics*, *35*(6), 756–776.

Auerbach, F. (1913). "Das Gesetz der Bevölkerungskonzentration (The law of population concentration)", *Petermanns Geographische Mitteilungen*, *59*, 74–76.

Batty, M. (2008). "The size, scale, and shape of cities", *Science*, *319*(5864), 769–771. https://doi.org/10.1126/science.1151419

Chan, R. C. K., & Zhao, X. B. (2002). "The relationship between administrative hierarchy position and city size development in China", *GeoJournal*, *56*(2), 97–112.

Christaller, W. (1966). *Central places in southern Germany*, Prentice-Hall, New Jersey.

Deng, Z. T., & Fan (2016). "B.H, 3-Dimension Synergy of Environment-Efficiency-Equilibrium and Industrial Optimization of Mega Cities", *Urban Development Studies*, *12*(23), 37–42. (In Chinese).

Fan, C. C. (1999). "The vertical and horizontal expansions of China's city system", *Urban Geography*, *20*(6), 493–515.

Fujita, M., Krugman, P. R., & Venables, A. J. (1999). *The spatial economy: Cities, regions, and international trade*, MIT press.

Giesen, K., & Südekum, J. (2011). "Zipf's law for cities in the regions and the country", *Journal of Economic Geography*, *11*(4), 667–686. https://doi.org/10.1093/jeg/lbq019

Ioannides, Y., & Skouras, S. (2013). "US city size distribution: Robustly Pareto, but only in the tail", *Journal of Urban Economics*, *73*(1), 18–29. https://doi.org/10.1016/j.jue.2012.06.005

Lin, G. C., & Yi, F. (2011). "Urbanization of Capital or Capitalization on Urban Land? Land Development and Local Public Finance in Urbanizing China", *Urban Geography*, *32*(1), 50–79. https://doi.org/10.2747/0272-3638.32.1.50

Mills, E. S., & Hamilton, B. W. (1994). *Urban Economics, 5th edn*, Harper Collins College Publishers, Harlow.

Rosen, K. T., & Resnick, M. (1980). "The size distribution of cities: an examination of the Pareto law and primacy", *Journal of Urban Economics*, *8*(2), 165–186. https://doi.org/10.1016/0094-1190(80)90043-1

Schaffar, A., & Michel Dimou (2012). "Rank-size city dynamics in China and India, 1981–2004", *Regional Studies*, *46*(6), 707–721. https://doi.org/10.1080/00343404.2010.521146

Wei, H. (2015). "The Administrative Hierarchy and Growth of Urban Scale in China", *Chinese Journal of Urban and Environmental Studies*, *3*(1), 1550001. https://doi.org/10.1142/S2345748115500013

Xiao, Z. (2016). "Market Mechanism, Government Regulation and City Development", *China Population, Resources and Environment*, *04*(26), 40–47. (in Chinese).

Yang, X., & Zhang, Y. S. (2000). *New classical economics and inframarginal analysis*, Social Sciences Academic Press, Beiijng. in Chinese.

Zipf, G. K. (1949). *Human behaviour and the principle of least-effort. Cambridge MA edn*, Addison-Wesley, Reading.

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