DEVELOPMENT OF URBAN SUSTAINABILITY STRATEGIES AND INDICATORS THROUGH PARTICIPATORY APPROACH WITHIN THIRTEENTH FIVE-YEAR PLAN FRAMEWORK

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Preface

This master thesis has been written as part of the requirement of the Erasmus Mundus Master Program: Joint European Master in Environmental Studies – Cities and Sustainability. This Master program is based at Aalborg Universitet, Universitat Autònoma Barcelona, Technische Universität Hamburg-Harburg and Universidade Aveiro. The master thesis was written at Aalborg Universitet in the period from February 2016 until June 2016. As part of the thesis, a poster communicating the thesis content has been created.

Declaration of Authorship

I hereby declare that the Master Thesis presented here is, to the best of knowledge and belief, original and the result of my own investigation and has not been submitted in part or whole, for a degree at this or any other university.

All the information derived from the work of others has been acknowledged in the text and in the list of references.

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Gilang Hardadi

Aalborg, 9th of June 2016.

Acknowledgement

I thankfully

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Abstract

Economic transformation in China was followed by numerous environmental problems, such as air pollution from the emissions of coal combustion and it is crucial to incorporate environmental protection on economic development. Green development strategy was developed in response to adopt sustainable development principles and it was incorporated into its Five-Year Plan Framework.

Efforts in supporting national development are closely related to the urban development since cities have always been focal points for national economic growth due to their important role as the center of economic activities. Recently, efforts in enhancing knowledge in practices for green development for cities in China have been prevalent due to openness of Chinese cities to collaborate with other cities worldwide, including development of indicator set for urban development to assist Chinese policymakers to accurately summarize and monitor the progress of urban sustainability.

While there has been prolific development of sustainability indicators, the current application of indicators is primarily a top-down approach led by experts, which often fails to engage local communities and subsequently falls short in measuring critical sustainability issues at the local level. Participatory approach could enable development of relevant urban development strategies and representative indicator set. This thesis aims to comprehend how participatory approach can help to detail the strategies in developing local-scale strategies for sustainable cities and develop indicators to measure the sustainability progress in achieving the goals of the cities. Four dimensions in urban sustainability were covered in this thesis; environmental, economic, social, and governance.

This study conducted focus group discussions with governing stakeholders; local government leaders, environmental and planning agencies, and private company executives. In combining this expert information with insight from local stakeholders, surveys were conducted to gain public perception on goals of urban sustainability and preferred methods of monitoring sustainability based on pre-selected indicators from the literature. The focus groups and the surveys were administered in Zhengzhou, the capital of Henan Province. It was selected since its recent urban transformation from a traditional agricultural area to industrial zones could represent China for a national experiment.

It was learned that inclusion of more diverse stakeholders can enrich the development of urban sustainability goals and strategies, especially on environmental and social dimensions since there were shared aspects in urban sustainability perceived as important by both actors, although they also prioritized other aspects deemed as less important to other side. Through the focus group discussion, detailed development on urban sustainability strategies was identified comprehensively and proposed measures were generated. Based on the survey result, citizens have identified 21 relevant indicators to represent diverse aspects of four dimensions in urban sustainability in the context of Zhengzhou. In order to elevate degree of public participation in China from informing to consultation, developing trust level between governing stakeholders and public citizens is critical.

Suggestions for future research are to complement this study with deep interview with citizen representatives and extensive study on developing strategies for enhancing social and governance aspects in urban sustainability within participatory approach to enrich knowledge on identifying relevant issues in urban sustainability and developing appropriate goals and strategies.

Development of Urban Sustainability Strategies and Indicators through Participatory Approach within Thirteenth Five-Year Plan Framework

1. Introduction

During these last decades, China has been considered as one of the major economic powers in the world. Due to free market reform policies in 1979, the economy in China has shifted from stagnant and centrally-controlled economy to one of the fastest-growing economies worldwide. Prior to its reform policies, China contributed just 1.8% of global Gross Domestic Product (GDP) in 1979. Currently China has transformed into one of the largest global economy and produced 9.3% of global GDP in 2010. From 1979 until 2010, the average annual GDP growth of China was 9.91% (World Bank, 2011).

China has governed Five-Year Plan to direct its national development strategies during that five-year period. The First Five-Year Plan for National Economic and Social Development was established in 1953. Recently, the Thirteenth Five-Year Guideline for National Economic and Social Development was formulated to plan national development strategies from 2016 to 2020. The plan focuses on five main principles; innovation as driver of economic development, coordinated development among rural and urban areas, inclusive development to ensure fair prosperity distribution among the whole population, openness to foreign trade and investment, and green development (Xinhua News, 2016).

Green development has been a constant focus since the Eleventh Five-Year Plan in 2006, which specified that the emission of greenhouse gases and other air pollutants would be controlled effectively (Yuan and Zuo, 2011). This strategy was developed in response to air pollution as one of the top environmental concerns in China, majorly caused by the emissions from combustion of coal. Coal combustion accounts for more than 70% of the total energy consumption China, which has increased drastically due to economic growth and urbanization (Chan et al., 2007). Due to its large GDP share, China has a major role to play in the transition of its economy to a low-carbon economy and it is crucial to incorporate environmental protection on economic development.

Incorporation of environmental aspects towards national development has been initiated since the adoption of sustainable development as the guiding principle for development, in accord with Agenda 21 as the outcome of the Earth Summit in Rio de Janeiro in 1992 (Beatley and Manning, 1998). The earliest definition of sustainable development is "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Bruntland, 1987). The concepts of sustainability are often shortly described as the triple bottom line; economic viability, social concerns, and natural or ecological issues (Elkington, 1994; Klöpffer, 2002; Abraham, 2006). This concept has been adopted as national development guidelines worldwide, including China.

Efforts in supporting national development are closely related to the urban development since cities have always been focal points for national economic growth due to their important role as the center of economic activities. However, this circumstance leads to higher consumption and emission level and substantial environment impacts of the cities. While cities generate around 80% of global GDP, they are also associated with about 70% of global energy consumption and energy-related greenhouse gas (GHG) emissions (UN, 2014). Further, major increase in this energy consumption is estimated to come from China and other emerging economies, such as India and the Middle East (IEA, 2013).

In addition to being the center of economic growth, importance of cities towards the realization of national development is also influenced by increase in the urban population. Since more than half of the world population lives in urban areas and an increasing part of them in cities, the problem of

economic and social development is accentuated in the process of city growth. This increase in urban population happened due to continued urbanization over the last 50 years (Tartaglia et al., 2014). At current population growth of 1.8% annually, the world's urban population can be expected to double in 38 years. Similar phenomenon is also experienced by China. Urban population in China increased from 170 million (17.9%) in 1978 to 730 million (53.7%) in 2013, with an annual growth rate of 1.02%. By 2050, the urbanization level of China is projected to be 77.5% (Wu et al., 2014). Growth of urban and rural population in China and worldwide from 1950 to 2050 projection is illustrated in Figure 1.1.

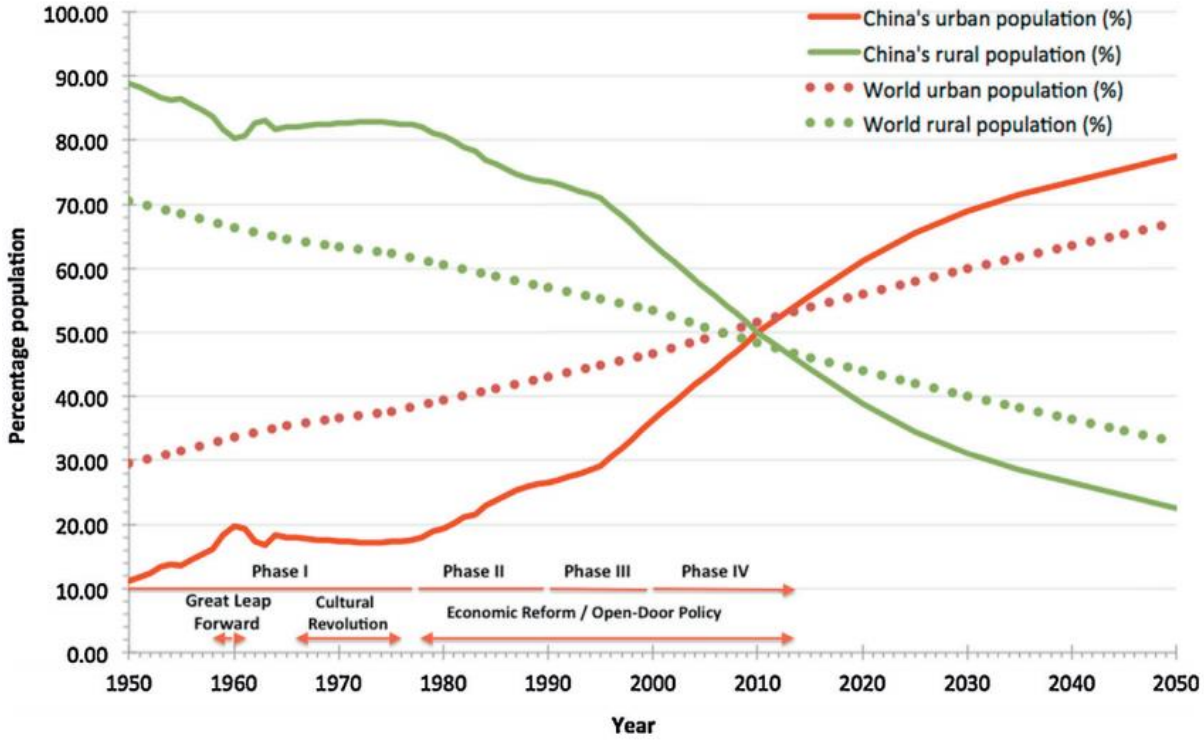

Figure 1.1: Urban and Rural Population in China, 1950-2010 (UN, 2014)

In addition, urbanization is an explicit government policy in China for accelerated national economy growth and getting tens of millions of poor rural peasants out of poverty (Keivani, 2009). Due to those reasons, Chinese cities can provide worthy illustration on the role of cities in national development. To ensure that they can contribute in the best way for national development, it is crucial to ensure that strategies for cities growth in China is synchronous with the strategies schemed in Five-Year Plan.

Green development is being one of the main focus for national development in China to answer its greatest environmental challenges. Rapid economic growth and immense scale of China's urbanization have induced a series of environmental problems, including landscape fragmentation due to drastic change in land use, regional climate change, biodiversity loss, and ecosystem degradation (He et al., 2014; Huang et al., 2015). In the latest Thirteenth Five-Year Plan, strategies for green development includes land use management, water consumption reduction, low-carbon energy consumption, forest development, and improving air and water quality (State Council, 2016).

It is inevitable that cities have been described as the center of creativity and innovation. Johnson and Lehmann (2006) argued that suitability of cities' climate for innovative activities could nurse interactive learning opportunities for sustainable development. Innovation in promoting sustainable development can be done by developing and communicating knowledge about what will be sustainable and environmentally-friendly solutions (Naess, 2001).

Recently, efforts in enhancing knowledge in practices for green development for cities in China have been prevalent due to openness of Chinese cities to collaborate and share knowledge with other cities worldwide. Six of megacities in China are now members of C40 Cities network, a network of the world's megacities committed to addressing climate change. They are Beijing, Shanghai, Shenzen, Wuhan, Guangzhou, and Nanjing (C40 Cities, 2016). This network could stimulate planning processes that generate more debate about the values and interests relevant to the cities for sustainability.

Pulling from many examples across leading C40 cities like Stockholm and Portland, China has developed Green and Smart Urban Development Guidelines to shift the economy of its cities to green, low-carbon economy. This guideline also aims to advance the practices in sustainable urban development in China. It consists of twelve guidelines under three key categories; urban form, transportation, and energy and resources (Huang et al., 2015). Still, since every planning-type problem is unique, these principles of solution might not fit to tackle the environmental problems in all cities and they have to be adjusted accordingly to the local context (Rittel and Weber, 1973).

Generating particular strategies for urban development requires a reliable basis for conducting policies decision. Consequently, there is a demand for tools to support those decision makers in assessing strategic plans multi-dimensionally. This includes environmental aspects, to support Five-Year Plan for National Development in green development. Gao et al. (2013) observed that indicators have been applied in Strategic Environmental Assessment (SEA) in China. Current use of indicators in China might be convenient to be applied for monitoring the overall progress in urban development.

Recently, Urban China Initiative and a team of McKinsey experts collaborated to develop a set of indicators for urban development in China in the effort of making China more sustainable. This set of indicators, also known as urban sustainability indicators, was designed to measure the relative performance of Chinese cities over time across a common set of sustainability categories. They identified 23 indicators to quantify the level of sustainability (Urban China Initiative, 2010). This development of urban sustainability indicators could assist Chinese policymakers and stakeholders to accurately summarize information from various aspects to monitor the progress of sustainability in urban development in China and further to attain relevant information for cognizant decision-making.

Nevertheless, this development of indicators, similar to those of other indicators in China, is very much scientifically and technically based, also known as top-down approach. This approach, mostly led by experts, often fails to engage local communities, and may fail to measure critical sustainability issues at the local level (Reed et al., 2006). To engage local communities, Yuan et al. (2003) have conducted an empirical study on public participation in urban sustainability through a bottom-up consultation process to identify urban sustainability indicators in Shanghai. However, those indicators may not be fully accurate or reliable to monitor urban sustainability as they were developed solely through participatory approach. Since an entirely bottom-up framework does not confirm their measurability and importance, their objectiveness is questionable (Lingayah and Sommer, 2001).

Contrasting differences between scientific (top-down) and participatory (bottom-up) approaches leads to academic debates on the need to develop innovative hybrid methodologies to capture both knowledge repertoires (Batterbury et al., 1997; Nygren, 1999; Thomas and Twyman, 2004). Innovation in development of urban sustainability indicators in China using hybridization of scientific and participatory approaches will enable the creation of a set of indicators that measures what is important for local communities, but also captures key factors of sustainable development that are sufficiently universal to enable broad cross-comparison between cities.

Reed et al. (2006) provided an adaptive learning process in integrating scientific and participatory approach for urban sustainability indicators development. They outlined four basic steps in developing and applying sustainability indicators at local scales; establishing context, establishing sustainability goals and strategies, identifying, evaluating, and selecting indicators, and collecting data to monitor the progress. Through this process, problems in urban sustainability can be accurately identified and goals and strategies as well as sustainability indicators are formulated more relevantly since more appropriate stakeholders are taken into consideration. Nevertheless, it cannot be claimed without a doubt that application of this framework will necessarily result in smooth environmental decision-making, considering that the results from different stages may not always be complementary and conflicts will emerge in the process. These circumstances generate an important research question;

"*How can participation of local stakeholders in developing local-scale strategies for sustainable cities help to detail the strategies and achieve the goals of the cities?*"

Answer to this question will be useful for decision makers to gather broader perspective in providing comprehensive information for developing strategies in shifting their current urban development towards a more sustainable direction. Selection of China as the case study can offer particular understanding in green and low-carbon development in cities, in accordance with its Five-Year Plan National Development. In addition, introduction of participatory approach in China will provide better understanding in implementation challenges of participatory approach since its benefits in decision-making processes is often not fully recognized by local officials in China (Xu and Ding, 2005).

This thesis attempts to answer that research question through assessing the implication of the integration of scientific and participatory approach in developing a set of urban sustainability indicators specifically towards the transition to green and low-carbon development in China. The next section (Section 2) provides relevant literature review on urban sustainability and progress of green and low-carbon development in China and an overview of urban sustainability indicators. It also clarifies the framework of participatory approach and its relevance to the development of urban sustainability strategies and indicators. Through the literature review, sub-research questions are further explored to help answering the main research question. The research methodologies are presented in Section 3. The results are presented and discussed in Section 4. The conclusion of the thesis is presented in Section 5.

2. Literature Review

The literature review starts with an overview in urban development in China in Subsection 2.1. Then short introduction into the current environmental problems in China and development of green, low-carbon cities in China is provided consecutively in Subsection 2.1.1 and Subsection 2.1.2. Urban sustainability indicators are reviewed in Subsection 2.2. Urban environmental indicators are further analyzed in Subsection 2.2.1 and efforts for development for urban sustainability indicators in China are discussed in Subsection 2.2.2. Methodology for hybridization of scientific and participatory approaches in developing urban sustainability indicators is discussed in Subsection 2.3. Finally, the sub-research questions appeared in each subsection are summarized in the last Subsection 2.4.

2.1 Urban Sustainability

Similar to the triple bottom line concept of sustainability, urban sustainability also aims to achieve a balance of environmental, economic, and social aspects in the city. Campbell (1996) used a simple triangular model to understand the conflicting divergent priorities of sustainable development in urban planning as depicted in Figure 2.1.

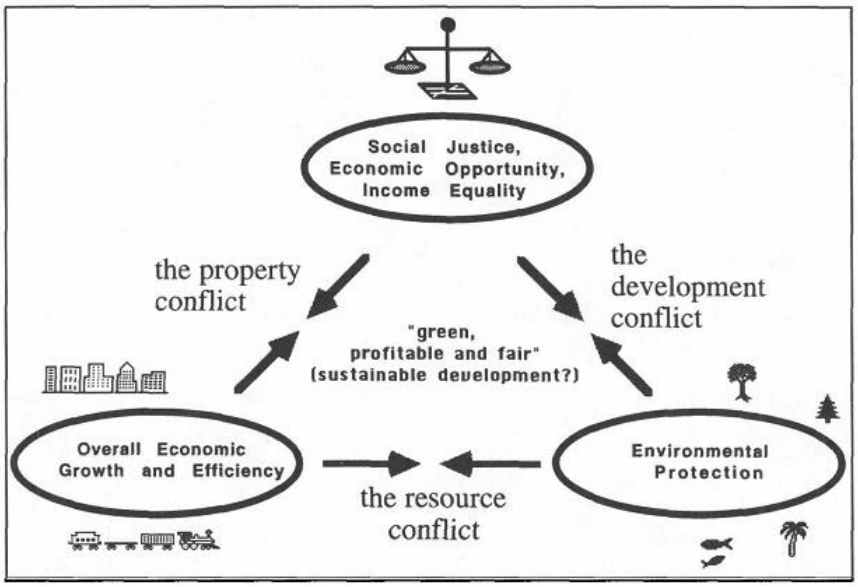

Figure 2.1: The Triangle of Sustainable Urban Development (Campbell, 1996)

Sustainable development is depicted in the center of the triangle as the balance of these three goals to equip cities better in meeting the challenges of the future global scene (Mega, 2005). These varying perspectives lead to three conflicts in achieving sustainability; property conflict between economic growth and social equity, resource conflict between economic utility of natural resources and their ecological utility, and development conflict between social equity and environmental preservation.

Those conflicts begins with conflicting interests from different stakeholders that generates three different planning perspectives on the city. Planners with economic development objectives see the city as the center of economic activities, where production, consumption, distribution, and innovation take place and aims to grow the economy. Environmental planners see the city as a threat to nature, competing for scarce resources and producing wastes and aims to protect urban environment. Equity planners see the city as a location of conflict over the distribution of resources, of services, and of opportunities among different social groups and aims to achieve social justice (Campbell, 1996).

Conflicts between socio-economic development and environmental protection (resource and development conflicts) have been an important barrier to sustainable development, especially in cities. Being the political, economic, and cultural centers of countries and regions, cities have played a crucial role in world development. Due to substantial resources accumulation and wealth generation, cities are continuing to undergo a rapid expansion that has caused severe problems in economic, social, and environmental aspects and threatened urban sustainability (Zhao, 2011).

This situation obliges urban planners to reconcile these conflicting interests and find a balance of all three goals. However, differences in these viewpoints could actually provide inspiration to develop strategies for urban sustainability since these might enrich conceptions of urban sustainability and make them more varied. Therefore, the triangle shows not only the conflicts of interest but also the potential complementarity of interests (Deelstra, 1998). Examples of complementarities and conflicts of interest due to interaction between those interests are provided in Table 2.1.

Table 2.1: Interaction of Complementarities and Conflicts among Different Interests in the City (Camagni et al., 1998)

	Interaction between Economic and Social Interests	Interaction between Economic and Environmental Interests	Interaction between Social and Environmental Interests
Positive complementarities	▪ Accessibility to qualified housing ▪ Accessibility to qualified jobs ▪ Accessibility to social amenities ▪ Accessibility to education facilities ▪ Accessibility to health services	▪ Efficient energy use ▪ Efficient use of non-renewable natural resources ▪ Economies of Scale in use of environmental amenities	▪ Green areas for social amenities ▪ Residential facilities in green areas ▪ Accessibility to urban environmental amenities
Negative conflicts	▪ Forced suburbanization due to high urban rents ▪ Social frictions on the labor market ▪ New poverty	▪ Depletion of natural resources ▪ Intensive energy use ▪ Water pollution ▪ Air pollution ▪ Traffic congestion and noise	▪ Urban health problems ▪ Depletion of historical buildings ▪ Loss in cultural heritage

In order to gain more positive complementary effects than negative conflicts, proper urban management are critical to shift current urban development to the more sustainable path. O'Connor (2007) proposed to include governance, or political sphere as the fourth elements in sustainability, which is constituted through the presence of conventions, rules and institutional frameworks within society for the regulation of the economic and social spheres and, indirectly, the environmental sphere as depicted in Figure 2.2. It aims to assure the simultaneous respect for sustainability performance goals pertaining to all three spheres.

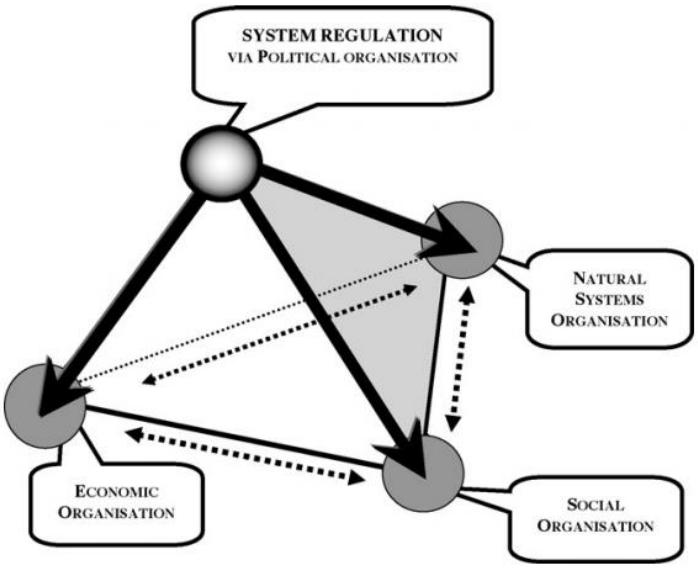

Figure 2.2: Governance for Sustainability: The "Four Spheres" (O'Connor, 2007)

In most definitions of sustainable cities, governance has rarely been included into them (Munier, 2007; Chi et al., 2006; Zheng, 2005; Zhao et al., 2009). Nevertheless, good governance is a necessary precondition for achieving sustainable development at the local level. In an in-depth study of 40 European towns and cities, Evans et al. (2006) observed the institutional and social factors and conditions that might contribute to achievement or failure of policies for local sustainable development. They found out that cities that exhibit sustainable development policy achievements have greater levels of civil society activities and knowledge regarding sustainability issues, and high levels of institutional capacity for sustainable development.

Further, Evans et al. (2006) presumed that institutional capacity for sustainable development is more important to increase the possibility for sustainability policy outcomes than social capacity for sustainable development. Cities with active government will have fairly high possibility for sustainability policy outcomes. In contrast, cities where civil society is expected to act alone in order to make progress with sustainability have low possibility to secure policy achievement as capacity building will be somewhat limited and only distributed by and through civil society actors.

These four dimensions of sustainability are summarized by Johnson and Lehmann (2006) into natural capital (environmental dimension), human and intellectual capital (social dimension), production capital (economic dimension), and social capital (governance dimension). These dimensions and their city-dimensions are provided in Table 2.2.

Table 2.2: Sustainability Dimensions and Their City-Dimensions (Johnson and Lehmann, 2006)

Sustainability Dimensions	City-Dimensions
Natural Capital (Environmental Dimension)	▪ Land-use and management ▪ Biodiversity (Green spaces) ▪ Climate (Air) ▪ Water supply and resources ▪ Wastewater (sanitation and drainage) ▪ Solid waste ▪ Soil ▪ Energy

Sustainability Dimensions	City-Dimensions
Human and Intellectual Capital (Social Dimension)	▪ Health ▪ Education ▪ Research and Development ▪ Technical Service
Production Capital (Economic Dimension)	▪ Incomes ▪ Employment ▪ Social Equity and Justice ▪ Housing ▪ Physical Infrastructures ▪ Finance ▪ Investment ▪ Growth
Social Capital (Governance Dimension)	▪ Governance ▪ Management ▪ (Forum for) Participation ▪ Responsibility and Empowerment ▪ Networks for Communication and Capacity Building ▪ Subcultures and Cultural Diversity

The city dimensions for each dimension are further expanded in more recent literatures. Suggested readings are Ameen et al. (2015), Xing et al. (2009). Through those literatures, 43 sustainability aspects are collected as the basis of this research, consisted of 11 environmental aspects, 7 economic aspects, 20 social aspects, and 5 governance aspects.

2.2 Urban Development in China

Being the center of economic activities, cities are now recognised as pivotal for national-scale development. Cities are delivering significant contribution towards Gross National Product (GNP), ranging from 55% of GNP in low-income countries to 85% in high-income countries (UN Habitat, 2006). Nevertheless, the fact that cities generate wealth, enable nationwide economic functions, and offer better life opportunities for their inhabitants does not negate the challenges they pose towards the environment. Due to substantial resources accumulation and wealth generation, cities are continuing to undergo a rapid expansion that has caused severe environmental problems (Zhao, 2011). In 2005, sixteen of the twenty-two most polluted cities in the world are located in China (World Bank, 2007).

In addition, along with rapid economy growth of China, the energy consumption soared. Between 1957 and 2010, the energy consumption increased by 32.7 times with the annual increase rate of 6.8%, reaching 3250 million tons of coal equivalent in 2010. Energy consumption in China has grown tremendously since 2000, with increase of more than 1500 million tons of coal equivalent in just ten years (National Bureau of Statistics of China, 2011). This rapid energy consumption increase in China has contributed significantly towards global greenhouse gas (GHG) emissions as China is responsible for approximately 19% of global energy consumption (IEA, 2014). Energy consumption rate in China from 1957 to 2010 is provided in Figure 2.3.

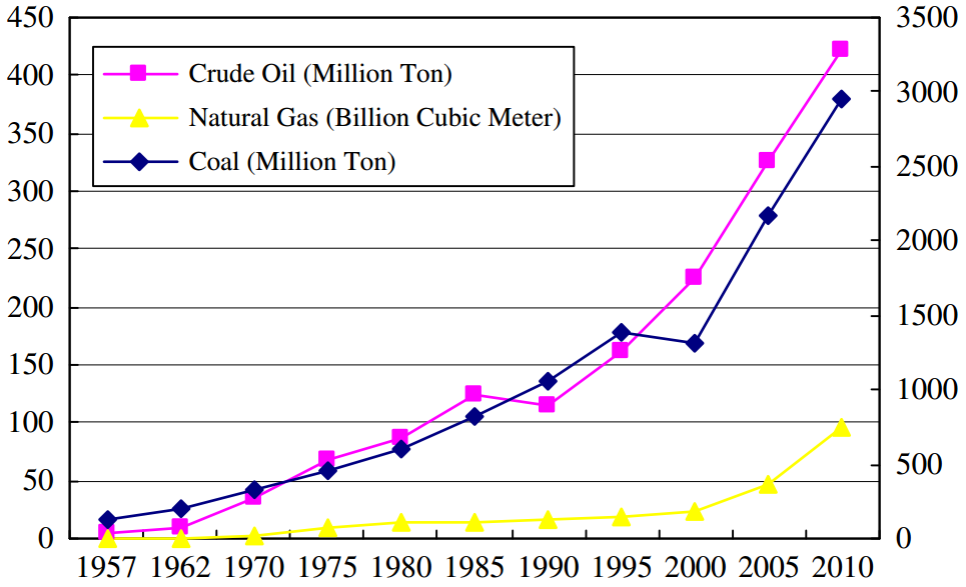

Figure 2.3: Energy Consumption in China (National Bureau of Statistics of China, 2011)

In addition, energy sources in China still relied heavily on coal. Coal accounts for approximately 70% of total commercial primary energy supply (National Bureau of Statistics of China, 2011). Since cities are responsible for around 70% of global energy consumption and energy-related greenhouse gas (GHG) emissions, cities in China faces challenges to stimulate economic growth while reducing its contribution towards climate change. In addition, as the urbanization level of China is projected to be 77.5% by 2050 (Wu et al., 2014), it is mandatory to ensure that the urban development could afford high urbanization rate without impacting negatively towards urban environment.

National Government of China has acknowledged these issues and emphasize importance in shifting its economy to low-carbon development into National Development Plan, also known as Five-Year Plan. Five-Year Plan is the national development framework that covers a series of economic development initiatives, mapping strategies for economic development, setting growth targets and launching reforms in the relative time frame of five years (Shiu and Lam, 2004). Recently, the Thirteenth Five-Year Plan was released on 5 March 2016 to govern national development in 2016 to 2020. The targets for national development in Thirteenth Five-Year Plan are enlisted in Table 2.1.

Table 2.1: China's National Development Targets in Thirteenth Five-Year Plan

Indicators		2015	Target 2020	Annual Growth Rate [or 5-Year Cumulative]
Economic Development				
Gross Domestic Product (GDP) (Trillion CNY)		67.7	> 92.7	> 6.5 %
Labor productivity (Ten thousand CNY/ person)		8.7	> 12	> 6.6 %
Urbanization rate	Resident population (%)	56.1	60	[3.9]
	Household population (%)	39.9	45	[5.1]
Share of service industries to GDP (%)		50.5	56	[5.5]
Innovation-Driven				
Share of Research and Development spending (%)		2.1	2.5	[0.4]
Patent ownership per million people (items)		6.3	12	[5.7]
Contribution rate of scientific and technological progress (%)		55.3	60	[4.7]
	Fixed household broadband (%)	40	70	[30]

Indicators		2015	Target 2020	Annual Growth Rate [or 5-Year Cumulative]
Internet penetration	Mobile broadband (%)	57	85	[28]
Welfare				
Growth rate of disposable income per capita (%)		-	-	6.5
Average years of schooling of working-age population (Years)		10.23	10.8	[0.57]
Number of new jobs for urban residents (10,000)		-	-	[> 5000]
Rural peasants out of poverty (10,000)		-	-	[5575]
Basic pension insurance rate (%)		82	90	[8]
Urban shantytowns housing renovation (Million units)		-	-	[2000]
Life expectancy (Years)		-	-	[1]
Resources and Environment				
Amount of cultivated land (Million acres)		18.65	18.65	[0]
New constructed land (Hectares)		-	-	[< 3256]
Water consumption per unit of GDP reduction (%)		-	-	[23]
Energy consumption per unit of GDP reduction (%)		-	-	[15]
Ratio of non-fossil fuels in primary energy consumption (%)		12	15	[5]
CO_2 emission per unit of GDP reduction (%)		-	-	[18]
Forest Development	Forest coverage rate (%)	21.66	23.04	[1.38]
	Forest stock volume (Hundred million m^3)	151	165	[14]
Air Quality	Days with good and above urban air quality (%)	76.7	80	-
	Fine Particulate (PM 2.5) (%)	-	-	[18]
Surface Water Quality	Ratio of water at or better than Class III (%)	66	> 70	-
	Ratio of water at Class V (%)	9.7	< 5	-
Emission Reduction	Chemical Oxygen Demand (%)	-	-	[10]
	Ammonia (%)	-	-	[10]
	Sulfur Dioxide (%)	-	-	[15]
	Nitrogen Oxides (%)	-	-	[15]

Compared to Twelfth Five-Year Plan, this plan has put more emphasis in environmental protection, allowing a lower economic growth rate of 6.5% p.a. compared to previous growth rate target at 7%. It has been suggested that in order to achieve overall sustainability, China has to move away from maximizing economic development and focus on improving its environmental quality (Huang et al., 2015). Under Resources and Environment section, China has outlined 16 indicators as their target for environmental protection. It focuses on sustainable land use, raising energy and water efficiency, encouraging low-carbon economy, protecting forest, and reducing pollution. These are developed to answer the main environmental problems in China.

2.2.1 Urban Environmental Problems in China

While open-door policy in China has led to significant economic growth, its transition from state socialism to market economy is accompanied by environmental deterioration (He et al., 2014; Huang et al., 2015). Identified main environmental problems in China are air pollution, water pollution, CO_2 and other GHG emission that causes global warming, and overdependence on non-renewable energy

resources (Chow, 2007). Most of these problems, except water pollution, are majorly contributed from the utilization of coal as primary energy source. It accounts for more than 70% of the total energy consumption China (Chan et al., 2007). This condition accentuates the importance of low-carbon economy development in China.

2.2.1.1 Air Pollution

Air pollution has become one of the top environmental concerns in China, which pollutants are suspended particulate matter (PM), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), volatile organic compounds (VOC), and ozone (O_3) (Chan and Yao, 2007). Air pollution is predominantly contributed from the emissions from combustion of coal, with SO_2 as the principal air pollutants (Kan et al., 2009). Coal combustion is responsible for 90% of the SO_2 emissions, 70% of the particulate emissions, 67% of the NO_2 emissions, and 70% of the CO_2 emissions (Chen and Xu, 2007). World Bank (2007) estimated that the total health cost associated with outdoor air pollution in urban areas of China in 2003 was between 157 and 520 billion Chinese Yuan, accounting for 1.2-3.3% of China's GDP. It further increased to 5% of GDP in 2005 (Matus et al., 2012).

Particulate concentrations such as $PM_{2.5}$ (PM of 2.5 μm or less in diameter) in most Chinese cities are still far above the annual average limit from Air Quality Guidelines from World Health Organization (WHO) of 10 $\mu g/m^3$ (WHO, 2005). $PM_{2.5}$ concentrations in Beijing were about ten times the guideline thresholds (He et al., 2001), while those in Beijing were about six times (Ye et al., 2003). This could be harmful to health of Chinese residents as studies have demonstrated an association between exposures to concentrations of particulate matter and mortality and morbidity. Example cases of the negative health impacts from particulate matter on human populations in urban areas are cardiovascular and respiratory disease, asthma attacks, acute bronchitis and restrictions in activity (Anenberg et al., 2010; Nel, 2005; Pope and Dockery, 2006; Salma et al., 2002).

The emission of SO_2, a major air pollutant from coal combustion, was 25.5 million tons in 2005, although it had decreased to 24.6 million tons in 2007 (State of the Environment in China, 2005; 2007). Industrial activities contributed to 86.7% of total SO_2 emission. SO_2 concentrations exceeded the Chinese Grade-II standards in 22% of the country's cities and caused acid rain problems in 38% of the cities (State of the Environment in China, 2005). In 2003, acid rain fell on 265 cities and annual average precipitation pH values equaled or was lower than 5.6 in 182 cities. This resulted into acid deposition on soil, which could significantly reduce soil arability and increase soil erosion through accelerating decomposition of organic matter and mobilization of ferric oxides (Xu et al., 2002).

China have attempted several efforts to decrease these hazardous pollutants, such as installing desulfurization units on coal-burning power plants for reducing SO_2 emission, gasification of coal into Carbon Monoxide (CO) and Hydrogen (H_2), and Carbon Capture and Storage (Chen and Xu, 2007). However, these efforts were deemed less effective since the pollution problems from coal burning are still serious, which has led to the objectives of environmental pollution treatment not being achieved effectively in the social and economic development goals established during the tenth Five-Year Plan (Jun, 2010). As long as energy structure in China is still dominated by coal and energy consumption continues to increase for attaining economic development target, air pollution treatment in China will face great challenges.

2.2.1.2 CO_2 and Other Greenhouse Gas Emission

There is a consensus in the scientific community that anthropogenic greenhouse gas emissions are the main contributor towards global warming (IPCC, 2014). The global average temperature has increased by 0.4°C to 0.8°C in the 20th century, and is projected to rise by 1.4°C to 5.8°C by the year 2100 (Pani

and Mukhopadhyay, 2010). This warming has widespread consequences for both ecosystems and humans. Warmer temperatures will change precipitation and increase snow and ice melting in the earth poles, resulting in changes in the hydrological cycle. The oceans are acidifying, heat waves are becoming more frequent, and rising sea levels and extreme weather events such as heavy rain and storms are causing floods and damages (IPCC, 2014).

The impacts of climate change can be divided into two groups, direct and indirect impacts. It is important to emphasize direct impacts from climate change on cities due to their vulnerability to climate change. In addition, consequences of climate change in cities is higher than those in rural areas since cities function as economic centers and have higher population density.

The most important impacts from climate change on cities are sea or river level rise, extreme weather events, impacts on human health, and increase in energy and water consumption. Cities are more prone to sea or river level rise due to their location nearby sea or next to rivers, leading to emerging risks of flooding. Extreme weather events such as storms and heavy rainfalls could magnify the flooding risks to the built environment in the cities. Human health will likely be affected directly by climate change due to increase in food-borne and vector-borne diseases, e.g. salmonella. In addition, energy and water consumption might increase due to temperature change to provide the changing need for heating and cooling (Hunt and Watkiss, 2011).

Many direct impacts such as sea level rise or extreme weather events lead to indirect impacts from climate change. In cities, indirect impacts from increased temperatures, floods, saline intrusion etc. can include effects on transportation systems, power supply, drinking water, food distribution, waste management and communication systems (da Silva, Kernaghan and Luque, 2012).

To alleviate those harmful consequences, it is agreed that the level of total CO_2 in the atmosphere should not exceed a level equal to twice the level existing before the Industrial Revolution (see Pacala and Socolow, 2004). In 1998, Kyoto Protocol is adopted to reduce the anthropogenic greenhouse gas emissions worldwide. However, this treaty was observed as a failure since United States refused to ratify the protocol and developing countries had no binding targets. This second reason led to dramatic increase of emission of China and India; 150% and 103% respectively.

While in 2001 China accounted only for 13% of the world's energy related carbon emission in comparison with the US for 24%, by 2007 China has taken over the US for the first time as the world's top producer of GHG emission. Thus, China held a huge responsibility in reducing emissions. From 1994 to 2004, the average annual growth rate of GHG emissions is around 4%, and the share of CO_2 in total GHG emissions increased from 76% to 83%.

Along with steady social and economic development, the CO_2 emission per unit of GDP declined generally. China's emission intensity fell to 2.76 kg CO_2 per USD (at 1999 prices) in 2004, as compared to 5.47 kg CO_2 per USD in 1990, a 49.5% decrease. For the same period, emission intensity of the world average dropped only 12.6% and of the OECD countries dropped 16.1%. Although CO_2 emission per capita of China was still considered low at 3.65 tons in 2004, only 87% of the world average, it was continually increasing at around 4% annually (IEA, 2004).

In 2009, China committed to reducing its CO_2 intensity by 40-45% by 2020 from a 2005 baseline. However, in order for China to be willing to reduce its use of coal-fired power plants that cause CO_2 emission, alternative energy source must be priced not higher than the price of power generated by coal. This will be possible if there shall be sufficient technological innovations in the production of clean energy at such low prices. Market incentives for such innovations have a good chance of success, according to Friedman (2007, p.50).

Some conventional suggestions to reduce the rate of carbon emission are by using alternative energy to coal such as gas, nuclear, ethanol and solar, reducing the consumption of electricity at homes, offices and factories, and controlling the amount of CO_2 emission by reducing the burning of forests and capturing the amount of carbon from coal burning (Chow, 2007). These suggestions are more applicable in China since those do not require advanced technology.

In addition to strategies mentioned in Five-Year Plan, Yuan and Zuo (2011) also mentioned four other actions to control greenhouse gas emission effectively. Those actions are to accelerate research and development and implementation of low carbon technologies to control the greenhouse gas emission in major sectors such as industrial, building and construction, transport and agriculture; to establish standards, labeling system and accreditation system for low carbon products; to establish and improve the statistical and auditing system for greenhouse gas emission; and to establish carbon trade market.

2.2.1.3 Overdependence on Non-Renewable Energy Resources

China has a very heavy dependence on coal due to its limited oil and gas reserves and abundant coal resources. In the past three decades, coal accounted for 70-80% of primary energy supply (excluding combustible renewables and waste), with oil the second-largest source with a share of about 20%. Further, three quarters of the electricity generated in China is still coal-fired.

In order to accommodate this energy independence, the Five-Year Plans have included the development of new and renewable energy for economic growth. In 2013, coal share has reduced to 65.7% of total primary energy consumption. The proportion of the new and renewable energy to total energy has increased from 3% in 1957 to about 11% in 2010, with focus on hydro, nuclear, and wind power. It had achieved the renewable energy increase targets of year 2010 to increase the installation capacity of hydro power, biomass power, wind power, solar hot water system and solar PV to 190 million kW, 5.5 million kW, 10 million kW, 150 million m2 and 300 MW, respectively, in 2009 (National Development and Reform Commission, 2008).

According to the Twelfth Five-Year Plan, the non-fossil fuel will account for 11.4% of total primary energy consumption by 2015 (State Council, 2011). Renewable energy resources will account for 20% of total energy consumption by 2020 (National Development and Reform Commission, 2007). The proportion of new energy and renewable energy to the energy mix will increase constantly in China.

2.2.2 Development of Low-Carbon Cities in China

Due to the problems aforementioned, China has begun to apply low-carbon cities development concepts and involved in global efforts in incorporating ecological and low-carbon development considerations into urban planning and management models in cities in China. The overall objective of a low-carbon city is to significantly reduce its carbon footprint in ways that do not compromise a city's economic development potential (Wang et al., 2012). In March 2011, China's Twelfth Five-Year Plan established a carbon intensity reduction goal of 17% between 2011 and 2015.

In the Twelfth Five-Year Plan, China developed eight action plans to achieve this target (State Council, 2014). Firstly, to vigorously promote industrial restructuring. This includes resolving overcapacity contradiction, accelerating the development of low-carbon emission industries, optimizing energy consumption structure, and strengthening environmental impact assessment to create binding effect for new projects. Secondly, to accelerate the construction of energy saving carbon reduction project. This covers promoting the implementation of key projects, accelerating the renovation of coal-fired boilers, increasing vehicle emission reduction efforts, and strengthening water pollution control. These two plans are the most important plans in accomplishing carbon intensity reduction goal.

Third, to pay close attention to key areas of energy-saving carbon. Fourth, to strengthen technical support for innovation and application. Fifth, to further strengthen policy support. Sixth, to actively promote market-oriented energy conservation mechanism. Seventh, to strengthen supervision, inspection, monitoring, and early warning of energy consumption and greenhouse gas and pollutant emissions. Eighth, to strengthen local and regional government responsibility. These action plans led to target accomplishment and an increased target of the Thirteenth Five-Year Plan in 2016 for carbon intensity reduction to 18% between 2016 and 2020.

Despite this optimistic target, the implementation at the provincial and city levels is a major challenge since relatively little policy guidance exists at the national level to describe what are the strategies in practical and operational terms, even though some degree of guidance is provided by the national standards on developed by Ministry of Environmental Protection and Ministry of Housing and Urban-Rural Development (Baeumler et al., 2012). Since every planning-type problem is unique, these guidance might not fit for low-carbon development in all cities and they have to be adjusted accordingly to the local context (Rittel and Weber, 1973). This increases the role of cities in developing their own strategies for low-carbon cities.

Since there are no agreed definitions, integrated standards, or well-accepted methodologies for low-carbon city development, different cities are using different approaches on different scales. In January 2010, MoHURD and the Shenzhen government signed a framework agreement, making Shenzhen China's first low-carbon eco-demonstration city. Shenzhen is also one of the eight low-carbon pilot cities under NDRC's plan. In October 2010, Shenzhen put in place the Shenzhen National Low-Carbon Pilot City Implementation Scheme (2010–20), which lays out a comprehensive plan for low-carbon development. The city is also developing an indicator system for low-carbon projects, which will be integrated into the environmental impact assessment and approval processes for new projects.

One national initiative from to shift the economy of its cities to low-carbon economy is by developing Green and Smart Urban Development Guidelines in cooperation with C40 cities network. Those action plans are taken from leading C40 cities like Stockholm and Portland. This guideline also aims to advance the practices in sustainable urban development in China. It consists of twelve guidelines under three key categories; urban form, transportation, and energy and resources (Huang et al., 2015). Those guidelines are provided in Table 3.

Table 2.4: Green Guidelines for Low-Carbon Cities Development (Huang et al., 2015)

Key Categories	Green Guidelines
Urban Form	▪ Urban Growth Boundary ▪ Transit-Oriented Development ▪ Mixed Use ▪ Small Blocks ▪ Public Green Space
Transportation	▪ Non-Motorized Transit ▪ Public Transit ▪ Car Control
Energy and Resources	▪ Green Buildings ▪ Renewable and District Energy ▪ Waste Management ▪ Water Efficiency

This subsection discloses current status of urban sustainability in China, explaining the sustainability problems and the strategies and efforts that have been made to overcome those problems. These exposures lead to the first sub-question; "*How do the local stakeholders perceive urban sustainability problems and plan the strategies to overcome those problems?*"

2.3 Urban Sustainability Indicators

Meanwhile, there have been numerous studies in urban sustainability indicators for cities in China (Urban China Initiative, 2010; . This subsection will discuss indicators in urban sustainability,

Since objectives of urban development cover wide range of disciplines, those involved a range of discipline-specific activities to measure the performance of sustainable urban environments, which are classified into environmental, economic, social, and governance aspects. These activities can be translated into topic area-specific indicators that highlight progress in crucial areas for sustainable development that may assist in identifying how, when and where action may be required (DEFRA, 2009; see also Hammond et al., 1995; Pagina, 2000).

European Economic Area (EEA) characterize indicators as measures that can be used to illustrate and communicate complex phenomena simply, including trends and progress over time. The measures are generally quantitative, which are often constructed from economic, social, and environmental statistics (EEA, 2005). In the context of sustainability, indicators represent an empirical model of reality that are analytically sound and have a fixed methodology of measurement (Hammond et al., 1995). More recently, indicators have been defined as variables representing as accurately as possible and necessary a phenomenon of interest based on measurement (Joumard and Gudmundsson, 2010).

The functions of indicators can be sorted into different levels (Cloquell-Ballester et al., 2006; Dale and Beyeler, 2001; Joumard and Gudmundsson, 2010). For scientific purpose, the components of a system and the complex relationships among the system could be represented by indicators (Walz, 2000). Indicators could also be used as a monitoring tool for environmental or sustainability programs (Strobel, 2000). In political function, indicators are beneficial as a tool for evaluating policies (Rydin et al., 2003; van der Heijden, 1997) or decision-making units in policy strategies (Alberti, 1996; Pannell and Schilizzi, 1999; Pannell and Glenn, 2000; Rydin et al., 2003; van der Loop, 2006). In addition, indicators could also be used to communicate with local communities about activities undertaken by organizations that are using indicators (Gahin et al., 2003; Rydin et al., 2003).

Urban sustainability indicators summarize the state of a city's sustainability in a quantified way, and are powerful tools to urban planners, policymakers and stakeholders, including citizens, for informed decision making. Therefore, urban sustainability indicators must be able to integrate inputs from multiple stakeholders and be used to communicate progress of urban sustainability to the stakeholders. In addition, they have to be forward-looking, distributional and ideally be the result of the inputs from multiple stakeholders (Alberti, 1996).

It is definite that efforts have to be made to transform cities in China into sustainable ones. In order to generate a reliable basis for conducting policies decisions on urban level, there is an urgent need in development of indicators for sustainable urban development capable to summarize information of social, economic, environmental, and governance aspects to monitor the progress of sustainability. It is witnessed that current research on environmental assessment in China focuses on assessment methodology rather than identification of indicators (Zhao et al., 2003).

Huang et al. (2016) suggest that sustainability assessment using multiple indicators with a "strong sustainability" framework will be necessary to gauge the effectiveness of this policy shift, and to guide

urban planning and management in China in achieving urban sustainability. Strong sustainability is characterized by its perception that substitutability of manufactured for natural capital is seriously limited by such environmental characteristics as irreversibility, uncertainty and the existence of critical components of natural capital, which make a unique contribution to welfare (Daly, 1991; Turner, 1993). This contrasts weak sustainability which perceives that welfare is not normally dependent on a specific form of capital and can be maintained by substituting manufactured for natural capital, though with exceptions (Turner, 1993).

Dietz and Neumayer (2007) suggest that it is preferred to pursue strong sustainability for four reasons. Firstly, there remains considerable risk, uncertainty and ignorance attached to the way in which natural capital such as the global carbon and biogeochemical cycles works and the damaging effects are unknown. Secondly, the loss of some natural capital may be irreversible. Thirdly, since people tend to be more averse to losses in utility rather than to be keen to gain it (Kahnemann and Tversky, 1979), people are highly averse to losses in natural capital functions that directly provide them with utility. Fourthly, substitutability are considered less ethical since increased future consumption is not an appropriate substitute for natural capital losses (Barry, 1990). Further suggestions for operationalizing strong sustainability are explored in Neumayer (2003).

In order to deliver objective and useful indicators, criteria have to be set in selecting indicators. Based on reviews from Xu et al. (2006), these are criteria for selecting indicators. Firstly, indicators must have direct relevance to current or future urban policies. Secondly, indicators are comprehensive; they could provide immediate and full understanding of the health of urban sustainability. Thirdly, they are easily accessed, collected, and used by residents. Fourthly, they are precise and quantifiable. Fifthly, they are scientific and effective; it is easy to tell from the indicators whether a goal is being satisfied, based on reasonable observation and without confusion from statistical interference. Finally, they are able to sensitively reflect change in time and space.

Related to carbon reduction, Price et al. (2013) proposed and examined a methodology for the development of a low carbon indicator system at the provincial and city level. While Five-Year Plan has established indicators for low-carbon development, those indicators are aggregated at macro-level, such as energy use or CO_2 emission per unit of GDP. This might cause them less meaningful to measure the level of low-carbon development in cities in China. Price et al. (2013) have developed a methodology for the development of a low-carbon indicator system at the provincial and city level, providing initial results for an end-use low carbon indicator system, based on data available at the provincial and municipal levels.

They identified two different sets of indicators, macro-level indicators and end-use sector-level indicators. Macro-level indicators cover primary energy consumption per unit of GDP, final energy consumption per unit of GDP, end-use CO_2 emission per unit of GDP, primary energy consumption per capita, final energy consumption per capita and end-use CO_2 emission per capita. Meanwhile, end-use sector-level indicators cover residential final energy per capita, commercial final energy per tertiary sector employees, industrial final energy per unit of industry GDP, transportation final energy per capita, and CO_2 emission per power produced.

This subsection identifies possible indicators in measuring the progress or state of urban sustainability for each sustainability aspect. This leads to the second sub-question; "*What indicators do the citizens give importance and preference in order to measure the progress or state of urban sustainability?*"

2.4 Participatory Approaches in Urban Sustainability

Gao et al. (2013) argued that current application of indicators is very much scientifically and technically based, also known as top-down approach. This approach, mostly led by experts, often fails to engage local communities, and may fail to measure critical sustainability issues at the local level (Reed et al., 2006). Thus, development of urban sustainability indicators in China with participatory approach is urgently needed. While an empirical study on development of identifying sustainability indicators with participatory approach has been conducted by Yuan et al. (2003) in Chongming County, Shanghai, indicators developed in this study may not be fully accurate or reliable to monitor sustainability. This happens since an entirely bottom-up framework might not provide objective indicators since it cannot confirm their measurability and importance (Lingayah and Sommer, 2001).

Due to contrasting difference between scientific (top-down) and participatory (bottom-up) approaches, there is increasing awareness and academic debate on the need to develop innovative hybrid methodologies to capture both knowledge repertoires (Batterbury et al., 1997; Nygren, 1999; Thomas and Twyman, 2004). Development of urban sustainability indicators in China using hybridization of scientific and participatory approaches will enable the creation of a set of indicators that measures what is important for local communities, but also captures key factors of sustainable development that are sufficiently universal to enable broad cross-comparison between cities. Further, it will strengthen the usefulness of indicators in monitoring urban sustainability in China.

While selection and interpretation of sustainability indicators has become an integral part of international and national policy in recent years, urban sustainability indicators is regarded as impotent to provide more benefits to the users since the majority of existing indicators are based on a top-down definition of sustainability that is fed by national-level data (Riley, 2001). As a result, current indicators has been critiqued for ignoring local contextual issues (Morse and Fraser, 2005).

The second problem is that communities are unlikely to invest in collecting data on sustainability indicators unless monitoring is linked to action that provides immediate and clear local benefits (Freebairn and King, 2003). In order to engage local communities in selecting, collecting, and monitoring the indicators, indicators must not only be relevant to local people, but the methods used to collect, interpret and display data must be easily and effectively used by non-specialists.

Gao et al. (2013) added that explicit recognition of the political and value-laden elements of using indicators is still generally quite weak in Chinese SEA practice. Since the application of indicators is also a value-laden social process, public participation in development of sustainability indicators that also cover economic and social aspects is urgently needed to monitor urban sustainability effectively.

2.3.1 Theory of Participatory Approach

Public participatory aims to involve public citizens in decision-making and the processes involved that will impact them. Public participatory is defined as the process to incorporate public concerns, needs, and values into governmental or corporate decision-making process. This involves two-way communication and interaction between public and governmental or corporate, with the overall goal to generate better decisions that are supported by the public (Creighton, 2005).

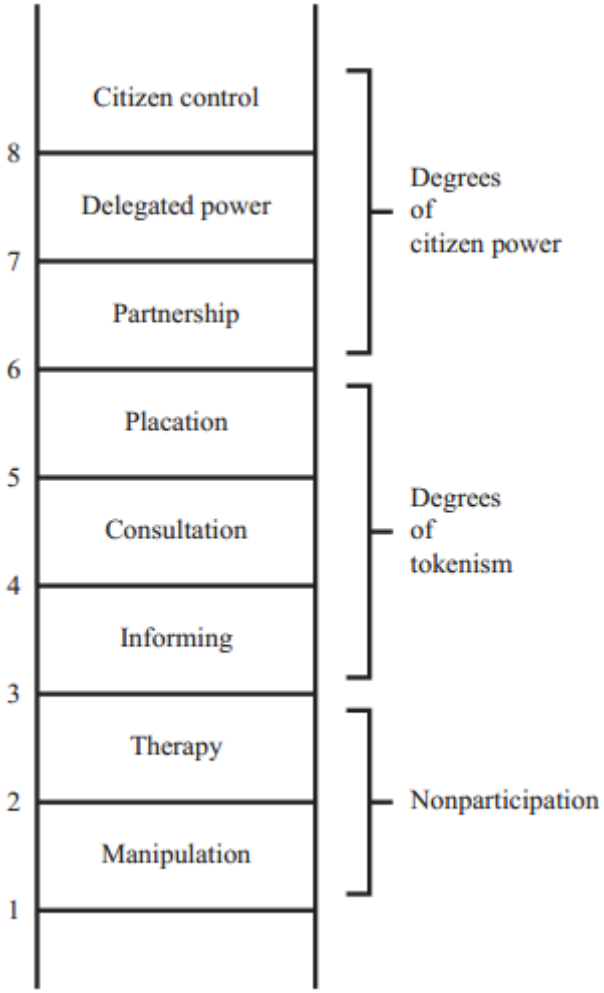

Figure 2.4: Ladder of Public Participation (Arnstein, 1969, p. 217)

There are several reasons to initiate public participation in urban sustainability context. Firstly, to improve urban planning. When urban planners gather more insights and learn about important concerns in local context from the public, the results could be more balanced (Creighton, 2005). This local knowledge gained through public participation could enable urban planners to make better judgment and more qualified decisions (Innes and Booher, 2004). In addition, a two-way communication in public participation could also enable urban planners to transfer their technical knowledge to the public for learning about the planning process and how to criticize plans or ongoing projects and present new ideas for urban development (Kørnøv, 2007).

Secondly, to stimulate democratization. When public participation is used as a way to delegate power to the public, this could support the democracy (Arnstein, 1969). In addition, this could also provide a platform for population groups that normally have difficulties in voicing their opinions and being heard, such as minorities, to voice their opinions and provide feedbacks (Creighton, 2005).

Thirdly, to reduce conflicts from diverse interests. Since the public might have different preferences, this could lead to a risk of contradicting interests that can trigger conflicts. When the public are involved from the beginning, these contradictions can be identified earlier and mitigated or resolved before escalating into real conflicts. This could also alleviate the implementation of urban development projects in the long run as the consensus has already been reached before, preventing opposition against final decisions that have been made (Kørnøv, 2007).

2.3.2 Integration of Scientific and Participatory Approaches in Urban Sustainability Indicators

In order to engage the community in every stage of the indicator development, Soft System Analysis is a popular method for indicator development using a participatory approach. This method enables describing problems difficult to define due to high social, political, and human activity component. Since it identifies reality as socially constructed, information on problem situation might be collected through observation, interviews, surveys, or focus group (Checkland, 2000).

Reed et al. (2006) suggested that it is possible to build on the strengths of both top-down reductionist and scientific methods to measure sustainability and bottom-up, community-driven participatory methods in the adaptive learning process. It combines the best practice from the different methods into a single framework to guide any local sustainability assessment. Despite the availability of the framework, there has no empirical study to conduct sustainability indicator development through integrating top-down and bottom-up methods. This project aims to develop a set of sustainability indicators—which covers the economic, environmental, social and institutional aspects of sustainability—for cities, using an integrated top-down and bottom-up scientific approach that engages the local community in the development, application and evaluation of the indicators.

Reed et al. (2006) provided an adaptive learning process for developing and applying sustainability indicators with local communities, based on top-down and bottom-up methods. It is notable that indicator frameworks from both methods approach four parallel fundamental steps. First, human and environmental context of sustainability have to be established. Second, sustainability goals and strategies need to be set. Third, indicators are identified, evaluated, and selected to measure sustainability progress. Finally, data are collected and analyzed to monitor progress. The detailed process of adaptive learning for sustainability indicator development is provided in Figure 5.

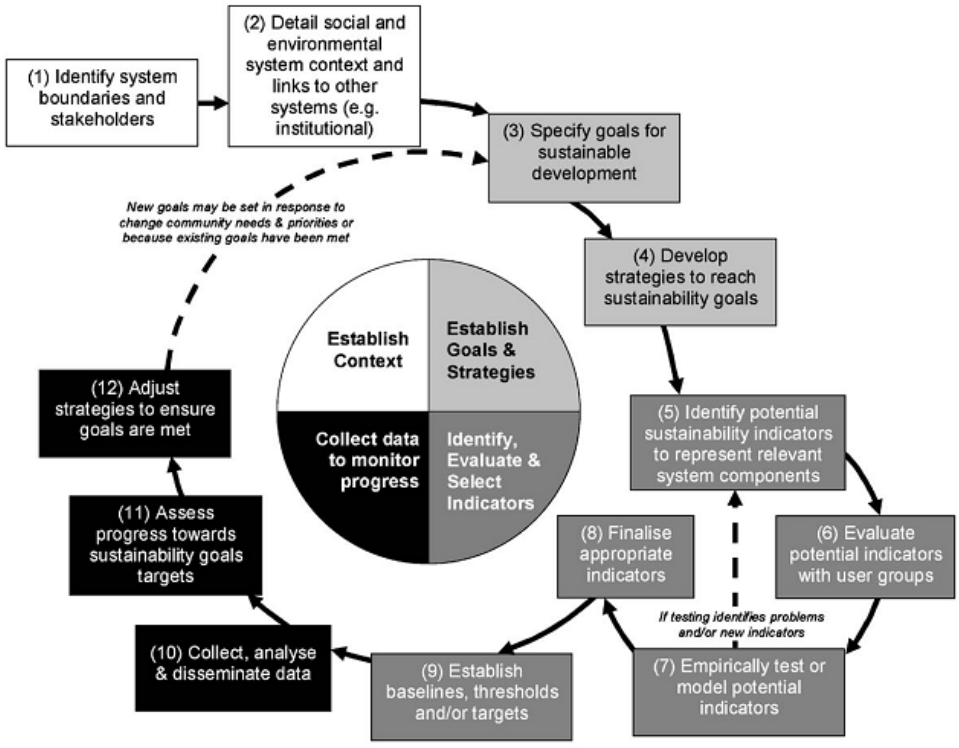

Figure 2.5: Adaptive Learning Process for Sustainability Indicator Development and Application (Reed et al., 2006)

Despite this framework limpidity, Turcu (2013) argued that it is not clear to what extent expert- and citizen-led models are intertwined: many sets do not rest on citizens' values and understanding of sustainability, but rather on expert views. In order to have corresponding values on sustainability, it is mandatory to gain public consensus of sustainability contexts and its goals and strategies between experts and citizens before identifying sustainability indicators. Therefore, it is important to cover not only the preferred urban sustainability indicators by citizens to use but also the definition of sustainability based on citizen's understanding to develop mutual urban sustainability goals.

However, an entirely bottom-up framework might not provide objective indicators despite their ease of use (Lingayah and Sommer, 2001). It might also provide a large number of potential indicators (Fraser et al., 2006). Reed et al. (2006) suggested that the divide between top-down and bottom-up approaches can be bridged and that by working together community members and researchers can develop locally relevant, objective, and easy-to-collect sustainability indicators capable of informing management decision-making. In addition, the engagement of local stakeholders in the indicator development process will enhance community capacity building, and the knowledge generated by the new indicators will provide contextualized evidence in formulating of local sustainability initiatives.

2.3.3 Practices of Participatory Approach in China

Current level of public participation in China is generally perceived at level 3, Informing. Most environmental protection measures used by China are providing publication on environmental status and statistics, ranging from river water and air quality to enterprise environmental performance (Kunmin, 2007). In order to enhance the participation level, it is encouraged to conduct more consultation activities to engage public citizens into urban development.

During promoting these efforts, there are a number of factors affecting the participation process. Kørnøv (2007) observed that the planner's attitude towards public participation will affect the approach and the communication with the public and involving the public late in the project might decrease their willingness to participate as many decisions have already been made. In addition, the level of education amongst the citizens targeted will affect their willingness and ability to participate. It is thus important to take these factors into consideration, when initiating public participation for any project to ensure success (Kørnøv, 2007).

This subsection leads to the third sub-research question; "*How prepared are the local stakeholders in embracing participatory approach for developing urban sustainability goal and strategies?*"

2.4 Summary of Research Questions

The main research question in this thesis is "*How can participation of local stakeholders in developing local-scale strategies for sustainable cities help to detail the strategies and achieve the goals of the cities?*" Answer to this question can provide a framework for local stakeholders to apply participatory approach in developing relevant and robust local-scale strategies for urban sustainability.

In addition, the sub-questions from this question are:

"*How do the local stakeholders perceive urban sustainability problems and plan the strategies to overcome those problems?*"

"*What indicators do the citizens give importance and preference in order to measure the progress or state of urban sustainability?*"

"*How prepared are the local stakeholders in embracing participatory approach for developing urban sustainability goal and strategies?*"

3. Methodology

This chapter presents the methodology used to answer research questions probed previously in Subsection 2.4. It outlines the research method, covering case study selection in Subsection 3.1, method in identifying the problem of urban sustainability in the selected case in Subsection 3.2, and method on how to collect the data in Subsection 3.3.

3.1 Case Study Selection

In order to investigate the residents' perception on urban sustainability, this project will be conducted in China's Henan Province, a medium-to-low income province with close to 100 million in population. Henan, as a traditional agricultural province, has a large rural population. The problems associated with its urbanization strategy range from acute environmental pollution to income and social inequality. These problems, as well as Henan's dependence on coal, are also major problems for China as a whole, and will therefore serve as an ideal pilot case for a national experiment (Song et al., 2014). In this study, the capital city Zhengzhou is chosen as the sampling area.

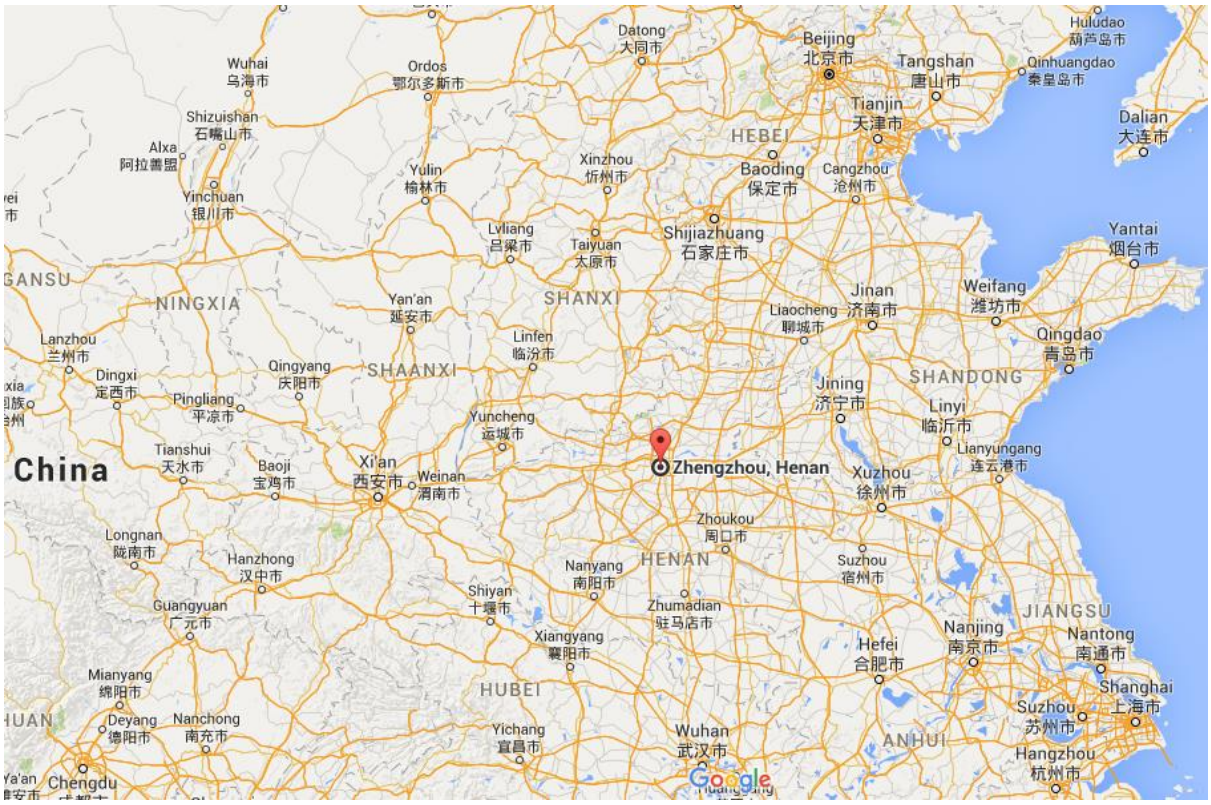

Figure 3.1: Location of Selected Case Study in China: Zhengzhou, Henan

3.2 Data Collection

To collect information on urban sustainability and its indicators, three stages of research will be carried out. Firstly, stakeholder analysis is conducted to establish the human context of urban sustainability. Secondly, focus group discussion is arranged to gain preliminary framework on developing mutual sustainability goals and strategies between experts and citizens. Finally, a survey or questionnaire is undertaken to gain wider public perception on urban sustainability and to conclude a set of sustainability indicators for Chinese cities.

3.2.1 Stakeholder Analysis

Prior to conduct the data collection stage, stakeholder analysis is conducted to identify key local partners in order to establish the human context of urban sustainability. In the stakeholder analysis, stakeholders will be identified with assistance from local informants to identify the roles that different groups play in a community and observe how these groups interact. These activities aim to obtain inputs of various stakeholders representing their communities and to identify conflicts and common interests between them (Dougill et al., 2006). This could ensure a representative sample of stakeholders, which is more advantageous than often-used sampling procedures such as stratified sampling techniques, as social stratification can alienate some stakeholders. After the stakeholders are identified and human context is established, the survey could be carried out.

The stakeholders assessed will cover those who are affected by or can affect a decision as defined by Reed (2008). Referring to a similar study of urban ecology in Bangkok, Thailand by Fraser (2002), the stakeholders analyzed are community members, local officials, urban planners, and academic representatives. In this study, representatives from coal industry either embedded as community members (workers) or as the industry representatives are also expected since coal industry is one of main contributor to environmental problem in Henan, China. Table 3 referred the suggested samples for stakeholders.

Table 3.1: Suggested Samples for Stakeholders

Stakeholders	Suggested Samples
Academia	Academia in Environmental Sciences, Social Development, Urban Planning, or Economics with extensive knowledge in Urban Sustainability Indicators.
Local Officers	Local government employees of Ministry of Agriculture, Ministry of Civil Affairs, Ministry of Environmental Protection, Ministry of Human Resources and Social Security, Ministry of Land and Resources; local legislative members.
Urban Planners	Urban planners, local government employees of Ministry of Housing and Urban-Rural Development.
Coal Workers	Managers in Engineering, Production, or Health, Safety, and Environmental (HSE) department with knowledge in sustainability.
Citizens	Citizens with adequate knowledge in sustainability and they are preferred to work on environmental or socio-economic sector.

3.2.2 Questionnaire

The material asked in the questionnaire is provided in the Appendix II. The first section of the questionnaire covers demographic information of the respondents to enable analyzing the significance of differences of public perception among different group. The information asked covers general attributes (gender, age, education, economic background, political affiliation) and attributes related to urban sustainability indicators. This covers the municipality of the respondents, their residence area, their duration of residence, their household type, and their current health state (James, 2015).

In the second section of the questionnaire developed for this project, their familiarity and own definition of sustainability are looked into. Further, it also assesses their perception of their city's (un)sustainability current state and important aspects that could construct or threaten urban sustainability. The objective of this section is to identify the specific area that is relevant to the problem that will be used to establish the environmental context of local urban sustainability.

Public perception on urban sustainability management in the studied cities is assessed in the third section, covering perception on ideal and actual responsibility of the stakeholders in urban sustainability and the priority enhancement areas of proposed strategy or implementation activities. These aspects are assessed to gain public perception of gaps in moving towards urban sustainability, and further to agree upon mutual sustainability goals and strategies between experts and citizens. Fraser (2002) demonstrated in an urban management project in Thailand that it is possible to use participatory approaches to foster community involvement and to improve the goals and strategies.

The fourth section aims to identify the indicators on urban sustainability indicators and to assess public perception on their monitoring practice. Based on the semi-structured surveys that include pre-selected indicators from literature (Shen et al., 2010), respondents will be asked to identify their preferred pre-selected indicators or to offer other indicators that are possible for local users to apply.

However, an entirely bottom-up framework might not provide objective indicators despite their ease of use (Lingayah and Sommer, 2001). It might also provide a large number of potential indicators (Fraser et al., 2006). Reed et al. (2006) suggested that the divide between top-down and bottom-up approaches can be bridged and that by working together community members and researchers can develop locally relevant, objective, and easy-to-collect sustainability indicators capable of informing management decision-making. In addition, the engagement of local stakeholders in the indicator development process will enhance community capacity building, and the knowledge generated by the new indicators will provide contextualized evidence for the formulation of local sustainability initiatives. Therefore, the identified potential indicators will further be evaluated with experts and tested empirically to ensure its objectiveness. Moreover, statistical methods for dimension reduction, such as cluster analysis and principal component analysis, will be employed to select a significantly smaller set of indicators that sufficiently account for large variability in sustainability performance.

3.2.3 Focus Group Discussion

Fraser et al. (2005) provided three different case studies to identify sustainability indicators using bottom-up and top-down approach, engaging community in a participatory process. In case study of Kalahari rangelands, they summarized the method in community participation in an adaptive learning process from Reed et al. (2006). While this case is assessed for rural neighborhood, this bottom-up and top-down framework might be applied for the proposed case study in Henan, China with several alterations to adapt the context of urban sustainability.

In this study, the process was developed over 18 month timeframe initially in South Kgalagadi, and then applied in a two week timeframe at the other study sites. The initial semi-structured interview stage was conducted widespread, with more than 50 interviews in each region. The stakeholders assessed also came from wide range of background. Referring to this framework, the proposal will also apply similar approach, except the initial 18 month timeframe due to time availability. The material questioned is provided in the Appendix I.

The number of participants in each group shall be limited to around 10 people to ensure that all participants have appropriate chance to contribute (Säynäjoki et al., 2014). Thus, there have to be at least five groups per region. The proposed background for each participant are provided in Figure 7.

Figure 3.2: Background of the Participants of Each Focus Group

Only one academia is allocated in each group in order to gain more public perspective of local urban sustainability, rather than a scientific, general knowledge. The local official might be local government employee of Ministry of Environment, local legislative members that concern on urban sustainability, etc. The coal industry worker selected shall be in middle-management level, such as managers in Engineering, Production, or Health, Safety, and Environmental (HSE) department with knowledge in sustainability. The citizen representatives shall have adequate knowledge in sustainability and they are preferred to work on environmental sector. The suggested samples for stakeholders involved in the Focus Group Discussion are similar as targeted stakeholders in Table 3.

4. Results and Discussion

This chapter presents the results derived from the conducted focus group discussions and surveys. The discussion is divided into three parts, which structure is to answer three sub-research questions derived. Two focus group discussions had been conducted to analyze urban sustainability in Zhengzhou and its goal and strategies in two regions; Economic Development Zone (EDZ) and Jinshui District of Zhengzhou. Survey was distributed to public citizens in Zhengzhou and returned by 336 respondents. The socio-demographic characteristics of the respondents are provided in Appendix IV.

4.1 Public Perception on Urban Sustainability Aspects

This subsection provides answer to sub-research question, "*How do the local stakeholders perceive urban sustainability problems and plan the strategies to overcome those problems?*"

Related to urban sustainability, it was apparent that both focus group discussions would identify three aspects; environmental, economic, and social dimension. However, governance dimension was only addressed in focus group discussion in Jinshui District, Zhengzhou. It was also observed that while both focus group discussions address comprehensive aspects of urban sustainability, each participant might not address all aspects of urban sustainability as demonstrated from each answer.

"*Sustainable development refers to ecological environment pressure is small, and live in the harmony with natural. If environment is excessively used and pollution discharge is large, the development is unsustainable.*" - Environmental Protection Agency, 2016. Economic Development Zone.

"*Three questions related to the sustainable development of automobile 1. Carbon dioxide emissions, 2. The use of energy, 3. Air pollution.*" - Hai Ma Automobile, 2016. Economic Development Zone.

"*Sustainable urban directly reflects the environment, it can be specifically undertaken into three aspects: environmental health; economic prosperity is enough to support the material and spiritual needs; the social justice; can also called as human beings and nature, human to human live in harmony.*" - Economic Development Board, 2016. Economic Development Zone.

"*Current status are houses in village are age-old, infrastructures are not complete, the existence of potential safety hazards, the protection of cultural relics shall be paid attention to in demolition process, and urban dust is in dire need of governance.*" - City and Town Office, 2016. Economic Development Zone.

"*As a citizen, sustainable development is the harmonious development between man and nature, which also includes various aspects of economic environment.*" - Director Ma of Environmental Protection Agency, 2016. Jinshui District.

"*Urban sustainability shall be associated with enterprise sustainability, enterprise is sustainable, urban economic will be sustained accordingly. Other aspects, such as the living standard, environment, (and) spirit and so on are also sustained. Park needs more policy supports from the government.*" - Manager Wu of Science and Technology Park, 2016. Jinshui District.

"*It (sustainable development) tends to solve the previous planning problems at present, (…). If we pursue GDP over quickly, it will be at the expense of the environment, social distribution, education, and unfair medical treatment are universal.*" - Planning Bureau, 2016. Jinshui District.

"*Sustainable city is relatively healthy, energy resource distribution is relatively reasonable, economic structure is rational, and society is relative fair.*" - Planning Bureau, 2016. Jinshui District.

"*In view of the sustainable problem, government responsibility is the first to be affected.*" - National Development and Reform Commission, 2016. Jinshui District.

"*Sustainability in China lays particular emphasis on environment, economy, but I think its sustainable development the inheritance, culture shall be involved in. This is the core of sustainable development.*" - National Development and Reform Commission, 2016. Jinshui District.

It was identified that identified dimension(s) of urban sustainability would be different for each participant based on the interest of the participants and location of the study. In addition, most participants had their own prioritized dimension(s) on urban sustainability based on the emphasis on their answers. The findings for each participant were summarized in Table 4.1.

Table 4.1: Covered Dimensions of Urban Sustainability for Each Participant

Participants	Location	Environmental	Economic	Social	Governance
Environmental Protection Agency	EDZ Zhengzhou	✓✓	-	-	-
Automobile Representative	EDZ Zhengzhou	✓✓	-	-	-
Economic Development Board	EDZ Zhengzhou	✓	✓	✓	-
City and Town Office	EDZ Zhengzhou	✓	-	✓✓	✓
Environmental Protection Agency	Jinshui District	✓✓	✓	-	-
Manager of Science and Technology Park	Jinshui District	✓	✓✓	-	✓
Planning Bureau	Jinshui District	✓	✓	✓✓	-
National Development and Reform Commission	Jinshui District	✓	✓	✓✓	✓✓

Information: ✓✓ = Prioritized, ✓ = Identified, - = Not identified

This result to some extent matched with proposition from Campbell (1996) that these different stakeholders would have differing interests on the unified objectives of urban sustainability. However, most participants perceived that urban sustainability was not restricted in just single dimension although each participant might have prioritized dimension(s) of urban sustainability.

Manager of Science and Technology Park with economic development objectives reasoned that urban sustainability will depend on enterprise sustainability. Since enterprises are the core of production, consumption, and innovation activities of the cities, they could grow urban economy and later affect urban sustainability accordingly. He also identified governance dimension in urban sustainability since he mentioned the importance of government to construct policies for urban development.

Contrarily, Economic Development Board which also functioned as economic development planner did not solely see economic dimension as its priority in urban sustainability. It covered environmental and social dimension too, and it was the only participant that did not put firm emphasis on specific urban sustainability dimensions. However, it did not mention governance dimension.

Meanwhile, Environmental Protection Agency emphasized environmental dimension in urban sustainability. It saw development activities as a possible threat to nature due to their excessive resource extraction activities and large pollution discharge. It also addressed importance of economic environment, which referred to the condition of urban economy and its influence on enterprises.

It was also observed from these different representatives from Environmental Protection Agency that two different participants from similar organization in different focus group discussions within the same municipality might have different perceptions on urban sustainability. While both prioritized environmental dimensions, representative for focus group discussion in Jinshui District identified economic dimension but the other representative did not. This might not be due to the different necessity of each district, but rather due to different management rank of each representative. Representative for focus group discussion in Jinshui District was the Director of Environmental Protection Agency. People in higher management rank might have developed T-shaped competency profile, which enabled them to explore insights into urban sustainability from many different perspectives, and contribute to the development of creative and integrated solutions (Uhlenbrook and de Jong, 2012).The vertical leg of the T stands for the solid knowledge in specific discipline while the horizontal bar of the T stands for both cognitive competence outside the own discipline and functional and ethical competencies (Cheetham and Chivers, 1996).

It was also intriguing that industrial representative from automobile identified solely environmental dimension from urban sustainability, since industrial representative as the generator of economic activities was expected to prioritize economic dimension in urban sustainability. This might happen due to limited understanding in terms sustainability and environment as interchangeable, not only by managers in industries but also by researchers. This misunderstanding was particularly prevalent during the early conceptualizations of sustainability, especially in less developed country such as China (Carter and Easton, 2011). While this phenomenon was not uncommon when introducing a new paradigm, perspectives have begun to converge into more comprehensive definition of the term sustainability as observed from answers from other participants.

Unsurprisingly, Planning Bureau as equity planner emphasized social dimension in urban sustainability as it highlighted the importance fair social distribution and accessibility of basic necessities, such as education and medical treatment over GDP as economic development indicator. It also emphasized environmental dimension over economic dimension in urban sustainability. Similarly, City and Town Office also emphasized other aspects in social dimension, namely housing, infrastructures, safety, and culture. In addition, it addressed environmental and governance dimension.

The only representative that mentioned all dimensions of urban sustainability was from National Government and Reform Commission. It emphasized the significance of government and culture in urban sustainability while addressing environmental and economic dimensions of urban sustainability. It regarded government as the most responsible actor in urban sustainability. This standpoint might happen since the power of the state was still felt in every facet of China's transformation despite the abandonment of centralized planning in shaping the national and local space-economies (Ma, 2002). Furthermore, the invisible as well as the visible hands of the state in local areas were still everywhere, including in the nebulous area of property rights reforms (Oi and Walder, 1999; Whiting, 1999).

Similar understanding in sustainability was also perceived based on the survey from the citizens. They perceived environmental dimension as the most important aspect in sustainability with mean score of 3.60 in 4-scale grading with 0 as very unimportant and 4 as very important. This understanding was shared within most of the participants, since the standard deviation was the lowest at 0.59. The other three dimensions were perceived as having similar importance to each other since the importance score was not significantly different, with mean score of economic, social, and governance dimensions are 3.24, 3.21, and 3.19, respectively. The results are presented in Figure 4.1 and the statistical information for the results is attached in Appendix IV.

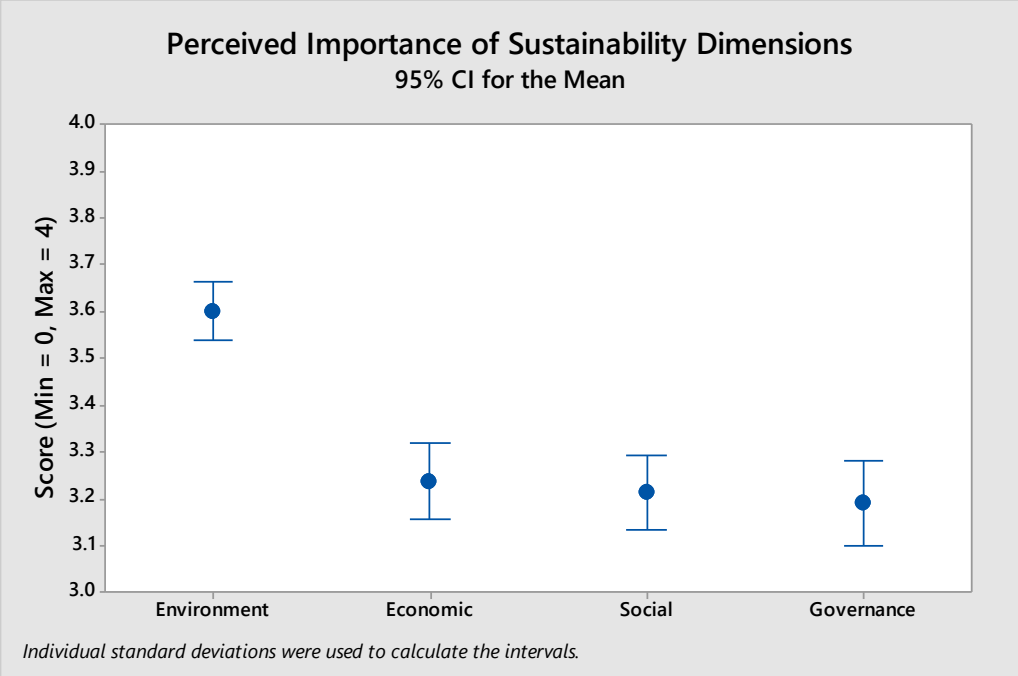

Figure 4.1: Perceived Importance of Sustainability Dimensions

Further, citizens graded the sustainability level in their residence, Zhengzhou. They perceived environmental dimension as the worst performer in urban sustainability with mean score of 4.52 based on 10-scale grading, with 0 as highly unsustainable and 10 as highly sustainable. Overall, they graded urban sustainability for mean score of 5.12, which inferred that citizens perceived Zhengzhou as neither unsustainable nor sustainable. The results are presented in Figure 4.2.

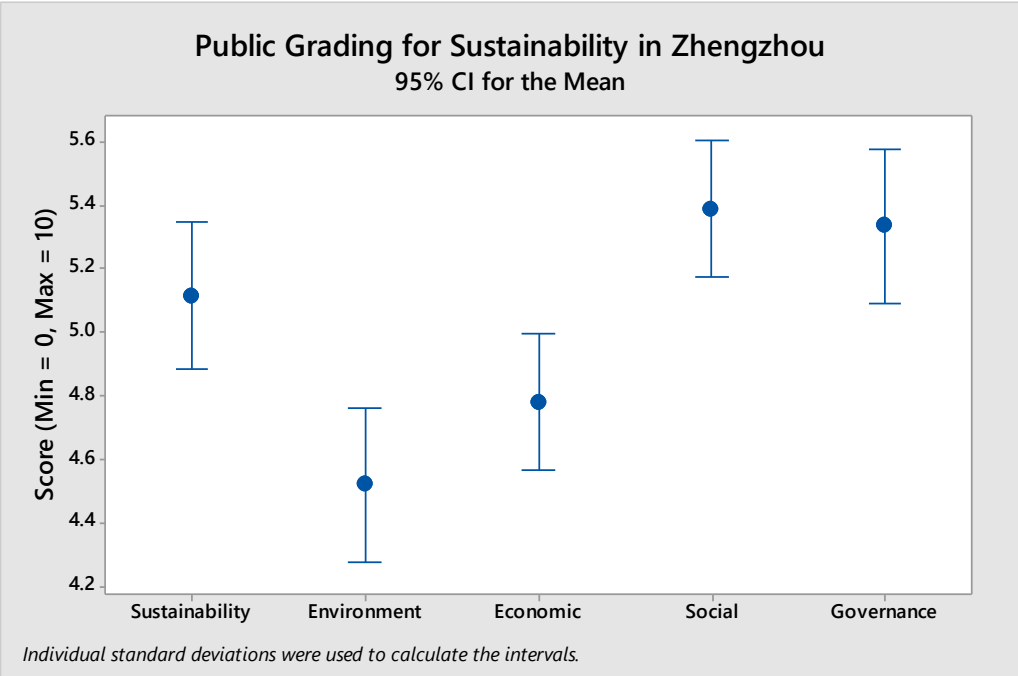

Figure 4.2: Public Grading for Sustainability in Zhengzhou

These sustainability dimensions will be further be discussed in each subsection. Environmental dimension, economic dimension, social dimension, and governance dimension are covered respectively in Subsection 4.1.1, Subsection 4.1.2, Subsection 4.1.3, and Subsection 4.1.4.

4.1.1 Environment Dimension

Based on the survey conducted, public citizens observed that air quality was the most important aspect in environmental dimension of urban sustainability in Zhengzhou with mean score of 3.69 and standard deviation of 0.57, the lowest among other aspects. Other relevant aspects perceived as important which scores were higher than 3.0 were freshwater quality, freshwater consumption, wastewater treatment, and sustainable land use with mean importance score of 3.47, 3.08, 3.40, and 3.19, respectively. The results are presented in Figure 4.3.

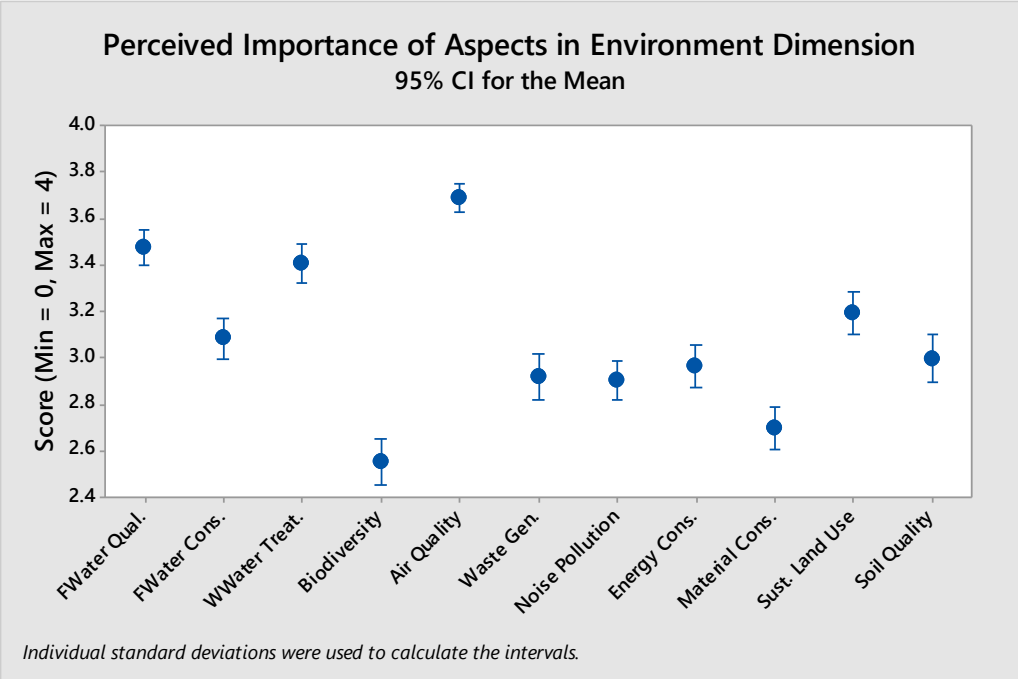

Figure 4.3: Perceived Importance of Aspects in Environment Dimension

Similarly, from the Focus Group Discussion, it was observed that both representatives from government and industrial observe that air pollution was the main threat in environmental dimension of urban sustainability since this issue was heavily discussed by most participants and mentioned as the most important aspect in environmental dimension of urban sustainability. Nevertheless, it was observed that while water shortage was captured as important by public citizens, this issue was only mentioned and discussed thoroughly by Environmental Protection Agency.

While air pollution might be the most well-known problem in China in general, it was perceived here by Environmental Protection Agency (2016) that water shortage was a more serious problem for residents in Zhengzhou although it still identified air pollution as important problem too. Other environmental aspects mentioned were progress of environmental protection programs as guided in National Development Plan and waste management. In addition, it also identified the importance of considering industrial added value in environmental dimension in urban sustainability.

"*Water shortage is a prominent problem for Zhengzhou, plans to build a new sewage treatment plant for water recycling. It shall add the corresponding indexes such as million unit industrial added value, pollution emissions, under the guide of planning environmental impact assessment, partition assessment of quantity of pollutant discharged, the establishment of thirteenth five-year plans of sustainable development and environmental protection program in 2016,*" - Environmental Protection Agency, 2016. Economic Development Zone.

Industrial added value was considered in this discussion due to efforts of government of China to shift its economic activities from industries to service sector. While this might be more associated with economic dimension, measurement of industrial added value could indicate urban sustainability performance in environmental dimension since a lower share of industry in GDP would lower the resource intensity of growth and resulted in less environmental degradation (Kuijs and Wang, 2006).

In contrast, Economic Development Board and most other participants did not mention water shortage as serious problem although it also addressed emission and air pollution in environmental dimension of urban sustainability. Absence of water shortage as environmental problem from economic development planners and other participants might be due to construction of South-North Water Transfer Project that alleviate the severe water shortage in the north, including Zhengzhou (Yang and Zehnder, 2005). In addition, they identified energy conservation and consumption reduction, which are part of resources consumption aspect.

"The sustainable development of the city, for regions, to implement specially according to the annual indicators of provinces and cities, indicators including energy conservation, emission reduction, consumption reduction, air contamination index." - Economic Development Board, 2016. Economic Development Zone.

Industrial representative from automobile observed that air pollution, carbon dioxide emissions, and energy consumption as important features in environmental dimension. It was predictable that these features were mentioned since they were closely related to automotive industries. Mayyas et al. (2012) covered environmental impacts and power consumption as major elements in design for sustainability in automotive industries.

"*Three questions related to the sustainable development of automobile 1. Carbon dioxide emissions, 2. The use of energy, 3. Air pollution.*" - Hai Ma Automobile, 2016. Economic Development Zone.

Meanwhile, National Development and Reform Commission mentioned wastewater discharge, resource consumption, renewable resources, and ecological technology and public infrastructure development. It accounted renewable resources into its consideration for environmental dimension since Government of China aimed to increase its ratio of non-fossil fuels in primary energy consumption, as incorporated in its Thirteenth Five-Year Plan. While public infrastructure is more related to social dimension, it could also contribute towards urban sustainability goals in environmental dimension. For instance, building public transport facilities as suggested could reduce use of private motorcycles and cars that further decrease energy consumption and CO_2 and other greenhouse gases emission (Pucher et al., 2007).

"*In view of the pollution, reducing the discharge of destructive wastewater, decreasing resource consumption, encouraging people to more use renewable resources, and protect renewable resources. For enterprise, it's better to do ecological technology development well. And it will invest more on the development of environmental protection to build public transport facilities and other infrastructure.*" - Director Ma of National Development and Reform Commission, 2016.

Waste management was also perceived as important, although similar to water shortage, only Environmental Protection Agency mentioned and discussed this issue thoroughly.

"*(…) Micro waste processing, 100% waste reuse, discharge is minimal.*" - Environmental Protection Agency, 2016. Economic Development Zone, Zhengzhou.

While both public citizens and government and industrial representatives perceived the importance of water shortage and air pollution, they ranked the importance of other aspects differently. While

citizens prioritized sustainable land use over resources consumption and waste management, government and industrial representatives put importance of resources consumption and waste management. Resource consumption was emphasized by government and industrial representatives since it was the main focus in the Thirteenth Five-Year Plan. Covered aspects in environmental dimension of urban sustainability by each participant were summarized in Table 4.2.

Table 4.2: Covered Aspects in Environmental Dimension of Urban Sustainability

Participants	Location	Water Shortage	Air Pollution	Resources Consumption	Waste Management
Environmental Protection Agency	EDZ Zhengzhou	✓✓	✓✓	✓	✓
Automobile Representative	EDZ Zhengzhou	-	✓✓	✓✓	-
Economic Development Board	EDZ Zhengzhou	-	✓✓	✓✓	-
City and Town Office	EDZ Zhengzhou	-	✓	-	-
Environmental Protection Agency	Jinshui District	✓✓	✓✓	✓	✓✓
Manager of Science and Technology Park	Jinshui District	-	-	✓	-
Planning Bureau	Jinshui District	-	✓	✓	-
National Development and Reform Commission	Jinshui District	✓	✓	✓✓	-

Information: ✓✓ = Discussed, ✓ = Identified, - = Not identified

Among these problems, four main urban environmental problems were addressed and further discussed in the focus group discussions. Results from the discussions on water shortage, air pollution, material and energy consumption, and waste management are covered respectively in Subsection 4.1.1.1, Subsection 4.1.1.2, Subsection 4.1.1.3, and Subsection 4.1.1.4.

4.1.1.1 Water Shortage

Along with the development of China, water shortage crisis is likely to deepen. Approximately 110 out of 669 cities in China are facing severe water deficit at present, including Zhengzhou (Zhang et al., 2010). To avoid this crisis, Government of China had strived to redistribute water from relatively water-wealthy regions to more parched provinces in the middle and the northwest regions through South-North Water Transfer Project (Yang and Zehnder, 2005). However, it was argued that this project did not play a major role in mitigating water stress in the water-receiving regions but exacerbate water stress for the water-exporting regions of China instead (Zhao et al., 2014).

Despite relatively abundant water resources of China at 2.8 trillion m^3, its annual available freshwater per capita is only 2200 m^3, around a quarter of the global average (Ministry of Water Resources, 2010). This limitation of freshwater sources in China was more likely to be the main cause of this water shortage crisis. United Nations reported that China contains only 7% of the world's freshwater supplies while supporting 21% of the world's population (The Wall Street Journal, 2015). These reasons might support argument from Environmental Protection Agency (2016) for building new wastewater treatment plant to recycle water for avoiding water shortage.

"*Water shortage is a prominent problem for Zhengzhou, plans to build a new sewage treatment plant for water recycling.*" - Environmental Protection Agency, 2016. Economic Development Zone.

Besides water recycling from wastewater treatment plant, other prospective initiatives for fighting water shortage was collecting freshwater from other resources, such as rainwater. Rainwater utilization could play an important role for countermeasures against water shortage in urban areas, and in the meanwhile is very effective for runoff control (Kim et al., 2001; Wang et al., 2004a, 2004b; Feng et al., 2006). Though, rainwater utilization requires proper treatment due to contamination level in rainwater runoffs with total suspended solids (TSS) and chemical oxygen demand (COD) as the main pollutants in urban runoff (Huang et al., 2007). Based on rainwater characteristics in Zhengzhou, Zhang et al. (2010) proposed sedimentation and filtration using local soils as an effective method for rainwater treatment, with 86.2%-98.3% of COD and 89.6%-97.3% of TSS removal.

Due to limitation of freshwater sources, it is important not only to recycle water but also to preserve the freshwater sources. Surface water and groundwater in China have been widely polluted by industrial and municipal wastewaters, household wastes, and agricultural activities over the past several decades (Liu and Diamond, 2005). Ministry of Water Resources (2012) reported that freshwater sources that could meet the quality criteria of drinking water sources were only from 64.2% of the river sections, 58.8% of the major lake areas, 81.1% of the major reservoirs, and 23.2% of the groundwater wells. Meanwhile, heavy pollution has caused water from 17.2% of the river sections, 24.7% of the lake areas, and 4.5% of the reservoirs practically unusable. This water pollution was also identified as serious problem that worsened water shortage in Zhengzhou by Environmental Protection Agency. It encouraged possible actions to monitor the quality of freshwater from industrial contaminants, which included observant quality control, investigation on contaminant sources, and law enforcement on contaminating industries as mentioned in its statement.

"*(…) about the problem of water, we will pay attention to control from the source of examination and approval, strengthen management on intermediate links and strengthen investigation and treatment on follow-up management. As far as possible to reduce pollution discharge, to strengthen the law enforcement on the original pollution discharge enterprises according to the new laws and regulations.*" - Environmental Protection Agency, 2016. Jinshui District.

These actions were relevant to root causes of water pollution in China explained by Hu and Cheng (2013). They proposed three causes; increased pollutant discharges, excessive water abstraction from the environment, and poor water resources management and enforcement of pollution control regulations. Related to increased pollutant discharges, it was observed that high levels of rural industrialization in Henan Province was associated with high levels of wastewater to runoff (Wang et al., 2008). The prevalence of small-scale manufacturing plants that often adopted obsolete and inefficient technologies led to the generation of large amounts of industrial waste and wastewater, which were mostly disposed of directly without proper treatment (Hu and Cheng, 2013).

While water abstraction was not mentioned in the discussion, poor management and enforcement are another relevant causes of water pollution in Zhengzhou and generally China. Water resources management and water pollution control in China are administered correspondingly by eight ministry-level government agencies, including their subordinate departments and local governmental offices. Those ministry-level agencies are Ministry of Water Resources, Ministry of Environmental Protection, Ministry of Housing and Urban-Rural Development, Ministry of Transportation, Ministry of Agriculture, National Health and Family Planning Commission, National Development and Reform Commission, and State Forestry Administration (Feng et al., 2006). These complex and interdependent institutional arrangements provoke very poor coordination due to conflicting interests. Along with the bureaucratic processes, these arrangements pose significant barriers for effective water resources management and water pollution control (Liu and Speed, 2009; Winalski, 2009). In addition, while a relatively well established legal system on environmental protection is present, they are often poorly

enforced. This poor enforcement primarily results from the general policy framework on the national level that favors economic development over the environment and natural resources (Cheng and Hu, 2012). Incoherent implementation of national policies and enforcement of laws and regulations across different administrative regions on the local level, divergent interests among different levels and branches of the government, and the lack of sufficient power and resources to the relevant governmental offices all contribute to the problem (OECD, 2006).

4.1.1.2 Air Pollution

Along with water scarcity, air pollution is one of the most prevalent environmental problems in China, including Zhengzhou. Zhengzhou is among the 47 key air pollution cities in China, and one of heavily polluted cities in the world (Baldasano et al., 2003). The severity of air pollution in Zhengzhou made this issue addressed by most focus group discussions participants and discussed in detail.

"*For air quality problem, such as haze, we set up atmosphere office in Jinshui district. EPA will focus on industrial haze, fugitive dust, etc. We are attaching great importance to air quality.*" - Environmental Protection Agency, 2016. Jinshui District.

"*Three questions related to the sustainable development of automobile 1. Carbon dioxide emissions, 2. The use of energy, 3. Air pollution.*" - Hai Ma Automobile, 2016. Economic Development Zone.

"*Current status are houses in village are age-old, infrastructures are not complete, the existence of potential safety hazards, the protection of cultural relics shall be paid attention to in demolition process, and urban dust is in dire need of governance.*" - City and Town Office, 2016. Economic Development Zone.

"*Poor air quality, main causes are dust, automobile exhaust, industrial emissions, primary air pollutant PM_{10}, the current major pollution is coal in Zhengzhou.*" - Economic Development Board, 2016. Economic Development Zone.

It was perceived from the discussions that main sources of air pollution in Zhengzhou were industries, automobiles, housing demolitions, and coal combustion in forms of haze and dust. This perception enriched the literature review that mentioned air quality problem in China was mostly contributed from coal utilization for energy. Energy diversification from coal and clean coal technology were identified from the discussions as applicable measures in solving air pollution in Zhengzhou.

"*The best measures to solve the problem: the development of electric vehicles (…) pure electric vehicles have the features of zero emissions, less pollution, (…); power source is varied: water power, wind power, geothermal, and nuclear energy.*" - Hai Ma Automobile, 2016. Economic Development Zone.

"*The ongoing project of Coal Water Slurry CWS is the coal through cleaning and removing impurities, sulfur curing, by thermal pilot and expert argumentation, the emission pollutant amount is reduced a lot as compared with traditional coal, and basically can achieve the objective of clean emissions. For enterprises, the main problem of clean using of coal is the cost.*" - Economic Development Board, 2016. Economic Development Zone.

"*We are attaching great importance to air quality. These years we almost demolished all coal-fired boilers, coal boilers are now all modified to cleaner energy.*" - Environmental Protection Agency, 2016. Jinshui District.

Other important measures identified in discussions were air quality monitoring and governance. It was observed that real time air quality monitoring has been implemented in Zhengzhou and other supporting towns in Henan Province. Ministry of Environmental Protection China has provided real-

time air pollution data since the beginning of 2013 at 496 state-controlled monitoring stations, covering 74 major cities across the country. The information collected includes monitoring $PM_{2.5}$, PM_{10}, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), and carbon monoxide (CO) (Lu et al., 2016). These indicators are relevant for the issues mentioned by Environmental Protection Agency (2016), particularly SO_2 and NO_2 for measurement of industrial haze and PM for measurement of fugitive and urban dust. This information is accessible real-time at aqicn.org (2016). However, it is important to take into account that there is no independent monitoring stations in Zhengzhou to validate reliability of the published results since only the Government of China is authorized to publish air pollution data (BBC, 2012).

In a study on air quality trend in Zhengzhou, Xile et al. (2012) assessed long-term air quality monitoring data from six monitoring stations to comprehend the effectiveness of pollution control strategies in Zhengzhou. Significant decreasing trend of SO_2 emission in 1999-2001 happened due to the emission control of 201 industrial enterprises of heavy pollution in 1998-2000, although it increased slightly afterwards as a result of increasing energy consumption. Since more than 70% of the primary energy consumption in Zhengzhou was sourced from coal, this resulted in higher industrial emissions from high-sulfur coal combustion. Correspondingly, it was observed that NO_2 showed a significant upward trend in 2002-2008 due to rapidly increased number of motor vehicles.

Meanwhile, PM_{10} decreased markedly in the last decade due to emission control measures for particulate matter. To gradually reduce industrial dust, the municipal authorities encouraged enterprises to adopt advanced technologies for desulphurization and dust removal. Meanwhile, improvement of the road system and traffic diversion reduced the road dust as demonstrated by reconstruction of Zhengzhou Railway Station and the traffic improvement in the surrounding areas. Conversion of heating system for urban dwellers transferred from household to central heating also reduced the emission of waste gas since it increased the efficiency of energy use. Furthermore, plantation of trees around the city and along highways blocked sand dust to the urban area. These strategies might be further implemented to reduce air pollution.

Similar to water shortage crisis, governance was also perceived as difficulty in dealing with air pollution problem. Lee et al. (2010) observed that implementation gap was the main problem for environmental regulatory enforcement as demonstrated by air pollution problem in Guangzhou, China. Five sets of measures undertaken by Guangzhou—desulfurization technologies, vehicular emissions control, dust control from construction sector, cooking fumes control, and promotion of the use of cleaner energy —did not work effectively to solve the problem of urban emissions. He proposed three possible explanation for the measures ineffectiveness; lack of strong institutional support and the presence of bureaucratic resistance embedded in China's fragmented authority structure, the absence of consultative and conflict resolution mechanisms in China's overall policy- and law-making processes, and failure of the existing policy approach to capture and respond to the changing structure of the problem. However, there was no detailed description on problem in governance specifically related to air pollution perceived from the discussions since most participants emphasized the discussion on the most effective measures for air pollution.

4.1.1.3 Resources Consumption

Discussion on resources consumption, covering both material and energy consumption, was emphasized on coal as both one of the most consumed material and main energy source in Zhengzhou. Due to the rapid development of industrialization, the energy consumption has been increased significantly in China, including Henan Province as the key part of Central Plains Economic Zone. To comply with international obligation, carbon reduction and energy-saving are becoming more and

more important. Henan Province has transformed from the energy output into the energy input province. Its industrial energy consumption climbed to 174 million metric tons coal equivalent in 2012, with total coal consumption of about 171 million metric tons (Henan Statistical Bureau, 2013). Therefore, controlling and reducing energy use, especially from coal is a serious challenge for Henan Province, in addition to reducing combustion emissions.

Encouragement of cleaner energy utilization was also mentioned in the discussion as part of shifting resources consumption from non-renewable ones to renewable ones.

"*Energy efficiency of pure electric vehicle is high, up to more than 80%; power source is varied: water power, wind power, geothermal, nuclear.*" - Hai Ma Automobile, 2016. Economic Development Zone.

"*These years we almost demolished all coal-fired boilers, coal boilers are now all modified to cleaner energy. Clean energy including biomass, natural gas, and electricity, while the biomass is rarely used.*" - Director Zhang of Environmental Protection Agency, 2016. Jinshui District.

"*Solar energy and electric energy are widely used now.*" - Planning Bureau, 2016. Jinshui District.

While most participants preferred conversion from coal to other cleaner sources for energy supplies, it was perceived that National Development and Reform Commission kept maintaining the idea of coal as desirable energy sources, while still controlling its negative environmental impacts.

"*As for the involved problems such as new energy, clean energy, the core is the energy conversion efficiency. Not only define the clean energy but view its conversion rate, its science and technology. If coal power generation can be controlled, utilization can be improved, and pollution can be controlled, then it can be said that coal is very good, cheap and good, why not use it?*" - National Development and Reform Commission, 2016. Jinshui District.

National Development and Reform Commission perceived that efficiency was still a major challenge in implementing cleaner energy. Maintaining high-level of energy efficiency is vital since it is part of environmental measures in Thirteenth Five-Year Plan, which indicator is reduction of energy consumption per GDP unit. Since coal utilization was more mature in Zhengzhou, development for controlling its pollutant emission and price competitiveness might be preferable. Nevertheless, they encouraged reduction of resource consumption and utilization of renewable resources.

"*In view of the pollution, reducing the discharge of destructive wastewater, decreasing resource consumption, encouraging people to more use renewable resources, and protect renewable resources.*" - National Development and Reform Commission, 2016. Jinshui District.

In addition, Economic Development Board suggested change in heating system for urban dwellers from household heating to central heating, which increased efficiency of energy use and reduced the emission of CO_2 and other pollutant discharge from coal combustion. It also mentioned measurement per household so that citizens could monitor and attempt to reduce their energy consumption.

"*In the field of new energy, improving the system of residual electric into net, implementing distributed energy, and strengthening the construction of power grid as the main direction. In addition try to realize the central heating, one household one heat meter, so as to promote urban area coal-electricity integration, optimize the structure of heating energy, and decrease the cost of coal to gas.*" - Economic Development Board, 2016. Economic Development Zone.

Countermeasures, such as shifting primary energy production from coal to gas or other cleaner resources, reducing sulfur emissions through increased use of low-sulfur coal and fuel gas

desulfurization, and promoting more stringent vehicular emission standards as well as switching to non-leaded gasoline, have been implemented in urban areas throughout the country.

4.1.1.4 Waste Management

Environmental Protection Agency considered that waste management faced problem due to lack of participation from both national government of China and its residents. It was perceived that national government was not putting adequate efforts on solid waste disposal and there had been lack of law enforcement towards industrial polluters.

"*For solid waste disposal problem, I think this is because of lack of national consciousness, and need further controls of government, but it is difficult to control, and require universal participation. Chemical industrial solid waste is the most difficult part to be controlled in solid waste, enterprises need to run into a lot of money, so they may not abide by the laws and regulations but adopt landfill secretly, etc.*" - Environmental Protection Agency, 2016. Jinshui District.

This statement was reinforced by the absence of waste management in Thirteenth Five-Year Plan. It was argued that this poor regulation and enforcement of environmental measures allows many small rural enterprises to operate without waste treatment facilities (Jahiel, 1997; Lin, 1997; Qu and Li, 1994). Jahiel (1997) summarized five impediments to policy enforcement that China had faced after economic and administrative reforms in 1990s; redirections of waste discharge fee money on other city expenses instead of pollution control, serious setback in the authority position of county and township environmental protection organs to monitor and control this sector bodes poorly for environmental protection, rapid growth of China's non-state-owned sector that weakened state control over industry for policy enforcement, reduced use of administrative forms of government regulation in waste discharge, and goal displacement in implementing the discharge fee system. It was perceived that setback in environmental protection organs to monitor and control industrial waste management was the most relevant reason of governance impotence in the case of Zhengzhou.

Two types of action are proposed to solve governance problem in industrial waste management (Jahiel, 1997). First, the central government must equip Environmental Protection Agencies in all local governments, including those at the district and county levels, with an ample number of trained personnel to assure that they have the regulatory authority and human resources to enforce policy, particularly in districts and counties which contain the fastest growing and most polluting sectors of the economy. Secondly, the central government must commit substantial financial resources to local Environmental Protection Agencies to cover their regulatory expenses and pay for pollution clean-up and control. In addition, it is also important to ensure that waste discharge fee money paid by the polluters directed on pollution control efforts. This second action could also help expanding investment funds of small rural enterprises in industrial waste management since it was perceived that unaffordability of waste treatment technologies was another problem for industries in implementing appropriate waste disposal.

In addition, it was also perceived that citizen disengagement in municipal waste management was problem, which was described as "*lack of national consciousness*" by Environmental Protection Agency. This perception was agreed by National Development and Reform Commission.

"*As far as I'm concerned, the problem on citizen consciousness is propaganda and education, public infrastructure also has problem, such as the packed garbage cannot be put in detailed classified garbage can. Sustainable propaganda and education should be started from elementary school.*" Director Ma of National Development and Reform Commission, 2016. Jinshui District.

"*Civilian know to recycle things that are bad to the environment, but they have no idea about whom they shall hand the recycled things to.*" - Section Li of National Development and Reform Commission, 2016. Jinshui District.

It was perceived that there was lack of environmental education in waste management. Residents understood the importance of waste recycling, yet they had no knowledge in the waste collection. This might be supported by a study on public perceptions of source-separated collection of rural solid waste in China (Zeng et al., 2016). It was found that only 65.1% of rural households dumped solid waste into the centralized waste facility or trash can and 14.29% burned rural solid waste in open space without pollution control. Even worse, 31.08% of rural households just dumped RSW on the moat banks and the roadsides without any initial treatment. However, some rural households did have the behaviors of source-separated collection of solid waste, although most of them only separate the recyclable waste. 75.8% of rural households sorted out the recyclable waste for selling, similar to municipal solid waste recycling (Linzner and Salhofer, 2014; Tai et al., 2011; Zhang et al., 2010).

It is worthwhile to think of that being a developing country, China also utilizes scavengers for waste collection for recycling. Figure 4.3 illustrates the general process of municipal solid waste management in China as taken from Tai et al. (2011). World Bank (2005) reported that there are twice as many people in the informal sector as those in the formal sector of waste collecting. These informal waste collection systems make it more difficult to regulate and implement an efficient and standardized waste treatment system when unregulated (Zhuang et al., 2008; Wang et al., 2008). Accounting this into consideration, incorporating existing informal collection and recycling systems into the operations of formal municipal solid waste management could be an effective measure for waste management in Zhengzhou since it is very expensive to establish new formal recovery systems once existing informal ones have been allowed to decline or disappear (Wilson et al., 2006). Nevertheless, measures need to be taken to protect livelihoods of scavengers while working to improve both the efficiency and the living and working conditions of those involved. Eerd (1996) summarized possible health effects from involvement in informal recycling, i.e. chronic backaches, coughs, cut injuries, eye infections, infestation from stray dogs and rats, diarrheas, jaundices, and skin diseases.

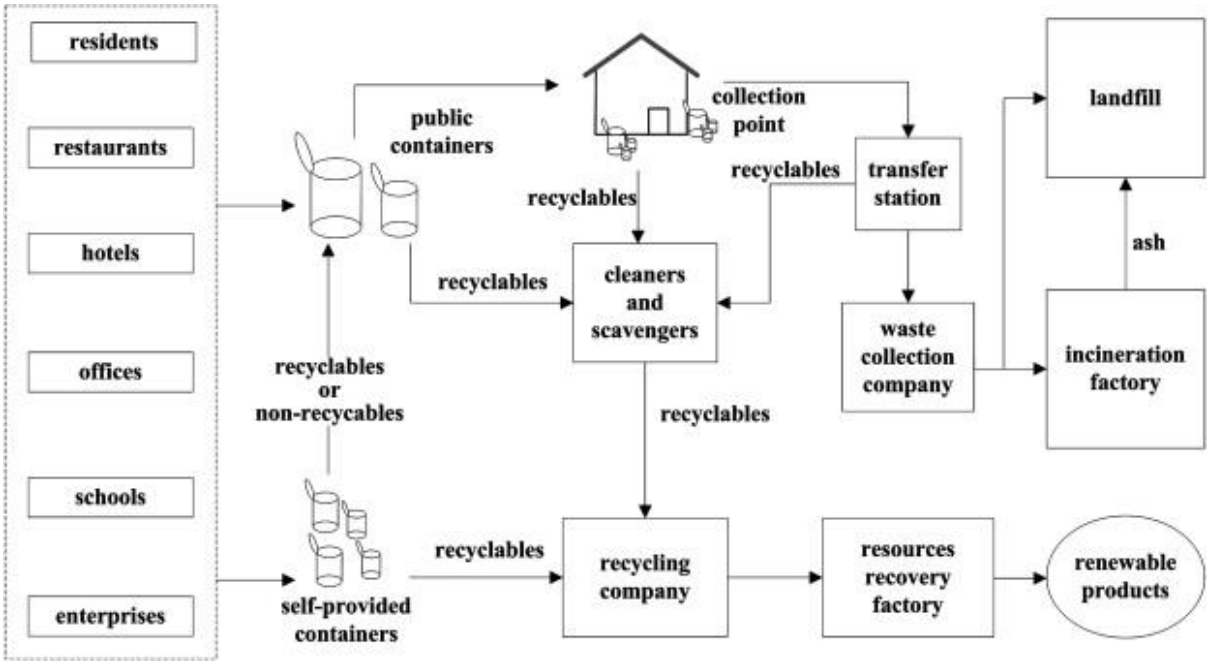

Figure 4.4: General Process of Municipal Solid Waste Management in China (Tai et al., 2011)

Related to understanding in waste management, Zeng et al. (2016) discovered that 75.0% of respondents considered that source-separated collection of solid waste could alleviate environmental pollution and negative health impacts, although 10.4% of respondents were unconscious of the importance of source-separated collection. However, while the attitudes towards source-separated collection of solid waste were generally positive, as demonstrated by more than half of rural households (61.3%), 25.0% of the rural households were willing to participate in source-separated collection of rural solid waste but not committed continuously, and 13.7% clarified that they refused to participate. This was mostly due to complication and inconvenience of separation and insufficient separation facility as replied by 55% of respondents who voted for inconstancy or reject of participation. While this study was conducted in rural areas, these results are similar to the investigation of the obstacles to municipal solid waste separation in Shanghai by Zhang et al. (2012). Therefore, providing sufficient separation facilities could be taken as another effective measure for municipal solid waste separation in Zhengzhou.

4.1.2 Economic Dimension

It was observed that there was a debate on the prioritization urgency between economic and environmental dimension during the discussion. Some participants argued that economic dimension shall be prioritized as it was perceived as the center of sustainable development, while some participants mentioned the importance of environmental protection within economic development.

"*Economic development shall take economic construction as the center, in the whole sustainable development, economy shall be put in the first, all aspects of damage would be paid a big cost, (…)*" - Planning Bureau, 2016. Jinshui District.

"*The industry admittance of development region shall be considered from industry type and industry condition, then non-conformance item of environmental protection will not be accepted.*" - Economic Development Board, 2016. Economic Development Zone.

In addition, it was perceived from other participants that there had been disproportionate pressure on economic development which myopically was measured into GDP and industrial revenues although they recognized the importance of economic development in urban sustainability.

"*Country views local development is GDP. Local governments want to increase GDP, shall depend on "three-in-hand" to stimulate GDP. (…) Country shall not view local development only on numbers, but need to have an ecological index rather than a single GDP to measure economic growth.*" - National Development and Reform Commission, 2016. Jinshui District.

"*Enterprise's pursuit of profit and citizen's unconscious, and larger citizens' base are the factors of difficult to control.*" - Environmental Protection Agency, 2016. Jinshui District.

"*Problem will be appeared when economic development is up to a certain extent. One shall coordinate the commercial profits and people's profits, to distribute the processing costs shall be undertaken to the corporate profit chain.*" - Manager of Science and Technology Park, 2016. Jinshui District.

"*It (sustainable development) tends to solve the previous planning problems at present, (…). If we pursue GDP over quickly, it will be at the expense of the environment, social distribution, education, and unfair medical treatment are universal.*" - Planning Bureau, 2016. Jinshui District.

This perception related to problem of China relying heavily on GDP as economic development indicator. The criticism of the GDP indicator has been recognized by many economists, although they denied its relevance (van der Bergh, 2009). It has come from some of the most respected economists

of the twentieth century, including various Nobel laureates such as Kuznets (1941), Hicks (1948), Samuelson (1961), Nordhaus and Tobin (1972), Sen (1976), and Arrow et al. (1995). Recent important contributions include Dasgupta and Mäler (2000), Ng (2003), and Kahneman et al. (2004).

Van der Bergh (2009) summarized seven main criticisms of the GDP indicators; its incapability to capture the benefits of all market-related economic activities in a country, its inability to measure social welfare, its limitation to differentiate basic needs and luxury services and material goods, its unsuitability to measure individual welfare, its neglecting of income distribution, its neglecting of the value of informal activities and services, and its exclusion of environmental externalities and depletion of natural resources. Some of these criticisms were addressed during the discussion.

"*Second, the industrial structure is also questionable. (…) The tertiary industry is accounted for too low proportion, and we shall improve the proportion of other industries, such as raising the emerging industry, science and technology industry, which are more reasonable, so the development can be sustainable.*" - National Development and Reform Commission, 2016. Jinshui District.

"*The industry admittance of development region shall be considered from industry type and industry condition, then non-conformance item of environmental protection will not be accepted.*" - Economic Development Board, 2016. Economic Development Zone.

Participants pointed out the importance of considering industrial structure in strategizing economic development. The criticisms were mostly related on how GDP did not address the contributors of economic development, thus enabling contribution on economic development from polluting industries. While several indicators are suggested to substitute GDP such as Genuine Progress Index (GPI) (Lawn and Sanders, 1999), removal of GDP from development indicators in Zhengzhou is not likely possible as it was still used as main economic development indicator at national level in China.

It was also perceived that financial investment was another constraint in economic development in China as well as its direction on construction and deconstruction. In addition, governance dimension was also identified in the discussion as demonstrated by perception of lack of government support and personnel capability in administrative units. Covered aspects in economic dimension of urban sustainability by each participant were summarized in Table 4.3.

Table 4.3: Covered Aspects in Economic Dimension of Urban Sustainability

Participants	Location	Economic Development	Industrial Structure	Financial Investment
Environmental Protection Agency	EDZ Zhengzhou	✓	-	-
Automobile Representative	EDZ Zhengzhou	-	-	-
Economic Development Board	EDZ Zhengzhou	✓	✓✓	-
City and Town Office	EDZ Zhengzhou	-	-	-
Environmental Protection Agency	Jinshui District	✓	✓✓	-
Manager of Science and Technology Park	Jinshui District	✓	✓✓	✓✓
Planning Bureau	Jinshui District	✓	-	-
National Development and Reform Commission	Jinshui District	✓	✓✓	✓✓

Information: ✓✓ = Discussed, ✓ = Identified, - = Not identified

"*Difficulties that enterprise is faced: financing difficulty, which expects more good policy supports form government.*" - Manager of Science and Technology Park, 2016. Jinshui District.

"*Investment is the main link for stimulating economic growth, while investment basically is removal, construction and repair, so the system is questionable.*" - National Development and Reform Commission, 2016. Jinshui District.

"*The ability and quality of some persons in administrative units are problematic, who only do what the government said so, and not do work without specific requirements, such manner of working is not correct. There are both advantages and disadvantages in vertical institutions, and vertical provinces and cities.*" - Environmental Protection Agency, 2016. Jinshui District.

Meanwhile, public citizens prioritized differently economic dimension of urban sustainability. They ranked income level as their first priority with mean score of 3.18, and perceived economic development and economic growth potential as other important aspects, with mean score of 3.11 and 3.13, respectively. Different from government and industrial representatives, they did not address industrial structure and investment (capital stock) as important with mean score of 2.85 and 2.73, respectively. Perceived importance of aspects in economic dimension is presented in Figure 4.4.

Nevertheless, both addressed the importance of economic development. Industrial structure could be integrated into economic development through classification of economic development contributions and measure the GDP increase independently based on the industrial activities. Classifying sources of GDP increase and targeting higher proportion of GDP increase on green industries as perceived by National Development and Reform Commission might be a prospective green development strategy to avoid excessive GDP increase from polluting industries.

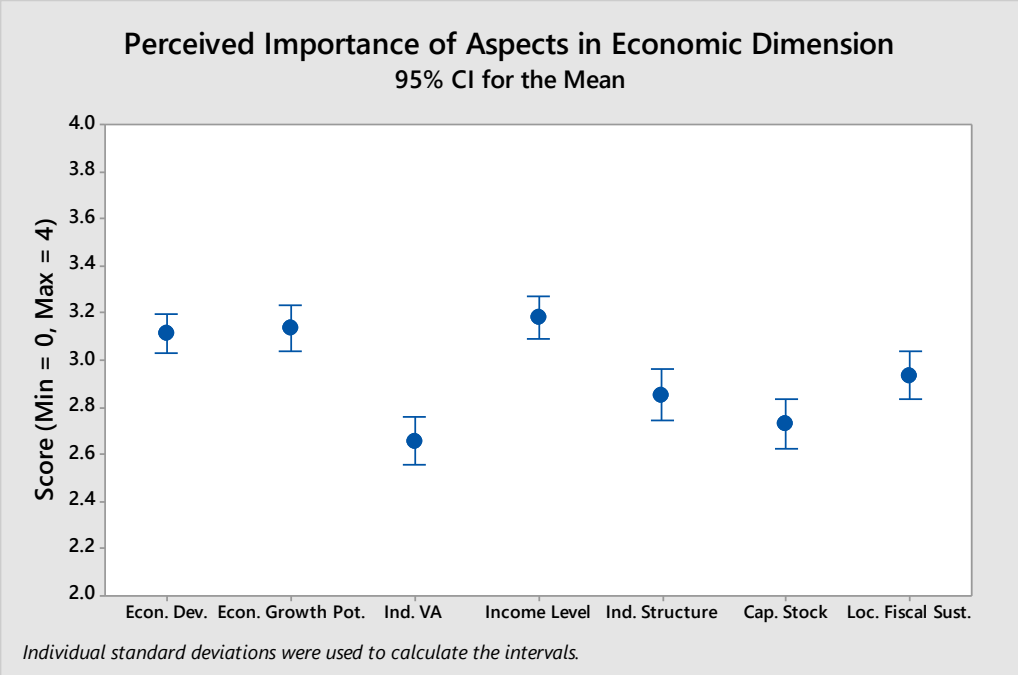

Figure 4.5: Perceived Importance of Aspects in Economic Dimension

In resolving financial investment difficulty, several strategies were conveyed by the Manager of Science and Technology Park and Economic Development Board. It covered government support and incentives for small and micro enterprises, building industrial ecosystem, shifting to technological sector, and infrastructure construction.

"*(1) Assist the small and micro enterprise with idea, help it to get more policy supports, (…) There will be some motivations, funds, (…) our park will also have some ways to help them, such as shares, free of ground rent, but also impose pressure on them for their better development. But when some projects require relatively larger demands of capital, which needs special supports from the government.*" - Manager of Science and Technology Park, 2016. Jinshui District.

"*New technology market project, mainly dominated by Internet companies (…) we are committed to build the ecological system, build ecological small closed-loop, so as to build enterprise mutual business ecosystem on a small scale.*" - Manager of Science and Technology Park, 2016. Jinshui District.

"*To build the enterprise ecosystem for the industrial planning, and third-party intervention. We provide convenient docking services.*" - Manager of Science and Technology Park, 2016. Jinshui District.

"*The economic development zone is industry cluster district, and needs to be: 1. To strengthen the planning guide, (2) make green industry system to improve the level, and technology content, (3) Strengthen brand awareness, 4. Dual drive of open and innovation, put innovation on the important position, 5. To further improve the public services and facilities, 6. Government provide services.*" - Economic Development Board, 2016. Economic Development Zone.

4.1.3 Social Dimension

Related to social dimension, it was perceived that integration of local culture in urban sustainability was important. This perception came not only from City and Town Office as social planner but also from Economic Development Board and National Development and Reform Commission.

"*Current status are houses in village are age-old, infrastructures are not complete, the existence of potential safety hazards, the protection of cultural relics shall be paid attention to in demolition process.*" - City and Town Office, 2016. Economic Development Zone.

"*(…) lack culture indicator. A city requires cultural spirit, cultural tradition, a sense of belonging, spirit consolation (cultural relics protection, cultural venues construction, traditional culture propaganda, public cultural activities shall be added into indicator system (…)*" - Economic Development Board, 2016. Economic Development Zone.

"*The core of sustainable unsustainable: (…) open and orderly cultural construction, culture is the center, the identity of culture is the confidence of urban development.*" - National Development and Reform Commission, 2016. Jinshui District.

Significance of culture in urban sustainability might be supported by cases of the impact of Chinese culture on Corporate Social Responsibility (CSR) efforts in China. Wang and Juslin (2009) found that Western CSR concepts did not adapt well to the Chinese market, because they had rarely defined the primary reason for CSR well, and the etic approach to CSR concepts did not take the Chinese reality and culture into consideration. They introduced a new definition of CSR in Chinese context as Harmony Approach, which means 'respecting nature and loving people'. Since this definition could possibly fit the characteristics of the Chinese market better and help corporations to adopt CSR on their own initiative, this approach might also be expanded to the urban sustainability practices in China.

It was also perceived by City and Town Office that planning was critical to control the population number and housing provision in ensuring ideal population number to support desirable quality of life. Besides housing, other important issues identified in the focus group discussion were safety and security, medical and health service, education, and public infrastructure, covering transportation and green space. Covered aspects in social dimension by each participant were summarized in Table 4.4.

Table 4.4: Covered Aspects in Social Dimension of Urban Sustainability

Participants	Location	Public Infra.	Safety	Health Serv.	Educ.	Housing	Culture
Environmental Protection Agency	EDZ Zhengzhou	-	-	-	-	-	-
Automobile Representative	EDZ Zhengzhou	-	-	-	-	-	-
Economic Development Board	EDZ Zhengzhou	✓	✓	-	-	-	✓✓
City and Town Office	EDZ Zhengzhou	-	✓	-	-	✓✓	✓
Environmental Protection Agency	Jinshui District	-	-	-	-	-	-
Manager of Science and Technology Park	Jinshui District	-	-	-	-	-	-
Planning Bureau	Jinshui District	✓	-	✓	✓	-	-
National Development and Reform Commission	Jinshui District	✓	-	-	✓	-	✓✓

Information: ✓✓ = Discussed, ✓ = Identified, - = Not identified

"*In view of the residents relocation, there shall arrange housing in accordance with the provisions and requirements first, and then make monetization compensation. (…) The job-housing balance problem is that the distance from the working place and living place shall be planned according to the project.*" - City and Town Office, 2016. Economic Development Zone.

"*The social security needs to be constantly improved and perfected (…)*" - Economic Development Board, 2016. Economic Development Zone.

"*(…) 5. To further improve the public services and facilities, 6. Government provide services.*" - Economic Development Board, 2016. Economic Development Zone.

"*Unfair belongs to the problems left over by history, (…) and the matching medical and health care, education, green space and other supporting resources shall be planned in advance, all kinds of resources shall be more fair and reasonable.*" - Planning Bureau, 2016. Jinshui District.

"*For quality education, the school is lack of this, so the sustainable should be deeply rooted in the minds of people from the beginning.*" - National Development and Reform Commission, 2016. Jinshui District.

"*(…) invest more on the development of environmental protection to build public transport facilities and other infrastructure.*" - National Development and Reform Commission, 2016. Jinshui District.

"*The core of sustainable unsustainable: (…) the continuous prosperity, social fairness and justice, good social environment, (…) Planning, medical security and other issues need to be handled by government.*" - National Development and Reform Commission, 2016. Jinshui District.

On the other hand, public citizens did not perceive culture as the most important aspect in urban sustainability, which mean scores of cultural events and recognition of social value were 2.53 and 2.66, respectively. They selected education, safety and security, and health service as their highest priorities, with mean score of 3.65, 3.64, and 3.59, respectively. While those aspects were not discussed in detail, they were still identified in the focus group discussions. Related to public infrastructure, they chose water and sanitation access over transportation with mean score of 3.21, 3.25, and 2.83, respectively. Other important aspect in social dimension shared by both citizens and

government and industrial representatives was housing security with mean score of 3.09. Meanwhile, aspects perceived by citizens as important but not by government and industrial representatives were human rights, employment, poverty, and pension service with mean score of 3.29, 3.34, 3.00, and 3.28, respectively. Perceived importance of aspects in social dimension is presented in Figure 4.5.

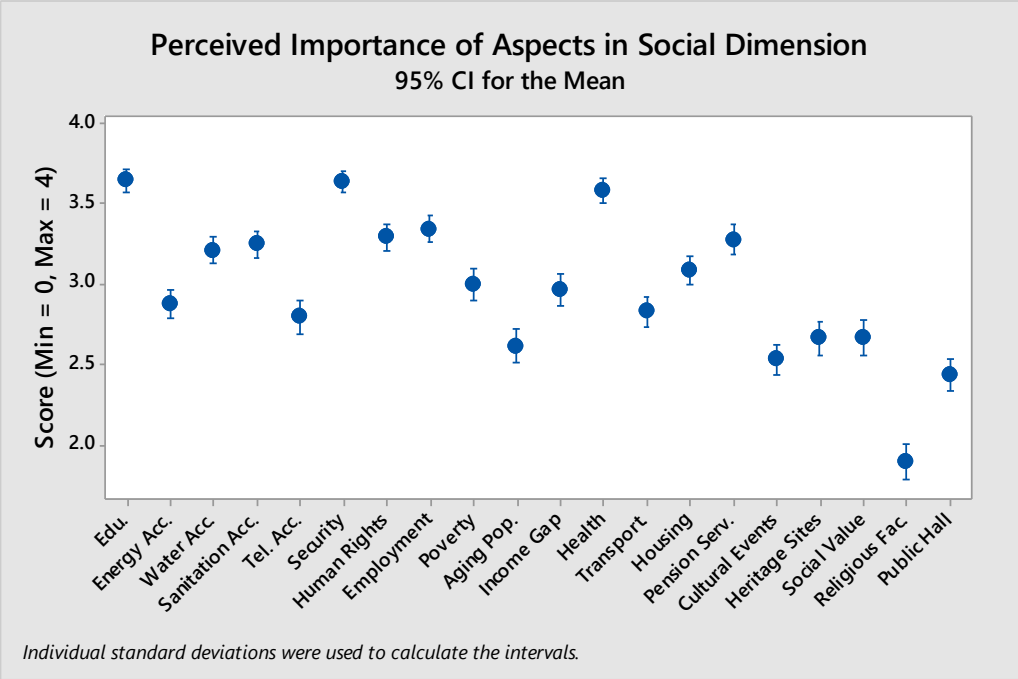

Figure 4.6: Perceived Importance of Aspects in Social Dimension

4.1.4 Governance Dimension

Related to governance dimension, it was perceived in focus group discussions that participation of citizens were not important in urban development plan and urban sustainability as mentioned by representatives from National Development and Reform Commission. Further, it was perceived that citizens lacked the experiences in providing advices in urban sustainability strategies.

"*(…) government responsibility is the first to be affected. Policy, resources, capital, public power, and media are all very important, enterprise is the second, and the last one is citizen.*" - Director Ma of National Development and Reform Commission, 2016. Jinshui District.

"*Government is the heaviest, and it also the policy-maker, the guider of many developing directions, second is enterprise, the policy-making is reflected onto the enterprise development. (…) The last one is citizen.*" - Section Li of National Development and Reform Commission, 2016. Jinshui District.

"*For the constraint and planning of a behavior, it needs a lot of experienced and capable men to give advices and suggestions. Civilian are usually short-sighted, so it needs high-level government to grasp the whole situation.*" - Section Li of National Development and Reform Commission, 2016. Jinshui District.

This perception arose due to assumption from government of citizens as being inexperienced and short-sighted, similar to findings by Li and Li (1998) that participatory models that have been being implemented in many Chinese cities were underlined by the assumption that the public still lacked the knowledge and capacity to participate in policy formulation and decision making.

Nevertheless, Planning Bureau admitted the importance of educating citizens to understand urban planning and suggested several measures to engage citizens in urban development and sustainability. It mentioned public notification and mailbox as effective measures, although it still undermined the value of the feedback from the citizens.

"*Public notification and mailbox are effective. Hearing is just started, and the effect is good. Letters and calls also have good results, but the public also have unreasonable appeals that hinder the efficiency. (…) Explain to them patiently, and get polished.*" - Planning Bureau, 2016. Jinshui District.

Other governance aspect covered by Planning Bureau and National Development and Reform Commission was fair and inclusive system within society.

"*From my personal view, sustainable city is relatively healthy, (…) economic structure is rational, and society is relative fair.*" - Planning Bureau, 2016. Jinshui District.

"*The core of sustainable (…) social fairness and justice, good social environment, modern management system, inclusive.*" - National Development and Reform Commission, 2016. Jinshui District.

In addition, it was perceived by Environmental Protection Agency that the government was not very efficient due to the ability and quality of the administrative employees and the poor budget and schedule management. Covered aspects in governance dimension of urban sustainability for each participant were summarized in Table 4.5.

"*The ability and quality of some persons in administrative units are problematic, who only do what the government said so, and not do work without specific requirements, such manner of working is not correct.*" - Director Zhang of Environmental Protection Agency, 2016. Jinshui District.

"*On government level, to fix the problems once were found, in fact, if we make plan in advance, and design development route and mode, such problem would not be circulated any more. The system, planning, legislation shall all be scheduled ahead of time, which can greatly reduce the emergence of the problem, therefore, the cost and prices of problem solving in later period can also be reduced.*" - Director Zhang of Environmental Protection Agency, 2016. Jinshui District.

Table 4.5: Covered Aspects in Governance Dimension of Urban Sustainability

Participants	Location	Citizen Participation	Fair System	Government Efficiency
Environmental Protection Agency	EDZ Zhengzhou	-	-	-
Automobile Representative	EDZ Zhengzhou	-	-	-
Economic Development Board	EDZ Zhengzhou	-	-	-
City and Town Office	EDZ Zhengzhou	-	-	-
Environmental Protection Agency	Jinshui District	-	-	✓✓
Manager of Science and Technology Park	Jinshui District	-	-	-
Planning Bureau	Jinshui District	✓✓	✓	-
National Development and Reform Commission	Jinshui District	✓	✓	-

Information: ✓✓ = Discussed, ✓ = Identified, - = Not identified

Similarly, citizens themselves did not perceived their participation as important since they ranked citizen participation last with mean score of 2.84. Citizen participation will further be discussed in Section 4.2.3. They ranked corruption the highest with mean score of 3.52. Due to increase of urban expansion in China resulted from economic transition initiated by the central government, exacerbated by lagging administrative reforms, Chinese cities have been involved with heavy debt, which led to corruption and inefficient development (Wei, 2015). Citizens also perceived government efficiency and fair system as important aspects with mean score of 3.33 and 3.31. Perceived importance of aspects in social dimension is presented in Figure 4.6.

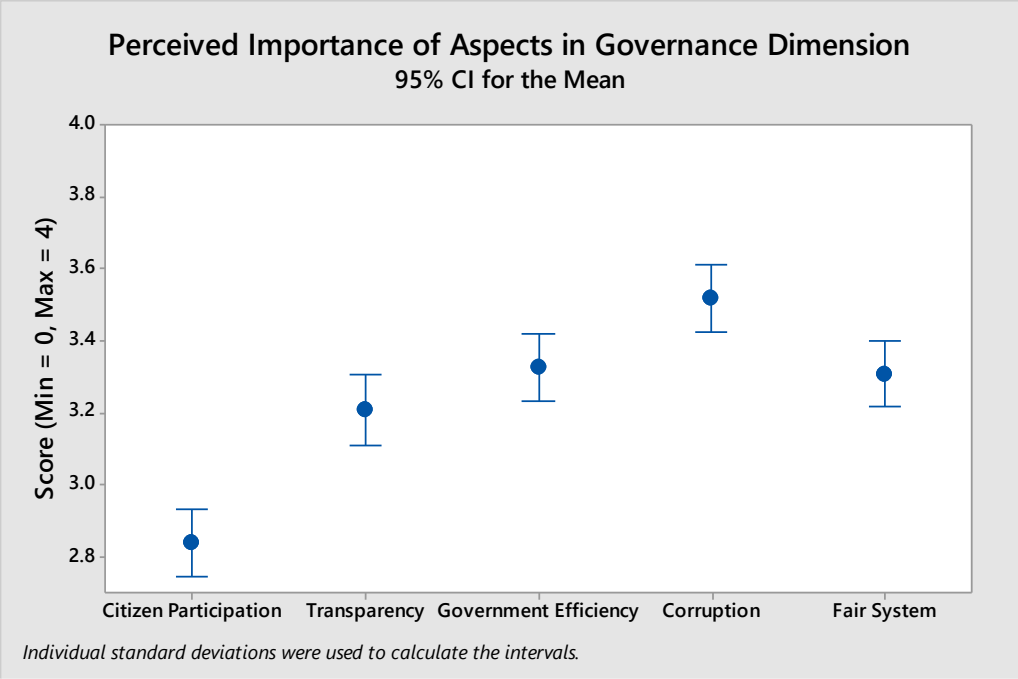

Figure 4.6: Perceived Importance in Governance Dimension

It was detected that the current performance of government projects was inefficient due to cost overrun, poor quality, and corruption. To ameliorate the institutional arrangement of government project management, Zhang and Zhu (2007) proposed six basic principles; effective funding sources, appropriate government function, procurement transparency, lower management cost, gathering management experience, and restraining corruption. Those selected aspects were highly relevant to monitor heavy expenditure on infrastructure and other public works by the Chinese government.

4.2 Preferred Indicators for Measuring Urban Sustainability

This subsection provides answer to sub-research question, "*What indicators do the citizens give importance and preference in order to measure the progress or state of urban sustainability?*" Indicators discussed here only covers those perceived mutually by both public citizens and government and industrial representatives as important aspects, except for environmental dimension. Discussion on environmental indicators covers aspects perceived as important by either public citizens or government and industrial representatives.

Selection criteria was based on preference of citizens which reliability and relevance further be assessed. Preference scoring was based on 2-scale grading with 0 as unimportant and 2 as important. At least one indicator with the highest rank was selected from each aspect. Indicators for environmental, economic, social, and governance dimension are covered respectively in Subsection 4.2.1, Subsection 4.2.2, Subsection 4.2.3, and Subsection 4.2.4.

4.2.1 Environmental Indicators

This subsection covers five issues perceived as important by either public citizens or government and industrial representatives; water shortage, air pollution, resources consumption, waste management, and sustainable land use. These issues comprised eight aspects in environmental dimension; freshwater quality, freshwater consumption, wastewater treatment, air quality, waste generation, energy consumption, material consumption, and sustainable land use. Preferred environmental indicators by citizens in Zhengzhou are summarized in Table 4.6.

Table 4.6: Preferred Environmental Indicators by Citizens in Zhengzhou

Environmental Aspects	Environmental Indicators	Mean Score	Standard Dev.
Freshwater Quality	Heavy Metal Content	1.58	0.53
Freshwater Consumption	Water Consumption per Capita	1.42	0.57
Wastewater Treatment	Industrial Water Recycling Rate	1.34	0.62
	Domestic Water Recycling Rate	1.35	0.65
Air Quality	Particulate Matter (PM) Level	1.64	0.55
	Air Pollutant (SO_2, NO_2) Level	1.65	0.56
Waste Generation	Hazardous Waste Recovery Rate	1.51	0.61
	Open Burning Rate	1.46	0.59
Energy Consumption	Total Energy Consumption Rate	1.43	0.62
Material Consumption	Non-Renewable Material Consumption Rate	1.36	0.71
Sustainable Land Use	Ratio of Built-Up and Green Area	1.45	0.60

The indicators collected were assessed as relevant in the context of urban sustainability in Zhengzhou. Most of those indicators were capable to measure the achievement progress of National Development Targets in the Thirteenth Five-Year Plan, which covered water consumption, air quality, energy consumption, and sustainable land use. Inclusion of six bottom-up indicators identified; heavy metal content in freshwater, industrial and domestic water recycling rate, hazardous waste recovery, open burning rate, and non-renewable material consumption rate, would enrich the information for developing urban sustainability strategies and measuring its progress.

Those bottom-up indicators were assessed as relevant in measuring urban sustainability in the context of Zhengzhou. Heavy metal content in freshwater and hazardous waste recovery rate were relevant to industrial waste, mainly due to hazardous waste emitted from coal mining activities in Zhengzhou, including coal sludge and fly-ash. Coal sludge was produced during washing process, which could contaminate water with heavy metals such as Arsenic, Mercury, Chromium, Cadmium, and Nickel (Haibin and Zhenling, 2010). Inclusion of non-renewable material consumption rate could also be synergized with energy consumption rate through quantification of coal consumption, since coal was one of the most consumed non-renewable material in Zhengzhou for energy generation.

Measurement of open burning rate was relevant since open burning was still practiced in China, especially agriculture waste open burning which mainly occurred in three kinds of regions; grain-producing regions with a low population densities, developed regions, and energy producing regions (Cao et al., 2006). Recognition of these indicators from a bottom-up approach demonstrated the significance of participatory approach in identifying urban sustainability indicators.

4.2.2 Economic Indicators

This subsection covers economic development as important aspect in economic dimension perceived by both public citizens and government and industrial representatives. The most preferred indicator

was local GDP per capita, with mean score of 1.41 and standard deviation of 0.62. While application of this indicator is debatable as discussed in Section 4.1.2, this indicator is still able to include sustainability into economic development by distinct industrial classification of GDP increase sources. Therefore, this indicator is capable to measure progress of urban sustainability strategies as GDP increase from green activities is quantifiable. In addition, application of this indicator also enables local government to measure its contribution towards economic target of the Thirteenth Five-Year Plan.

4.2.3 Social Indicators

This subsection covers six issues perceived as important by both public citizens and government and industrial representatives; education, water access, sanitation access, security, health service, and housing security. Preferred social indicators by citizens in Zhengzhou are summarized in Table 4.7.

Table 4.7: Preferred Social Indicators by Citizens in Zhengzhou

Social Aspects	Social Indicators	Mean Score	Standard Dev.
Education	Compulsory Education Completion Rate	1.59	0.58
Water Access	Percentage of People with Access to Potable Water	1.56	0.54
Sanitation Access	Percentage of People with Access to Sanitation	1.46	0.58
Safety and Security	Occupational Accident Rate	1.44	0.63
Health Service	Immunization Rate	1.62	0.53
	Percentage of People with Access to Health Care (Clinics, Hospitals)	1.55	0.56
Housing Security	Rent-to-Income Ratio	1.43	0.63

The indicators collected were assessed as relevant in the context of urban sustainability in Zhengzhou. In 2010, 35% of adults between 25-64 years old in China did not complete the compulsory education, which covered only primary and junior secondary education. This number was much lower compared to developed countries which secondary education completion rates were higher than 90% (OECD, 2014). Measurement of compulsory education completion rate enables monitoring development of education in China. Similarly, access to potable water and sanitation was perceived as more important in infrastructure construction by the citizens than public transportation since percentage of people with access to potable water and sanitation in China in 2015 were still at 93% and 76%, respectively. This relatively extensive access to potable water was due to accounting of other improved potable water sources, since the access from water pipeline was only at 73% (WHO-UNICEF, 2015).

Inclusion of occupational accident rate was perceived as important due to the high number of accident casualties in China, mostly in coal mining, construction, and manufacturing sector. In 2010, the recorded number of fatalities was 2,433 cases in coal mining, 2,769 cases in construction, and 3,796 cases in manufacturing, with total fatalities of 10,616 cases (ILO, 2012). Inclusion of percentage of people with access to health care was also relevant since growth of physical access to health facilities was dawdling. Physical access to health facilities in China was at 80.7% in 2003, and 83.3% in 2011. The number has even declined in urban areas, with access percentage of 91.0% in 2003 and 89.2% in 2011 (Meng et al., 2012). However, inclusion of immunization rate was inconclusive since the immunization rate of China was already at 99% for the last four consecutive years (2011-2014), covering DPT (Diphtheria, Pertussis, and Tetanus) and measles, although particular data for immunization rate in Zhengzhou was not available (World Bank, 2015). This perception might be originated due to more than hundred measles outbreaks in Henan Province in 2001, with 1,665 cases laboratory confirmed (Aiqiang et al., 2003). Rent-to-income ratio was preferred as indicator for

housing security since it represented housing affordability as main problem in Zhengzhou. Angel et al. (2011) observed that there was no evidence of homelessness and shantytowns in Zhengzhou, which made those indicators irrelevant to measure.

4.2.4 Governance Indicators

This subsection covers government efficiency and fair system as important aspects in governance dimension perceived by both public citizens and government and industrial representatives. Preferred governance indicators by citizens in Zhengzhou are summarized in Table 4.8.

Table 4.8: Preferred Governance Indicators by Citizens in Zhengzhou

Governance Aspects	Governance Indicators	Mean Score	Standard Dev.
Government Efficiency	Government Expenditure	1.46	0.62
Fair System	Availability of Legal Assistance	1.73	0.47

The indicators collected were assessed as relevant in the context of governance dimension of urban sustainability in Zhengzhou. Government expenditure was relevant for ensuring the efficiency of government in allocating and expending budget for urban development. In addition, it also enabled transparency and monitoring corruption as other aspects in governance dimension perceived as important by public citizens. Similarly, availability of legal assistance was important not only for fair system, but also human rights as aspect in social dimension not included in the social indicators set.

However, it was important to consider that these indicators were highly sensitive. While China had decentralized its government within the broader context of economic modernization, cities in China have created numerous informal political opportunities through decentralization, leading to highly centralized and undemocratic political hierarchy even in cities level (Miller and Bunnell, 2013). This circumstance might inhibit proper implementation of measuring and reporting these indicators.

4.3 Readiness of Participatory Approach for Urban Sustainability

As discussed in Subsection 4.1.4, it was perceived that neither side valued highly citizen participation in contributing towards urban sustainability strategies. Government representatives perceived that citizens had minimum knowledge to contribute in developing urban sustainability strategies. This perception was strengthened by self-assessment of the respondents, since respondents perceiving their level of understanding on sustainability adequate were less than 50%. The result of respondents understanding on sustainability is shown in Figure 4.7.

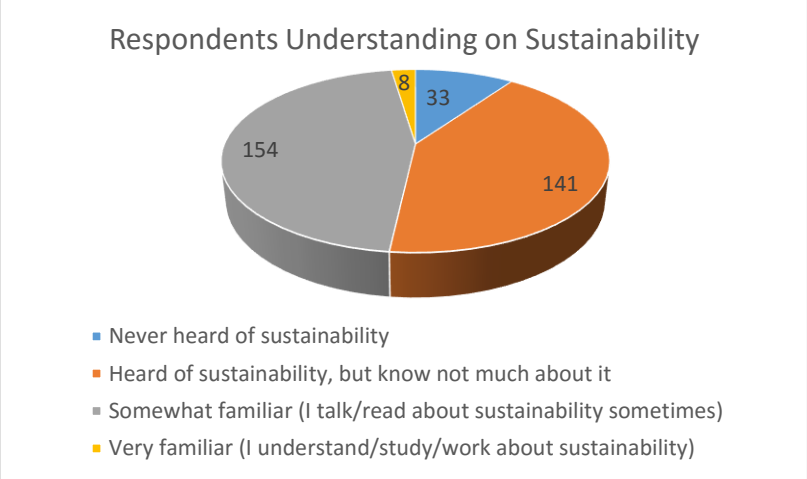

Figure 4.7: Respondents Understanding on Sustainability

Furthermore, most respondents emphasized the responsibility on the government. They perceived that government ideally held the largest responsibility for urban sustainability, with mean score of 3.20. The next stakeholders perceived as ideally responsible for urban sustainability were industries with mean score of 2.74, followed by media (2.42), residents (2.37), academia (2.14), and finally NGOs (2.08). Yet, it was also possible that this result occurred due to respondents misunderstanding of the question since 33.3% of respondents chose medium level instead of more distinct responsibility level; i.e. low or very low. Perception of citizens on responsibility level of stakeholders on urban sustainability is presented in Figure 4.8.

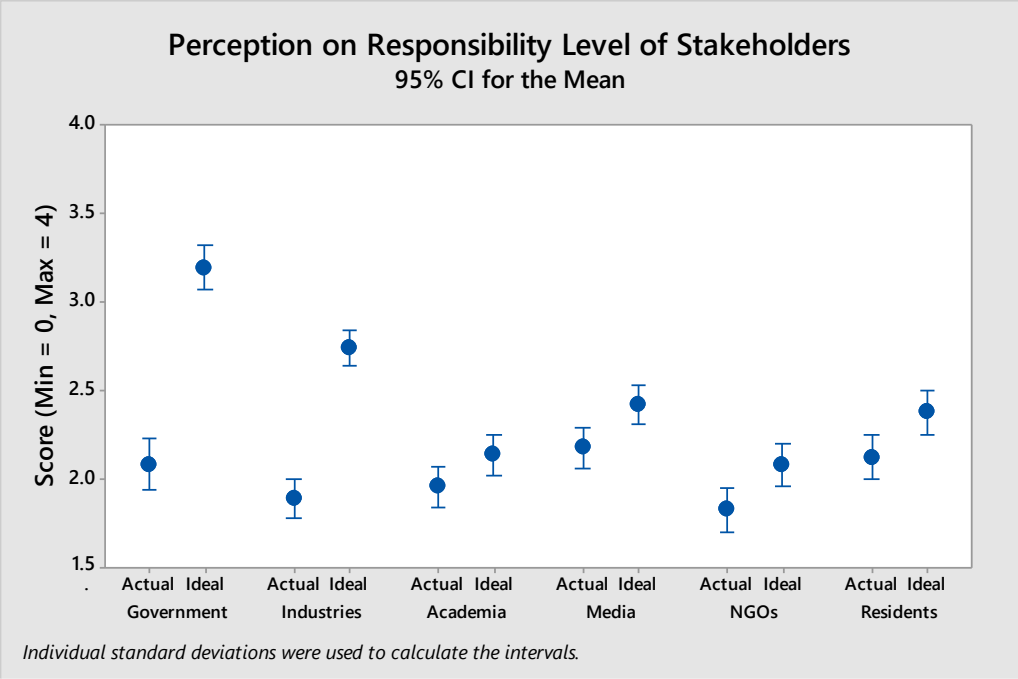

Figure 4.8: Perception on Responsibility Level of Stakeholders

NGOs was perceived as stakeholder with the least level of responsibility in urban sustainability due to difference of environmental NGOs functionality in China. While western environmental NGOs were capable to monitor government activities in an independent and sometimes confrontational manner, environmental NGOs in China operated in a highly controlled political space. The main tasks attributed to Chinese NGOs were to raise public awareness, organize clean-up campaigns, and attract aid from foreign organizations refusing to work directly with the government (Schwartz, 2004).

Nevertheless, it was perceived that in general all stakeholders delivered medium level of actual responsibility for urban sustainability. No actors were perceived to deliver higher responsibility level compared to the ideal level expected by citizens. Distinct gap of responsibility level was observed in government and industries since citizens expected high responsibility from them compared to others.

While both citizens and government and industrial representatives perceived that citizens were less accountable for urban sustainability, citizen participation were still relevant as observed in Section 4.1.1. They were capable to identify relevant aspects in urban sustainability missing in focus group discussions, such as sustainable land use and a number of social aspects. This supported argument from Creighton (2005) that participatory approach could provide a platform for exchanging local knowledge between governing stakeholders and public citizens. Nevertheless, an extent of distrust it was observed between them since they supposed unaccountability of the other side. Developing trust level was critical to elevate degree of public participation in China from informing to consultation.

5. Conclusion

This section provides the summarized discussion based on the sub-research questions and further constructed to answer the main research question in Subsection 5.1. Suggestions for future research are explored in Subsection 5.2.

5.1 Summarized Discussion

"*How do the local stakeholders perceive urban sustainability problems and plan the strategies to overcome those problems?*"

It was observed that there were shared aspects in urban sustainability perceived as important by both actors, although they also prioritized other aspects deemed as less important to other side. The aspects perceived as important by each public citizens and government and industrial representatives are illustrated by Venn diagram in Figure 5.1.

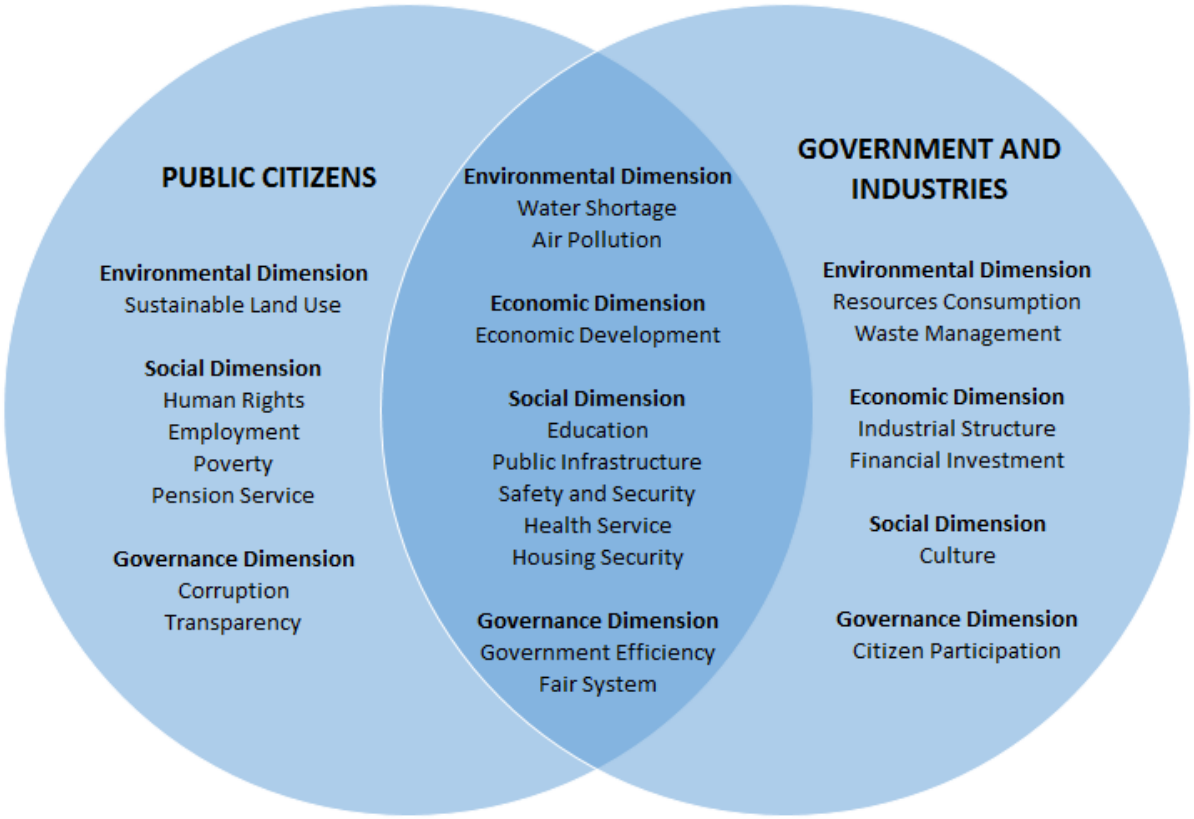

Figure 5.1: Aspects Perceived as Important by Local Stakeholders

It was observed that the important aspects relevant in Thirteenth Five-Year Plan was missing in the perception of both the government and industries and public citizens. Government and industries missed acknowledging sustainable land use and poverty, while public citizens were unaware about the importance of resource consumption and industrial structure change. This demonstrated the capability of participatory approach in complementing knowledge of both sides to improve urban planning and further to support development efforts in urban sustainability.

The summary of strategies for urban sustainability in Zhengzhou gathered directly from focus group discussion and inferred indirectly from surveys and relevant literature is provided in Table 5.1.

Table 5.1: Summary of Strategies for Urban Sustainability in Zhengzhou

Dimension	Perceived Problems	Proposed Measures
Environmental	Water Shortage	• Installing wastewater treatment plant. • Installing rainwater treatment plant. • Improving cross-level administration for water distribution and water pollution control.
	Air Pollution	• Adapting desulfurization technologies. • Adapting dust removal technologies. • Energy diversification from coal. • Limitation of motor vehicles possessions. • Trees plantations and green areas expansion. • Centralized urban heating system. • Providing institutional support for consultation.
	Resources Consumption	• Reducing resources consumption. • Shifting consumption to non-renewable resources. • Centralized urban heating system. • Increasing coal power generation efficiency.
	Waste Management	• Authorize local agencies to monitor industrial waste. • Investing in industrial pollution control efforts. • Involving scavengers and other informal sectors into formal municipal solid waste management. • Providing source-separated waste collection facilities.
Economic	Economic Development	• Providing financial assistance for enterprises. • Stimulating ideas for small and micro enterprises. • Accelerating infrastructure construction.
	Industrial Structure	• Building industrial ecosystem. • Shifting industries focus to technological sector.
	Financial Investment	• Providing policies guidance and incentives for small and micro enterprises from government.
Social	Culture and Social Value	• Communicating urban sustainability as part of culture to the citizens.
	Education	• Ensuring attendance of school-age children to compulsory education. • Providing compulsory education equivalence for adults without compulsory education level.
	Safety	• Ensuring safety of working conditions for perilous sectors; coal mining, construction, and manufacturing.
	Housing Security	• Providing affordable housing for underprivileged.
	Public Infrastructure	• Expanding piping infrastructure for potable water. • Constructing improved sanitation for underprivileged. • Assuring accessibility to health facilities.
Governance	Citizen Participation	• Distributing public notifications. • Hearing for collecting public opinions.
	Government Efficiency	• Enhancing effectiveness of funding sources. • Lowering management cost. • Gathering government management experience.
	Fair System	• Enabling access to legal assistances to underprivileged.

"*What indicators do the citizens give importance and preference in order to measure the progress or state of urban sustainability?*"

Twenty one (21) indicators selected by citizens relevant for supporting developed strategies in urban sustainability by government and industries are summarized in Table 5.2.

Table 5.2: Selected Urban Sustainability Indicators in Zhengzhou

Dimension	Aspects	Selected Indicators
Environment	Freshwater Quality	Heavy Metal Content
	Freshwater Consumption	Water Consumption per Capita
	Wastewater Treatment	Industrial Water Recycling Rate
		Domestic Water Recycling Rate
	Air Quality	Particulate Matter (PM) Level
		Air Pollutant (SO_2, NO_2) Level
	Waste Generation	Hazardous Waste Recovery
		Open Burning Rate
	Energy Consumption	Total Energy Consumption Rate
	Material Consumption	Non-Renewable Material (Coal) Consumption Rate
	Sustainable Land Use	Ratio of Built-Up and Green Area
Economic	Economic Development	Local GDP per Capita (Overall and by Industries)
Social	Education	Compulsory Education Completion Rate
	Water Access	Percentage of People with Access to Potable Water
	Sanitation Access	Percentage of People with Access to Sanitation
	Safety and Security	Accident Rate in Production Area
	Health Service	Immunization Rate
		Percentage of People with Access to Health Care
	Housing Security	Rent to Income Ratio
Governance	Government Efficiency	Government Expenditure
	Fair System	Percentage of People with Access to Legal Assistance

Compared to other indicators set in China (China Urban Initiative, 2013), it was observed that the developed set was relatively unique. This set was capable to monitor several issues that was locally relevant in Zhengzhou, not only environmental aspects such as hazardous waste and open burning, but also social aspects such as access to potable water and sanitation. This inferred the local context of the set which made it more relevant to measure the urban sustainability progress of the cities, and still were objective and measurable to compare with other cities facing similar issues.

"*How prepared are the local stakeholders in embracing participatory approach for developing urban sustainability goals and strategies?*"

There was still perception from both sides on ineptness of citizen participation in contributing towards urban sustainability strategies. Most citizens still considered themselves lack of understanding on sustainability. In addition, they also still laid the largest responsibility on urban sustainability to government and industries and did not consider mandatory to be as responsible as government and industries to contribute on urban sustainability.

Nevertheless, it was demonstrated that since both public citizens and government and industrial representatives had varying perception on urban sustainability, participatory approach could enrich development of urban sustainability goals and strategies and citizens were capable to provide relevant local knowledge. Since current level of public participation in China was still on informing stage,

developing trust level between governing stakeholders and public citizens was critical to elevate degree of public participation in China from informing to consultation.

Since NGOs were not functioning as proper monitoring tools in China, it was important to look for other possible party to bridge communication in building trust between government and industries and public citizens. Academics could be proposed as a communicator so that they could encourage citizens to deliver their concerns anonymously and filter the issues perceived as relevant in urban sustainability, and later government and industries could receive relevant feedback important in developing relevant urban sustainability strategies and goals.

"*How can participation of local stakeholders in developing local-scale strategies for sustainable cities help to detail the strategies and achieve the goals of the cities?*"

Summarizing from the three sub-research questions, it was acknowledged that inclusion of more diverse stakeholders can enrich the development of urban sustainability goals and strategies, especially on environmental and social dimensions. Relevant indicators were also could be identified by the citizens to identify representative problems in diverse aspects of four dimensions in urban sustainability. In order to elevate degree of public participation in China from informing to consultation, developing trust level between governing stakeholders and public citizens was critical.

5.2 Suggestions for Future Research

This thesis provided insight for future implementation of participatory approach for developing urban sustainability goals and strategies and identifying relevant indicators for measuring the sustainability progress. In this study, it was only possible to conduct survey to identify public perception on important aspects in urban sustainability due to time limitation. Complementing this study with deep interview with citizen representatives could enrich knowledge on identifying relevant issues in urban sustainability and developing appropriate goals and strategies. In addition, deep interview could also investigate issues identified in the surveys. Two important questions raised from the surveys are "Why do public citizens identify those issues as relevant towards urban sustainability?" and "Why do public citizens feel that their participation is less significant in contributing towards urban sustainability?"

Another limitation within this study was its focus on this thesis is emphasized on environmental dimension of urban sustainability neglected the detailed investigation in social and governance aspects. It was observed in this study that there were distinct perception on social and governance aspects in urban sustainability between ruling stakeholders and public citizens. Extensive study on developing strategies for enhancing social and governance aspects in urban sustainability within participatory approach could complete the knowledge. Furthermore, research in developing a framework to bridge communication between government and industries and public citizens in China through academia or other objective parties is important to ensure a convenient climate for citizens to contribute in urban sustainability through participatory approach.

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