



IHS
Making cities work

Erasmus

IHS is the international institute of urban management
of Erasmus University Rotterdam

MSc Programme in Urban Management and Development

Rotterdam, The Netherlands

September 2010

Thesis

Title: Assessing the Sustainable Building Policy in Shanghai, China

Xiangjie Di

Supervisor: Liliane Geerling,

BVR adviseurs ruimtelijke ontwikkeling

UMD 6 UEIM



MASTER'S PROGRAMME IN URBAN MANAGEMENT AND DEVELOPMENT

(October 2009 – September 2010)

Assessing the Sustainable Building Policy in Shanghai, China

Xiangjie Di

China

Supervisor:

Liliane Geerling,

BVR adviseurs ruimtelijke ontwikkeling

UMD 6 Report number:

Rotterdam, September 2010

Summary

The building sector plays a key role in the global economic, social and environmental development; the sustainable building issue has already been widely accepted as a consensus which can be considered as the specific performance of sustainable development. It is because the building industry itself converge major indexes of energy, water, material and usage of land, all of which affect to the environment. China, experiencing a very fast economic growth and urbanization period, is facing the most serious environmental and social issues ever. A large number of migrants swarm into the urban area from rural area, for which many house were needed. However, the energy efficiency is very low in China that the building sector associated with relevant sectors consumed 46.7 % of the total amount of the national energy consumption. What is worse, although the designed life-cycle is 50 years, the average life-cycle in reality is 30 years. Most of the existing stocks have been demolished instead of renovation even before the designed life cycle.

Since 1986, the Chinese government formed serial policies which were relevant to sustainable building issue. Although both the national government and the local government have already paid much attention to sustainable building issues, there are still many barriers in this area. This research attempts to analyse Shanghai's current sustainable building policy and find out the strong points and weak points. Furthermore, exam the performance of Tongji University campus program in Shanghai. Finally, it tries to give the suggestions of potential approaches to the sustainable building development in China.

Based on the proposed framework by extensive literature review, a combination of research approach with qualitative methods (in-depth interview) and quantitative method (survey) was developed for this research. There were ten respondents which divided into four groups: local authority officer, university managers, design team and private developer manager. The result of the qualitative methods was used to identify the sustainable building policy design and implementation from the perspective of different stakeholders. The respondents of the survey were chosen from the Tongji campus, which most of them were high educated. It attempts to analysis the public awareness of sustainable building of the people in the sustainable campus program.

According to the analysis, several factors are identified. 1) There no specific local policy based on the national core strategy. It is the simply repetition of the national policy without the local planning. 2) The awareness of the development control officer, the developer and the design team are high while they are more focus on the energy issue for the special national conditions. 3) The local industry capacity is a key element of high incremental cost of sustainable building. 4) The enforcement of the law is worrying that mandatory regulation is needed. 5) There are no third party organizations which meet the local context to assess the sustainable building. 6) The official rating system is not explicit and authentic that the market is more willing to adopt the LEED as the main rating system while the government encourage the combination of those different two systems. 7) the awareness of the public have not been high promoted that even for whom with high educated background in a sustainable campus program.

Based on the analysis of this research, five recommendations were given to the sustainable building policy in Shanghai. 1) Develop a local policy based on the national strategy. 2) Promote the public awareness 3) Establish a clear and efficient monitoring system. 4) Strengthen the enforcement of the law. 5) Establish an effective incentive mechanism. 6) Develop a comprehensive rating system which meets the local context.

Key words: sustainable building policy; rating system; sustainable policy design; approach to sustainable building; Tongji University, Shanghai, China

Acknowledgements

Since this thesis is not an individual work, I would like to acknowledge my sincere regards and thanks to all the people who provide support and assistance for its completion.

First I would like to express my unreserved gratitude to my supervisor Liliane Geerling, who deserves special recognition for her professional unremitting support, encouragement and the time she spent to review all my drafts. Liliane always offer me many opportunities to extent and stretch the research area. Without her contribution, absolutely this research project cannot be completed.

A very special gratitude to Professor Zhenyu Li. Particularly the advice about the selection of research topic and the Contact Role he played during the field work in Shanghai. Several times he discussed the thesis topic with me and helped me learn the sustainable compus program of Tongji University and provided the access of interview. Also thanks to his kindness of offering me the opportunity of internship to further research in this field.

Many people contributed to the finalization of this thesis. My appreciating to my friends Cha Lu, Shaojia Song, Jian Cheng, Ting Lei, Wenwu Wang, Ying Li and Pengcheng Zhang. They provided me significant suggestions and convince during my data collection and field work.

Of course I would like the express my gratefulness to all the respondents of the interview. Hongwei Tan, Zhengyu Li, Cunyi Wu, Wei Wei, Li Zhang, Feng Qian, Paul Chen, Shaojia Song, Fang Wang and Xunling Xu. And all the respondents of the questionnaire who offer valuable insights and helped me obtain the data.

In addition, all the UMD 6 colleagues of IHS deserved my sincere appreciation that I learnt a lot from all of you during one year study and collaboration. Besides, I would like express my grate thanks to IHS and all staff there. They provided me a warm and excellent academic study environment. Special gratitude should be given to Yincheng Guo and Yiping Fang who make me fast adapt to the Dutch study and living life.

Last but not least, I would like like to say, I am grateful for my father Boyu di, my mother Juping Dong and my grandmother Yunzhu Zhang, you are always supporting me unconditionally with endless love. I would also thank all my relatives for your support.

Special thanks to Guanghua Lu, Cuiping Tian for your understanding and support.

Abbreviations

CNPC	:	Chinese National People's Congress
DEFRA	:	The Department For Environment, Food And Rural Affairs (UK)
EPA	:	Environmental Protection Agency (Us)
GDP	:	Gross Domestic Product
HTF	:	Housing Trust Fund
LGA	:	Local Government Association Of London
LPA	:	Local Planning Authorities
MOHURD	:	Ministry Of Housing And Urban-Rural Development Of The People's Republic Of China
MOST	:	Ministry Of Science And Technology Of China
NBSC	:	Chinese Statistic Yearbook
NWDA	:	Northwest Regional Development Agency (England)
OECD	:	Organization For Economic Co-Operation And Development
OPSI	:	Office Of Public Sector Information
PPS	:	Planning Policy Statements
SBP	:	Sustainable Building Policy
SCNPC	:	Standing Committee Of The National People's Congress (China)
WBCSD	:	World Business Council For Sustainable Development

Table of Contents

Summary	iii
Acknowledgements	v
Abbreviations	vi
List of Tables	ix
List of Charts.....	ix
List of Figures	ix
List of Pictures	x
Chapter 1: Introduction.....	1
1.1 Background.....	1
1.1.1 The Rational for sustainable building	1
1.1.2 Sustainable building development in China	2
1.2 Problem statement.....	4
1.3 The aim of this research.....	5
1.4 Objectives of this thesis	5
1.5 Research area and scope	5
1.6 Main research question and sub questions.....	7
1.6.1 Main research question	7
1.6.2 Sub questions	7
Chapter 2: Literature Review	8
2.1 Introduction of Sustainable building movement in the world	8
2.2 Theories Related to Access to the Successful Sustainable Building Policy	9
2.2.1 Well Planned Policies	9
2.2.2 Key Elements of Successful Implementation of a sustainable Policy	11
2.2.3 Approach to the Sustainable Building Policy	12
2.3 Criteria of Sustainable Building and main rating systems.....	13
2.4 Objectives of Sustainable Building Policy	15
2.5 The role of the government and communities in sustainable building ..	17
2.6 A model for developing countries.....	17
2.7 Conclusion	18
Chapter 3: Research methodology.....	19
3.1 Research Type.....	19
3.2 Research Design.....	19
3.3 Research Population and Sampling Methods	20
3.4 Data Collection	20
3.4.1 Primary Data	20
3.4.2 Secondary Data	21
3.3 Data Analysis	21
3.4 Validity and Reliability.....	21

3.5	Respondents	21
3.6	Research Variables and Indicators	21
3.7	Limitation.....	23
Chapter 4: Research Results and Analysis.....		24
4.1	Desk Research Findings.....	24
4.1.1	Policy Design- National Development Policies and programs.....	24
4.1.1.1	Energy Efficiency Policy	24
4.1.1.2	Policy Design hierarchy	25
4.1.2	The Approach- National Sustainable Building Standard and Rating 25	
4.1.2.1	The Technical Assessment Handbook for Ecological Housing in China	25
4.1.2.2	Green Olympic Building Assessment System	26
4.1.2.3	Evaluation Standard for Green Building (ESGB).....	26
4.1.2.4	Market oriented LEED.....	26
4.2.1.4	Incremental Cost of Green Building	27
4.2	Field Work Findings and Analysis	30
4.2.1	Public and Private Participation.....	30
4.2.1.1	Institutional Structure.....	30
4.2.1.2	Legislation.....	31
4.2.1.3	Private developers' Participation	32
4.2.2	Case study of Tongji Sustainable Campus program	33
4.2.2.1	Sustainable Campus from Managers and Designers' Perspective.34	
4.2.2.1.1	Institution of sustainable campus construction	34
4.2.2.1.2	Objective and Achievement	34
4.2.2.2	Public Awareness from User Perspective	38
4.2.2.2.1	Questionnaire Sampling	38
4.2.2.2.2	Analysis of Questionnaire.....	38
4.3	Implementation- Key Element of Successful SBP	43
4.3.1	Awareness of the development control officer	44
4.3.2	Local industry capacity of sustainable building technology.....	45
4.3.3	The enforcement of the law	46
4.3.4	Relationship between building control staff and monitoring.....	46
Chapter 5: Conclusion.....		48
5.1	Introduction.....	48
5.2	Recapitulation of the Study.....	48
5.3	Reflection on Research Findings and Conclusion	48
5.4	Recommendation	50
Bibliography		52
Annex 1: list of interview.....		55
Annex 2: list of questionnaire		58

List of Tables

Table 1: Definitions of sustainable building.....	8
Table 2: Assessing policy objectives	12
Table 3: A suggested template of policy:.....	13
Table 4: Criteria of sustainable building	14
Table 5: Main rating systems of sustainable building.....	14
Table 6: The objectives of sustainable buildings	15
Table 7: The elements of sustainable buildings	15
Table 8: Variables and Indicators of Policy Analysis.....	22
Table 9: Variables and Indicators of Case	22
Table 10: Comparison between ESGB and LEED	27

List of Charts

Chart 1: The proportion of the incremental cost of green building category	28
Chart 2: Green technology influence the incremental cost.....	28
Chart 3: Incremental cost tables of different concepts of green building.....	29
Chart 4: The LEED application process	31
Chart 5: The LEED application process	32
Chart 6: Institution organization structure	34
Chart 7: Electricity fee for the campus from 2004-2008.....	36
Chart 8: Water fee from 2004-2008.....	36
Chart 9: Components of respondents.....	38
Chart 10: Understanding objectives of sustainable building.....	39
Chart 11: Those who select the Green plants	39
Chart 12: The most important aspects respondents considered	40
Chart 13: The most popular clean energies respondents preferred.....	41
Chart 14: Factors to human health:	41
Chart 15: Respondents who knew the sustainable campus program	42
Chart 16: Respondents who knew the sustainable campus program	43
Chart 17: The awareness of sustainable building issue.....	44
Chart 18: Local industry capacity of sustainable building technology.....	45
Chart 19: Enforcement of the law	46
Chart 20: Monitoring and rating system	47

List of Figures

Figure 1: Contents of a local development framework	10
Figure 2: Possible policy hierarchy arrangements	10
Figure 3: Research design diagram	19
Figure 4: LEED Certification Phase.....	27

List of Pictures

Picture 1: Sustainable buildings in the campus	6	
Picture 2: Green Building Demonstration in Campus	33	
Picture 3: Solar panel	Picture 4: Skylight	35
Picture 5: Planting facade	35	
Picture 6: Energy saving propaganda team.....	37	

Chapter 1: Introduction

1.1 Background

1.1.1 The Rational for sustainable building

“Energy efficiency is fast becoming one of the defining issues of our times, and buildings are that issue's ‘elephant in the room’. Buildings use more energy than any other sector and as such are a major contributor to climate change”

-----*Björn Stigson, president of the WBCSD*

Buildings as the major components of the build environment have a very close linkage to environmental protection issues. Together with the transportation and the industry sectors, the building sector is the main consumer of energy. A study showed by the World Business Council for Sustainable Development (WBCSD) indicated that the building sector surprisingly accounted for 40% of the global energy consumption (WBCSD, 2009). In order to achieve the target of reducing 60 % of the energy consumption in the building sector by 2050, the WBCSD recommends that all the governments, private organizations and individuals try to achieve energy efficiency in various methods which combine public policies, creative technologies and individual behaviour change.

In many countries, the sustainable building issue is becoming more and more popular in recent years. It involves many aspects of the environmental degradation. It is because the building industry itself converge major indexes of energy, water, material and usage of land, all of which affect the environment. Imperatives of climate change need building technology to contribute to the demand of climate change, especially reducing CO₂ emissions. For instance, housing account for a significant part of the CO₂ emission in the UK (DCLG, 2007a). As a result of domestic lighting, heating and running of buildings, the CO₂ emission is around 27% (per year).

Except environmental aspects, there are also social and economic driving forces for sustainable building. The main energy is from gas, oil and coal and those resources are limited. And the prices keep on rising. In the UK, the average gas price rose by 109%, and the electricity price by 70% in five years since January 2003(Energywatch, 2008). Water is another stressed factor worldwide. New measures have to be taken in water resource conservation during the construction of buildings. As faster the development of the world goes, these trends will become even worse in the future. (Seyfang, 2009)

The urbanization process is still going on in the world, especially in developing countries. The immoderate development and construction not only cuts of the natural relationship between human and the environment but also results in a heavy burden to the ecological tolerance and natural resources. According to the figures (Seyfang, 2009), over 50% of the natural resources are used for buildings and facilities. The energy consumed during these processes (construction and operation) accounts for around 40% of the global energy use. The pollutant relevant with buildings which cause air pollution, light pollution and radiation pollution reach 34% of the total amount of pollutions. The construction waste takes 40% of the wastes generated by human activities worldwide. In some fast economic growing countries, the occupation of the land and degradation of the

ecological system increases rapidly by the enormous building activities. Thus the promotion of sustainable building issues is an urgent topic in the world.

As the building sectors plays a key role in the global economic, social and environmental development, the sustainable building issue has already been widely accepted as a consensus which can be considered as the specific performance of sustainable development. The main objectives of sustainable building defined by U.S. Environmental Protection Agency is that the practice of creating structures and using processes which keep environmental friendly and resource efficiency throughout the life-cycle of the building from siting, designing, construction, operation, maintenance, renovation and deconstruction. At the same time, it creates a healthy and comfortable living environment for humans (USEPA, 2009). It is also called Green Building, Ecological Building or Healthy Building. Thus there are three explicit objectives: the first thing is to reduce the resource and energy consumption. The second thing is to reduce the negative impacts on the environment and the eco-system. And the third one is to promote the human health in or around buildings.

1.1.2 Sustainable building development in China

Urbanization

China, which is experiencing a very fast economic growth and urbanization period, is facing the most serious environmental and social issues ever. After 30 years of high economic growth, with an average annual GDP growth rate of approximately 10% from 1979 to 2007 (NBSC, 2007). A large number of migrants swarm from the rural area into the urban area, for whom many house were needed. The residential and commercial building floor area have increased very fast and the total building floor area increased by 1.6-1.9 billion square meters. In 2008, there were about 2.2 billion m² of buildings under construction. There are approximately 40 million square meters of building floor area in China and the amount will reach around 70 billion in 2020. The newly started construction projects take around half of the total amount of global construction projects (Di, 2010). With the building floor area increasing 5-8% annually, the existing building floor area will double in the year 2020.

Low Energy Efficiency

The fast development of urbanization process directly accelerates the development of construction materials such as cement, metal and glass. According to Tiehong Wang, who was the Chief Engineer of the Ministry of Construction from P.R. China, the energy consumption of these sectors has taken 16.7 % of the national energy consumption. At the same time, the energy consumed directly by buildings (including the construction, operation and heating) has reached 30 % of the total energy consumption. Thus the building sector associated with relevant sectors consumed 46.7 % of the total amount of the national energy consumption.

Short Life-cycle

Although the designed life-cycle is 50 years, the average life-cycle in reality is 30 years. Most of the existing stocks have been demolished instead of renovation even before the designed life cycle.

A possible food shortage might appear due to the unlimited building construction development. That is because the farm land is continually occupied by the construction. More than half of the land use for urbanization was farm land from 1996-2008. Cultivated land per capita dropped from 0.1 hectares to 0.09 hectares. Only in 2008, a total of 191.6 thousand hectares of cultivated land was used for construction purposes (NBSC, 2009). As a sharp contrast between the huge total building and a minimum building floor area per capita due to huge population, it is not possible to repeat the developed countries track which has a big per capita living space. Additionally, the disequilibrium between the 1.3 billion people and the shortage of natural resources forces the building industry to carry out a sustainable development in the building sector.

China, as one of the fastest developing countries of the world, has a great impact on the improvement of the world's economy, the environment protection and climate change. It is the Chinese government and individual's responsibility to make their own effect to a sustainable development of the building sector, for it is the largest construction field of the world. The energy consumption per unit area is more than two times that of developed countries. So it is urgent for the government to make and implement a sustainable building policy. According to the agenda of MOHURD (Ministry of housing and Urban-Rural Development of the People's Republic of China), about one third of new constructed building will satisfy the green and energy efficiency building.

POLICY

China has not experienced the same development history like the developed countries. The sustainable building issue is a new topic that emerged only after the economic reform and opening up of China in 1978. "*Design standard for energy efficiency of residential buildings in northern China*" (1986) was the very beginning of the national government's effort on that issue. After twenty years of research and implementation, the Chinese government formed a framework on sustainable building strategy.

- First, building energy efficiency is intergraded into national long-term development plans as a primary topic of the nation energy strategies.
- Second, establish the primary law system on building energy efficiency. Chinese National People's Congress establish "*Energy Conservation Law of the People's Republic of China*" (CNPC, 1997). "*Law of the People's Republic of China on Renewable Energies*"(SCNPC, 2005).
- Third, the objective that new buildings have to save the build energy consumption by 50 per cent compared with 1980s. Several standards were published to insure the implementation of and monitoring of building energy efficiency improvement by MOHURD.
- Fourth, focus on new building technology. MOHURD established "*Green Building Technology Cooperation Agreement Action*" together with MOST to cooperate in public education, green technology research and sustainable building demonstration projects. "*Evaluation Standard for Green Building*" is the basic evaluation criteria of green building in China.
- Fifth, MOHURD is starting to create an incentive mechanism for sustainable building.

The local governments are following the national government's step and establish local sustainable building policy based on the national policy. In Shanghai for instance, the government designed their local policy after the national building energy efficiency objectivity was established.

Some private developers and communities also work on sustainable building issues as in demonstration projects in many cities.

1.2 Problem statement

Although both the national government and the local government have already paid much attention to sustainable building issues, there are still many barriers in this area.

- **Absence of Specific Regulations and Standards:** The building energy efficiency projects need more legislation. The objective of saving 50 % building energy is lacking action planning as well as monitoring and evaluation. For instance, at this moment there is only legislation on residential buildings and public buildings but industry buildings lack an energy conversation. Furthermore the framework of energy, land use, water, material and environmental protection in a comprehensive standards system has not been established yet.
- **No Incentive Mechanism:** Sustainable projects need a fiscal subsidy, while both the central and local government have not established an effective system yet. The developers and the users cannot achieve the objective by themselves, for most sustainable building design and technologies investments are very high in the initial stage.
- **Technical barriers:** There is still a big production capacity between China and the developed countries. As a result from this the building sector and developers have to import new green technology at a high price from abroad. For instance, the Unit energy consumption of steel, cement and brick is 1.2 times that of western countries; glass is 1.5 times and building ceramics is 2 times (Di, 2010). At the same time the input for green building technology by the government is still rare.
- **Public Awareness of Sustainable Development:** Low carbon emission has become a fashion topic in the climate change background. Some people and even the government consider low carbon emission building equal to sustainable building. In fact, low carbon emission is only one aspect of sustainable building. One significant truth is that low carbon emission does not mean less environmental pollutions. The solid waste, sewerage treatment, land use and material efficiency are also important. In some projects, the private developer cut all the trees down on the site before the construction starts, after which they start their "green building" project. They simply think that "green building" is using high technology like solar energy, green facades and a planted roof, leaving the whole life cycle of the building behind.

1.3 The aim of this research

Although the current problems take a dim view of the sustainable building development, as global trends go on, more researches have to be made on the issue. This research attempts to analyse Shanghai's current sustainable building policy and to find out the strong and weak points. Furthermore it will examine the performance of Tongji University campus program in Shanghai. And finally it tries to give suggestion for potential approaches to a sustainable building development in China.

1.4 Objectives of this thesis

1. To carry out a critical review on Shanghai's sustainable building policy and Identify the problems and achievements of the policy in Shanghai;
2. To conclude the lessons learned from literature and particular successful cases;
3. To analyse a sustainable building case under the current policy context in Shanghai;
4. To find out the integrated approach among the public sector, the private sector and individuals
5. Find out a new insight to current sustainable building issue.

1.5 Research area and scope

My topic in this area

This thesis research tries to measure the sustainable building policy of Shanghai and attempts to find out what are the potential strategies to improve the current policy. This paper reviews literature about the background and movement on sustainable building. It is important to know what the idea came from and what the objectives are. The literature reviewed in this paper provides a framework for the sustainable development of buildings, and it helps to develop my own point of view. The analysis is divided into two parts.

1. The first part gives an overview of the sustainable building policy of Shanghai. It will analyse from the three aspects: policy design, implementation and approaches. During the analysis, the international experience will be compared with the policy of Shanghai. I'll try to find out the trends and successful case studies and provide a possible vision for the development of the local sustainable building policy of Shanghai under the national policy framework.

Shanghai is located in the central of east China, besides the estuary of Yangtze River, facing the East China Sea. It borders on Jiangsu and Zhejiang Provinces. Shanghai is China's largest integrated industrial base and cultural centre. Since the reform and opening up, Shanghai's GDP developed at an average rate of 12.3% every year. It is one of the most economically developed cities in China.

The building floor area is over 500 million square metres; there are around 380 million m² residential buildings and 135 million m² public buildings. It is pointed out that the total energy consumption will be 16 million tons standard

coal according to 2005's developing trend. The "eleventh five-year" plan has set the objective that Shanghai has to achieve the target of energy saving of 15% by the building sector at the end of the year 2010, which equals 13.6 million standard coals. That is why the government makes great effort on the energy saving building issue.

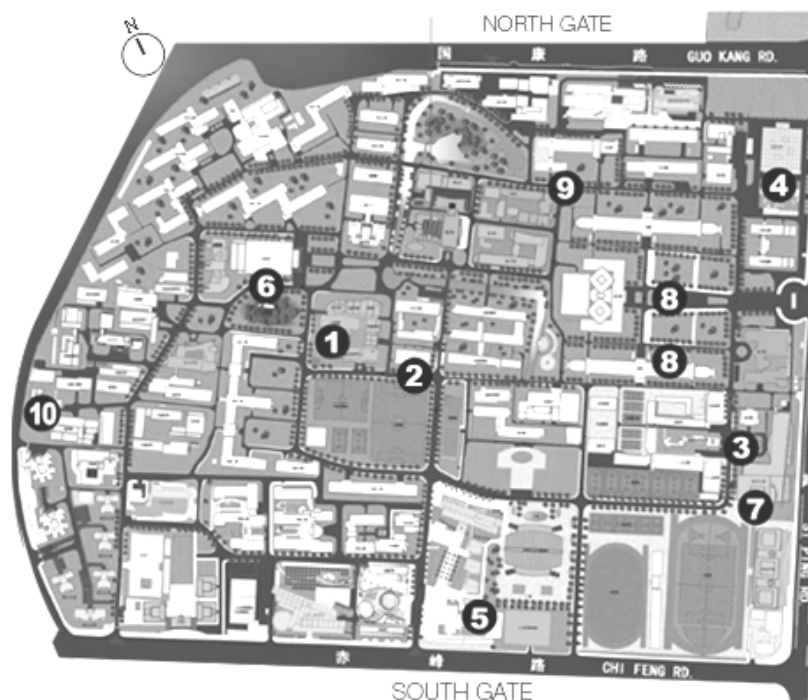
There are several sustainable building demonstration projects right now in Shanghai. They can be divided into residential buildings and public buildings.

- Residential buildings: Insulation Renovation To Enclosure Construction Projects; HVAC efficiency improvement; Residential building re-roofing projects
- Public buildings: Establish the standards of “*Energy efficient design standards for public buildings in Shanghai*”; Green building demonstration projects

2. The second part of the analysis is the case study of the Green Campus program in Tongji University. It analysis the sustainability of the campus from the perspective of the managers, designers and users. The research chooses Tongji as case study intends to measure it as a practice and attempts find out some new insight vision to the sustainable building policy of Shanghai.

Tongji university has taken the leading position in sustainable campus area since 2003 and has consensus among the students and staff of all faculties on resource and energy saving. The university does not only focus on technical renovation but also attempts to achieve the sustainable purpose by management and education approaches.

Picture 1: Sustainable buildings in the campus



The colleges and the university with multiple functions of cultivating talent, scientific research, social service and culture leader are supposed to become pioneers in the process of a sustainable building development in the climate change background and environmental friendly society. Tongji University makes a great effort on sustainable development by scientific innovation, energy saving supervision and gets consensus through the participation of the whole campus. The university demonstrates education based on environmental protection and sustainable development.

1.6 Main research question and sub questions

1.6.1 Main research question

How to measure the sustainable building policy of Shanghai and what can we learn from that?

1.6.2 Sub questions

- What kind of system is used to measure the sustainable building policy?
- How sustainable is the design and implementation of the Tongji university campus from the perspective of the managers, designers and users?

Chapter 2: Literature Review

2.1 Introduction of Sustainable building movement in the world

Seyfang (2009) claimed in his thesis that the new technologies are already in use for the development of sustainable building while the demand has become more urgent right now. The first idea of “sustainable building” comes up in 1970s, the ‘Limits to Growth’ hypothesis, which promoted greater energy efficiency and security during the oil crises (Club of Rome). The founding concern for eco-housing is the housing stock becoming more self-sufficient due to expensive and unreliable energy, which meant it was a low-tech solution to creating a ‘natural’ house which supports human health and environment health (Pearson, 1989) once the movement was formed, the activities of the builders, it boosts the spread of the consensus to the public education.

But with the oil crises gone and the prices of energy going down, the financial incentive of sustainable energy disappeared. The movement lost its mainstream attention of builders and government. However, the sustainable development continued throughout the 1980s and 1990s. The idea of “Green Architecture” was defined by Vale and Vale (2000). The concept was: saving energy, respecting its user, holistic environment, minimizing the consumption of resources, considering the climate change. At the same time, there has been a resurgence of interest in traditional locally sourced materials which can be renewable or recycled, such as straw bale, wood, bamboo and reed. Along with that, the social innovations like housing cooperatives and co-housing, intentional communities and communes were growing.

Due to the advent of protecting for climate change, sustainable building becomes a hot issue again. And right now, it is primarily understood as ‘energy-efficient’ or ‘low-carbon’ building (Lovell, 2004). And latter, it is more about technology-intensive ‘smart’ building. Another trend of sustainable building is ‘low-impact’ development which attempts to minimize the ecological footprints.

Table 1: Definitions of sustainable building

Source	Sustainable Building Development
OECD (2002)	“...buildings that have minimum adverse impact on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global settings.”
DEFRA (2003)	“continuous economic and social progress that respects the limits of the Earth’s ecosystems, and meets the needs and aspirations of everyone for a better quality of life, now and for future generations to come”
King, N. J. (2005)	“Sustainable construction uses less energy, reduces environmental impacts, and improves the quality of life for those who work or live in buildings and surrounding communities.”
Hikmat H. Ali (2009)	“..., green buildings are energy efficient, water conserving, durable and non-toxic, with high-quality spaces and high-recycled content materials, ...”

2.2 Theories Related to Access to the Successful Sustainable Building Policy

This part intends to find out the theoretic success of sustainable building policy. As the report by (LGA, 2006) recommended, the sustainable building development framework can be divided into three parts: policy planning, implementation and the approach. The case study and comparison will be introduced in the following context in the three parts

2.2.1 Well Planned Policies

As the Planning & Compulsory Purchase Act 2004 of UK section 39 pointed out, the first time that the national government set the duty of planning authorities to sustainability, the local planning authorities (LPAs) have the statutory duty to exercise the functions, with the objective of achieving the sustainable development while planning a local development document. However, full plan-making and development control of national policy is not the only role of LPAs. Another role is to facilitate and promote the implementation of good quality development. Paragraph 13 of Planning and Compulsory Purchase Act 2004 (LGA, 2006) indicates that the planning policies should at the overall lifetime of the development improve the quality of design in the layout of new developments and single building in form of function and impact, but not in the short term (OPSI, 2004).

Therefore the national planning policy statements (PPS) have already built the basis framework for sustainable building policies at regional and local level. It provides the local evidence base for the application of the policy at any particular local area. It is the obligation of LPAs to apply both the national and regional policies while taking the local context into account.

As the local development frames (LDFs) are obligatory to promote a positive management to development, the role of the documents in different hierarchy within the development framework should be explicitly identified. The *figure 2* shows the development plan relationships. The core strategy should be a concise vision that states and reflects the local priorities based on the PPS and RSS. Once the core strategy has explained the vision, the sustainable building policies should be placed in a development control policy which allows more detailed policies to be developed based on the core strategy. Thus the sustainable building policies would be constructed to apply the local planning area.

There are two main possible policy hierarchies (LGA, 2006). *Figure 1* shows that the LPAs can choose either of them to meet the local context. The diagram of *figure 2* below shows the policy routes. In one condition, if the RSS and core strategy have not provided the concrete sustainable building policies, LPAs should develop a further development planning document in addition; otherwise, LPAs may only choose to provide an SPD when necessary if the RSS and core strategy have already include sufficient strength policies.

Figure 1: Contents of a local development framework

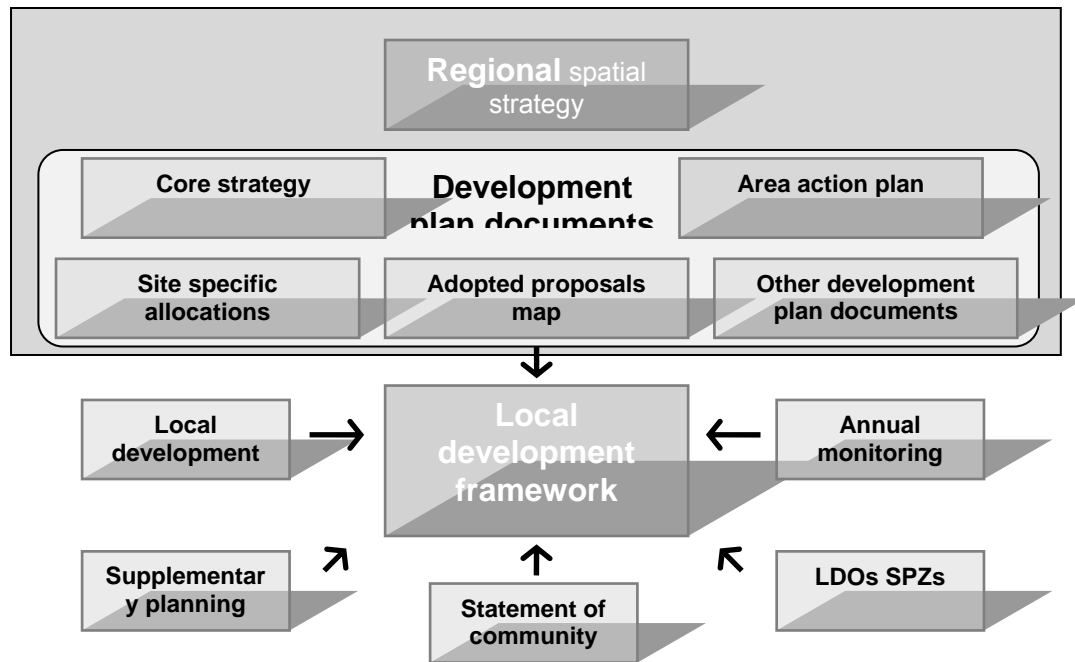


Figure 2: Possible policy hierarchy arrangements



Source: Local Government Association (2006)

The building regulation has to ensure the health and safety of the occupants and at the same time improves the energy and resource efficiency with less impact on the environment (pollutions and carbon emission). The building regulation should set the minimum standards. Furthermore it should focus on passive and low technology approaches to improve the performance of the building, rather than expensive and high technology.

To conclude, the LPAs must interpret PPS and RSS rather simply and repeat them. All the interpretations application should be based on robust local evidence and adapted to the local context.

2.2.2 Key Elements of Successful Implementation of a sustainable Policy

There are several success factors to implement sustainable building policies (LGA, 2006).

1. The most important factors are the awareness of the development control officer, the developer and the design team. In fact, some of the private developers and design teams are not ready to respond to sustainable building policies. What is worse, even some of the LPAs officers are lacking awareness and confidence to apply the policies. Thus a specialist training for the promotion of hybrid skills relevant to the sustainable planning construction industry to any type of organization and management commitment is necessary.

Provide training for members, for instance projects partners. In addition the local authorities have to raise the awareness of developers and design teams by leaflets, training and requests.

2. The standards should meet the capacity of the local construction industry that the planning framework plays a key role in creating the demand and supply to create a more sustainable construction industry.
3. The enforcement of the law is very important to the extent to which sustainable building policies can be carried out and how they can be enforced. Thus a clear definition how applicants should respond and improve the performance is obligatory.
4. Another key element to ensure success is building up a clear understanding and relationship between the building control staff and the monitoring and reporting. The integrated building control monitoring and site checks for the indicator will be a great support to the enforcement of the law.

The base line for monitoring is a local report on the environmental conditions. It is very important for the authorities to formulate the local responsibilities and the relevant impacts of the policy. One common problem for the monitoring is that the authorities have no access to resources which leads to little or no information about the success of a sustainable building policy. What's worse, without the monitoring results, it will be more difficult for continued improvement of the sustainable policies. Thus an annual report needs to create a clear framework against the plan objectives.

5. In order to make the monitoring report explicit and authentic, criteria should be clearly established to each aspect of the sustainable policies. For instance, a Sustainable Buildings Guidance (CCI, 2008) for the Northwest of Regional Development Agency have set very clear objectives and criteria for each approach of the sustainable building policy, such as carbon, waste, water use, etc. The *table 2* is an example:

Table 2: Assessing policy objectives

Policy Objective	Tools and Measures
Carbon	<ul style="list-style-type: none"> • Sustainability Checklist for Developments • BREEAM • Energy Performance Certificates • SBEM • Carbon Strategy
Waste	<ul style="list-style-type: none"> • Sustainability Checklist for Developments • BREEAM • Volume Recycled Material Content • Volume Waste to Landfill • Waste Strategy (Site Waste Management Plans, for example).
Water	<ul style="list-style-type: none"> • Sustainability Checklist for Developments • BREEAM • Net Water Use • Water Strategy
Etc.	

Source: NWDA Sustainable Buildings: Guidance Note (CCI, 2008)

2.2.3 Approach to the Sustainable Building Policy

The suggested approach in the policy should be developed from a variety of sources and take advantage of a recognised rating system such as LEED, BREEAM or EcoHomes which are regularly updated and independently assessed. The approaches should focus on technical subjects and be described at the head of the document, within flexibility schemes such as LEED and BREEAM.

The LPA should “require” particular standards based on local evidence and justification, and require from the developers to provide compliance information. If the evidence is not actually valid, LPAs may “encourage” instead, although it will have less impact on the policy.

One thing should be noted that the target or standards used in the policy should be a little challenging for the developer while they are achievable at the same time. That means that the target should present the best practises in current technical background in the local context. Thus the policies should clearly state the standard that have to be achieved rather than recommend or encourage approaches for the developers.

Table 3: A suggested template of policy:

Policy context	Planning Policy Statement Planning Policy Context
Suggested Approach	<ul style="list-style-type: none"> • General requirements which can be applied to all applications • Additional requirements developments over an appropriate threshold • Reference to SPD
optional clause	This clause could be applied to all of the policies to strengthen the implementation, if required.
potential contents for Sustainable Design and Construction (SDP)	SPD includes a detailed guidance about additional requirements and measures that would be 'deemed to satisfy' the council's requirements.
sources	Examples of policies that have been used to develop suggested policy
key guidance	Examples

Source: summarised from Local Government Association (2006)

2.3 Criteria of Sustainable Building and main rating systems

The green housing standard of Green Communities™ developed by Enterprise Community Partners was chosen by experts to apply to the Housing Trust Fund (HTF) projects in Washington State, U.S. It focuses on direct benefits to low-income tenants and it specifically states what is required and flexible to be modified, which are related to a diversity of projects that are funded by the HTF and the building practices, codes, and the climate. The objectives are helping to produce green affordable housing, which are:

- High-quality, healthy living environment;
- Lower the unit costs;
- Enhancing the connection to nature;
- Saving energy and resources to protect the environment;
- Reducing the degradation of the ecosystem;
- Local economy improvement.

Evergreen Sustainable Development Criteria(Housing Trust Fund, 2008) can be found in *Table 4*.

Another organization which develops its criteria is OECD (2002).They started the Sustainable Buildings Project since 1998 and it lasted for four years. They proposed to design government policies to concern the environmental impact of the building sector. Reducing the CO2 emissions, minimize the waste during construction and demolition and preventing indoor air pollution were considered to be more important. The criteria of the document can be found in *Table 4*.

As it is illustrated in *Table 4*, the criteria are similar, the land use, energy efficiency, recourse conservation, impact on the environment, human health and operation and the monitoring of the policy. That might be a result of globalization,

which lead to a similar development situation in the environment, society and economy. Global warming is another key factor that made people takes similar measures.

Table 4: Criteria of sustainable building

Source	Criteria of Sustainable Building
Housing Trust Fund (2008)	<ul style="list-style-type: none"> • Site, Location And Neighbourhood Fabric • Site Improvements • Water Conservation • Energy Efficiency • Materials Beneficial to the Environment • Healthy Living Environment • Operations and Maintenance
OECD (2002)	<ul style="list-style-type: none"> • Resource efficiency • Energy efficiency • Pollution prevention • Harmonization with environment • Integrated and systemic approaches

There are many rating systems and sustainable designs which provide useful instruments to assess the sustainability the buildings based on the needs of the users. There are five main rating systems for the sustainable buildings:

Table 5: Main rating systems of sustainable building

Rating Systems	Description	Countries
BREEAM	Building Research Establishment's Environmental Assessment Method	United Kingdom
CASBEE	Comprehensive Assessment System for Building Environmental Efficiency	Japanese
GBTool	an international system that has been used to evaluate U.S. buildings for the Green Building Challenge	U.S
Green Globes™ U.S.	It was from Green Globes Canada and it is tools that address the renovation, tenant build-out, operations and maintenance issues.	U.S
LEED®	Wildly used in the U. S. market and spread to multiple market of worldwide	U.S. & international

Resource: Sustainable Building Rating Systems Summary (K.M. Fowler, 2006)

There is an official adoption of an existing rating system or self-established rating system in China called *Evaluation Standard for Green Building (ESGB)* since 2006. The Chapter 4 will analysis this rating system and compare it with LEED.

2.4 Objectives of Sustainable Building Policy

According to the NWDA Sustainable Buildings Guidance (CCI, 2008), the objectives of the policy can be split into primary and secondary parts, *Table 6*. The primary objectives are a collection of wide numbers of government and NWDA strategies, therefore they need to be more detailed assessed and managed. The secondary part is the issues that have no direct target link to them but are relevant to other aspects. However, the California Department of Resources Recycling and Recovery divided the objectives simply into three parts: environmental, social and Economic, *Table 7*. Thus the priorities of objectives of the sustainable building policy should be set according to PPS or PPC.

Table 6: The objectives of sustainable buildings

Primary Policy Objectives	<ul style="list-style-type: none"> • Carbon • Waste • Water
Secondary Policy Objectives	<ul style="list-style-type: none"> • Transport • Place Shaping and Adaption • Communities • Business • Employment and Training • Whole Life Value • User Satisfaction and Comfort

Table 7: The elements of sustainable buildings

Impacts	Elements	Description
Environmental	Siting	<ul style="list-style-type: none"> • A site to well suited to take advantage of mass transit • Protect and retain existing landscaping and natural features • Recycled paving materials
	Energy Efficiency	<ul style="list-style-type: none"> • Passive design strategies e.g. building shape, orientation, passive solar design and natural lighting • High-efficiency lighting system • Properly sized and energy-efficient heat/cooling system • Minimize the electric loads from lighting, equipment and appliances • Use alternative energy sources like renewable energy • Computer modelling to optimize energy design of building

	Materials Efficiency	<ul style="list-style-type: none"> • Use sustainable construction materials; it has the several characteristics such as zero/low harmful emission; high recyclability; longevity and local production • Well-designed material planning and other material efficiency strategies to reduce the amount of material used in the building • Good plans and management for material throughout the deconstruction, demolition and construction • Adequate space and facility to manage the solid waste
	Water Efficiency	<ul style="list-style-type: none"> • Use dual plumbing system which can treat waste water and grey water separately • Using low-flush toilets and shower heads • Recirculating system for central hot water distribution
Social	Occupant Health and Safety	<ul style="list-style-type: none"> • Good overall building environmental quality can reduce the rate of respiratory disease, allergy and promote the working performance • Reduce the emit of toxic gases by zero or low emission material and Furniture • Provide positive ventilation and filtration system by good cooling and heating system • Prevent the microbial contamination by resistant materials
Economical	High investment while high cost saving	<ul style="list-style-type: none"> • High cost up front • Save more for lower operating cost throughout the life of the building • Integrated system at conceptual phase to ensure the building is one system rather than a collection of stand-alone systems which saves cost • Some costs saved by improving occupant health, reducing pollution and landfill waste which usually cannot be simply quantified

*Source: Summarised from California Government Green Building website:
<http://www.calrecycle.ca.gov/GreenBuilding/Basics.htm>*

2.5 The role of the government and communities in sustainable building

In the United States, some states established an incentive mechanism to stimulate businesses to make more effect on sustainable building construction in practice. It includes tax credits, financial grants, streamlined government permitting processes and exemptions or relaxations of zoning restrictions and other laws. Nancy J. Jing and Brian J. King(2005) analysed the benefits and limitation of government-provided financial and compared it with those of EU. It was indicated in this article that there are only a few states in the U.S. that provide a financial incentive to encourage sustainable constructions for commercial buildings. There are virtually no laws that mandate a sustainable construction. The only one exists at a state and local level but not on a federal level. The evaluation system such as LEED is developed by the industry. Self-regulation and few incentives are provided by the government to encourage using the tool. In contrast, the European Union has played a more important role in that area. The government of the EU is very active in dealing with the sustainable development and performance assessment, using BREEAM and GBTool. It is expected that the EU and the EU-level regulation will take the lead role in the issue.

Nevertheless, different from King's perspective, Seyfang (2009) more focuses on the Community action for sustainable housing. It describes a framework of 'grassroots innovation' which lay emphasis on the community-led initiatives. This framework addresses a community-based sustainable development issue on buildings. This article provided an example of America using local material to achieve the sustainable goal, and it proved to be successful. Although, it does not mean this pattern is suitable for wild spreading or scaling up, it may be an important case to attract the mainstream of the society. New approaches to create a bottom-up community action for sustainable development may be realized through this innovation at the policy level by the government.

2.6 A model for developing countries

Melchert (2007) explored the institutionalization of environmental policies in the Dutch building sector and tried to find out if they are applicable for developing countries. First, in this article, Melchert analyses the development of sustainable building practices in the Netherlands, and indicates that it turned from 'de-modernization' to 'ecological modernization', which means they are seeking the integrating approaches from self-sufficient to efficient technologies. Also he illustrates how the current Dutch sustainable building framework can serve to the area of developing countries. Although there are many differences between developed and developing countries, the environmental impact of the building sector is similar. In fact, sustainable building turns out to be more urgent in developing countries due to the fast economic growing and urbanization. Finally he points out that in those developing countries which are already fully modernized, the Dutch experience can give relevant guide lines for sustainable building and urban design. First, it is important create a sense of partnership and commitment between the government and the construction industry, which is starting by fostering dialogue and promoting the environmental awareness of all stakeholders involved. Second, a common understanding of cooperation on sustainable building practice should be clear defined in the official document.

Finally, the effective of mandatory and feasibility, which is legal, economic and voluntary instruments, should be established. Considering the problem of showed during the implementation, the enforcement of the law is very important.

2.7 Conclusion

The sustainable building context is developing along with technology, society and climate change for around 40 years. Although different organizations have different definitions of it, the basis has not been changed, which is creating a harmonious society between human and the planet.

Sustainable building policy plays a key role in sustainable building issues. A good sustainable building policy is the insurance of the success of a sustainable building development. It can be divided into three main parts: policy& planning, implementation and approaches.

The Local planning authorities must interpret a policy planning statement and regional spatial strategy rather than simply repeats them: all the interpretations application should be based on robust local evidence and adapted to the local context. There are several key factors that affect the success of a policy such as public awareness, training, enforcement and monitoring. The approaches should also be specifically developed in a particular technology area explicitly for developers.

A variety of criteria and rating systems on sustainable building is available and improved every day. From this perspective, the whole world is on the same starting line. But there are differences between the developed and developing countries and also between the U.S., the European Union and Japan. Different policies and regulations are implemented on the different levels of community from the local government to the national government. The unimpeached fact is that cooperation both horizontal and vertical is necessary for a future sustainable development on a global scale.

After the literature review my topic area became more explicit. I intend to analyse the sustainable building policy in Shanghai. I would like to analyse community actions that make effects on sustainable building issues with a case study in Shanghai in general and at Tongji University in particular. I'll evaluate whether it is successful under the SBP framework and attempt to seek a new insight in this issue and give some suggestions.

Chapter 3: Research methodology

This chapter is consisted by the method which will be used during the field work and also providing the concrete data and toolkit to analyse the research. It runs through the whole research strategic design and implementation. It provides the methods to evaluate the analysis frame work.

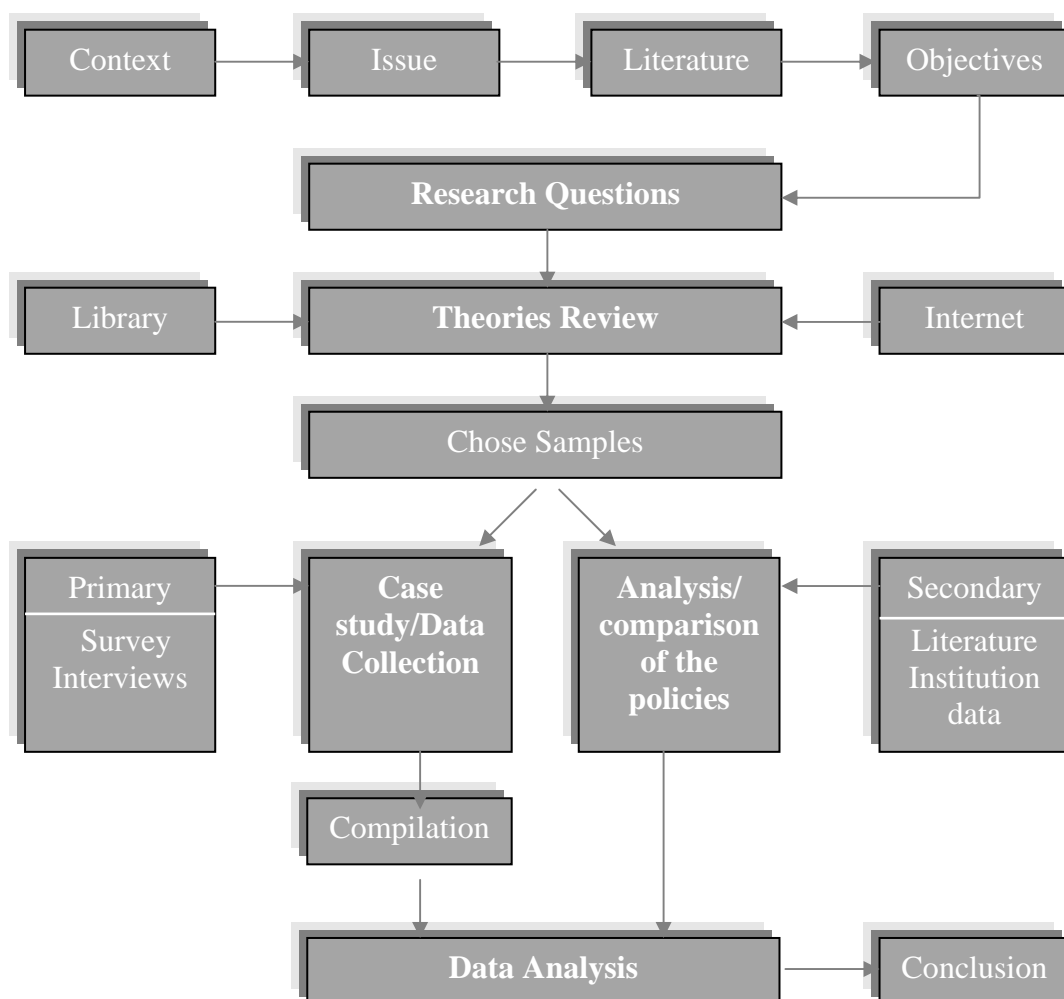
3.1 Research Type

This thesis will mainly use exploratory and descriptive research to find out what is happening in the current sustainable development in Shanghai and attempts to seek new insights on that issue. First it will analyse the current sustainable building policy in Shanghai's local context and compares it with an international study case.

This research will also use qualitative and quantitative research methods. The qualitative research will be carried out by in-depth data analysis and experts interviews. The quantitative research will rely on a community based questionnaire.

3.2 Research Design

Figure 3: Research design diagram



3.3 Research Population and Sampling Methods

This research mainly focuses on the community level. Tongji University as a big community with approximately 50,000 inhabitants is a very good sample for a case study. The students and staff selected from Tongji University will be interviewed and questioned. They can approximately be divided into four levels:

- Government/management: the manager, the local authority and institute experts
- Design: the Architects and planners, they play the key role in the design of the projects and apply the strategy into practise
- Development: the developer, the manager of Tongji university and the manager of the green campus projects
- Users: staff and students, they are the main body of users of the building. Their behaviour and awareness are also very important to the approach of sustainable building development.

3.4 Data Collection

This research uses mainly qualitative data gained by primary and secondary data sources.

3.4.1 Primary Data

In-depth interview and group discussions are the main methods that will be used to collect the primary data in the field work. The in-depth interviews will be held with the LPA, project managers, designers and the users of the buildings.

In-depth Interviews

As Cohen and Manion (1997) described, a well conducted interview is a powerful tool for it can rich the data through different people's opinions experiences and living behaviors. That means keeping the exploration and description in mind, in-depth interviewing the actors of the sustainable building issue is an efficient way to get the needed data.

This method provides the research an access to find out what is the true awareness of the managers, developers and building users. All the respondents attitudes and responses in the face to face interviews help the researcher to find out the most detailed responses and clarified answers to the research questions. Furthermore the interviews with the people that are relevant to the research issue has the advantages to collect more detail and fresh material about the research questions which can have a great contribution to this research issue.

Questionnaire

The group discussion is another method to collect the data with the goal of a directed discussion through questionnaire survey. The researcher can gather much general information from the data collected from questions while the in-depth discussion is only about one specific area. The feeling, attitudes, ideas of the participants can be collected and contribute to the research topic and make it clear.

3.4.2 Secondary Data

The secondary data is collected from the reviewed literature which is relevant to this issue, policies and programs, the report from governmental documents and programs.

3.3 Data Analysis

A qualitative data analysis method will be used to analyse the data collected from the in-depth interviews and group discussions. It can examine the means of the qualitative data. Being related to the theoretical concept of this relevant issue, the data from the collection can be compared with the conceptual framework of the issue.

The secondary data collected from the literature or other secondary sources can be analysed by exploratory and descriptive data analyses methods.

3.4 Validity and Reliability

In order to ensure the measure and collection method are valid and reliable, as Easterby-Smith et al. (1991) (Easterby-Smith, 1991) mentioned, triangulation is a good toolkit to ensure this. The data will be collected at different times of the day and from different sources. Thus the primary data and the secondary data can be collected validly. The interviewees are selected and interviewed at different times of day and different gender from different faculties and departments are chosen to ensure comprehensive data.

'Reliability is an indication of consistency between two measures of the same thing'(Black, 1999). If the data is analyzed by different measures and by different methods and it keeps the same result, then it can be considered to be reliable.

3.5 Respondents

In order to ensure the data to be reliable, the respondents are chosen from different stakeholder groups involved in the sustainable building issue, from policy decision making consultants to the executants and the building users.

Interviews

1. Manager, the local authority and institute experts (2);
2. The developer, the manager (3) of Tongji university and the manager of the green campus projects;
3. The Architects and planner (5), they play the key role to design the projects which transform the strategy into practises.

Questionnaire

1. Staff and students, they are the main body of users of the buildings.

3.6 Research Variables and Indicators

Here is a possible concept for research variables and indicators in order to measure the objectives of this study. The detailed questions of the interviews will be attached in the annex.

Table 8: Variables and Indicators of Policy Analysis

Research question	Variables	Indicators	Source of Data
What kind of system is used to measure the sustainable building policy?	Policy designing	Hierarchy	Literature
		Objectives of the policy	Government documents
	Implementation	Stakeholders awareness	interview
		Industry capacity	Literature / interview
		Enforcement of the law	Literature / interview
		Independence of building control and monitoring	Literature / interview
		Specific criteria	Government documents
	Approaches	Energy saved	Government documents
		Resource saved	Government documents
		Human health	Government documents

Table 9: Variables and Indicators of Case

Research question	Variables	Indicators	Source of Data
How sustainable is the design and implementation of the Tongji university campus from the perspective of the managers, designers and users?	Resources and energy saved	Consumed resources	Interview
		Consumed energy	Interview
		CO2 emission reduced	Interview
	Operations/ Maintenance	Money saved	Interview
	Healthy Living Environment	Temperature, humidity	Questionnaire
	Behaviour change	Individual actions	Questionnaire
		Public awareness	Questionnaire

3.7 Limitation

This study is carried out and focuses on the city of Shanghai. However, it is a very large city with approximately a population of 20 million people. It is hard to gather the overall and accurate data only through in-depth interviews and small group discussions in the short period of a month. Thus the data and analysis based on the data might not be adequate enough to represent and explain the situation in current Shanghai on sustainable building development.

In addition, there are some difficulties to get access to the data in China due to the special political system. For some information is considered to be state secret that is not allowed to be released to the public. However, this research will try to the collect the data and analyse it as adequate as possible to enhance the quality of this thesis. Therefore biased respondents selections are avoided.

Chapter 4: Research Results and Analysis

This chapter reports the research finding from the desk research and field work which mainly focus on the sustainable building policy analysis of Shanghai and evaluation of the case study sustainable campus projects of Tongji University. However, since the analysis are focus on the policy and the case study. The following analysis will combine the desk review and the field work finding to have a better understanding of the phenomenon.

The following presentation and discussion will follow the content of the first three chapters.

4.1 Desk Research Findings

4.1.1 Policy Design- National Development Policies and programs

As mentioned in chapter one, China has the biggest construction volume of the world. The energy consumption reached more than 25% of total national energy consumption in 2006 while the figure was 10% in later 1970s. However, this number was expected to grow to 35% in 2020 (Xu, 2007). Thus, the national governments concerned about the sustainable energy issues in construction sector. At the same time, energy efficiency development is expected to expand very fast since a huge expenditure of 500 billion RMB (67.7 billion US\$) was invested in energy efficiency projects only in 2008. (Xu, 2007) according to the objectives of energy efficiency improvement in 11th Five-Year Plan (2006-2010), 40% of the total energy saving targets should be contributed by the building sector.

4.1.1.1 Energy Efficiency Policy

As a result of the narrow scope and a lack of a strong regulation frame work of early building energy standards which were already discussed in the first chapter, the MOHURD (Ministry of housing and Urban-Rural Development of the People's Republic of China) begun to build an inspection program to monitor the implementation of building energy efficiency, addressing such unsuccessful issues in 2005.

The National Development and Reform Commission (NDRC) issued *the Medium and Long Term Energy Conservation Plan of China*, which intend to address the energy conservation as the basic principle for sustainable social and economic development in China and consider it to be the most urgent issue. There are different objectives based one new building and existing stock(NDRC, 2004):

1. New buildings should strictly focus on the energy saving issue which should achieve 50% energy conservation. Shanghai and other major cities like Beijing should take the lead in implementation which should reach the 65% energy-saving standard.
2. Energy conservation retrofit for existing residential and public buildings should be addressed in the urban reconstruction process. Big cities should improve 25% of the existing building area, medium cities 15% and small cities 10%.

The national government promotes the priority of office buildings and public buildings in this program for energy conservation initiatives. The monitoring and

data collection will be audited by relevant government agencies as the requirement of the 11th Five-Year Plan. However, there are no financial incentives to promote the public interest in energy efficiency building issues. Meanwhile, the MOHURD are trying to develop the incentives mechanism with other government agencies. New taxes and policies are under design to encourage the commercialization of creative energy efficiency equipment and technology by the Regional Finance Research Division of the Research Institute for Fiscal Science together with the China National Institute of Standardization. The policy and implementation plan are expected to be developed in the next few years.

4.1.1.2 Policy Design hierarchy

As the Planning & Compulsory Purchase Act 2004 of UK section 39 pointed out, the first time that the national government set the duty of planning authorities to sustainability, the local planning authorities (LPAs) have the statutory duty to exercise the functions, with the objective of achieving the sustainable development while planning local development document. However, although China's national government require the local governments to set out their own policy, Shanghai government simply use the national strategy as local policy. Since full plan-making and development control of national policy is not the only role of LPAs, the Shanghai government also has to facilitate and promote the implementation of a good quality development.

4.1.2 The Approach- National Sustainable Building Standard and Rating

4.1.2.1 The Technical Assessment Handbook for Ecological Housing in China

The technical assessment handbook for ecological housing used the sustainable development strategy as a guideline in order to protect natural resources, create a human health, living comfortable, environmental friendly build environment, and to promote the sustainable development of China's housing industry. The handbook was issued in 2001 to provide a standard for spatial planning, architecture design and construction management. This is the first eco-housing assessment system which was also the first step on sustainable building evaluation research.

There were five aspects involved in ecological housing in this handbook: Landscape Design, Energy and environment, Indoor environmental quality, Residential water environment, and Materials & Resources. It mainly emphasizes the master planning, basic performance, and life cycle of the building assessment from social, environmental and user profits aspects.

There are so many problems in the handbook that it failed to reduce the negative impacts of building to the environment. For instance, there are too many qualitative indexes while little quantitative indexes; some core data index was absent with vague or suggestive words instead. As a result, the objectivities of assessment results were easily affected by human factors due to a lack of objective constraints.

4.1.2.2 Green Olympic Building Assessment System

Another rating system called Green Olympic Building Assessment System (GOBAS) was developed from Japan's Comprehensive Assessment System for Building Environment Efficiency (CASBEE) in 2004. It was designed to assist the commitment Beijing 2008 Olympics the "Green Olympics" target. It is the first rating system about the green building issue. There is also software included in this rating system that provides "smart assessment" technical support to professional rating experts by computer.

In order to guide and evaluate the design and construction of Olympic buildings, CASBEE was monitoring the whole process while assessing the building in different stages: Master planning stage, Design stage, Construction stage and Acceptance & Management stage. Each stage has its own unique criteria to control the whole project.

It was specifically divided into two types which were called the QL score method. Q (Quality) means the building environment and occupants feeling; L (Load) means the energy, resources and environmental load. It describes green building as "acquires the best quality at a minimal cost":

$$B = \frac{Q}{S+H} = \frac{Q}{L}$$

B: Maximum building benefits; Q: Building environmental quality; L: Environmental load; S: resources consumed; H: Environmental impact and damage

4.1.2.3 Evaluation Standard for Green Building (ESGB)

Summarizing from the practical experiences and research studies combined with the international standards (especially LEED), MOHURD issued "Evaluation Standard for Green Building" (GB/T 50378-2006) in 2006. This is the first recommended national green building policy which involved with residential and public buildings considering the building lifecycle. The data of the building will be collected by MOHURD to evaluate the performance of the sustainability of the building which intends to apply a green building certification. A Three-star Green Building label will be awarded to the buildings which pass the green building assessment based on the standard.

However, the sustainable building assessment is still in a starting stage, the current system largely with reference to the U.S. LEED and mainly focussing on the environmental impact. The integrity of the evaluation criteria, hierarchy, and economic feasibility, quantitative analysis of the proportion and the establishment of relative policy still need to be more comprehensive.

4.1.2.4 Market oriented LEED

High-performance building projects are being supported both by the government and business. LEED itself is also being used. At the end of 2007, there are reported to be 24 Shanghai projects certified under LEED, with another 64 projects registered (LEED)

Figure 4: LEED Certification Phase

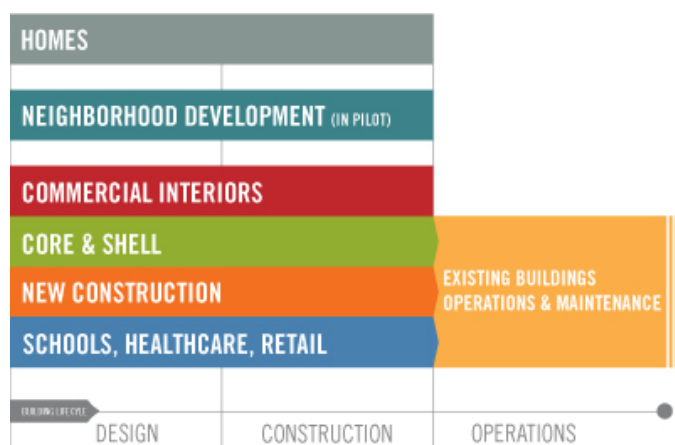


Table 10: Comparison between ESGB and LEED

Differences	ESGB	LEED
Organization	Official: MOHURD	Third-party: USGBC
Classification	<ul style="list-style-type: none"> Residential Public buildings 	<ul style="list-style-type: none"> LEED NC2.2 (New construction) LEED EB (Existing buildings) LEED CI (Commercial interiors) LEED CS (Core and shell) LEED ND(Neighborhood development) LEED Schools LEED Homes LEED Retail LEED Healthcare
Applying process	No electronic information platform	Electronic information platform
Economic benefit	rarely involved	Throughout the whole process

4.2.1.4 Incremental Cost of Green Building

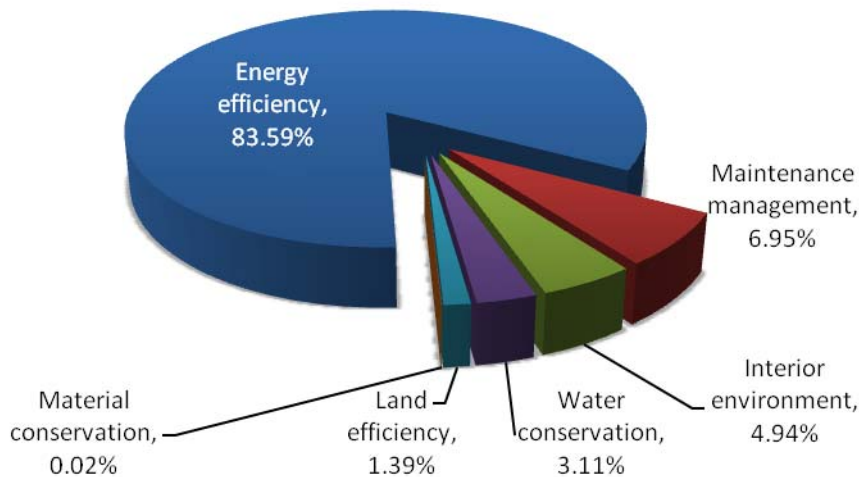
There is one incremental cost survey to China’s current green building (Sun, 2008) by the Green and Eco Building Research Centre of Shanghai. The incremental cost of green building in China means that in the *Evaluation Standard for Green Building (ESGB)* context, the incremental cost for using green technologies. For instance, efficiency land uses energy efficiency, water conservation, indoor environmental quality and sustainable management.

There is one common misunderstanding about the cost of sustainable building: many people think it is very expensive. One reason is that the developers which work on sustainable buildings projects prefer more to choose top grade projects as green building demonstration projects, plus they usually propagate the new and luxury technologies in the advertisement. As a result, the public think green building must be very expensive. Another reason is that still the green technology

is in the starting phase. Therefore the products market is small, no economies of scale and price is high, which directly causes the high cost of green building.

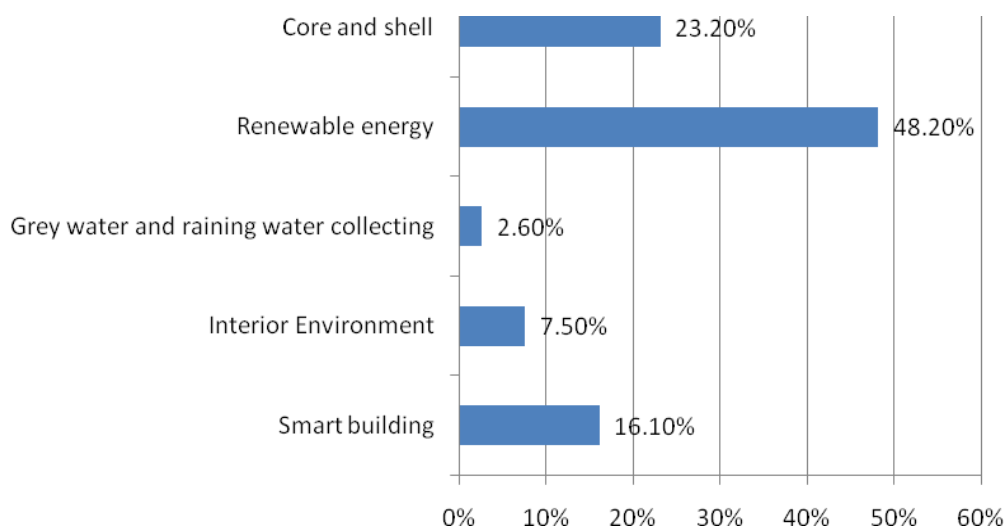
The research of the incremental cost survey indicated that the most increased aspects throughout in total 18 cases is energy conservation, the second one is maintenance and management and the following are water saving, land efficiency and material conservation.

Chart 1: The proportion of the incremental cost of green building category



Among the technologies which influence the incremental cost, the renewable energy takes about 48.2%, interior takes 7.5%, grey water 2.6%, core and shell reach 23.2%

Chart 2: Green technology influence the incremental cost



Indicated from the *chart 2*, significant data indicates that most incremental costs were spent on the energy saving of the building. There may be several reasons to explain this. One is the energy saving measures in the past were not enough, with the result that the energy saving issue became the key element of sustainable building right now. The second reason is that as the energy saving objective was

set by the government and the energy efficiency assessment becomes stricter (Miss Wang indicated that during the interview). The developers had to focus more on the energy saving issue. That means the government's actions are effective for they set building energy saving as one the main objectives of the 11th Five-Year Plan and strengthen the assessment of building energy conservation. The developers had to spend more money on that issue.

Another result demonstrated by the data was that the developers' understandings about the sustainable building significantly influence the incremental cost. According to the Mr Sun's analysis, the sustainable buildings can be divided into three types: certifications oriented, effectiveness oriented, and high-tech oriented. The reason why Mr Sun did such a division was that different concepts of the projects have huge impacts on the results of the incremental cost of sustainable building. Certifications oriented intend to achieve China's green building certification target; Effectiveness oriented mainly utilize the technology to promote the performance of the building and achieve the sustainable management objective; high-tech oriented attempts to adopt the most high and new technology in the projects to enhance the advertisement impacts and practical results. The *chart 3* shows that these different preferences lead to the differences in the incremental cost.

Chart 3: Incremental cost tables of different concepts of green building

Type	Total Investment(CNY)	Incremental Cost Proportion
Certifications oriented	209 Million	4.2%
Effectiveness oriented	755 Million	8.3%
High-tech oriented	188Million	15.9%

The *chart 3* indicates that among 18 projects that were researched, most money was invested on the effectiveness oriented green building. Those developers who only care about the "green building certification", have the lowest incremental cost proportion. In contrast, those who were more preferred to adopt high technology in the green building had the highest incremental cost proportion among these three types: 15.9%.

Thus, that means the incremental costs are not always as high as the public think. It is largely affected by aspects of the building adopting the green technology or by the objective the developers attempt to achieve. In absence of a governmental incentive, developers can design their own green buildings which meet their market strategy. By targeted strategy, developers can effectively reduce the incremental cost. On the other hand, the government can optimize the incentive policy to adapt different green technologies. For instance, the government should focus more on an energy conservation incentive to reduce the burden of the developers and improve the certification system to meet the real requirements of the market and residents.

However, as the industrial production capacity is promoting, the research shows that the newer projects has low incremental cost compared to old projects while adopting the same technology.

4.2 Field Work Findings and Analysis

This part presents what the researcher found during the field work through interviews and survey. Tongji University was chosen as a case study because of its Sustainable Campus Program. Combined with the data collected from desk research, this part tries to measure the sustainable building policy of Shanghai through the data analysis and give personal suggestions based on the research result. As a recap, my sub questions that were focused on during desk research and field work:

1. What kind of system is used to measure the sustainable building policy?
2. How sustainable is the design and implementation of the Tongji university campus from the perspective of the managers, designers and users?

Based on the two outline objectives and the research questions, the data was analysed in the following sessions. The first part presents the public and private participation in Shanghai's sustainable building issue. The next part is case study of Tongji sustainable campus program. This research tries to analyse and evaluate the case study through the data collected from interview and questionnaires, and attempts to assess it whether it is a successful sample to the city. The last session attempts to measure the sustainable building policy and implementation for several key elements that were concluded from the literature review.

4.2.1 Public and Private Participation

4.2.1.1 Institutional Structure

Shanghai Green Building Council (SGBC) is the subdivision of Shanghai Urban Construction and Communication Commission (SUCCC) which are consisted by universities, research institutes, design institutes, real estate developers, green building technologies and products manufacturing company. As the respondent from SGBC, Mr. Xu (Vice-Secretary General of SGBC) indicated during the interview, t this council is public and private participated. It is the first organization which focuses on green building issues throughout the whole country. It is commissioned by the Shanghai government, exercising and managing green building-related administrative work. The main objective is in charge of accepting, inspecting and assessing the application of green building rating labelling project in Shanghai. Besides, there are several other objectives that this council have to work on:

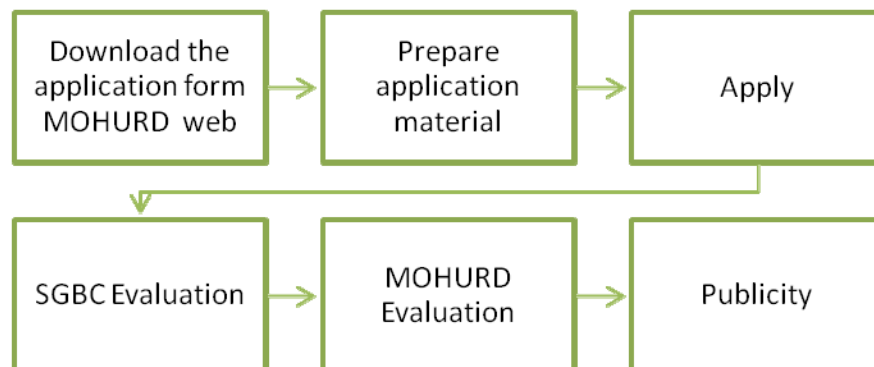
- Promote green building concepts, and enhance public awareness of green building, universal-related knowledge, promote new products, new materials and new technology applications which involve information technology, intelligent technology and green building technologies;
- Organise market development, release market information and promote green building-related technologies and products and provide business training and advisory services;
- Give suggestions to relevant department of local government to formulate recommendations of relative standards or participate in the formulation of technical standards;

- Reflect the sustainable building issues involved the professional field to the government and concerning economic policy and legislative advice;
- Carry out the statistics research, publish information in the professional field and undertake the implementation of green building labelling assessment;
- Organize the scientific research in sustainable building field through the commission by private organizations;
- There is also long-term cooperation with U.S. Energy Foundation to promote demonstration and practice projects in Shanghai.

4.2.1.2 Legislation

As the main objective is green building certification, here is the work flow of the application.

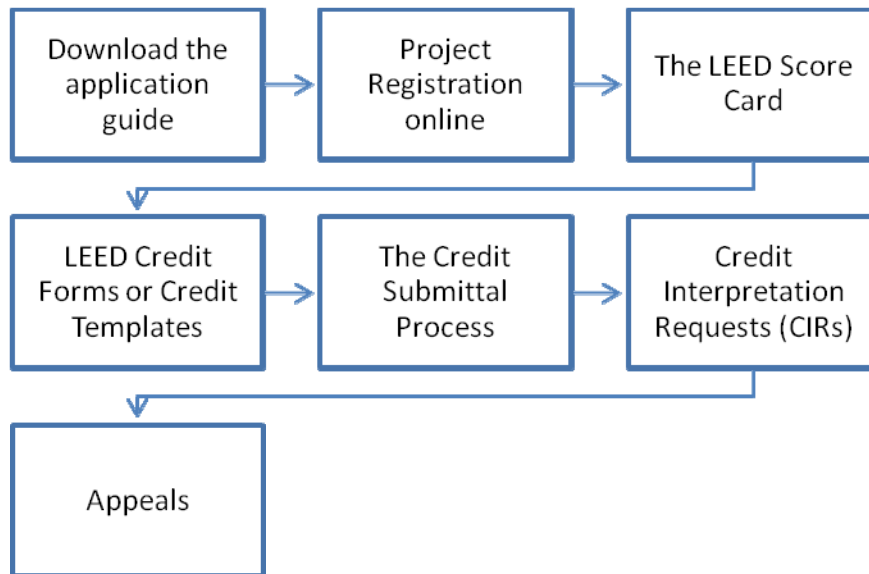
Chart 4: The LEED application process



Comparing with China's application process, the Compact and simple application process is one of the reasons that LEED can success in building market(Wan, 2009). As indicated by chart 5, LEED is more mature and efficient. For all the building is evaluated by USGBC, that makes the process more equitable and convincing. In addition, LEED has a clear requirement on the assessment time for each phase of the certification. And the information platform of certification is open to public that members can learn the necessary information. That is what the China government can learn from.

According to Mr Xu, Vice-Secretary General of the Shanghai Green Building Council, there are 40 projects that have passed the green building certification countrywide and more than 10 are located in Shanghai at the end of 2009.

Chart 5: The LEED application process



4.2.1.3 Private developers' Participation

The private developers do not only focus on the single sustainable building but also on the whole sustainable residential community. In 2009, China Real Estate Chamber of Commerce (CRECC) formulated their own “*Green and Low Carbon Residential Community Assessment System*” based on the “*Technical Assessment Handbook for Ecological House of China*”. The respondent Mss Wang who was junior manager of Poly Real Estate Group indicated, the green and low carbon concepts are overlapping, but also different. They have both an energy saving issue. However “green” means more focus on occupants comfort and health while low carbon building attempts to reduce the GHG emission. There are no contradictions between the two. To her opinion, carbon quantifying is necessary for further development of green building according to international trends.

Mss Wang also said that the Poly Real Estate Group is one the members who participated in formulating the “*Green and Low Carbon Residential Community Assessment System*”. According to their own company’s survey, most of the residential buildings are already reaching the “low carbon” target, however, that is not true. For it reduces the comfort of service and facilities. Low carbon is not always energy efficient. Right now the key point for China’s low carbon process is achieving the energy efficiency providing a comfortable indoor environment. Thus CRECC formulated the assessment system for low carbon house to promote the developers and residents awareness.

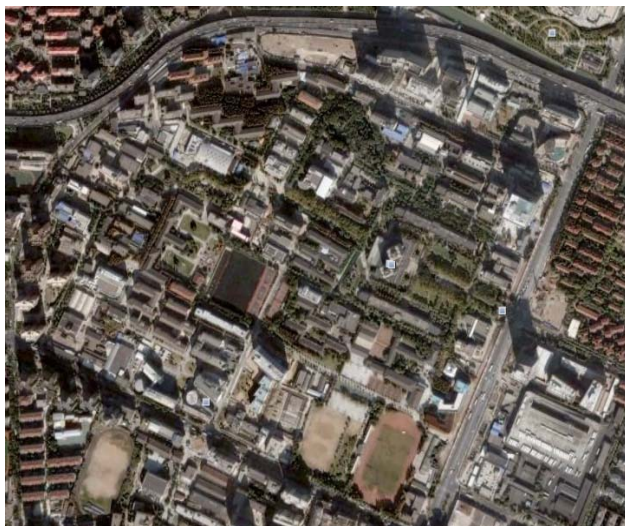
Although the developers are very interested in sustainable residential complexes, the high cost simulated form market feasibility analysis showed that it is still not possible to apply green technology in large scale. For there is not any incentive mechanism by either national government or local government, the company which Mss Wang belong to is more willing to choose one or two newly developed residential complex as a “touchstone” of the market demand. “Marketization of Green building is just at starting step.” Miss Wang said, “Our Company intends to try a demonstration project to show our confidence on this area.” “After all,” she

added “the customers are more care about the price and area rather the sustainability, for there is no brief evidence to show how much money they can save if they live in a green building.”

4.2.2 Case study of Tongji Sustainable Campus program

Tongji University was founded in 1907 by a German doctor in Shanghai. Right now, Tongji is a comprehensive university with nearly 40,000 students at all levels. The School of Environmental Science and Engineering and the Institute of Environment for Sustainable Development of Tongji University have been crested in partnership with UNEP. The university has already been thinking about the greenhouse gas emissions. Plus, based on the research and experience of sustainable campus, Tongji also formulated the “*the Guide of Sustainable Campus Construction and management*” for MOHURD and operated as a demonstration campus for other universities.

Picture 2: Green Building Demonstration in Campus



In general, colleges and universities undertake multiple functions like talent training, scientific research, social services and culture leader. In the sustainable development background, they are expected to be the pioneers. Tongji University insist the concepts of sustainable development and construct a sustainable campus through scientific innovation, energy efficient technologies and sustainable management. Besides, the sustainable consensus is promoted by public participation. Students and staff are educated to form the conservation campus culture through three approaches: technology, management and public education with participation. According to the Dr. Tan, Vice Executive Director of Green Building & New Energy Research Centre in Tongji University, the university attempts to emphasize the sustainable development concept throughout the education process with scientific research and to apply it in each management

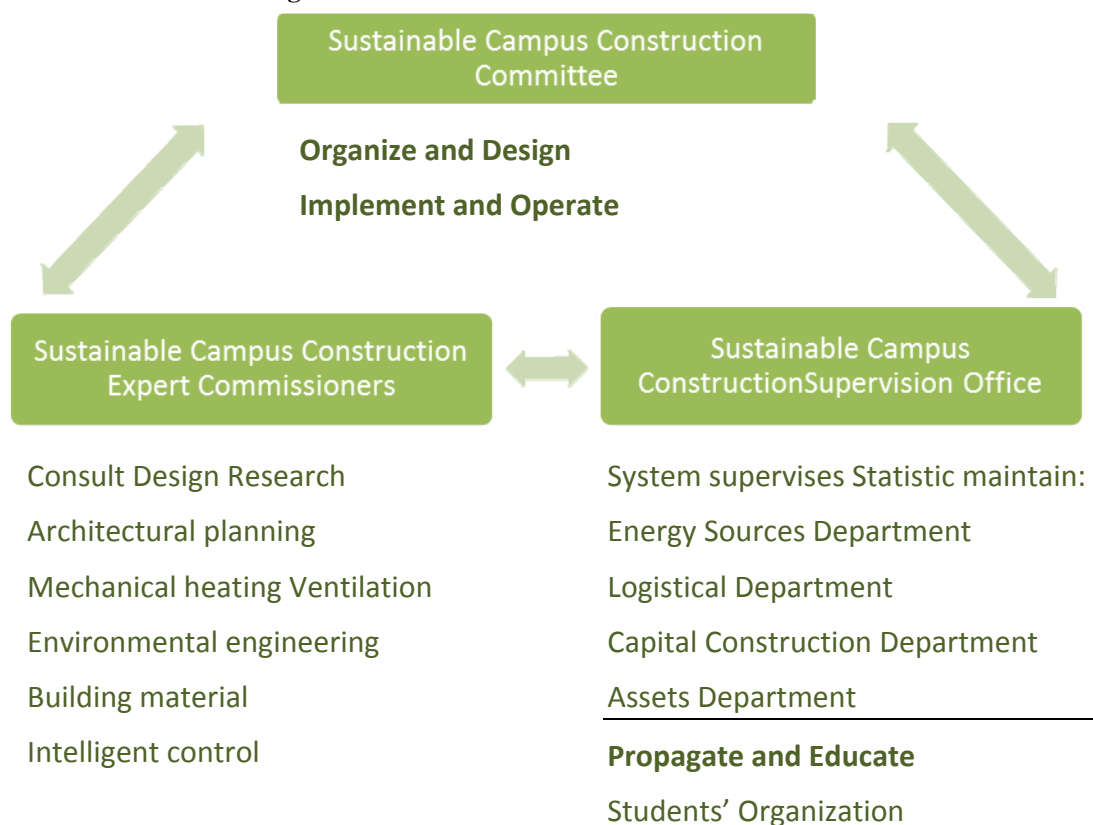
platform. He indicated during the interview, Tongji attempts to become the demonstrative education base of sustainable development for other colleges and universities. Furthermore Tongji can also provide a scientific support for national and regional sustainable development strategies.

4.2.2.1 Sustainable Campus from Managers and Designers' Perspective

4.2.2.1.1 Institution of sustainable campus construction

There are three main organizations that deal with a sustainable campus construction. The sustainable campus construction committee takes the responsibility to develop the policy in the campus. They mainly make their decisions based on academic research, but consider less about the local and national policy. "Our standards are much more restricted and beyond the governmental policy" Dr Tan said, "we also have international communication about sustainable campus issues with different university, like ETH and the University of Tokyo."

Chart 6: Institution organization structure



4.2.2.1.2 Objective and Achievement

Tongji University started to build a sustainable campus since 2003 and took the lead nationwide. Through the participation of faculty, students and staff on resource-saving, the consensus was formed. The sustainability has been approached through three ways of technology, management and education.

Technology approach

A variety of energy-saving systems had been applied in the campus, such as a solar water heating system for the students central bathhouse, an electricity thermal storage boiler, bathhouse wastewater reuse and heat recovery and an artificial wetland for wastewater. The primary objective was energy saving and water conservation, which follows the renewable energy and resources recycling development policy. Energy-saving and water-saving measures have been emphasized. 100% of the irrigation water in the campus comes from non-tap-water sources. During the building of these projects, one has been strictly focused on the national energy-saving design standards. Comparing the national objective of the performance of building energy saving, Tongji campus had already achieved more than 65% (official website). New eco materials and green technologies for building energy saving have been fully applied in the new building or renewal of historical buildings, for instance heat-insulating, low-E windows, architectural sun shading, roof greening, and energy-saving lighting. The projects took different measures according to specific conditions and have adopted a geothermal heat pump, air cooling/heating preconditioning system with wind tunnel ventilation, and the comfortable and energy-efficient radiant cooling/heating system. The displacement of air-conditioning and a hybrid ventilation system have also been applied in the large spaces of the buildings. The application of the ice storage air-conditioning system is beneficial to city power grid peak load shifting. Obviously, the application of these integrated energy-saving technologies plays a key role in energy saving improvement while achieving remarkable economic benefits and the effect of environment protection.

Picture 3: Solar panel



Picture 4: Skylight



Picture 5: Planting facade



Management approach

As Dr Tan indicated that management in achieving the energy-saving and resource saving objective had brought great economic benefits for Tongji University. The university focus on the management of electric power and water use for students. The installation of intelligent card faucets in the bathhouse and dormitories and the use of all-in-one cards for paying for water and electric power fee in campus have result in a remarkable decrease of electric power (40%) and water (30%). In addition, the bathhouse can receive over 4,000 people each day after the renovation, which was 1.5 times increase compared to its previous capacity of 1,700 people. Therefore, a large amount of the investment which should originally have been paid in the new bathhouse had been saved.

Chart 7: Electricity fee for the campus from 2004-2008

Million Yuan

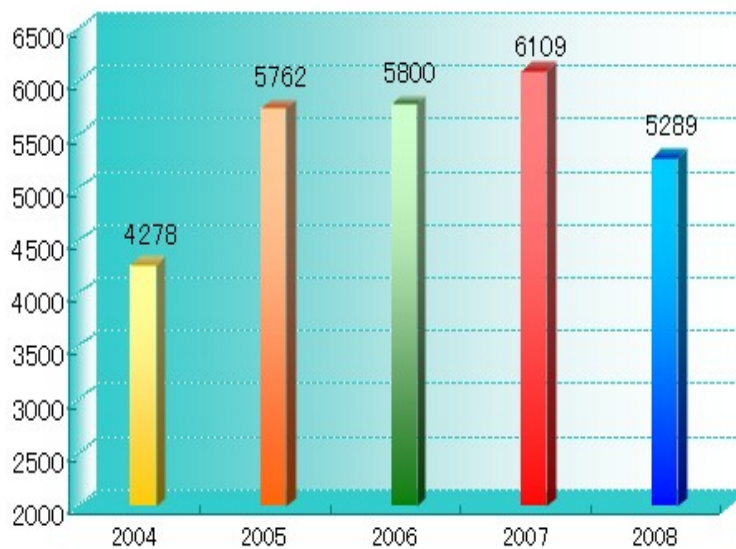
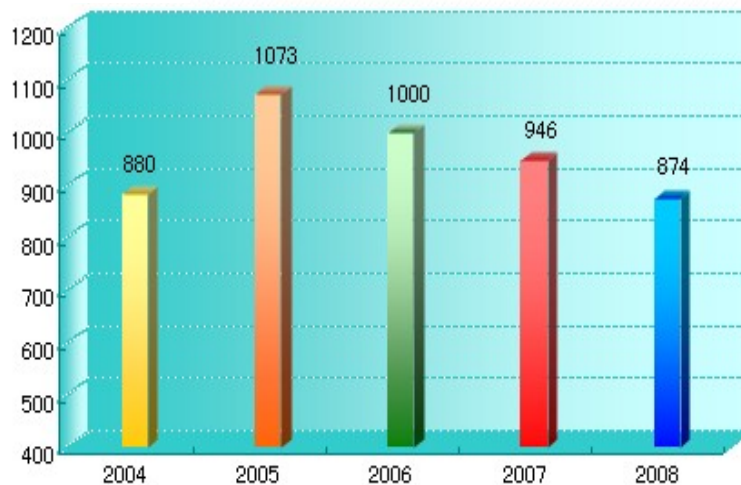


Chart 8: Water fee from 2004-2008

Million Yuan



Source: <http://www.tongji.edu.cn/sc/statistics.asp>

Education and behaviour approach

Learning from the official website the researcher found out that the multi-level sustainable education and activities have been established on the campus for demonstrating and popularizing the green technologies, promoting the public awareness, and offering support and guidance to sustainable activities of the students. A series of theme activities for all the students such as Water-saving and Power-saving Week, food-saving Week, Green Week of Environment Protection have been held on the campus. In 2005 students took the initiative and organized the Energy-saving Supervisory Team on campus. This team works not only to supervise but also to educate in terms of energy saving. Supported by its academics strength, the university offers well-planned courses in energy saving and environment protection. Lectures on energy saving and recycling resources have also been held for people both inside and outside the university, which plays a role in disseminating the know-how of energy saving while serving the society. This research has an investigation of the achievement of the public awareness promotion by the university to see whether was successful. Dr Tan indicated that saving energy through technology, management, and education has brought remarkable effects. The total energy cost in 2006 is 12 million RMB less than that of the budget.

The Sustainable Campus Construction Management and Technological Guidelines in Higher Educational Institutions, the nationwide regulation has been implemented in Tongji University. The academic researchers are leading the construction of the sustainable campus while the latter promotes the former. This also offers great support in science and technology to energy saving and emission reduction for the society.

Picture 6: Energy saving propaganda team



Source: <http://www.tongji.edu.cn/sc/statistics.asp>

4.2.2.2 Public Awareness from User Perspective

4.2.2.2.1 Questionnaire Sampling

As the university attempts to promote the public awareness through multi approaches, this research did a survey about the public awareness about the sustainable behaviour of the students and the staff. There was a pre-test in order to validate the items. The questionnaires were sent to five students, two building operators and three lecturers. Several changes have been made based on the feedback of the first questionnaire. First, two questions were too specific and were not suitable for the public and deleted in the final version. Second, one question about the information of the background of the responds was added into the questionnaire on to the results of the survey.

Fifty final version questionnaires were sent to different respondents which are main body of the users of the buildings in the campus. Since the questionnaire was not very long and the respondents were all selected from the campus, thus all fifty questionnaires were considered to be valid.

Chart 9: Components of respondents

Respondents	Number	Rate
Lecturers	10	20%
Building Operators	10	20%
Students (Architecture and Environmental Science major)	10	20%
Students (Other major)	20	40%
Total	50	100%

4.2.2.2.2 Analysis of Questionnaire

Understanding about sustainable building issue

The first part of the questionnaire is about understanding sustainable building. With the main objectives of sustainable building being:

- Efficiently using energy, water, and other resources;
- Protecting occupant health and improving the employees productivity;
- Reducing waste, pollution and environmental degradation.

It involves several aspects including the definition of sustainable building. What according to the respondents are the most important aspects to sustainable; the life cycle of sustainable building. The *chart 10* shows that almost all the respondents think energy efficiency and resource efficiency belong to sustainable building objective; Most of them think it involves environmental friendly and human health issues. However, 29 respondents, 58%, think Green Plants on the facade or on a roof is one the objectives of sustainable building. In fact, it could be green

facades or green roofs on the building; however, it is not the main objective of sustainable building. Among those who select the green plants, showed in *chart 11*, the lectures and relevant major students performed better than building operators and other major students. That means education of relevant knowledge is necessary because it effectively promotes the public awareness.

Chart 10: Understanding objectives of sustainable building

Objectives of SB	Number	Percentage
Energy efficiency	49	98%
Resource efficiency	46	92%
Environmental friendly	43	86%
Good to human health	41	82%
Green plants	29	58%

Chart 11: Those who select the Green plants

Respondents	Number	Percentage
Lectures	4	40%
Building operators	6	60%
Relevant major students	3	30%
Other major students	16	80%

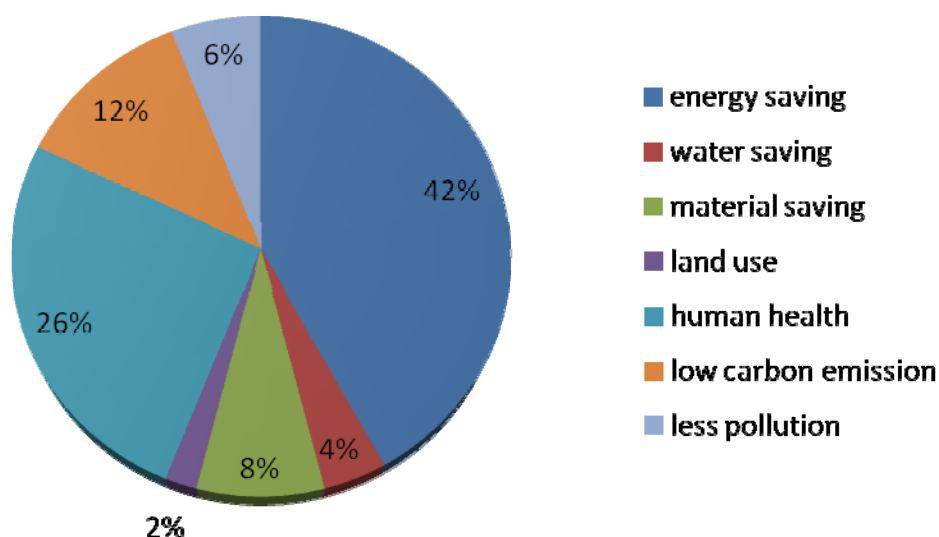
The next *chart 12* shows the attitude of the respondents to different objectives of sustainable building. Around 42% of the respondents think the energy saving issue is the most important aspect related to the sustainable building issue. There were also 26 % thinking human health was the key point of sustainable development. There were mainly three categories answered by the respondents. The first is public education, most of the propagation is about energy saving issue, thus the public agree and think it is the most urgent issue; second, the government also emphasize energy conservation objective in the 11th Five-Year Plan (2006-2010), 40% of the total energy saving targets should be contributed by building sector. Third, the energy waste was very common in normal building use.

Another objective respondents think to be important is human health. Respondents who chose this item think the old buildings in China were focusing on the function while the human health is less considered about. That is the fact, especially in Shanghai which has a hot humid summer and a cold humid winter; human comfort is really terrible in a building without fans and air conditioner or heating

system (there are no mandatory heating mandatory facilities in south China). Normal Natural ventilation design is useless in summer for there is no wind and even when there is, the wind is humid and hot. Besides the windows in Shanghai used to be single-glazing, although the “*Design Standard for Energy Efficiency of Public Buildings (GB 50189-2005)*” requires that all the new public building should use double-glazing. According to one investigation (JN, 2008) only 10% of the current total building have already been adopted in 2008. Building energy consumption is ostensibly very low, the actually situation is that the human health and comfort was lowered down. The result from the questionnaire shows that the occupants realized their situation and have a demand to improve the interior environmental quality.

The rest of the other aspects are not so important to the respondents because they are not very close to the users when they are operating and maintaining the building.

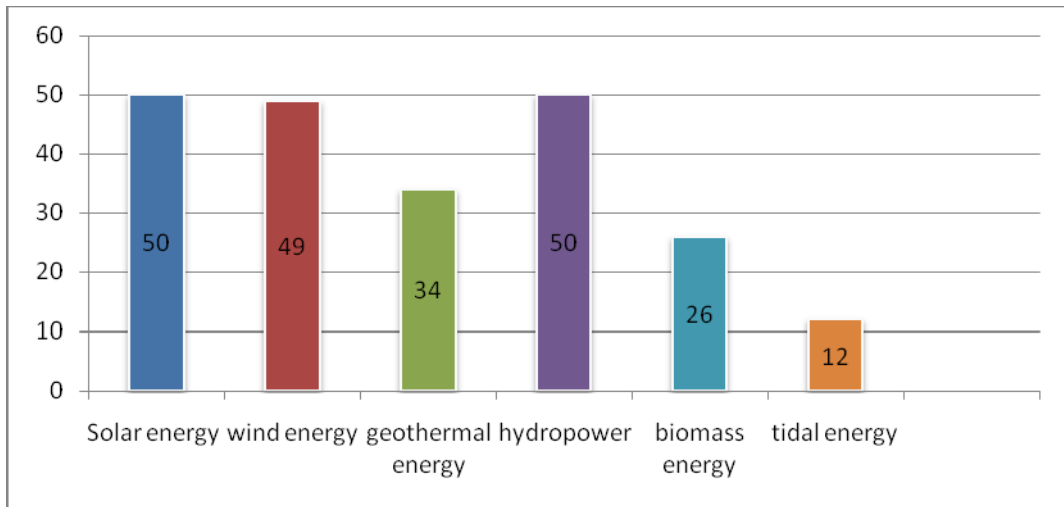
Chart 12: The most important aspects respondents considered



Human comfort about sustainable building

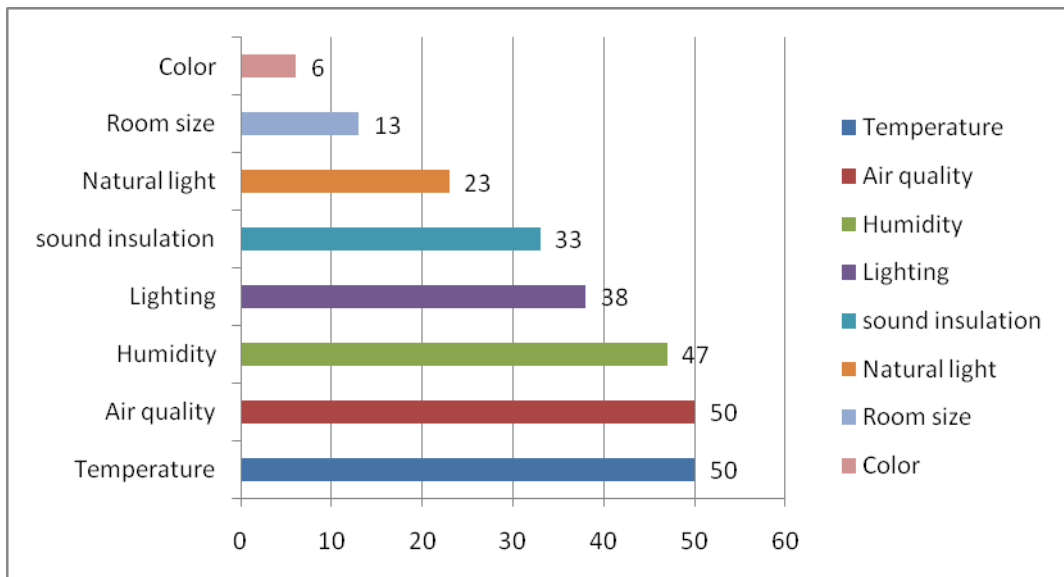
Almost all the respondents think that solar energy, wind energy and hydropower are suitable for the building consumption as renewable energy. In fact, in Tongji Campus, solar energy transformed from solar panels is used as the energy supply. Dr. Tan indicated that the central bathhouse, where all the students in the campus have to take their shower, is totally supplied by solar energy. Passive energy conservation design is also widely applied in sustainable building renovation. However, most of the buildings, including sustainable renovated buildings, still use single-glazing windows, for there used to be no mandatory regulations to force the developer to adopt double –glazing windows. Thus, although people realized the role of double –glazing windows played in energy conservation, only a few building use that.

Chart 13: The most popular clean energies respondents preferred



The survey shows that the temperature, indoor air quality and humidity are the factors respondents think to be significantly related to human health. 38 persons consider lighting in door is very important. 33 persons think sound insulation is important.

Chart 14: Factors to human health:



The question if the respondents have different experiences in sustainable buildings compared to normal buildings was answered by 39 persons who ever have been in a sustainable building. 27 persons indicate significant differences between sustainable and normal buildings. 9 persons are neutral and 3 persons think they are totally the same.

According to the survey, the most famous building is the Wenyuan Building which finished its sustainable renovation in 2007. It was built up in 1953 and is the earliest building with Bauhaus style. The renovation project was accomplished by a combination of various green technologies and new materials, including interior thermal isolation, low-E window glass, roof greening, solar photo voltaic

conservation technique, a rainwater collection system, a ground source heat pump system, efficient lighting, and etc. The architect Mr Wei was very proud of this project. He said it is the most sustainable building in the campus. There are even no central air conditioners or fans in the building. He said they did a survey to the students having lectures here. Most of the respondents have comfort experiences after the renovation due to the excellent passive energy conservation design that achieves better thermal performances and natural ventilation. However, Mr Wei admitted that they spend a lot of money in this project and some facilities are sponsored by the manufacturer. He pointed out that it is not possible to apply these technologies on a large scale in the city. Because the university has its own technology and financial support they do not always have to think about the economic benefits and they were able to build so many sustainable buildings in the campus. At last, He added, the passive energy conservation design lead to a really good result and it should be encouraged in the current situation.

Public awareness about the campus education activities

The next part of the questionnaire was about the public awareness about the campus education activities. As the university intend to promote the sustainable awareness through a multi-level education and practice, the following analysis looked if it was effective.

Chart 15: Respondents who knew the sustainable campus program

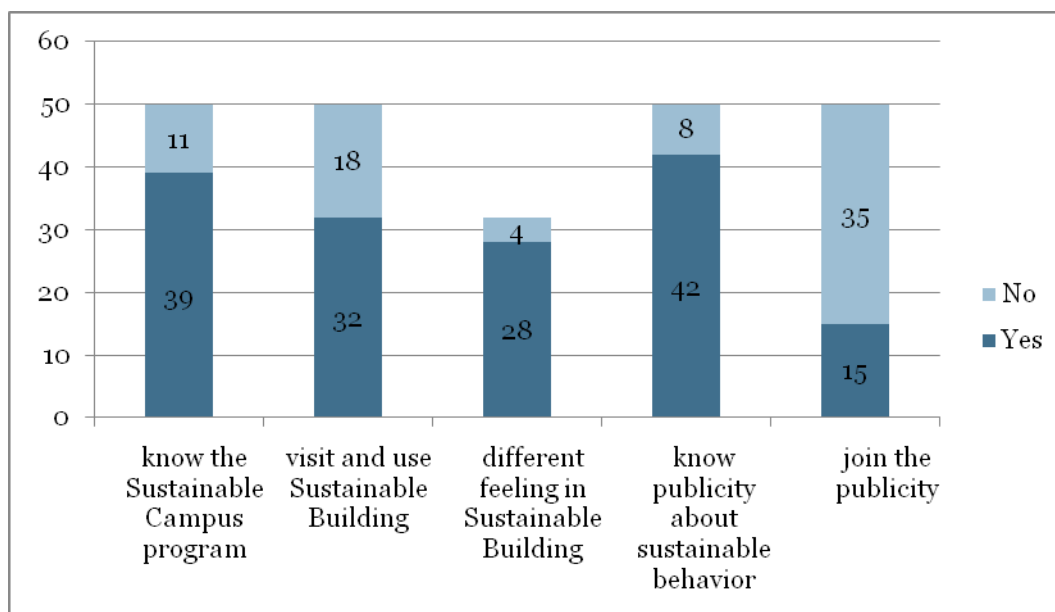
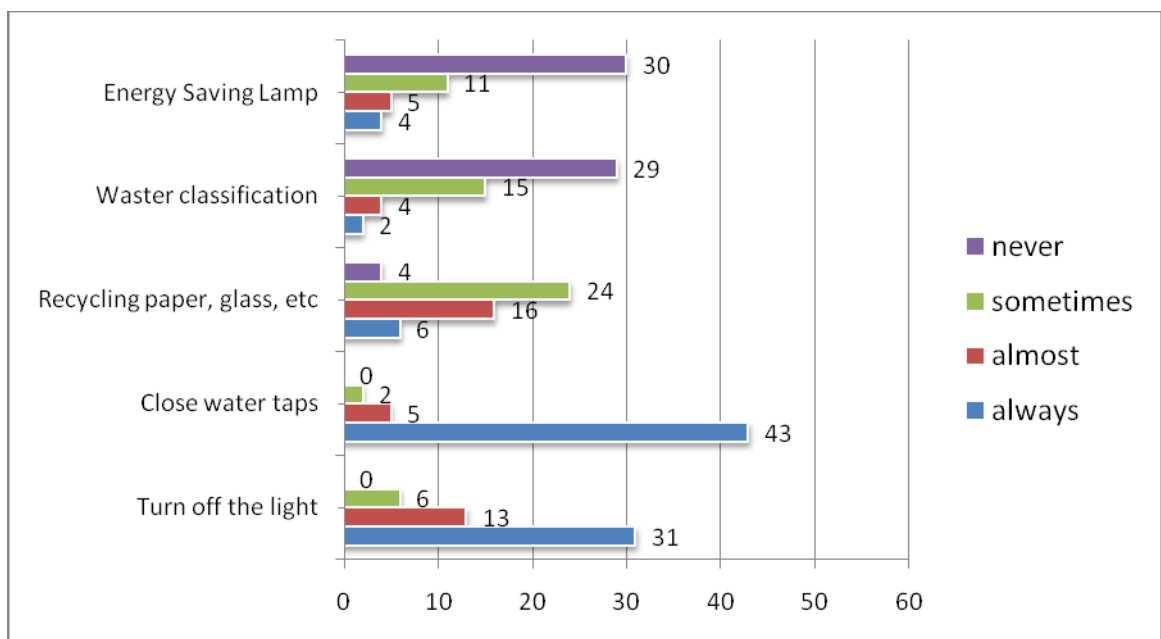


Chart 15 shows that 39 persons out of 50 knew the sustainable campus program. 32 had ever been visiting the sustainable buildings in the campus, and among these 32, 28 have a different feeling in the sustainable buildings. Some of the students and almost all the lectures have been working or studying in the campus before the program started. Thus the result illustrated that the sustainable renovation was effective. Furthermore 42 people know the public education and practice publicity. However, only 15 out of 50 had participated in the publicity activates. That means that although the university provides the support and guidance to sustainable issues in the campus and most people know the activities,

only a few people chose to join the activities. The public interest still needs to be promoted.

Chart 16 shows the sustainable behaviour in the building from the respondents. It shows, most respondents close the water taps and turn off the light in the buildings without an automatic system. Little respondents have a recycling behaviour. Nearly 30 persons never used solid waste classification or energy saving lamps. A reason that can explain this situation, according to the researcher's experience in the University and the observation, is the fact that there are no rights for the user in the campus to change the lamps in the room. The university do not use that kind of facilities yet. Mr Wu, vice director of the Energy Centre of Tongji University told me that the university is thinking about change all the lamps in the dormitory into energy saving ones, however, since it was a big project, it had not been implemented yet. As for the solid waste classification, Mr Wu indicated, although the university held several waste classification publicity, it is hard to apply it right now in the practise phase, because Shanghai city do not have an efficient system. Thus it still stayed in the promotion stage.

Chart 16: Respondents who knew the sustainable campus program



4.3 Implementation- Key Element of Successful SBP

In chapter 2, several key elements of a successful implementation of sustainable building policy(LGA, 2006) have been listed. They are based on these key elements. This thesis will analyse the sustainable building policy by desk research and in-depth interviews. Respondents are selected form different groups and mainly belong to three categories: Manager, Designer and Developer.

1. Local authority (1) of Shanghai green building council (SGBC)
 - *Xuling Xu, Vice-Secretary General, Shanghai Green Building Council*

2. The manager (3) of Sustainable Campus Commit (SCC) of Tongji University
 - *Hongwei Tan, Dr. Prof, Vice Executive Director of Research Center of Green Building & New Energy.*
 - *Zhenyu Li, Dr. Prof., Vice Director of Architecture and Urban Planning faculty.*
 - *Cunyi Wu, Director of management Centre.*
3. The architects involved in green building designing (2); other architects (3)
 - *Wei Wei, Feng Qian,*
 - *Li Zhang, Paul Chen, Shaojia Song*
4. Private developer manager (1)
 - *Fang Wang, junior manager of Poly Real Estate Group Co., Ltd*

4.3.1 Awareness of the development control officer

The most important factor is the awareness of the development control officer, the developer and the design team. As indicated in the *chart 17*, the manager, local authority, developer and architects who are involved in the sustainable building field have a good understanding of the topic. While ‘normal’ architects without green building projects are not very clear about it. But during the interview they mainly emphasize the energy efficiency issue while other objectives of sustainable building are more or less ignored. No respondents were talking about land use for instance, although they know the importance. Life cycle assessment is in a similar situation. Related to the questionnaire, the whole society sets energy saving as primary target. Since the social structure in China is top down, the national government is encouraging that issue and set it as the main objective of the 11th Five year plan. All departments are working toward this aim. Unfortunately, the achievements of the 11th five year plan will be published next year, so the efforts cannot be evaluated yet. However, Mr Xu (SGBC officer) disclosed that according to 2009 statistics, and stated that it is very challenging to achieve to objective that the energy saving in the building sector reaches 50%.

Chart 17: The awareness of sustainable building issue

Respondents	The awareness of sustainable building issue
SGBC Manager	Both the government officer and the manager of Tongji university have good understanding of the objectives of sustainable building; however all of them mainly focus on the energy saving issue
University Manager	

Architects	To my surprise, most of the architects except one green building renovation project designer only have a rough understanding of sustainable building. As the design team, they simply think that sustainable building equals energy saving building.
Developer Manager	In contrast, the private developer manager has a better understanding than other respondents.

4.3.2 Local industry capacity of sustainable building technology

The standards should meet the capacity of the local construction industry because the planning framework plays a key role in creating the demand and supply for a more sustainable construction industry. The survey by the Green and Eco Building Research Centre of Shanghai (Sun, 2008) showed that an important part of the incremental cost in sustainable building is caused by new sustainable materials, new energy or new technology. However, the price of the new technology or industry production will lower down year by year because the industrial capacity of sustainable building technology is rising.

Chart 18: Local industry capacity of sustainable building technology

Respondents	Local industry capacity of sustainable building technology
SGBC Manager	<ul style="list-style-type: none"> • Encourage the low-tech design and local material construction right now for the high cost of green technology; • At the same time, they also encourage innovative development of the local industry;
University Manager	<ul style="list-style-type: none"> • Mainly based on the new technology for the university can provide the technical and financial support; • Associated with the Passive Building Energy Conservation Design;
Architects	<ul style="list-style-type: none"> • It is difficult to apply new technology in current design projects for the clients do not have enough budgets on that. • Basic principle to use Passive Building Energy Conservation design;
Developer Manager	<ul style="list-style-type: none"> • Willing to use the Mature technology.

4.3.3 The enforcement of the law

The enforcement of the law is very important to the extent which the sustainable building policy can be carried out and how they can be enforced. However, although there are many policies involving different aspects of sustainable building issues, like water, energy, land, there is no mandatory comprehensive policy specifically focussing on sustainable building. The application of green building certification is in voluntary without incentives. The enforcement of the policy is very weak. The *Evaluation Standard for Green Building* is not so comprehensive compared with other countries' rating systems like LEED or BREEAM. The effect which follows the ESGB is not as effective as LEED.

Chart 19: Enforcement of the law

Respondents	The enforcement law and standards
SGBC Manager	<ul style="list-style-type: none"> • No mandatory norms except several basic principles involved in the Passive Building Energy Conservation Design; • No incentive mechanism except Green Building Labeling;
University Manager	<ul style="list-style-type: none"> • In order to meet the university centennial, intent to building a sustainable campus; • Demonstration program in concert with the newly established Technical and Management Guideline Of Sustainable Campus by MOHURD;
Architects	<ul style="list-style-type: none"> • There is already a mandatory Passive Building Energy Conservation regulation, however the standard is quite low;
Developer Manager	<ul style="list-style-type: none"> • Pay more attention on this issue; • As the green building policy regulation is not obligatory and there are no strong requirements from the market, has less interest to apply the green building technology on current projects.

4.3.4 Relationship between building control staff and monitoring

A clear understanding and relationship between the building control staff and the monitoring and reporting is another key element to ensure success. The integrated building control monitoring and site checks for the indicator will be a great support to the enforcement of the law. Take Tongji as an example, there is a smart network all over the campus with which data can be directly checked through one interpreted platform. The construction supervision office implements the policy of the sustainable campus construction committee and collects data and gives input to to the smart platform. A construction committee can check the data at any time and adjudge the policy based on the data analysis.

However, according to SGBC manager, all the data of the building which would like to apply the green building certification are collected by the user of the

building and send to SGBC by paper application. SGBC evaluates the building through those data. The obvious weak point is that the government have no real time data resource. What's worse, a lack of a third party assessment organization might cause unclear, unequal and non-transparent monitoring and reporting. At a large scale, when the government cannot collect the clear and accurate feedback, it might result in difficulties for continued improvement of sustainable policy.

Chart 20: Monitoring and rating system

Respondents	Monitoring and rating system
SGBC Manager	<ul style="list-style-type: none"> • Encourage developers to apply the Green Building Labeling voluntarily at the design period; • Evaluate the data sent by the developers in operating period; • Encourage the combination of Green Building Labeling system and other industry rating system;
University Manager	<ul style="list-style-type: none"> • Follow the Evaluation System of Sustainable Campus by MOHURD ;
Architects	<ul style="list-style-type: none"> • Green Building Labeling by government; • LEED is wildly accepted as industry rating system in current market.
Developer Manager	

Chapter 5: Conclusion

5.1 Introduction

This chapter reveals the primary research findings and the answers to the research questions. Subsequently, it forwards recommendations which are concluded from the research results and attempts to give an indication for future research in this research field.

5.2 Recapitulation of the Study

This research attempts to analyse Shanghai's current sustainable building policy and to find out the strong points and weak points. Furthermore, it exams the performance of demonstration projects in Shanghai. Finally, it tries to give suggestions for potential approaches to the sustainable building development in China. The foundation mentioned in the first chapter brought the background of this research that the building sectors plays a key role in the global economic, social and environmental development. China, which is experiencing a very fast economic growth and urbanization period, meets many problems in sustainable land use, energy efficiency, life cycle of the building, etc. Although both the national government and the local government have already paid much attention to sustainable building issues, there are still many barriers in this area to overcome. The most important are: absence of specific regulations and standards, technical barriers, public awareness of sustainable development and the lack of an incentive mechanism.

Related to the theories (LGA, 2006) of accessing to successful sustainable building policy, the sustainable building development framework can be divided into three parts: policy planning, implementation and the approach. The desk review and case study followed these three parts.

5.3 Reflection on Research Findings and Conclusion

In this research, the main research question is:

How to measure the sustainable building policy of Shanghai and what can we learn from that?

To answer the main research question two sub questions are formulated:

- What kind of system is used to measure the sustainable building policy?
- How sustainable is the design and implementation of the Tongji university campus from the perspective of the managers, designers and users?

The data collection and analysis was divided into two parts. One part tried to find out a method to measure the sustainable building policy. According to the literature, this study assessed the policy from three aspects: policy planning, implementation and the approach. The other part was assessing the sustainability of Tongji campus from the perspective of the managers, designers and users. In-depth interview and questionnaire were used to collect primary data and gain insights as additional information besides the desk research to answer the questions.

Policy design

Unfortunately, the study through desk research did not find anything on how the Shanghai local authority developed its own local development strategy based on the regional development strategy and national policy. As the Planning & Compulsory Purchase Act 2004 of UK section 39 (LGA, 2006) points out, the first time that the national government set the duty of planning authorities to sustainability, the local planning authorities (LPAs) have the statutory duty to exercise the functions, with the objective of achieving the sustainable development while planning a local development document. The local planning authorities (LPAs) just simple plan and implement the national policy. The interviewee Mr Xu from Shanghai Green Building Council also confirmed that there is no independent local planning based on the national planning.

Implementation

There are several key elements that ensure the successful implementation of the sustainable building policy according to the Local Government Association of London (LGA, 2006).

1□The most important factor is the awareness of the development control officer, the developer and the design team. After the interview, the study found out that the manager, the local authority, the developer and architects who are involved in this field have a good understanding of the sustainable building concept. While architects without green building design experience were not very clear about it. The architects' awareness was a little out of image compared to the experts in the design field. The answer to this situation could be: the professional education of architecture in the university has less relevance to sustainable building design especially to passive energy conservation design.

2□The local industry capacity is another key factor. The government and the developers encourage the passive energy conservation design due to high cost of new green technology. At the same time, they were trying to promote the capacity of the industry to reduce the incremental cost. In contrast, since the university have more technology and financial support they were more willing to adopt the new technology, at the same time, the passive energy conservation design was also emphasized.

3. The enforcement of the law is very important. Although there are many policies involving different aspects of sustainable building issues in China, like water, energy, land, there is no mandatory comprehensive policy specifically focussing on sustainable building. On the other hand, the application of green building certification is voluntary without incentives.

4. Another key element to ensure success is building up a clear understanding and relationship between the building control staff and the monitoring and reporting. Take Tongji as an example, which has a smart network all over the campus with whom data can be directly checked through one interpreted platform. The integrated building control monitoring and site checks for the indicator will be a great support to the enforcement of the law. However, Shanghai is lacking that kind of integrated platform. In addition, there is no third party assessment organization to carry out the assessment.

5. Criteria should be clearly established to each aspect of the sustainable policies, in order to make the monitoring report explicit and authentic. Comparing with LEED, the Evaluation Standard for Green Building (ESGB) considers less about the regional differences which are very important in such big country areas as in China. ESGB only deal with residential and public buildings. It is a very simple classification. Plus there is no economic benefit consideration which is the most important to the developers in ESGB.

The approach

Several standards and rating systems are developed these years in China. The newest one is the Evaluation Standard for Green Building (ESGB) which is published in 2006. It is a big improvement since the first standard to ESGB. However, there are still many aspects to be improved.

Public awareness

The survey in the campus showed that some people have a basic understanding of sustainable building issues. However, considering high educational level of the respondents the results are not that satisfying. The public in the city might be having lower education and awareness than those in this research. Although the university had a serial of public education programs, the participation rate is not high enough.

5.4 Recommendation

Policy design

A well planned policy is very important. Full plan-making and development control of national policy is not the only role of LPAs, but also to facilitate and promote the implementation of good quality development. As the local development frames (LDFs) are obligatory to promote a positive management to development, the role of the documents in different hierarchy within the development framework should be explicitly identified. For the Chinese government, the decentralization and public private participation should be encouraged. Once the core strategy has explained the vision, the sustainable building policies should be placed in a development control policy which allows more detailed policies to be developed based on the core strategy. Thus the sustainable building policies would be constructed to apply the local planning area.

The sustainable building policy needs an incentive or other tax policy support. Since the building whole life cycle has different contributes to the environment, social and economic. The developers have to afford the whole cost. A proper designed incentive mechanism like tax support, subsidy or special loan can effectively promote the public interest. For instance, to those buildings which have the green building certification or the LEED certification, the government could reduce the property tax or income tax. Besides a subsidy to developers, the government can also chose to give the users a subsidy to promote the market demand of sustainable building. To those who are working on sustainable building projects, the government could also provide preferential loans.

Implementation

The first step is to promote the public awareness on sustainable building issues. The key point is to have a comprehensive awareness, especially by the design team of new buildings. The design team should have the ability to transform the policy into real sustainable buildings. A comprehensive understanding of sustainable building issues is an insurance to achieve a sustainable building.

Promoting the local industry capacity guarantee the achievement of sustainable buildings without high incremental costs.

Establish a clear and efficient monitoring system. A high integrated data collection platform helps to get valid and comprehensive information to assess the building. The cooperation among different departments, intuition and private sectors is needed that will contribute to timely feedback and evaluation and adjust to continuing the policy.

Strengthen the enforcement of the law. Action plans are very important and all policies should have specific action plans based on the national strategies but developed by local authorities to meet the local situation.

Establish an effective incentive system to promote the private developers' interest, including tax Drawback, financial subsidy, and Loan offers.

Promote the public education and behaviour change, so that the public truly realize the significance of the sustainable building.

Rating system

1. ESGB only deals with residential and public buildings. It is a very simple classification. LEED has a 6 kind catalogue that involves new construction, existing buildings, commercial interiors, core and shell, neighbourhood development, neighbourhood development, schools, homes and retail.
2. Extensive use of information technology tools to optimize the flow of green building certification process. That makes the green building process to be fair, open and efficient.
3. Strengthen the economic benefits factor in the rating system. Because the standard for Green Building (ESGB) do not specifically focus on the economic benefit aspect of the building. Without the economic profits, it is hard for the developer to stop the show and truly consider about the users and the environment.

Recommendations for future research

This research attempts to measure the sustainable building policy of Shanghai and the practice in Tongji University. The development of sustainable building issues in China is still in a starting phase. The framework has not been completed yet, and the design of the local strategy still needs to be enhanced.

Future research in this field may specifically focus on the design of local policy based on a regional planning strategy and a national strategy; Further on the establishment of a clear and efficient monitoring system, and on the improvement of an own rating system. The achievements of the energy conservation objectives of the 11th five year plan (from 2006-2010) also need be evaluated in 2011.

Bibliography

- AGENCY, U. S. E. P. (2009) Green Building Basic Information.
- BLACK, T. R. (1999) *Doing Quantitative Research*. London, Sage.
- CNPC (1997) Energy Conservation Law of the People's Republic of China. IN CONGRESS, C. N. P. S. (Ed.).
- DI, L. (2010) the Stumble of China's Green Building. *Science News Bi-weekly*, vol 07.
- EASTERBY-SMITH, M., THORPE, R. AND LOWE, A. (1991) *Management Research: An Introduction*, London, Sage.
- NBSC (2007) Chinese Statistic Yearbook 2007. Beijing, National Bureau of Statistics of China.
- NBSC (2009) Chinese Statistic Yearbook 2009. National Bureau of Statistics of China.
- SCNPC (2005) Law of the People's Republic of China on Regenerable Energies. IN CONGRESS, S. C. O. T. N. P. S. (Ed.).
- WBCSD (2009) Transforming The Market: Energy Efficiency in Buildings. World Business Council for Sustainable Development.
- ALI, H. H. & AL NSAIRAT, S. F. 2009. Developing a green building assessment tool for developing countries - Case of Jordan. *Building and Environment*, 44, 1053-1064.
- BLACK, T. R. 1999. *Doing Quantitative Research*. London: Sage.
- CCI 2008. NWDA Sustainable Buildings: Guidance Note. Centre for Construction Innovation.
- CNPC 1997. Energy Conservation Law of the People's Republic of China. In: CONGRESS, C. N. P. S. (ed.).
- COHEN, L., MANION, L. 1997. *Research Methods in Education* London, Routledge.
- DCLG, D. 2007a. Building a greener future: policy statement. The Stationery Office, London.
- DEFRA 2003. Changing Patterns: UK Government Framework for Sustainable Consumption and Production. London: DEFRA.
- DI, L. 2010. the Stumble of China's Green Building. *Science News Bi-weekly*, vol 07.
- EASTERBY-SMITH, M., THORPE, R. AND LOWE, A. 1991. *Management Research: An Introduction*, London, Sage.
- ENERGYWATCH. 2008. *Cheapest energy bills not the same as affordable bills, says energywatch* [Online]. Available: <http://www.energywatch.org.uk> [Accessed].
- HOUSING TRUST FUND 2008. Evergreen Sustainable Development Standard (ESDS). state of washington: Department of Commerce.

- JN. 2008. *How to implement the "public building energy efficiency design standards"* [Online]. Available: <http://www.365jn.cn/html/2008/0623/5468.htm> [Accessed 20th August 2010].
- K.M. FOWLER, E. M. R. 2006. Sustainable Building Rating Systems Summary. Battelle Memorial Institute.
- KING, N. J. K., B. J. 2005. Creating Incentives for Sustainable Buildings: A Comparative Law Approach Featuring the United States and the European Union. *Virginia Environmental Law Journal*, VOL 23, pages 397-460.
- LEED. <http://www.usgbc.org/LEED/Project/RegisteredProjectList.aspx> [Online]. [Accessed 1st August 2010].
- LGA 2006. Planning policies for sustainable buildings: guidance for Local Development Frameworks. London: Local Government Association.
- LOVELL, H. 2004. Framing sustainable housing as a solution to climate change. *Journal of Environmental Policy and Planning* 6, 35–55.
- MELCHERT, L. 2007. The Dutch sustainable building policy: A model for developing countries? *Building and Environment*, 42.
- NBSC 2007. Chinese Statistic Yearbook 2007. Beijing: National Bureau of Statistics of China.
- NBSC 2009. Chinese Statistic Yearbook 2009. National Bureau of Statistics of China.
- NDRC 2004. China Medium and Long Term Energy Conservation Plan. *National Development and Reform Commission*.
- OECD 2002. OECD/IEA Joint Workshop on the Design of Sustainable Building Policies: Summary, Conclusions and Contributed Papers.
- OPSI 2004. Planning and Compulsory Purchase Act 2004. the Office of Public Sector Information.
- PEARSON, D. 1989. *The Natural House Book: Creating a Healthy, Harmonious and Ecologically Sound Home*, London, Conran Octopus.
- SCNPC 2005. Law of the People's Republic of China on Regenerable Energies. In: CONGRESS, S. C. O. T. N. P. S. (ed.).
- SEYFANG, G. 2009. Community action for sustainable housing: Building a low-carbon future. *Energy Policy*, In Press, Corrected Proof.
- SUN, D. 2008. Incremental Cost Survey to China's Current Green Building. *China Science and Technology Achievements*, vol23.
- USEPA. 2009. *Green Building Basic Information* [Online]. Available: <http://www.epa.gov/greenbuilding/pubs/about.htm> [Accessed 25 May 2010].
- VALE, B., VALE, R. 2000. *The New Autonomous House: Design and Planning for Sustainability*, London, Thames and Hudson.

- WAN, Y., XU, R., HUANG, T. 2009. Comparison and Analysis on Chinese Green Building Evaluation Standard and LEED. *Building Science*, Vol 25.
- WBCSD 2009. Transforming The Market: Energy Efficiency in Buildings. World Business Council for Sustainable Development.
- XU, H. 2007. Good Governance Approaches to Sustainable Development in China. *workshop on Developing Sustainable Strategies in China*.

Annex 1: list of interview

This list is the main principle of the question which was asked to the interviewee about the sustainable building issue. It was translated from the Chinese version.

All information will be analyzed collectively and treated confidentially only for academic purpose

GROUP 1 Local Authority

Name	Xuling Xu
Organization	Shanghai Green Building Council
Position in the organization	Vice-Secretary General

GROUP 2 Managers from Sustainable Campus Commit of Tongji

Name	Hongwei Tan	Zhenyu Li	Cunyi Wu
Organization	Research Center of Green Building & New Energy	Architecture and Urban Planning faculty	Energy management Centre
Position in the organization	Vice Executive Director	Vice Director	Director

GROUP 3 Design team of sustainable building

Name	Wei Wei	Feng Qian	Li Zhang
Organization	Architecture and planning institute of Tongji University	Architecture and planning institute of Tongji University	Private architecture studio
Position in the organization	Chief Architect	Chief Architect	Chief Architect
Name	Paul Chen	Shaojia Song	
Organization	Private architecture firm	Private architecture studio	
Position in the organization	Chief Architect	Senior Architect	

GROUP 4 Manager from private developer

Name	Fang Wang
Organization	Poly Real Estate Group
Position in the organization	Junior manager

Interview to local authority:

1. What does the Shanghai Green Building Council do in the sustainable building issue?
2. Did Shanghai government develop their own policy based on the national government?
3. What is the enforcement of the policy?
4. Is there any incentive mechanism?
5. Can you explain how do you promote the public awareness of sustainable building?
6. What do you think about the green building certification system, and how do you consider about the relationship between it and other rating system, like LEED?
7. How many projects have applied the green building certification?
8. How did you evaluate and monitor the assessment?

Interview to managers of Tongji Sustainable Campus Committee:

1. Why do you intend to do such a sustainable campus program?
2. What is the structure of the sustainable campus committee and what aspects are involved?
3. How do you design your policy based on the local sustainable building policy or other policies?
4. How do you organize the different department of the university to ensure the policy design, implementation and evaluation?
5. What have you done to promote the public awareness?
6. How the committee evaluate the projects?
7. What is the achievement of the program?
8. What's the significance of Tongji sustainable campus to other university or to the city do you think?
9. What is the future plan of sustainable campus program?

Interview to architects:

1. What is the sustainable building according to you?
2. Have you ever designed sustainable buildings?
3. If yes, which building did you designed?
4. What kind of design approaches and facilities did you applied in that building?
5. Is there any rating system?
6. Do you collect the data of the sustainable building?
7. What are the difficulties during the designing phase?
8. Which kind of regulations or policies do you follow?
9. What is your suggestion to current policy?

Interview to the manager of the private developer:

1. Do you have any sustainable building projects or plan right now?
2. What is the result through your feasibility analysis?
3. What's the market demand of sustainable building?
4. What do you understanding of sustainable building issue?
5. What is the barrier when adopt the sustainable technology in sustainable building?
6. What is the role you think the government should play?
7. Which rating system do you prefer?

Annex 2: list of questionnaire

Profession : Student Lecturer Staff

Academy :

Years in university :

1. What is sustainable building_____?
2. What are the objectives of sustainable building?(multi choice)
 - a) Energy efficient
 - b) resource efficient
 - c) environmental friendly
 - d) good to human health
 - e) green plants
3. Which part do you think is the most important among the following items:
 - a) energy saving,
 - b) water saving,
 - c) material saving,
 - d) land use,
 - e) human health,
 - f) low carbon emission
 - g) low pollution
4. Why do you choose that item?

5. which period of the building shows the sustainable characteristic:
 - a) design period
 - b) construction period
 - c) operating period
 - d) demolition period
 - e) above all

=====
6. Do you know which kind of energies is clean energy?

7. Which of them do you think can be used in building energy supply?

8. Do you know what do the following words mean?
 - a) Black water_____
 - b) Gray water_____
9. Do you know which following items have significant impact to human health?(multi choice)
 - a) Temperature
 - b) Humidity
 - c) Lighting
 - d) Air quality
 - e) Sound insulation
 - f) Room size

- g) Color
- h) Natural light

- =====
10. Do you know the sustainable campus program in Tongji University?
- a) Yes
 - b) No
 - c) Don't care

11. Do you know any sustainable building or projects in the campus? If yes, please list them

- _____
12. Have you visit the sustainable building before? If yes, please write down the name of the building and what do you do there

- _____
13. Do you have any different experience in the sustainable building with normal building?

- _____
14. Which one do you think is the most successful sustainable building?

- _____
15. Do you know any publicity about sustainable behavior by the university or Student Union?

- a) Yes
- b) No
- c) Don't care

16. Have you joined the activities?

- _____
17. Is it helpful for you to learn the knowledge?

- =====
18. Do you have the following Environmental protection behavior:

- a) Turn off the light when nobody use the room
- b) Close water taps
- c) Recycling such as paper, glass,
- d) Waster classification
- e) Energy Saving Lamp
- f) Others _____