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Research on drivers and barriers of green building development in China: A case study of Shanghai

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Being a dissertation submitted to the faculty of The Built Environment as part of the requirements for the award of ***MSc Sustainable Urbanism*** at University College London:

I declare that this dissertation is entirely my own work and that ideas, data, and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

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Table of abbreviations and acronyms

ESGB - Evaluation Standard for Green Buildings
GB - Green Building
GBDL- Green Building Design Label
GBL- Green Building Label
MOF -Ministry of Finance
NDRC - National Development and Reform Commission
SHFB - Shanghai Municipal Finance Bureau
SHMCHURDM- Shanghai Municipal Commission of Housing, Urban-Rural Development and Management
SHMDRC- Shanghai Municipal Development & Reform Commission
WGBC - World Green Building Council

Abstract

In the context of the huge challenges of climate change and energy consumption constraints that have become a major global issue, China has also set an important goal of carbon neutrality and carbon peaking. Against the backdrop of a major push to reduce carbon emissions, the building sector has received widespread attention for its inherently high carbon emissions and inefficient use of energy, making it particularly significant to promote its green transformation. A number of studies have been conducted on the subject of green buildings, of which the drivers and barriers to green building development have received much attention. Currently, more research in Chinese academia concentrates on green building development pathways at the national level, with less research exploring local green building development from a local perspective. This dissertation will take Shanghai as an example, and through a combination of policy analysis and interview findings, examine the drivers and barriers to green building development, and hopefully provide a selection of practical policy recommendations.

1. Introduction

1.1 Background

Since the 20th century, the world has been depleted of fresh water resources, energy consumption is increasing and the amount of CO2 emitted into the atmosphere is growing at a rate of 0.5% per year, making the idea of sustainable development an inevitable trend in the face of the enormous pressure on resources, energy and the environment (Wackernagel et al., 1999). Overall, buildings will account for 36% of global energy demand and 37% of energy-related CO2 emissions by 2020, compared to 38% in 2019 (UNEP, 2021). Global investment in energy efficiency is on the rise and the acceptance of green building (GB) certification (uptake) increases by 13.9% in 2020 compared to 2019 (UNEP, 2021). The International Energy Agency suggests that a 50% reduction in direct CO2 emissions from buildings is required by 2030 to achieve the goal of net zero operational emissions by 2050, which is a daunting challenge for the industry as a whole (UNEP, 2021). In order to reduce the negative impact of buildings, GB research has been an international architectural concern since the 1980s (Wackernagel et al., 1999).

With rapid urbanisation and industrialisation, China is now faced with the enormous challenge of meeting the growing demand for new buildings and the corresponding energy consumption. According to the China Association of Building Energy Efficiency (2021), in 2018, the total life-cycle energy consumption of buildings accounted for 46.5% of China's energy consumption, and building carbon emissions accounted for 51.2% of the country's energy carbon emissions. Based on the simulation results of peak energy consumption, building energy consumption will reach its peak in 2042 (China Association of Building Energy Efficiency, 2021). China is committed to reaching peak carbon by 2030 and achieving carbon neutrality by 2060, a goal that will depend not only on the right administrative intervention but also on the joint participation of government and business entities at all levels and nationals (Qiu, 2021). In this context, implementing the goals of sustainable development and GB and developing national standards for GBs will be the way to respond.

In fact, China has made significant progress in developing national GB standards since the *Evaluation Standard for Green Buildings (ESGB)* was promulgated by the Ministry of Housing and Urban-Rural Development in 2006 (MOHURD, 2006). In 2021, under the context of the national efforts to promote high-quality urban and rural development, China's total GB construction area has been exceeded 6.6 billion square metres (Xinhua Net, 2021). This year, the MOHURD issued the *14th Five-Year Plan for the Development of Building Energy Efficiency and Green Buildings*, which clearly states that China will vigorously promote the construction of GBs, and that by 2025, all new buildings in urban areas will be GBs and more than 350 million square metres of existing buildings will have been renovated for energy efficiency (MOHURD, 2022).

GB development has been widely studied in developed countries. Nevertheless, relatively less attention has been placed on developing countries. Furthermore, a few pieces of literature focus on the GB development at the local level in China. This dissertation aims to contribute to filling in this gap in the literature, using a local government perspective in a China context to examine the key drivers and barriers through the analysis of GB development in Shanghai.

1.2 Research aim and objectives

The primary research objective of this dissertation is to identify the key drivers and barriers relating to GB development in China. By conducting an empirical study of GB in the case city, it is hoped to gain a deeper understanding of how to improve the driving forces and overcome the barriers, and to provide suggestions to the Chinese public sector to improve their ability to promote GB practices.

There are three main objectives required to be met in this research:

1. To develop an understanding of international academic and public discourse on green building development, especially in China
2. To examine and analyse critically the drivers and barriers to the green building development in Shanghai

3. To propose a set of feasible recommendations for improving policy and regulations to promote green building development

More specifically, the study aims to answer the following research questions:

1. What is the current policy context regulating the green building development in China and specifically Shanghai?
2. What are the key drivers and barriers of green building development in Shanghai?
3. How to resolve the obstacles and promote the development of green buildings in China?

2. Literature review

The literature review starts by introducing the definition of the GB and GB evaluation system. Then, it explores the existing academic debates around GB development and its key drivers and barriers from four aspects to form an understanding of the main public discourse.

2.1 Concepts of green building

A 'green' building, as defined by the World Green Building Council (WGBC), is a building that is designed, constructed or operated in a way that reduces or eliminates negative impacts and has a positive impact on our climate and natural environment. GBs protect valuable natural resources and improve our quality of life (WGBC, 2022). Kibert (2016) defines GB as " a healthy facility designed and constructed in a resource-efficient manner using ecologically based principles" (p.9). GB in China originated in the 1980s, when the concept of building energy efficiency was always promoted in China. By around 2005, the concept of GB was introduced and widely disseminated in China (Zhang, Kang and Jin, 2018). According to the definition in *ESGB (2006 version)*, a GB is a building that maximises the conservation of resources, protects the environment, reduces pollution, and provides people with a healthy, suitable and efficient space to use, in harmony with nature, throughout its lifetime (MOHURD, 2006). While different definitions in the literature, the aim of this dissertation is to examine the GB development in Shanghai, therefore, GB is used through this dissertation to indicate a building which is certificated by the certification scheme such as the ESGB.

The development of GBs cannot be achieved without the strong support of the GB policy system. In order to promote the development of GBs in their own countries, many countries around the world have formulated and introduced special policy systems, involving legal systems, standards and specifications and related supporting measures to support the development of GBs (Geng et al., 2012). Sustainable building and built environment certification schemes have emerged as tools to assess sustainability performance and facilitate informed decision-making on the built environment. Such tools can be considered

as the latest generation of impact assessment tools, drawing on the Environmental Impact Assessment developed in the 1970s (Turcu, 2018). BREEAM, introduced by the British Building Research Establishment in 1990, was the first method to certify sustainable buildings (Turcu, 2018). Currently, GB assessment systems in developed countries include the BREEAM system in the UK, the LEED system in the US, the CASBEE system in Japan and the GBC assessment system initiated by Canada in collaboration with several countries. All of these systems are voluntary rather than mandatory (Zuo and Zhao, 2014). These initiatives have resulted in significant energy, economic and social benefits, such as buildings with the LEED label being far more energy efficient than conventional buildings, and better quality of work and life (Geng et al., 2012). As far as accreditation schemes themselves are concerned, they are often criticised for their weighted approach to chapters and indicators, as well as their complexity, non-transparency and poor portability (Turcu, 2018). Moreover, the measurement indicators of schemes tend to be environmental and ignore economic, social and institutional/cultural factors (Turcu, 2018).

2.2 Drivers of GB development

It is essential to analyse the drivers and barriers to the development of GBs in a macro context. Through a review of previous studies, this thesis divides these observations into four main categories, namely policy level, economic level, social level and technical level

2.2.1 Policy drivers

Previous studies (Ofori and Kien, 2004; Murtagh et al., 2016; Chan, Qian, and Lam, 2009; Darko et al., 2017) have found strong evidence that government involvement is one of the most important and effective ways to stimulate the development and supply of GBs. Top-down government intervention can occur in mandatory forms, such as legislation, executive orders, and mandatory labelling, or in voluntary forms, such as incentive instruments and policy support (Häkkinen and Belloni, 2011). As regulations can guarantee minimum quality

standards, market-based incentives can address market failures and 'non-market' issues (Chan, Qian, and Lam, 2009). In terms of government incentives, categorising external government incentives into economic and non-economic incentives. For GBs, economic incentives are more common and include “direct grants, tax incentives, rebates and discounted development application fees” (Chan, Qian, and Lam, 2009). Non-financial incentives include “Floor-to-Area density technical assistance, expedited permitting, business planning assistance, marketing assistance, regulatory relief and guarantee programmes” (Chan, Qian, and Lam, 2009). In Singapore, questionnaires and interviews conducted by Low et al. (2014) and others with stakeholders of new and existing buildings showed that the majority of respondents, including developers, contractors, architects, project managers, and engineers, believed that government legislation and related policies played a very important role in promoting GB development. Fuerst et al. (2014) conducted a survey of 174 LEED-certified commercial buildings in the US, showing that regulations mandating LEED certification for new buildings have had a positive effect. Similar to these findings is a study in a Chinese context where both mandatory regulations and incentives increased GB certification, with mandatory regulations having a stronger effect (Song et al, 2021).

2.2.2 Economic drivers

The economic environment is also a compelling aspect when it comes to driving the development of GBs. Financial factors are a central driver for companies to consider investing in GBs, while the price of GBs is also an important factor in consumer purchasing (O'Neill and Gibbs, 2014; Zhang, Wu and Liu, 2018). From a developer's perspective, their primary motivation is to pursue profit, and since it is economic viability that is at the heart of the market mechanism, meaning that whether the benefits are sufficient to offset the incremental costs and risks is of critical importance to developers (Zhang, Wu and Liu, 2018). There is already some research that demonstrates that the price premium of GBs, increased expected returns and long-term financial returns are positive drivers of real estate firms'

willingness to increase their investment in materials and technology costs for GB design and construction (Liu and He, 2011; Fuerst and McAllister, 2011).

In addition to increasing the return on capital, gaining a competitive advantage and company reputation is another reason that persuades real estate companies to promote GB (Zhang, Shen and Wu, 2011; Darko et al., 2017). For this reason, many real estate companies have incorporated green strategies into their sustainability plans, with an emphasis on improving the living environment for residents and reducing negative externalities on the environment. A case study of green housing projects in China by Zhang, Shen and Wu (2011) found that developers believe that green housing can help them gain competitive advantages such as lower construction and operating costs, favourable land prices and greater access to finance. The reputation of a green brand as an intangible asset can help companies become more competitive in the marketplace (Zhang, Shen and Wu, 2011). A company's green and low-carbon strategy can be further reflected in its commitment to social responsibility, through which some leading real estate companies can gain significant positive media publicity, branding and differentiation (Low et al., 2014).

The role of market demand in GB development has been described in Häkkinen and Belloni (2011). The authors have explained the increasing market demand is closely related to issues of knowledge, supply, methods, value and cost, and ultimately determines the extent of GB development. In addition, Murtagh et al.'s (2016) study interviewed 28 architects in the UK and found that many of them answered client demand first when asked about the drivers of GB. The dynamics between architects and clients may be mutual, with the client becoming an external factor that encourages them to design sustainably, while the architect creates higher value for the client, such as switching to energy-efficient materials to gain environmental benefits (Murtagh et al, 2016).

2.2.3 Social drivers

Socio-cultural drivers exist as a more flexible and voluntary form of motivating people internally to achieve sustainable goals (Darko, Zhang and Chan, 2017). A review of the literature reveals that social drivers include developers' values, environmental awareness, social responsibility and advocacy for a sustainable approach (Abidin, 2010; Häkkinen and Belloni, 2011; Darko, Zhang and Chan, 2017). Furthermore, from the perspective of consumer groups, the public's awareness of green values, self-perceptions, personal commitments, attitudes and traditions, and ethical imperatives determine their environmental behavioural preferences, while influencing the perception and acceptance of green products (Darko, Zhang and Chan, 2017). This ethical responsibility can be interpreted as a concept of pro-environmental behaviour based on altruism or personal ethical norms and values that require individuals to consider human well-being and take action to reduce their environmental impact (Abidin, 2010).

2.2.4 Technological drivers

Innovation in GB technologies is another important driver for GBs. GB technologies can bring incremental economic and environmental benefits, improve energy efficiency, reduce material procurement costs and lower maintenance costs (Darko et al., 2017; Jiang and Payne, 2022). The innovation, application and diffusion of GB technologies require extensive expertise and top management support from designers (Wang et al., 2018). Wang et al. (2021) used statistics on GB and green finance in China from 2013-2017 and analysed them through python modelling to conclude that talent development and investment in science and technology innovation are the key factors supporting the development of GB technologies.

2.3 Barriers of GB development

A review of the literature suggests that there are barriers to GB development, which may take different forms depending on the context, ranging from the market acceptance, policy incentives, increasing costs to technical feasibility. It is important for local governments to correctly recognize the barriers and take appropriate measures to rectify them (Deng et al., 2018). As with the logic of the review of drivers, the following paragraphs will summarise and conclude the barriers studied in previous literature at the same four macro levels: policy, economic, social and technological.

2.3.1 Policy barriers

Legislation or incentives for GBs are closely linked to the context of national and regional governments. A number of scholars (Luthra et al., 2015; Häkkinen and Belloni, 2011; Darko and Chan, 2017; Zhang et al., 2011; Darko et al., 2018) have pointed out that the most important challenge in delivering GBs is the lack of policy instruments, and relevant evidence has been found in countries such as Finland, India, China and Ghana. In general, developed countries (e.g. the UK, USA and Canada) perform somewhat better than developing countries in terms of both policy development and implementation (Jiang and Payne, 2022). On the one hand, in the absence of clear mandatory regulations and GB assessment criteria, it is difficult to ensure widespread market acceptance of GBs and to constrain and regulate developers' market activities, while on the other hand, developer behaviour in the absence of financial incentives and support policies is often hardly driven by the regulation of single market demand (Darko and Chan, 2017). Darko et al. (2018) examined 20 key factors influencing the development of GBs and found that the lack of government support (regulations and standards, incentives and R&D support) was the top barrier to GB adoption in Ghana. In South Africa, few clients would develop GBs for the sole purpose of environmental sustainability without government incentives and downstream economic benefits due to lower operating costs and higher rental incomes (Windapo, 2014).

Furthermore, Windapo and Goulding (2015) referred to non-compliance of the South African GB regulations themselves and the lack of government oversight at the enforcement stage. Ding et al. (2018) conducted interviews with key participants in the Vanke project in Shenzhen, China, thus observing that government regulations inconsistency is one of the main barriers in the operational phase of GBs. In the enforcement stage, unclear laws and regulations, poor building energy design systems and lack of legislative authority are also regarded as obstacles to green residential projects by Chinese developers (Zhang et al., 2011).

2.3.2 Economic barriers

The global perception that GB development is costly limits developers' willingness to promote GBs (Williams and Dair, 2007; Darko and Chan, 2017; Zhang et al., 2011; Luthra et al., 2015). This is due to the additional costs associated with upfront investment compared to the traditional construction industry, which is not limited to green materials and equipment, training fees and consultancy fees for hiring professional staff or teams with green knowledge (Zhang, Platten and Shen, 2011). Although there is evidence that GBs can save money during the operation and maintenance phase, developers often ignore the whole life cycle concept of a building and abandon GB practices to shorten the payback period (Zhang, Platten and Shen, 2011).

Wilson and Tagaza (2006) interviewed key stakeholders in the Australian construction industry about the business drivers and barriers to GB and found that the perceived financial risks, such as carve-out incentives and the lack of expertise, prevented developers and owners from investing in GBs. Chan, Qian and Lam (2009) surveyed the GB market in Singapore and Hong Kong through the lens of architects and discovered that high upfront costs remain an undeniable barrier in the context of developed Asia. Factors related to risk costs were identified as a common barrier in Darko et al.'s (2017) study of Ghana. Nonetheless, in Darko

et al.'s (2018) study, this factor was shown to be not significantly associated with the adoption of GB.

Teng et al. (2016) indicated that green technology adoption in China is still at an early stage, with high incremental costs and immature green technologies being the two main barriers to the full and balanced development of GBs in the country. This is in line with the findings of Zhang, Platten and Shen (2011), who studied the costs and barriers to the application of green elements in the development of real estate projects, and asserted that concerns about the high cost of green technologies had become the biggest barrier to the widespread application of green strategies.

2.3.3 Social barriers

In terms of social aspects, the absence of information, education, research and awareness will exacerbate the separation of the public from the GB market (Luthra et al., 2015; Zhao et al., 2015; Darko and Chan, 2017). Architects in Singapore and Hong Kong acknowledged that 'lack of education' and 'lack of awareness' are two important deterrents (Chan, Qian and Lam, 2009). Similar findings were reported in a study of 33 GB practitioners, where a poor understanding and awareness of GB technologies and their potential benefits was the second most significant barrier to the advancement of GB in the United States, with entrenched non-green mindset prevalent in practice (Darko et al., 2017). In a study in Vietnam, researchers also demonstrated that consumers often have misconceptions about GBs, with one common misconception being that "national standards are perceived to have a lot of trees", as residential renderings often feature many trees and are advertised with words such as "eco" and "green" (Nguyen et al., 2017).

A public opinion survey in Changsha, China, indicated that the majority of people were neutral or sceptical about GB, mainly due to the non-transparent information about companies' GB practices and the missing consumer feedback mechanism (Huang, 2010 cited in Zhao et al.,

2015). In general, China's GB market environment is not mature enough and the awareness of stakeholders (including suppliers, developers and the public) to 'go green' needs to be raised due to a shortage of training, education and promotion of professional knowledge (Wu et al., 2019). However, reported by Wu et al. (2019), there were indications that consumer awareness and demand in the more developed first-tier cities has gradually increased. Furthermore, it has been argued that stakeholder resistance to green technologies is due to the consistency of lifestyles, cultures and behaviours, and possibly that it is human nature to put up resistance to change (Darko et al., 2017).

2.3.4 Technological barriers

The literature review has shown that developers face challenges regarding the feasibility of green technology, which is another frequently reported barrier to GB adoption (Darko et al., 2017). It is found by Darko et al. (2017) that the fourth major factor affecting GB development in the United States is the "lack of GB expertise and skilled labour". Other studies (Chan, Qian, Lam, 2009; Williams and Dair, 2007; Nguyen et al., 2017; Wilson and Tagaza, 2006) have identified the same issue in different countries such as the UK, Singapore, Vietnam and Australia. The complexity of GB techniques requires education and training in the construction industry, otherwise the lack of skills will greatly hinder the practice and development of GB.

Ding et al. (2018) observed in their survey of Vanke projects that there were deviations in the application of green technologies in design and practice, as evidenced by the fact that the performance of many GB materials did not meet the technical requirements, and a high proportion of technologies were not put into use or some were not operating well. Beyond the design and construction phases, the level of property management in the operational phase of GB projects also needed to be improved (Ding et al., 2018).

2.4 Summary and research gap

To conclude, the key drivers and barriers surrounding the international GB development are reviewed in the above sections including policy aspects, economic aspects, social aspects and technological aspects. Table 1 provides a summary of the drivers and barriers discussed above. It can be seen that the driving forces and barriers of GB in each country or region have certain commonalities as well as unique characteristics. However, most of the existing research focuses on developed countries, and in the context of China, how the diverse factors drive and constrain the delivery of the GB remain empirically and conceptually under-explored. Moreover, the majority of the literature are studied on a very macro national scale with only a few articles proposing local measures for the development of GBs. The research gap in the perspective of local government in China is still prevalent. Therefore, this dissertation will take Shanghai as an example to study the main driving forces and obstacles of GB development in China.

	Drivers	Barriers
Policy level	Government mandatory regulations and policies Government incentives instruments and policy support	Lack of policy instruments Lack of government oversight Unclear laws and regulations
Economic level	Expected returns on capital Gaining the competitive advantage and company reputation Increasing market demand	High incremental costs of GBs
Social level	Developer's environmental awareness & social responsibility Increasing public awareness Attitude and culture traditions	Lack of household awareness Absence of information and education
Technological level	Innovation in GB technologies Investment in science and technology	Immature GB technologies Shortage of skilled labors

Table 1. Drivers and barriers of GB development
Source: Author

3. Methodology

3.1 Research Design

The research objectives of this dissertation are to understand the current practice of GB development in Shanghai, try to identify the drivers and barriers to the development of GBs in Shanghai and propose possible solutions. In this chapter, a clear explanation of the methodology and rationale for choosing research techniques will be provided. This research mainly follows a qualitative analysis, and the research methods encompass policy analysis, semi-structured interviews and Content Analysis. Figure 1 shows the research structure of this dissertation, and each research method will be explained in detail in the following sections.

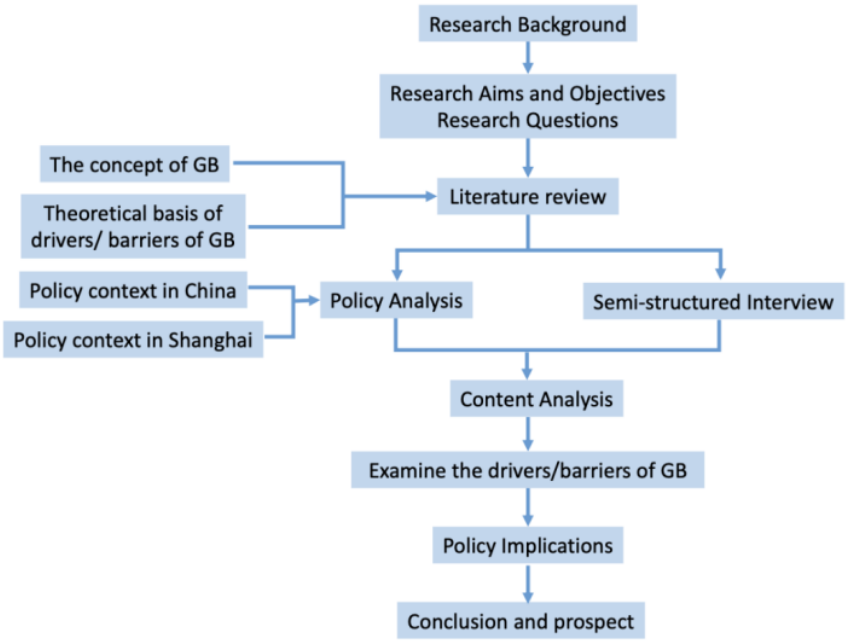

Figure 1. Research Design

Source: Author

3.2 Research Method

3.2.1 Policy analysis

To have a better understanding of the current practice of GB development, policy analysis is necessary for this study because it is carried out from the perspective of the Chinese government. Policy analysis often provides important reference significance to the development of new policies by analyzing current policies and implementation effects (Patton and Sawicki, 1993). This research will review the GB-related policies (including laws, regulations, evaluation standards, action plans, and management methods) at the national level and in Shanghai (see Appendix B), in order to sort out the overall structure and changing trend of GB policies. GB-Related policies and regulations were gathered by searching for "green building" on the website, www.pkulaw.com, which is China's leading online legal search engine. Also, relevant policies were collected through national and local government websites, including MOHURD, Shanghai Municipal Commission of Housing and Urban-rural Development (SHMCHURDM), Shanghai Municipal People's Government (SMPC), Shanghai Green Building Council (SHGBC). These government documents could be used as secondary data sources to develop a solid understanding of the policy context of GB development in China and Shanghai (Research Question 1) and help identify some drivers and barriers (Research Question 2).

3.2.2 Semi-structured interview

Semi-structured interviews were deemed appropriate for this survey, as on the one hand, they allowed for an in-depth exploration of the participants' views, and on the other hand, the content of the interviews could be flexibly adapted to the interviewees, allowing for the exploration of new themes that emerged from the dialogue (Rubin and Rubin, 2011). To assess the drivers and barriers to GB in Shanghai, in-depth semi-structured interviews were implemented in order to investigate the views of industry players. The interviews were

conducted with three stakeholders, all of whom were involved in the building industry in Shanghai. The invited participants were a government staff from the Shanghai housing planning department, a project manager from the GB real estate developer, and an architect who has been involved in the design of GB projects. As there are different stakeholders in the GB industry, the interviewees were selected because they come from different organizations that they could provide a variety of perspectives. However, due to the insufficient number of people interviewed, the information they were able to provide may be partial and will be used to supplement the policy analysis. The interviews were conducted in a web-based format and guided by several prepared questions (See Appendix A), with each interview lasting no less than one hour. All interviews were audio-recorded and transcribed with the permission of the interviewees as primary data for this study.

3.2.3 Content analysis

Qualitative content analysis was used to analyze the collected documents and interviews in this research. Hsien and Shannon (2005) interpreted content analysis as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns". The authors categorise content analysis methods into three types, conventional, directed and summative, and summarise their differences in terms of coding schemes and the sources they come from (Hsieh and Shannon, 2005). Conventional content analysis codes are derived directly from textual data, directed content analysis identifies initial codes from existing theory or research findings, and summative content analysis usually identifies, counts and compares keywords or content (Hsieh and Shannon, 2005). In this study, it was decided to adopt directed content analysis, that is, to follow the keywords identified in the literature review for subsequent analysis and discussion.

3.3 Limitations of the methodology

There are certain limitations to the methodology of this study that need to be noted. As the scope of the study was chosen in Shanghai, which has its own particular path of urban development and is not representative of other cities in China, the results of the study may not be applicable to treat the development of China as a whole. Thus, the generalisation of this study is considered to be limited and the findings can be referenced on the premise that they should be in a place with a similar context, such as a first-tier emerging city in a developing country. Secondly, given the limited sample size of the interviewees and their background in the industry, the information they were able to provide may have been one-sided, which means that their views on GB development may have been missing. Thirdly, despite being told that the interview is anonymous, respondents may still be prone to concerns about privacy or about avoiding or not answering some relatively sensitive questions truthfully, which may affect the accuracy of the answers. Lastly, what needs to be acknowledged in the content analysis is the inevitability of the emergence of subjective bias. Efforts were made to discard this and to conduct an objective analysis.

3.4 Ethics and risk statement

This research project was conducted with full compliance of research ethics norms, established by UCL Research Ethics Committee in the Codes of Conduct. A risk assessment (see Appendix D) was analyzed and approved before starting the research. Documents used in the policy anlysis for this study, such as laws, plans and government reports, are available for public inspection. Before participating in the survey, the interviewees were informed of the purpose of the study and related requirements, and signed a consent form (see Appendix C). In accordance with the principle of privacy, personal information such as name and position of the interviewees will not be represented in this dissertation. Audio and written records of this anonymous interview will be protected.

4. The Chinese landscape

This chapter will provide a comprehensive policy context for the development of GBs in China and Shanghai, laying a solid foundation for dissecting the drivers and barriers of GB development in Shanghai. Through careful analysis of relevant planning policies and documents from authorities at all levels (Appendix B), research question 1 was answered and a preliminary understanding of research question 2 was developed.

4.1 Green building policies in China

Chinese scholars have summarised the policy path of GB in China into four phases, namely the working pilot phase (2003 and before), the working promotion phase (2004-2008), the gradual deepening phase (2008-2016), and the all-round promotion phase (2016-now) (Qian, Zhou and Wu, 2019). Figure 2 outlines a policy framework for China's legal and policy systems for GB (Deng and Tang, 2015). China started making policies to promote GB development in the early 2000s. In China, control and regulatory mechanisms are the main instruments of policy for the building sector, and in the field of GB development, China has introduced a policy structure characterised by laws, standards and regulations. In terms of legislation,1998 saw the release of the *Energy Conservation Law* included building energy efficiency in the law for the first time, clarifying the government's duty for building energy conservation, supervision, and determining the legal liabilities of construction industry participants (Wei and Wang, 2019). As shown in Figure 2, in March 1998, *Construction Law* was enforced as the fundamental legal foundation for engineering construction management in China (Wei and Wang, 2019). In the promotion phase, the *Technical Guidelines for Green Buildings, a* technical specification document for GBs, was released in 2005, marking the beginning of the generalization of GBs from the perspective of the government administration. The first comprehensive rating system for GBs, the *Evaluation Standard for Green Building (ESGB)*, was formulated in 2006, assessing building performance in terms of site planning, energy use, land use, water conservation and internal air quality (MOHURD, 2006). In 2007, the *Green Building*

Evaluation Technology Conditions and the *Green Building Evaluation Identity Management Method* were introduced by MOHURD to provide specific guidance on the planning, design, construction and management of GBs and gradually enhance the GB evaluation system (Qian, Zhou and Wu, 2019).

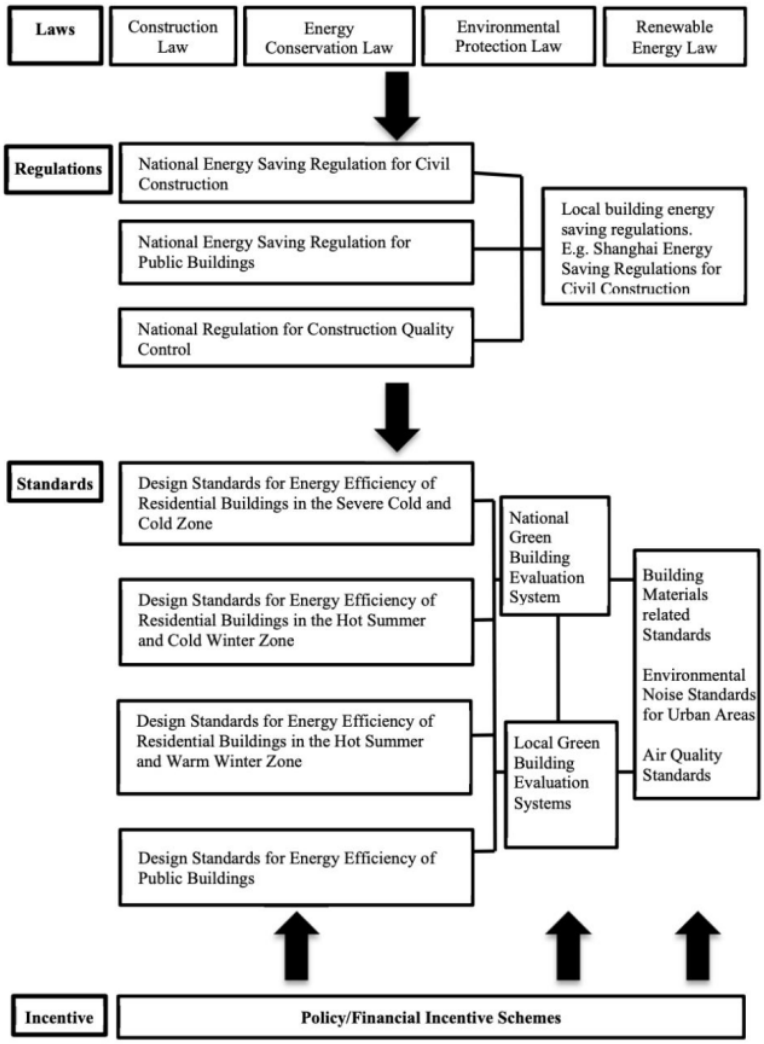

Figure 2: China's legal and policy systems for GB development

Source: Deng and Tang, 2015

Since 2008, the promotion of GB has expanded from the central and local governments to industrial developers and owners, and has gradually shifted from relying on government-led laws and regulations to being guided by market and economic incentives (Qian, Zhou and Wu, 2019). In 2012, the Ministry of Finance (MOF) and MOHURD published *Implementation Opinions on Accelerating the Development of Green Building in China*, guiding the construction of GBs at a higher level and scale through the establishment of a GB policy incentive mechanism (MOF, 2012). The *Opinions* noted that priority should be given to the development of GBs in the public housing and public welfare sectors and that owners, real estate development, design, construction and property management units should be encouraged to develop GBs (MOF, 2012). MOF has set up financial incentives for high-star GBs, with "a reward of 45 yuan /m² for two-star GBs and 80 yuan /m² for three-star GBs" (MOF, 2012). In 2013, the State Council transmitted the *Green Building Action Plan* developed by the National Development and Reform Commission (NDRC) and MOHURD, which marked the gradual move from the planning level to the practical level, promoting the development of GBs from the national level and focusing on green energy efficiency from planning and design (Qian, Zhou and Wu, 2019). This action plan makes GB standards mandatory for government-invested buildings from 2014 onwards, signalling a shift from voluntary to mandatory trends (Energy Foundation, 2019).

Since 2016, the development of GBs has entered a comprehensive promotion phase, further clarifying the main objectives and key tasks of promoting GBs (Qian, Zhou and Wu, 2019). In 2017, MOHURD released the *13th Five-Year Plan for Building Energy Conservation and Green Building Development*, which clearly proposed that by 2020, the proportion of GBs promoted in new buildings in urban areas would exceed 50% and the proportion of GB materials applied would exceed 40%, and that policies would pay more eyes on supply-side structural reform (MOHURD, 2017). In 2019, the *ESGB* was revised twice and introduced as the latest national standard, with the revised standard certification code placing more emphasis on "people-oriented, performance-oriented and quality-oriented". The updated standard adds a foundation level to the GB rating class before the one-star rating, creating a four-level rating system, which is more aligned with other global GB standards (MOHURD, 2019).

In July 2020, MOHURD and seven other departments jointly issued the *Action Plan for the Creation of Green Buildings*, with the goal that by 2022, the percentage of green floor space in newly built buildings in cities would reach 70% in that year, the number of star-rated GBs would continue to increase, the energy efficiency level of existing buildings would continue to improve, the application of GB materials would further expand, and people will actively participate in the creation of GBs, creating a social atmosphere of green livelihoods (MOHURD et al., 2020).

Following China's "peak carbon and carbon neutral" target, MOHURD issued *the 14th Five-Year Plan for Building Energy Conservation and Green Building Development* in 2022, proposing that new urban buildings should fully implement GB standards by 2025 (the penetration rate of new buildings has reached 77% by 2020) (MOHURD, 2022). Key objectives include improving the energy efficiency of new buildings and enhancing the energy efficiency and green renovation of existing buildings (MOHURD, 2022). The *Plan* also encourages the building sector to work with financial, taxation and R&D departments to strengthen cooperation and to seek the fulfilment of supportive policies in terms of financial resources, prices and taxes, and to provide policy incentives for high-star GBs, ultra-low energy buildings and green farmhouses (MOHURD, 2022). The government will "lead the synergistic development of green finance and GBs, innovate green financial products such as credit, and strengthen green insurance support, and likewise improve government procurement standards for GBs and GB materials to promote the application of GBs and GB materials in public sector procurement" (MOHURD, 2022).

Beyond that, *the General Specification for Energy Efficiency and Renewable Energy Use in Buildings* (2021) becomes compulsory from 1 April 2022, stipulating that the building sector will launch mandatory carbon calculations to control the growth of energy consumption and carbon emissions in buildings, laying a solid foundation for carbon peaking in urban and rural construction by 2030 (Sohu, 2022). This reflects a gradual shift in national policy instruments towards compulsory development

4.2 Green building development in Shanghai

4.2.1 The city context

As mentioned before, this research chooses Shanghai as the study area. As can be shown in the map (Figure 3), located at the mouth of the Yangtze River in the middle of China's mainland coastline, Shanghai covers an area of 6,340 sq km and has a resident population of over 24 million, making it a representative of China's high-density as well as fast-growing megacities (Boxer, 2022). Shanghai is at the forefront of the development of GBs in China and has carried out research and promotion of GB applications at an early stage. In recent years, the Shanghai Municipal Government has issued a series of documents to clarify the development of GBs in Shanghai (Ren, 2015).

Figure 3. Location of Shanghai

Source: Ebrahimpour et al., 2020

4.2.2 Green building policies in Shanghai

According to the *2021 China City Green Building Development Competitiveness Index Report,* Shanghai ranks first in the 2021 GB quality development index and second in overall competitiveness, making it the city with the highest quality of GB development in China (Sohu, 2021). According to the *Shanghai Green Building Report 2020* published by *the* Shanghai Municipal Commission of Housing, Urban-Rural Development and Management (SHMCHURDM), by the end of 2020, a total of 874 projects had been awarded the Green Building Label (GBL), including 823 projects with the Green Building Design Label (GBDL) and 49 projects with the operational Green Building Label (GBL) (SHMCHURDM, 2021a). Figure 4 shows the number of GBDL/GBL projects in Shanghai over the years. Since 2019, 100% of newly built civil buildings (residential buildings and public buildings not involving industrial activities) in Shanghai have met GB standards (SHMCHURDM, 2021a).

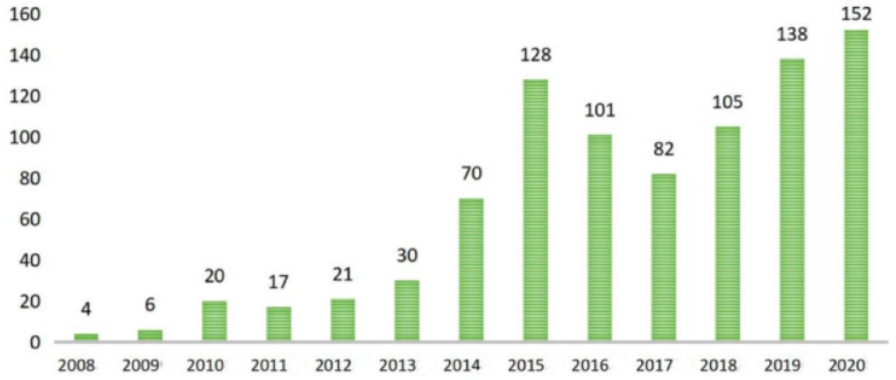

Figure 4. The number of GBDL/GBL projects over the years

Source: SHMCHURDM, 2021a

Following the strategic documents issued at the national level, Shanghai has also been deepening its research in GB and has introduced a series of local codes and policies. Speaking of planning documents, SHMCHURDM and other departments have continuously formulated the "*Shanghai Green Building Development Three-Year Action Plan (2014-2016)"* (2014), *"13th*

FYP Green Building, Shanghai City Planning" (2016), *"14th FYP Green Building, Shanghai City Planning"* (2021) and other documents as a guideline to promote the gradual development of GBs in Shanghai in an orderly manner (SHMCHURDM, 2021a). It is worth noting that according to the *"14th FYP Green Building, Shanghai City Planning"*, "all new civil buildings must be built to the basic level of GBL or higher" (SHMCHURDM, 2021b). New large public buildings must achieve 2 stars (office buildings and government investment projects over 5,000 sqm) or 3 stars (super high-rise buildings) based on GBL (SHMCHURDM, 2021b). The *Shanghai Green Building Management Measures* (2021) issued by the SMPC is a practical initiative at the legislative level. The *Measures* further promote the rule of law for GB development in Shanghai by combining management, supervision and service and incentive mechanisms (SMPC, 2021). The *Measures* encourage the adoption of various innovative models and research and development applications in GB activities, and accelerate the upgrading of buildings to intelligence and digitalization (SMPC, 2021). In addition, considering the special characteristics of rural housing construction, it is encouraged to adopt other GB-related measures (SMPC, 2021). Apart from the need to comply with GB design standards in the design and construction stages, public buildings are required to transmit energy monitoring data during the operational phase of the building to keep within the energy quota standards (SMPC, 2021).

Documents on GB standards for example, from 2013-2014, Shanghai introduced a selection of local design standards such as the *Green Design Standards for Residential Buildings (2014) and Green Design Standards for Public Buildings (2014)* (Ren, 2016). The latest revision of the *Shanghai Green Building Evaluation Standards* (2020), which came into implementation in July 2020, further clarifies the new requirements for local GB evaluation based on the *ESGB 2019 version* in combination with Shanghai's local climate, environment, resources and cultural characteristics and economic development level (SHMCHURDM, 2020). The revised local code highlights Shanghai's needs as a mega-city in terms of efficient energy use and smart information integration, and adds evaluation indicators such as reliability and charging facilities to align with Shanghai's financial support policies for GBs, thus more effectively safeguarding GB performance requirements (SHMCHURDM, 2020). In March 2020,

SHMCHURDM, Shanghai Municipal Development & Reform Commission (SHMDRC) and Shanghai Municipal Finance Bureau (SHFB) jointly issued the *"Shanghai Municipal Energy Efficiency and Green Building Demonstration Projects Special Support Measure*s" to continuously promote the development of incentive mechanisms. The subsidy rate for GB demonstration projects (2-star or 3-star GBDL/GBL) is 50 yuan/m^2 for 2-star projects and 100 yuan/m^2 for 3-star projects. Besides, corresponding financial funding support standards and methods have been determined for demonstration projects of assembled monolithic buildings, energy-saving renovation projects and demonstration projects of ultra-low energy buildings (SHMCHURDM, SHMDRC and SHFB, 2020).

GB evaluation and labelling activities in Shanghai also require the coordination and facilitation of relevant institutions and bodies. The Shanghai Green Building Evaluation and Labelling Office was established in 2008 and is responsible for the evaluation and routine management of GB evaluation and labelling in Shanghai (Ren, 2016). 2013 saw the establishment of the Shanghai Green Building Council, which is designed to implement relevant national laws, regulations and policies, and serve as a platform for the planning, design, development, construction, management and service of GBs in Shanghai, and function as a bridge. The main members of this council are the enterprises, institutions and individuals engaged in all aspects of GB in Shanghai, which are voluntarily formed to promote the sustainable development of GB (Ren, 2016). In 2014, Shanghai also established the Shanghai Green Building Standardisation Professional Technical Committee, which helps to carry out the certification work in the field of GB and improve the technical standard specification of engineering construction (Ren, 2016).

5. Findings and Discussions

This chapter will mainly conduct the content analysis to the policy findings and interview data that was collected from the semi-structured interviews with key stakeholders involved in the Shanghai GB industry to form a more holistic view to examine the drivers and barriers of Shanghai's GB development. The drivers and barriers will be classified into four categories (policy, economic, social and technological) which were identified in the literature review.

5.1 Policy drivers and barriers

As much has been discussed in chapter 4, Chinese GB development is heavily driven by the policies at different levels of authorities, which is in line with the argument of Chan, Qian and Lam (2009), Low et al. (2014) and Murtagh et al. (2016) that government involvement is the most powerful drivers to the GB development. All of the interviewees admitted that the government's introduction of GB-related regulations has greatly driven and stimulated the development of GBs in Shanghai. Among them, the government staff said:

> *"Shanghai has been at the forefront of the country in recent years in terms of policy mechanisms, standards and specifications, and pilot demonstrations of GBs, and has formed a good demonstration-driven effect."*

In addition, Shanghai has implemented a new version of the *Shanghai Green Building Evaluation Standards (2020)*, which is based on national standards with more local characteristics and tailored to local conditions (SHMCHURDM, 2020). However, the ESGB is a recommendatory national standard in terms of its legal nature, which undermines the enforceability of the standard and fails to provide the effective impetus for GB development. The absence of GB legislation at the national level and the inability of the current superordinate law to clarify the relevant provisions of GB may be the root cause of the current unsatisfactory implementation of GB, which extends Zhang et al.'s (2011) claim that the

unclear law and regulations are barriers to the GB development. As the government staff explained：

> *"GBDL/GBL applications follow the voluntary principle, but the implementation of the voluntary principle is not satisfactory. The ESGB lack a clear legal basis, with no legislation for GBs and corresponding legal responsibilities and penalties. For instance, although the Energy Conservation Law has been implemented, it lacks specific content regarding buildings. Similarly, the current Construction Law does not address the requirements for GBs, and the State Council has not issued corresponding administrative regulations."*

Regarding the incentive policies, the developer project manager admitted in the interview that the policy support received from the national and local government really encourages them to develop and invest GB projects. However, project managers noted that in Shenzhen, another first-tier city in China, there have been cases where developers have given up on subsidies. This may reflect Song et al.'s (2021) argument that GB development has been accelerated as a result of both mandatory regulations and incentives, with mandatory regulations having a greater impact. Besides, the specific policies of the GB-related incentive system have poor operability. This can be seen from the words of the government staff:

> *"The GB incentive policy that has been implemented at the local level in Shanghai is financial subsidies, while the incentive policies on land transfer, land planning, recycling, credit and approval are currently lacking in operability or have not yet been put into practice."*

The main reasons for this are that some policies are ineffective and do not have a binding effect due to the low risk of non-compliance; some policies do not have specific criteria and are not enforceable by local governments. This is consistent with Zhang et al.'s (2011) finding that inadequate policy implementation is also a significant barrier.

5.2 Economic drivers and barriers

Turning to the economic drivers and barriers, it has been shown in the research to have a complex and oppositional nature in the GB market. On one hand, the view that the high cost of GB is currently the main barrier to green property development was borne out in the interviews (Zhang, Platten and Shen, 2011; Chan, Qian and Lam, 2009). All three interviewees, when asked about the economic viability of GBs, indicated that the incremental cost of constructing a GB was to some extent a barrier to GB development. The developer project manager explains:

> *"In one of the GB projects I was involved in, the report showed that the larger incremental costs were in the area of renewable energy use, such as ground source heat pump technology and photovoltaics, but from 2008 to now, the prices of equipment such as solar PV and ground source heat pumps have been falling, so the incremental costs […] on a downward trend."*

The architect puts it slightly differently, stating that:

> *" [...] it doesn't mean that high-priced, high-cost, high-tech is GB. For example, the Yan'an kiln is warm in winter and cool in summer, which is a traditional Chinese style GB, and it doesn't cost much."*

This suggests that the financial constraints faced by developers may indeed be limiting their efforts to promote GB. However, it is worth noting that the words of the architect's perspective indicate that GBs sometimes do not necessarily need to be costly, but rather require the development of site-specific building solutions. On the other hand, company reputation and competitiveness drive developers to undertake GB-related activities. The project manager expressed：

"In recent years, leading property developers in China have sought to build their green brands by using GB technologies to develop their property projects. A green real estate ranking was also released in the industry last year, with the top names including Greenland Group and Sunac China, among other notable companies."

This shows how the green brand reputation and effect has started to influence the market. Moreover, GB certification also generates a much higher premium for developers by promoting green, healthy, comfortable, smart and energy efficient as a differentiation point than traditional methods. These findings support the existing literature that anticipated benefits and gaining a competitive advantage are positive drivers for developers to move to GB developments (Liu and He, 2011; Fuerst and McAllister, 2011; Zhang, Shen and Wu, 2011). Evidence of this can be found in the statement of the project manager：

"A good green project not only has a high premium, but is also quick to be realised and adds value. For example, one property company sold six office buildings in Shanghai in 2019 for more than 90,000 yuan/m^2, and it was the green concept that made its building price 10,000 yuan/m^2 higher than similar properties nearby. "

In terms of financial policies, the policy analysis and interview results show an overall favourable central and local policy on green finance to support GB development. This finding is consistent with the opinion of Chen, Qian and Lam (2009) that market-based incentives may have a positive impact on the development of GBs. As mentioned in Chapter 4, in 2012 the MOF announced financial subsidies for buildings with 2 or 3-star GBL certification and the Shanghai government announced even greater subsidies (MOF, 2012; SHMCHURDM, SHMDRC and SHFB, 2020). At the central level, GBs have been covered in the *Catalogue of Projects Supported by Green Bonds* issued by the People's Bank of China in 2015; it was revised in 2021 to add GB materials to the scope of green finance support as well (Li and Liu, 2021). Nevertheless, the developer project manager holds the view that:

"The current tightening of national policies on the property sector has affected the overall financing environment for GB finance, not only in Shanghai but also nationally, and thus has not been fully supported by policy. It could be seen from that 30% of green bonds issued globally in 2019 went to the GB sector, while only 6% of RMB green bonds went to the sector."

To put it another way, green finance support for the GB sector has taken off, but the potential remains limited, with Shanghai and the country as a whole facing an overall lack of green finance support for GBs.

Lastly, while green finance policies have encouraged construction companies and real estate developers to apply for subsidies, there are few government subsidies or benefits for homebuyers to purchase a GB. This is a noval idea that has not been reviewed in the literature. As the government staff demonstrated the state could take the means to subsidise homebuyers rather than subsidise companies, which would be a better incentive for property developers to meet the needs of their customers rather than transferring funds directly to them. He explains like:

"If the mortgage rate for buyers of GBs could be reduced by one point, or if the state could subsidise 200 yuan/m^2, there would be positive market demand. As long as the client is made willing to buy, the developer will be motivated and […]"

5.3 Social drivers and barriers

As mentioned by Abidin (2010), the results of the interviews suggest that many companies' choice to move to GB is driven by corporate social responsibility (CSR).

"[…] because of the company's CSR, corporate green transformation and other factors that influence the CEO's vision, which in turn will promote a sustainable strategy for the company in the GB sector. "

Based on the information provided by the three interviewees, it is understood that the demand side of GB in Shanghai has not yet been effectively formed. Overall, most consumers lack awareness of the concept of GB and its advantages, there is a clear lack of spontaneous demand for GB and green consumer awareness needs to be deepened. Furthermore, some consumers often choose to forego purchasing green products when there is a green premium for green consumer goods at a lighter price.

Despite the current limited demand in Shanghai's GB market, it is considered to be a potential rich consumer environment. This supports Wu et al.'s (2019) conclusion that the market for GB demand is immature, but that there is potential therein. Interestingly, both development project managers and architects believed there is growing interest in green, healthy buildings in the wake of the epidemic, which is an unexpected finding. As the project manager elaborated:

"The epidemic, which started at the end of 2019, has also increased awareness of green and healthy buildings, with projects that include the keywords 'green' and 'healthy' taking precedence in the eyes of buyers when it comes to buying. This is because, especially after the epidemic in Shanghai this year, more clients are aware of the importance of the human environment"

Another possible reason for the public having no access to the relevant information is the lack of publicity and education in the GB sector. During the interview, the government staff mentioned that Shanghai had held a building energy efficiency awareness week in 2021, where experts were invited to share their knowledge about GB energy efficiency with the public through a combination of online and offline methods. Shanghai has been a good

example of how the media can promote energy efficiency in buildings, but the importance of this campaign needs to be given more attention.

5.4 Technological drivers and barriers

When referring to the technological aspect, interviewees all indicated that the innovative development of green technology plays a large role as a driving force for GB to move forward. As mentioned earlier, Shanghai Green Building Standardisation Professional Technical Committee was established aiming to provide technical help. This finding supports the conclusion of Jiang and Payne's (2022) study that GB technologies contribute to the diffusion of GBs. Amongst other things, the architects noted that:

> *"Digital, smart and intelligent construction use information technology to improve construction in the building industry, and these successful innovations in construction methods are an effective way and necessary means to accelerate the achievement of GBs"*

However, the interviews also revealed that the current poor practical operation of GBs and the lack of expertise is also a major challenge to the current development of GBs. Despite the high level of GDP in Shanghai, these issues are still significant and it can be inferred that these barriers can be observed nationwide. It also confirms the findings of Ding et al. (2018) that there is a gap between the design and practical application of green technologies.

There is a concern with GBs in Shanghai, which can also be extrapolated to the national level, in that 90% of the buildings that are currently ESGB certified have received GBDL certification (design phase) and very few projects have received GBL certification (operational phase). Therefore, the majority of GB projects have not yet been verified in operation. The architect gave an example:

"Take rainwater harvesting systems, which are used in Shanghai and other areas [...] although the principle is relatively simple, it also uses a lot of advanced energy-saving technology, such as using solenoid valves to control the level, but once these solenoid valves are put into the machine room, there are constantly some problems. [...] It costs a certain amount of money to put them into actual operation, but many property companies tend to abandon these efforts and gradually scale down the staffing requirements, technical requirements and management requirements at the back end of the operation, resulting in the actual operation failing to achieve the expected results."

In addition, the lack of green construction composite talents in enterprises is a common problem for real estate enterprises at present. These findings confirm Darko et al.'s (2017) argument that the lack of GB expertise and skilled labor is a major challenge of GB development. The project manager mentioned in the interview:

"[…] most real estate enterprises do not have a complete grasp of GB design, GB evaluation, the application of green technology and the control of the corresponding GB costs. Most GB design, construction and operation are the responsibility of different teams, and the GB design concept is easily lost in these transmission links, so it is not effectively implemented in building operation."

6. Conclusion

This research aims to assess the drivers and barriers to the GB development in Shanghai and to provide the government with valuable suggestions for promoting the scale of GB development in China. Through the analysis of policy documents and the content analysis of semi-structured interviews, this study considers the key drivers and barriers from four perspectives: policy, economic, social and technological. This chapter will summarise the findings of the above research and offer policy implications for the subsequent high-quality development of GBs in the light of real-life dilemmas. Besides, the relevant limitations of this study will be mentioned, as well as the prospects for future research.

6.1 Summary of findings and discussions

Through a review and analysis of GB related policies in China and Shanghai, it is evident that a relatively well-established GB policy system has been established in China, encompassing evaluation criteria and a range of incentive policies, and even a range of legislation has been introduced at the local government level to govern GB development within their jurisdictions. Combined with the results of the literature review and content analysis, the main drivers and barriers to GB development in Shanghai identified in this study have been mentioned in the existing literature, with the exception of a few unanticipated results due to the unique geographical characteristics of China and Shanghai.

GBs are driven by mandatory regulations and policies, green finance and incentive strategies, access to market competitiveness and corporate reputation, along with innovative green technologies. The key barriers to the development of GBs identified were the absence of clear provisions in the supreme law, high incremental costs of GBs, immaturity of the green financial system, inadequate incentives for consumers, inactive demand markets, lack of publicity and education, and shortage of professional talent.

6.2 Policy implications

The transition to GBs requires the involvement of multiple parties, including the government, developers, architects and the financial sector. What follows are a few possible recommendations based on the above summary of the current barriers to GB development.

a. Perfecting the GB institutional system

In response to the current lack of a mandatory legal basis for GB standards, the legal positioning of *ESGB* should be clarified through the revision of higher laws, such as *the Construction Law*, and supplemented by the provisions of local legislation to form a more complete system with mandatory and recommended standards to provide adequate institutional support for the development of GBs.

b. Promoting green finance and financial support

Local housing and urban-rural construction departments should strengthen communication with financial departments and seek financial support to encourage the use of government and social capital cooperation to promote the creation of GBs. At the same time, the government should strengthen incentive policies on the demand side to promote consumer purchasing behaviour, and can provide consumers with policies such as preferential interest rates on home purchase loans.

c. Focusing on technology development and talent training

Firstly, universities should pay attention to the cultivation of talents in the field of GB, not only in design and construction, but also in the comprehensive operation and maintenance of GBs. Secondly, relevant scientific research institutions should put more effort into the research and development of GB technologies and other fields, using independent innovation to drive market development.

d. Creating a GB "atmosphere"

The state and the relevant industry parties have to further improve consumer awareness of GB, form an environment in which the whole society advocates green civilisation, guide residents to green housing and office needs, and make the development of GB gradually transition from government guidance to market promotion.

6.3 Limitations of the study

Although this dissertation attempts to give an exhaustive answer to the research question, it still has limitations. Firstly, this study mainly refers to four perspectives on the drivers and barriers of GBs, which may not be comprehensive and there are likely to be other more influential factors present. Secondly, due to the limited number of people interviewed, the data collected may be partial, thus reducing the adequacy of the study's conclusions. Finally, due to the atypical economic background, geographical location and climate of Shanghai, the applicability of the study findings needs to be considered when generalising to other regions.

6.4 Areas for future research

Future research could consider expanding the sample size of interviews and selecting a wider geographical context for the study, which may lead to different conclusions. Besides, the study could compare the development of GBs in different regions, either in different parts of China or comparing China with other countries, to draw the practical lessons. Additionally, the perspective of this dissertation is mainly from the government's point of view; future research could choose to investigate from the perspective of developers or the public.

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8. Appendix

Appendix A: Semi-structured Interview Questions

Background

a. What is your role in the green building projects?

b. What is your role in the green building projects?

c. Working experience (years)

General question

a. What are your views on the overall development of green building in Shanghai?

b. From your work perspective, what are the key drivers and barriers within the green building industry? (If possible, rank the influence of these factors in general)

Policy drivers and barriers

a. How do you think national or municipal level policies are driving and facilitating the development of green buildings in Shanghai? How influential are they?

b. Do you think the current policies related to green building development in Shanghai are effective enough? Are there any institutional weaknesses? Discuss your views on the current policies.

c. What are your views on China's green building standards (ESGB)?

Economic drivers and barriers

a. From an economic perspective, what factors do you think are currently driving or hindering the development of green buildings in Shanghai? (This could be from the perspective of developers, consumers, etc.)

b. Have you encountered any shortage of funds in the green building projects you have been involved in in Shanghai? What are the long-term benefits of green buildings?

c. How has green finance supported the development of green buildings in Shanghai? How effective has it been? What are the constraints?

Social drivers and barriers

a. Regarding social aspects, what factors do you think drive or hinder the development of green buildings in Shanghai?

b. What do you think is the current level of public awareness of green buildings in Shanghai? And how does the knowledge and awareness, culture, lifestyle and behaviour of the public in Shanghai influence their purchase or use of green buildings?

Technological drivers and barriers

a. From a technical perspective, have you encountered any technical difficulties in the various stages of green building, including design, construction, operation and supervision?

b. What are the current technological developments in green building development? Is it effectively driving the development of green buildings? What are the current constraints?

c. What green building technologies do you think are particularly suitable for Shanghai in terms of regional characteristics?

Suggestions

Do you have any suggestions on how to overcome the barriers we discussed earlier?

How can you further support the expansion of green building development in Shanghai and China?

Appendix B: List of GB Policies and Documents Analysed in Chapter 4

National level green building policies (Summary of Chapter 4.1)

National Level Green Building policies			
Policy/ Document Name in English	**Policy/ Document Name in Chinese**	**Year of Introduction**	**Publishing Department**
Energy Conservation Law	节约能源法	1998	Standing Committee of the National People's Congress
Construction Law	建筑法	1998	Standing Committee of the National People's Congress
Technical Guidelines for Green Building	绿色建筑技术导则	2005	MOHURD
Evaluation Standard for Green Building (GB／T50378—2006)	绿色建筑评价标准	2006	MOHURD
Green Building Evaluation Technology Conditions	绿色建筑评价技术细则	2007	MOHURD
Green Building Evaluation Identity Management Method	绿色建筑评价标识管理办法	2007	MOHURD
Implementation Opinions on Accelerating the Development of Green Building in China	关于加快推动我国绿色建筑发展的实施意见	2012	Ministry of Finance (MOF) and MOHURD
Green Building Action Plan	绿色建筑行动方案	2013	The State Council, NDRC, MOHURD
The 13th Five-Year Plan for Building Energy Conservation and Green Building Development	建筑节能与绿色建筑发展“十三五”规划	2017	MOHURD
Evaluation Standard for Green Building（GB/T50378－2019）	绿色建筑评价标准(GB/T50378-2019）	2019	MOHURD
Action Plan for the Creation of Green Buildings	绿色建筑创建行动方案	2020	MOHURD, NDRC
The General Specification for Energy Efficiency and Renewable Energy Use in Buildings	建筑节能与可再生能源利用通用规范	2021	MOHURD
The 14th Five-Year Plan for Building Energy Conservation and Green Building Development	建筑节能与绿色建筑发展“十四五”规划	2022	MOHURD

Shanghai green building policies (Summary of Chapter 4.2)

Shanghai Green Building policies			
Policy/ Document Name in English	**Policy/ Document Name in Chinese**	**Year of Introduction**	**Publishing Department**
Shanghai Green Building Development Three-Year Action Plan (2014-2016)	上海市绿色建筑发展三年行动计划（2014-2016）》	2014	SMPC
Green Design Standards for Residential Buildings	公共建筑绿色设计标准	2014	SHMCHURDM
Green Design Standards for Public Buildings	住宅建筑绿色设计标准	2014	SHMCHURDM
13th FYP Green Building, Shanghai City Planning	上海市绿色建筑“十三五”专项规划	2016	SHMCHURDM
14th FYP Green Building, Shanghai City Planning	上海市绿色建筑“十四五”规划	2021	SHMCHURDM
Shanghai Green Building Evaluation Standards	上海市绿色建筑评价标准	2020	SHMCHURDM
Shanghai Green Building Management Measures	上海市绿色建筑管理办法	2021	SMPC

Appendix C: Semi-Structured Interview information and consent form

Information and consent form

Project Title **Research on drivers and barriers of green building development in China: A case study of Shanghai**

Researcher Jiajing.Liu

Introduction

You are being invited to take part in a research project being undertaken by a Masters student from the Bartlett School of Planning, University College London (UCL).

Before you decide whether or not to participate it is important for you to understand why the research is being conducted and what participation will involve. Please read the following information carefully, feel free to discuss it with others if you wish, or ask the research team for clarification or further information. Please take time to decide whether or not you wish to take part.

Why is this research being conducted?

The aim of this project is to identify the key drivers and barriers relating to the GB development in China and provide suggestions to the Chinese public sector to improve their ability to promote GB practices.

Why am I being invited to take part?

You are being invited to take part due to your working experience in green building projects. Your expertise in the area of green building development is important to help form a holistic view of this study. It is hoped that you could give some information about the green building development in Shanghai based on your experience.

Do I have to participate?

Participation is entirely voluntary. If you do choose to participate and then change your mind, you may withdraw from the research at any time with no consequences and without having to give a reason.

What will happen if I choose to take part?

If you do choose to participate, you will be invited to face-to-face interview explore the issues highlighted above. The interview will be conducted at a mutually agreed location. The interview will last approximately … and will be audio recorded (and transcribed at a later date). You will have the opportunity to see the interview transcript and agree any amendments with the researcher after the interview is concluded. Travel and subsistence expenses are not offered for participation.

What are the advantages of taking part?

There are no immediate benefits for participating in this project and no financial incentive or reward is offered, however it is hoped that this project will inform the Chinese public sectors with some valuable suggestions to help them improve the ability to promote the green building.

What are the possible disadvantages of taking part?

We anticipate no significant disadvantages associated with taking part in this project. If you experience any unexpected adverse consequences as a result of taking part in the project you are encouraged to contact the researcher as soon as possible using the contact details on page 2 of this information and consent sheet.

If I choose to take part, what will happen to the data?

The interview data will be anonymised at the point of transcription and identified by a general identifier (e.g. ‘Planning officer A’ or ‘Planning consultant B’ or a suitable pseudonym). A record of participant identities and any notes will be kept separately and securely from the anonymised data. All data and information affiliated with this project will be securely stored on an encrypted computer drive and physical documents will be stored securely on University property.

The data will be only used for the purposes of this research and relevant outputs and will not be shared with any third party. The anonymised data may be utilised in the

written dissertation produced at the end of this project, and this dissertation may then be made publicly available via the University Library's Open Access Portal, however no identifiable or commercial sensitive information will be accessible in this way.

What will happen to the results of the research project?

It is anticipated that the data collected in this project will be included in the dissertation produced at the end of this project, submitted for the award of a Masters degree at University College London (UCL). You will not be personally identified in any of the outputs from this work, and attributions and quotations will be anonymised. If you would like to receive an electronic copy of any outputs stemming from this project please ask the contact below who will be happy to provide this.

Contact Details

If you would like more information or have any questions or concerns about the project or your participation please use the contact details below:

Primary contact Jiajing Liu

Role MSc student

Email ucbq372@ucl.ac.uk

Supervisor Dr. Catalina Turcu

Role MSc dissertation supervisor

Email catalina.turcu@ucl.ac.uk

Telephone +44(0)2031089525

Concerns and / or Complaints

If you have concerns about any aspect of this research project please contact the MSc student contact the student in the first instance, then escalate to the supervisor.

Informed Consent Sheet

Research on drivers and barriers of green building development in China: A case study of Shanghai

If you are happy to participate, please complete this consent form by ticking the boxes to acknowledge the following statements and signing your name at the bottom of the page.

Please give the signed form to the researcher conducting your interview at the interview. They will also be able to explain this consent form further with you, if required.

1.	I have read and understood the information sheet.	☐
2.	I agree to participate in the above research by attending a face-to-face interview as described on the Information Sheet.	☐
3.	I understand that my participation is entirely voluntary.	☐
4.	I understand that I may withdraw at any time without giving a reason and with no consequences.	☐
5.	I agree for the interview to be audio recorded.	☐
6.	I understand that I may see a copy of the interview transcript after it has been transcribed and agree any amendments with the researcher.	☐
7.	I understand that the intention is that interviews are anonymised and that if any of my words are used in a research output that they will not be directly attributed to me unless otherwise agreed by all parties.	☐
8.	I understand the data from this project will be considered for repository in the UCL Open Access repository as described on the Information Sheet but that this will be anonymised data only.	☐
9.	I understand that I can contact the student who interviewed me at any time using the email address they contacted me on to arrange the interview, or the dissertation supervisor using the contact details provided on page X of the information sheet.	☐

Participant name: **Signature:** **Date:**

Researcher name: **Signature:** **Date:**

Appendix D: Risk Form

RISK ASSESSMENT FORM

FIELD / LOCATION WORK

DEPARTMENT/SECTION: BARTLETT SCHOOL OF PLANNING

LOCATION(S): CHINA

PERSONS COVERED BY THE RISK ASSESSMENT: Jiajing.Liu

BRIEF DESCRIPTION OF FIELDWORK (including geographic location): The fieldwork is based on the publicly available documents

COVID-19 RELATED GENERIC RISK ASSESSMENT STATEMENT:

Coronavirus disease (COVID-19) is an infectious disease caused by coronavirus SARS-CoV-2. The virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes. Droplets fall on people in the vicinity and can be directly inhaled or picked up on the hands and transferred when someone touches their face. This risk assessment documents key risks associated fieldwork during a pandemic, but it is not exhaustive and will not be able to cover all known risks, globally. This assessment outlines principles adopted by UCL at an institutional level and it is necessarily general. Please use the open text box 'Other' to indicate any contingent risk factors and control measures you might encounter during the course of your dissertation research and writing.

Please refer to the Dissertation in Planning Guidance Document (available on Moodle) to help you complete this form.

Hazard 1: Risk of Covid -19 infection during research related travel and research related interactions with others (when face-to-face is possible and/or unavoidable)

Risk Level - Medium /Moderate

Existing Advisable Control Measures: Do not travel if you are unwell, particularly if you have COVID-19 symptoms. Self-isolate in line with NHS (or country-specific) guidance.

Avoid travelling and face-to-face interactions; if you need to travel and meet with others:

- If possible, avoid using public transport and cycle or walk instead.
- If you need to use public transport travel in off-peak times and follow transport provider's and

governmental guidelines.

- Maintain (2 metre) social distancing where possible and where 2 metre social distancing is not achievable, wear face covering.
- Wear face covering at all times in enclosed or indoor spaces.
- Use hand sanitiser prior to and after journey.
- Avoid consuming food or drinks, if possible, during journey.
- Avoid, if possible, interchanges when travelling - choose direct route.
- Face away from other persons. If you have to face a person ensure that the duration is as short as possible.
- Do not share any items i.e. stationary, tablets, laptops etc. If items need to be shared use disinfectant wipes to disinfect items prior to and after sharing.
- If meeting in a group for research purposes ensure you are following current country specific guidance on face-to-face meetings (i.e rule of 6 etc.)
- If and when possible meet outside and when not possible meet in venues with good ventilation (e.g. open a window)
- If you feel unwell during or after a meeting with others, inform others you have interacted with, self-isolate and get tested for Covid-19
- Avoid high noise areas as this mean the need to shout which increases risk of aerosol transmission of the virus.
- Follow one way circulation systems, if in place. Make sure to check before you visit a building.
- Always read and follow the visitors policy for the organisation you will be visiting.
- Flush toilets with toilet lid closed.
-'Other' Control Measures you will take (specify):

NOTE: The hazards and existing control measures above pertain to Covid-19 infection risks only. More generalised health and safety risk may exist due to remote field work activities and these are outlined in your Dissertation in Planning Guidance document. Please consider these as possible 'risk' factors in completing the remainder of this standard form. For more information also see: Guidance Framework for Fieldwork in Taught and MRes Programmes, 2021-22

Consider, in turn, each hazard (white on black). If **NO** hazard exists select **NO** and move to next hazard section.
If a hazard does exist select **YES** and assess the risks that could arise from that hazard in the risk assessment box.

Where risks are identified that are not adequately controlled they must be brought to the attention of your Departmental Management who should put temporary control measures in place or stop the work. Detail such risks in the final section.

ENVIRONMENT	**The environment always represents a safety hazard. Use space below to identify and assess any risks associated with this hazard**
e.g. location, climate, terrain, neighbourhood, in outside organizations, pollution, animals.	Examples of risk: adverse weather, illness, hypothermia, assault, getting lost. Is the risk high / medium / low ? NO

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	work abroad incorporates Foreign Office advice
	only accredited centres are used for rural field work
	participants will wear appropriate clothing and footwear for the specified environment
	refuge is available
	work in outside organisations is subject to their having satisfactory H&S procedures in place
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EMERGENCIES	**Where emergencies may arise use space below to identify and assess any risks**
e.g. fire, accidents	Examples of risk: loss of property, loss of life NO

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	participants have registered with LOCATE at http://www.fco.gov.uk/en/travel-and-living-abroad/
	contact numbers for emergency services are known to all participants
	participants have means of contacting emergency services
	a plan for rescue has been formulated, all parties understand the procedure

	the plan for rescue /emergency has a reciprocal element
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EQUIPMENT	**Is equipment used?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. clothing, outboard motors.	Examples of risk: inappropriate, failure, insufficient training to use or repair, injury. Is the risk high / medium / low ?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	the departmental written Arrangement for equipment is followed
	participants have been provided with any necessary equipment appropriate for the work
	all equipment has been inspected, before issue, by a competent person
	all users have been advised of correct use
	special equipment is only issued to persons trained in its use by a competent person
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

LONE WORKING	**Is lone working a possibility?**	**NO** Low	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. alone or in isolation *lone interviews.*	Examples of risk: difficult to summon help. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	the departmental written Arrangement for lone/out of hours working for field work is followed
	lone or isolated working is not allowed
	location, route and expected time of return of lone workers is logged daily before work commences
	all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
	all workers are fully familiar with emergency procedures
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

ILL HEALTH	The possibility of ill health always represents a safety hazard. Use space below to identify and assess any risks associated with this Hazard.
e.g. accident, illness, personal attack, special personal considerations or vulnerabilities.	Examples of risk: injury, asthma, allergies. Is the risk high / medium / low?
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	all participants have had the necessary inoculations/ carry appropriate prophylactics
	participants have been advised of the physical demands of the research and are deemed to be physically suited
	participants have been adequate advice on harmful plants, animals and substances they may encounter
	participants who require medication should carry sufficient medication for their needs
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

TRANSPORT	Will transport be required	NO		Move to next hazard
				Use space below to identify and assess any risks
e.g. hired vehicles	Examples of risk: accidents arising from lack of maintenance, suitability or training			
	Is the risk high / medium / low?			
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**			

	only public transport will be used
	the vehicle will be hired from a reputable supplier
	transport must be properly maintained in compliance with relevant national regulations
	drivers comply with UCL Policy on Drivers http://www.ucl.ac.uk/hr/docs/college_drivers.php
	drivers have been trained and hold the appropriate licence

	there will be more than one driver to prevent driver/operator fatigue, and there will be adequate rest periods
	sufficient spare parts carried to meet foreseeable emergencies
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

DEALING WITH THE PUBLIC	**Will people be dealing with public**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. interviews, observing	Examples of risk: personal attack, causing offence, being misinterpreted. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	all participants are trained in interviewing techniques
	advice and support from local groups has been sought
	participants do not wear clothes that might cause offence or attract unwanted attention
	interviews are conducted at neutral locations or where neither party could be at risk
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

WORKING ON OR NEAR WATER	**Will people work on or near water?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. rivers, marshland, sea.	Examples of risk: drowning, malaria, hepatitis A, parasites. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	lone working on or near water will not be allowed
	coastguard information is understood; all work takes place outside those times when tides could prove a threat
	all participants are competent swimmers
	participants always wear adequate protective equipment, e.g. buoyancy aids, wellingtons
	boat is operated by a competent person
	all boats are equipped with an alternative means of propulsion e.g. oars
	participants have received any appropriate inoculations
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

MANUAL HANDLING (MH)	Do MH activities take place?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. lifting, carrying, moving large or heavy equipment, physical unsuitability for the task.	Examples of risk: strain, cuts, broken bones. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	the departmental written Arrangement for MH is followed
	the supervisor has attended a MH risk assessment course
	all tasks are within reasonable limits, persons physically unsuited to the MH task are prohibited from such activities
	all persons performing MH tasks are adequately trained
	equipment components will be assembled on site
	any MH task outside the competence of staff will be done by contractors

☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

FIELDWORK	**4**	May 2010

SUBSTANCES	Will participants work with substances	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. plants, chemical, biohazard, waste	Examples of risk: ill health - poisoning, infection, illness, burns, cuts. Is the risk high / medium / low?		
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**		

	the departmental written Arrangements for dealing with hazardous substances and waste are followed
	all participants are given information, training and protective equipment for hazardous substances they may encounter
	participants who have allergies have advised the leader of this and carry sufficient medication for their needs
	waste is disposed of in a responsible manner
	suitable containers are provided for hazardous waste
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

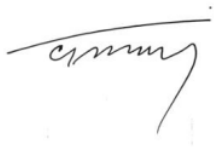
OTHER HAZARDS	Have you identified any other hazards?	NO	If 'No' move to next section If 'Yes' use space below to identify and assess any risks
i.e. any other hazards must be noted and assessed here.	Hazard: Risk: is the risk		
CONTROL MEASURES	**Give details of control measures in place to control the identified risks**		

Have you identified any risks that are not	**NO**		**Move to Declaration**
adequately controlled?			**Use space below to identify the risk and what action was taken**

DECLARATION	The work will be reassessed whenever there is a significant change and at least annually. Those participating in the work have read the assessment.

Select the appropriate statement:

√	I the undersigned have assessed the activity and associated risks and declare that there is no significant residual risk
√	I the undersigned have assessed the activity and associated risks and declare that the risk will be controlled by the method(s) listed above



NAME OF SUPERVISOR
Dr Catalina Turcu

FIELDWORK 5 May 2010

BPLN0039_RZDT5

GRADEMARK REPORT

FINAL GRADE

/100

GENERAL COMMENTS

Instructor

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