ECONOMIC INCENTIVES OF GREEN BUILDINGS: FOCUS STUDY ON THE GROSS FLOOR AREA CONCESSION SCHEME

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Economic Incentives of Green Buildings: Focus Study on the Gross Floor Area Concession Scheme

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CERTIFICATE OF ORIGINALITY

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Abstract

Improving building energy efficiency has become an increasing priority for policy makers in many countries and regions. The involvement of the government in such initiative is recognized as an effective way to promote green buildings (GBs). Economic incentives, such as grants, the Gross Floor Area (GFA) Concession Scheme, and expedited permitting, are commonly used to address the significant barriers to GB development by increasing its associated monetary benefits and reducing its time costs. However, recent studies reveal some issues in the effectiveness and efficiency of these incentives. Some of these studies ask whether these economic incentives can benefit stakeholders, why some stakeholders participate in the incentive schemes, and why others refuse to participate in such schemes. Economic incentives are offered by the government and may be considered as contracts between the government and the stakeholders in the private sector. The costs and benefits for the stakeholders must be fully considered in order to make the economic incentives more effective and efficient.

This study aims to analyze the costs and benefits, including the hidden ones (i.e., transaction costs or TCs), borne by the different stakeholders of GB economic incentives to further understand the mechanisms of these incentives and to explore how they can be better designed. The objectives of this study are as follows:

- To review the economic incentives, (with particular focus on costs and benefits, including hidden transaction costs), for promoting green buildings;
- To develop a cost–benefit analysis framework and establish an associated theoretical basis to explain the effectiveness of the GFA Concession scheme in Hong Kong;
- To evaluate to what extent the costs and benefits for different stakeholders have been considered by the policy makers by measuring the costs and benefits associated with the mechanism of the GFA Concession Scheme;
- To offer recommendations on how to better design economic incentives, specifically the GFA Concession Scheme.

This study examines the GFA Concession Scheme, a popular economic incentive implemented in Hong Kong, as a case study. Expert interviews, analytical hierarchy process, and computational fluid dynamics simulation were used to collect and analyze data. A focus group forum was also organized to validate the data analysis results.

Three significant findings are obtained from the results. First, with regard to cost, the construction cost remains the major concern of the private sector and the actual costs are more important than the transaction costs. Among the actual benefits, energy savings and enhanced value of GBs are valued most by the participants of the GFA Concession Scheme. In terms of hidden benefits, the environmental benefits by following the Sustainable Building Design Guidelines reveal that building separations and setbacks can effectively remove pollutants and reduce the health risks for pedestrians.

Second, TC is a significant cost component that affects the efficiency of the incentive scheme and must therefore not be ignored. Professionals bear much TC yet receive few benefits from the scheme. The findings indicate that: 1) additional knowledge, information, and practical experience that can be transferred across projects may help reduce the information searching cost and research/learning cost; and 2) the over-qualitative GB assessment method and incomplete government documents can increase the negotiation and approval cost.

Third, the incentive scheme is offered by the government and may be regarded as the contract between the government and the stakeholders in the private sector. The government did not fully consider the costs and benefits for the stakeholders when designing the contract. The findings indicate that: 1) the incompleteness of the incentive scheme apparently affects the TCs and actual costs of stakeholders; 2) the residual rights of control belonging to the government make the developers minimize their ex ante investment, which reduces the efficiency of economic incentives and affects the promotion of GBs; and 3) for incentive schemes with many deficiencies, the short-term scheme is ideal for renegotiations yet discourages specific investments. A long-term incentive scheme must be implemented and regularly reviewed, and the stakeholders must be informed regarding the review time to reduce their investment risks.

With regard to the current incentive level, 10% GFA concession is too much for GB promotion and increases the land value. Developers will only face losses when the scheme is terminated or when the incentive level is lowered. This finding supports the theory of the transitional gains trap.

This study expands the framework of the traditional CBA by taking TCs and hidden benefits into account. This study also provides a new lens—the incomplete contract—to look at government incentives. An incomplete contract turns out to be an effective instrument for evaluating incentive schemes and provides policy makers with a novel perspective toward the incentive design. The findings also support the theory of transitional gains trap, which is usually ignored by policy makers. Three analytical frameworks, namely, TC theory, the incomplete contract theory, and the transitional gains trap, explain how the identified costs and benefits can change along with the mechanism of economic incentives, which in turn helps policy makers improve the incentive scheme and predict its corresponding impacts on the stakeholders in the private sector. This study not only fills the theoretical gap in analyzing the effectiveness and efficiency of economic incentives but also contributes to the analytical techniques of policy evaluation.

Publications arising from the thesis

Journal Articles and Monograph

1. **Fan, K**., Chan, E.H.W., Chau, C.K. (2018) New lens to look at green building economic incentives: focus study on the GFA Concession scheme. Building Research & Information. (Under review)

2. **Fan, K**., Qian, Q. K., Chan, E. H. W. (2017) Transaction Costs in Green Building Incentive Schemes: Gross Floor Area (GFA) Concession Scheme in Hong Kong. Energy Policy. (Second Review)

3. **Fan, K.** Chan, E.H.W., Wei Feng (2017) Assessing green building incentives through the theory of incomplete contract, Renewable and Sustainable Energy Reviews. (Under Review)

4. Qian, Q. K., **Fan, K.**, Chan, E. H. W. (2016). Regulatory incentives for green buildings: gross floor area concessions. Building Research & Information, Vol. 5, No. 6, 1–23.

5. Chan, E.H.W., **Fan, K.**, Chau, C.K., Qian, K.Q., Khalid, G. (2017), Cost-benefit-analysis (CBA) for implementing green buildings (GB) promotion incentives: with Transaction Costs (TCs) Considerations. Research Monograph for the Construction Industry Council, project No: K-ZJJR

6. Chan, Edwin H.W., Choy Lennon H.T., Qian, K.Q., **Fan, K.,** Framework for quantifying the Transaction Costs (TCs) of the Green Building (GB) project delivery: A case of Hong Kong Real Estate Development Process (REDP). Research Monograph for the Construction Industry Institute Hong Kong (CII-HK).

Conference paper:

7. **Fan, K.,** Chan, E. H. W. (2017) Developers' Gains and Losses from the Economic Incentives of Green Building: Explanations from the Transitional Gains Trap and Transaction Cost Economics. 19th International Conference on Real Estate and Urban Economics June 2017, London, web publication without page number

8. **Fan, K.** Gu, W., Qian, Q.K., Chan, E.H.W. (2017). Costs and benefits of implementing green building policy: developers' perspective. World Sustainable Built Environmental Conference 5-7 June, 2017, Hong Kong. P 741-746.

9. **Fan, K.**, Qian, Q. K., Chan, E. H. W. (2016). Transaction costs (TCs) in building regulations and control for green buildings: case study of Hong Kong. The 20th CIB World Building Congress 30th May to 3rd June, 2016, Tampere, Finland. P818-828.

10. Gu, W., Guo, J., **Fan, K**., & Chan, E. H. (2016). Dynamic Land Use Change and Sustainable Urban Development in a Third-tier City within Yangtze Delta. Procedia Environmental Sciences, 36, 98-105.

11. **Fan, K.**, Qian, Q. K., Chan, E. H. W. (2015). Floor area concession incentives as planning instruments to promote green building: A critical review of International practices. Smart and Sustainable Built Environments (SASBE) conference 9– 11 Dec, 2015, Pretoria, South Africa. Web publication without page number

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Glossary

BEAM (Building Environmental Assessment Method) Plus is a green building assessment tool, particularly designed for Hong Kong.

Gross Floor Area of a building is the area contained within the external walls of the building measured at each floor level and the area of balcony.

Incomplete contract theory argues that every contract is incomplete that negatively affect contracting parties to enter the contract.

Sustainable Building Design Guidelines is designed by Hong Kong government to improve outdoor air ventilation.

Transitional Gains Trap is a theory stating that when government granted special privileges to a group of people, only transitional gains were made.

Abbreviations

AHP	Analytical Hierarchy Process
BEE	Building Energy Efficiency
BEAM Plus	Building Environmental Assessment Method Plus
CBA	Cost-benefit Analysis
CFD	Computational Fluid Dynamics
EIA	Environmental Impact Assessment
GB	Green Building
GFA	Gross Floor Area
GM	Green Mark
IC	Incomplete Contract
LCA	Life Cycle Analysis
MCA	Multi-criteria Analysis
RA	Risk Analysis
SBDGs	Sustainable Building Design Guidelines
SEA	Strategic Environmental Assessment
TC	Transaction Cost
TGT	Transitional Gains Trap

Chapter 1 Introduction

1.1 Research background

1.1.1 Incentives to promote green building (GB)

The energy consumption of buildings accounts for over 40% of the global energy use and one-third of the global greenhouse gas emissions (UNEP, 2009). In Hong Kong, residential and commercial buildings consume around 64% of all energy and 92% of electricity in 2014 (Electrical and Mechanical Services Department, 2016). Apart from its energy consumption, the building sector influences the environment in many other ways, such as in solid waste generation, resource depletion, and environmental damage. The building industry is increasingly seeking for solutions to minimize the impacts of the building sector on the environment. Against this background, green building (GB) gains its popularity as it not only can satisfy basic building requirements but also can minimize environmental impact and life cycle cost (Ali & Al Nsairat, 2009; Gowri, 2004). Various incentive schemes are implemented to promote the development of GB and stimulate its investment (Odebiyi Sunday et al., 2010; Shen et al., 2016; Weeks, 2010). In general, incentive is defined as something that motivates people to act in certain ways (Frances & Sivasailam, 1992).

These incentives have encountered challenges. For example, Balachandra et al. (2010) stated that most developing countries do not effectively implement BEE policies owing to limited resources and economic development priority. Ryghaug and Sørensen (2009) claimed that the deficiencies in public policies constrain the development of the BEE market. Shi et al. (2014) evaluated 24 GB policies implemented in China and believed that only half of them are regarded as effective by experts. Shen et al. (2016) argued that voluntary incentive schemes can be improved through effective communication and cooperation between the government and private participants.

1.1.2 Economic incentives

The affordability of green construction is a significant challenge, and economic incentives that can increase affordability is an important driver of green construction (Pitt et al., 2009). Economic incentives are implemented mainly in the form of subsidies, tax reduction, rebate system, low-cost loans, gross floor area (GFA) concession (i.e., density bonus), expedited permitting, and cash incentives (Qian & Chan, 2009; Yudelson, 2007). Economic incentives have been implemented in many countries and regions and consume social resources. For example, Singapore rewards cash incentives to developers and project consultants of new development with a gross area of at least 2000 m^2 that achieves a green mark gold rating or higher. UK and US provide subsidies to developers (He et al., 2015; Sangster, 2006). These economic incentives also receive criticism. For example, Johnston et al. (1989) questioned the impacts of income and land price on the participation rate of density bonus scheme and impacts of incentive level on project profits in the USA. Fletcher (2009) and Retzlaff (2009) claimed that the mechanism for determining the optimal level of incentives is lacking. Insufficient incentives barely motivate developers to construct GB, whereas excessive incentives result in much social cost (Feiock et al., 2008; Retzlaff, 2009). Making the level of incentive suitable for the incremental cost of GB remains a challenge for the government (Fletcher, 2009).

Few studies have focused on the cost–benefit analysis (CBA) of economic incentives. The hidden cost of GB development, such as cost of dealing with inflexible building code regulators and cost of integrating sustainable design elements, are relatively small but still exert noticeable impacts on the overall cost (Miller et al., 2008; Morris & Langdon, 2007). Therefore, CBA should include hidden cost (transaction cost (TC)).

1.1.3 The GFA Concession scheme

Among all the economic incentives of GB, the GFA concession scheme as a planning instrument is popular and implemented in many countries and regions.

The GFA incentive scheme leverages on private investment to provide public amenities (Tang and Tang, 1999). The original notion of "making developers pay" comes from UK. This notion is a policy instrument for redistributing resources between the private sector and the general public through the design of the incentive scheme. The government grants extra GFA to developers in exchange for their contributions to public amenities such that the government can save money to invest in public facilities. This incentive instrument has a long history and has been applied to affordable housing programs in the USA, Australia, and UK (Fox & Davis, 1975; Gurran et al., 2008) and renewable energy of buildings in Japan, France, and New Zealand (Paetz & Pinto-Delas, 2007). In recent years, this incentive instrument has been used to promote GB in many countries and regions, such as the USA, Singapore, and Hong Kong.

In Hong Kong, the scheme is designed to facilitate the adoption of BEAM Plus and Sustainable Building Design Guidelines (SBDGs) (Council for Sustainable Development, 2010) and certain building design features to solve the urgent problems of built environment. Given that Hong Kong has limited land provision, extra GFA as an incentive is preferred by developers (Fan, Qian, & Chan, 2015). However, only less than 40% of developers have applied for GFA concession in the past 5 years given the high land price in Hong Kong and that as high as 10% GFA Concession can be awarded. If GFA concession fails to work efficiently in Hong Kong, then implementing this scheme to other less dense cities, where GFA is not a critical issue, is difficult.

1.2 Research aim and objectives

1.2.1 Research questions

This study attempts to answer the following four questions to fully understand the effectiveness and efficiency of the GFA concession scheme in Hong Kong.

Question 1: Why do some stakeholders participate in the scheme and others

do not even though 10% GFA concession significantly benefits developers in Hong Kong?

In a high-density city like Hong Kong, extra floor area means extra profits. If 10% GFA concession benefits developers, why do not some of them participate in the scheme? Similar situation also happened in other countries. Density bonus is ranked 1st among all the incentives by developers in the US (Yudelson, 2007), but green buildings still have limited market penetration. The following sub-questions remain to be answered:

- What costs and benefits do the GFA concession scheme in Hong Kong bring to stakeholders?
- Who bear the costs and benefits?
- To what extent the benefits motivate stakeholders and costs concern stakeholders?

Question 2: To what extent does the government consider the costs and benefits of stakeholders in designing the incentive scheme?

The GFA concession scheme is made by the government. The question on to what extent does the government consider the costs and benefits of stakeholders in designing the GFA concession scheme remains and can be evaluated using cost and benefit as criteria.

Question 3: How long should the incentive scheme last? If the incentive

scheme is terminated, then who will gain or loss?

Long-standing GB incentives are a great concern for stakeholders (Qian et al., 2012). Short-term incentive schemes affect GB investment (Choi, 2009; Olubunmi et al., 2016; Rainwater & Martin, 2008). Whether the government should remove the incentive when the number of GBs in the market increases is uncertain. If the incentive scheme is terminated, then who will gain or loss?

Question 4: How should the incentive scheme be designed to increase participation of stakeholders? What are the costs and benefits effect on stakeholders with the change of mechanism of economic incentives?

Economic incentives aim to provide benefits to participants. How should the economic incentives be designed to increase participation of stakeholders in the scheme? If the government wants to revise the incentive scheme, then what are the changes in the costs and benefits of stakeholders? Answering these challenging questions guarantees the effectiveness of incentives to the affected parties.

1.2.2 Research aim and objectives

Aim:

This study aims to analyze the costs and benefits borne by different stakeholders of green building economic incentives to better understand their mechanisms and explore how to better design the economic incentives.

The objectives are:

- To review the economic incentives, (with particular focus on costs and benefits, including hidden transaction costs), for promoting green buildings;
- To develop the cost-benefit analysis framework and associated theoretical basis to explain the effectiveness of the Gross Floor Area (GFA) Concession scheme in Hong Kong;
- To evaluate to what extent different stakeholders' costs and benefits have been considered by policy-makers, and by measuring the costs and benefits associated with the mechanism of the GFA Concession Scheme.
- To recommend how to better design economic incentives, and particular focus on the GFA Concession Scheme.

1.3 Research design and framework

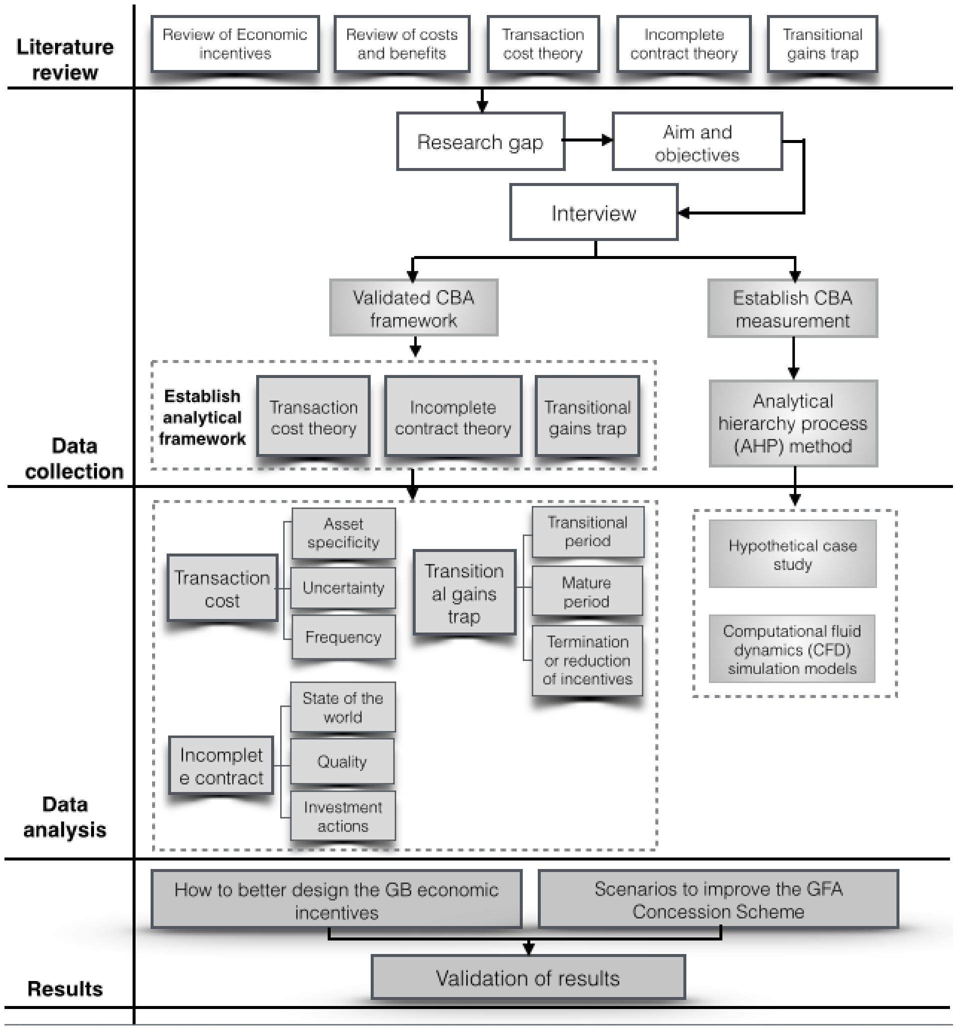


Figure 1 Research design

This research involves four main phases, namely, literature review, data collection, data analysis, and results (Figure 1). The literature review stage aims to identify the research gap and develop a CBA framework and the associated theoretical basis. Thereafter, the research framework of this study in Figure 2 is established. The three identified theories are used to determine the changes in the identified costs and benefits with the changes of mechanism of the GFA concession scheme (Figure 2).

The data collection stage aims to validate the established CBA framework and collect data under the analytical frameworks of three theories through expert interview. Meanwhile, the data on CBA measurement by the analytical hierarchy process (AHP) method are collected.

The data analysis stage aims to analyze the changes in the identified costs and benefits with the changes of mechanism of the GFA concession scheme. The costs and benefits, including TCs and hidden benefits, are measured through a hypothetical case selected from the baseline model of the SBDGs and computational fluid dynamics (CFD) simulation models and AHP.

In the last stage, several suggestions are proposed to design GB economic incentives effectively and three scenarios are provided to improve the GFA concession scheme.

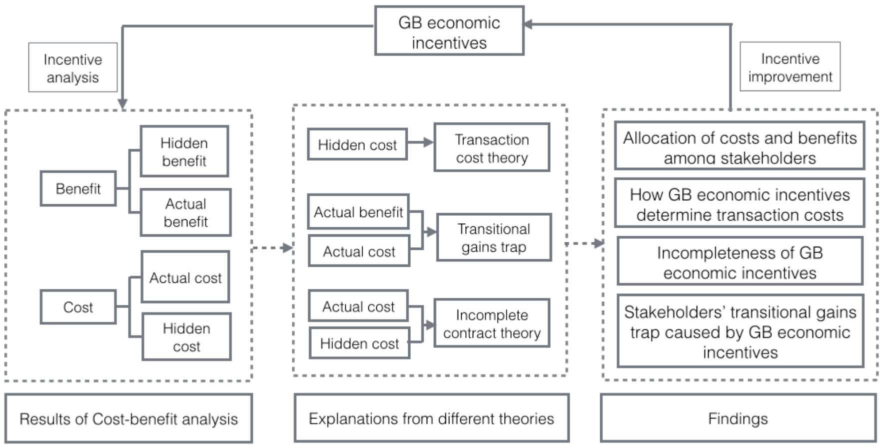


Figure 2 Research framework

1.4 Significance and originality of this study

Economic incentives consume social resources to promote GBs but do not reach their optimal effectiveness and efficiency, thereby resulting in significant loss for a society. Few studies have evaluated the effectiveness and efficiency of economic incentives from the CBA perspective, and little knowledge is known on the changes in costs and benefits with the changes of mechanism of economic incentives.

This study provides new lens to look at economic incentives of GB by combining the theories below to explain the changes in costs and benefits with the changes of mechanism of economic incentives.

- Integrating transaction cost theory into the traditional CBA framework.
- Applying the incomplete contract theory to evaluate the impacts of incompleteness of incentives on stakeholders' costs and benefits.
- Applying the theory of the transitional gains trap to explain stakeholders' costs and benefits at different stage of GB market development.

Through this study, these new lens turn out to be useful to evaluate the effectiveness and efficiency of economic incentives of green buildings. They could be applied to evaluate other economic incentives to promote green buildings, affordable housing, renewable energy, etc.

1.5 Structure of this thesis

This thesis comprises eight chapters.

Chapter 1 is an overall introduction that highlights the essential information of the entire thesis, including the background, research objectives, research design and framework, significance and originality of research, and structure.

Chapter 2 presents a comprehensive review of the literature on economic incentives, stakeholders of GB economic incentives, costs and benefits relevant to the identified economic incentive (i.e., the GFA concession scheme), TC theory, incomplete contract theory, and transitional gain trap. The research gap is identified after the literature review.

Chapter 3 presents a comprehensive review of the GFA concession scheme implemented in Hong Kong, US, and Singapore and conducts a comparison study.

Chapter 4 presents the analytical frameworks of costs and benefits as well as the three identified theories. The chapter also describes the methodologies adopted throughout this research and the details on the research methods employed, including expert interview, AHP, CFD modeling, and focus group forum.

Chapter 5 presents the data analysis of CBA, TC theory, incomplete contract theory, and transitional gain trap. Interview data are categorized and placed under the analytical frameworks presented in Chapter 4.

Chapter 6 presents the research results and answers to the first three research questions presented in Chapter 1.4. The chapter also presents the validated CBA framework and analyzes the effect of the mechanism of the GFA concession scheme on the costs and benefits of stakeholders on the basis of the three above-mentioned theories.

Chapter 7 proposes three scenarios to improve the existing GFA concession scheme in Hong Kong and discusses the possible changes in costs and benefits under the three scenarios. Suggestions for designing economic incentives with CBA effectively are proposed, and an associated theoretical basis is provided.

Chapter 8 summarizes the primary findings, contributions, and limitations of the study as well as directions for future study.

Chapter 2 Literature review and theoretical context

2.1 Economic incentives of GB

Economic incentives and innovative fiscal arrangements are made available to compensate additional costs and thus overcome economic barriers (Lam et al., 2009; Sayce et al., 2007; Sodagar & Fieldson, 2008). Economic incentive schemes provide financial incentives to firms and thus compensate market participants and address economic barriers (Clemens, 2006). They attract private sectors in joining the development of GBs by reducing costs and increasing demands (Qian & Chan, 2009). Compensating developers or property owners directly can overcome the market barrier that only occupants can enjoy the benefits of GB and improve investment priority. Such scheme can reduce the financial risk, especially when the payback period is longer than the standard (Tanaka, 2011).

2.1.1 Categorization of the economic incentives

From the literature review, all the economic incentives implemented in the world, including tax reduction, subsidies, rebates, cash incentive, and GFA concession, are collected. These economic incentives are categorized into two types, namely, those with and without restrictions of government fiscal situation (Figure 3).

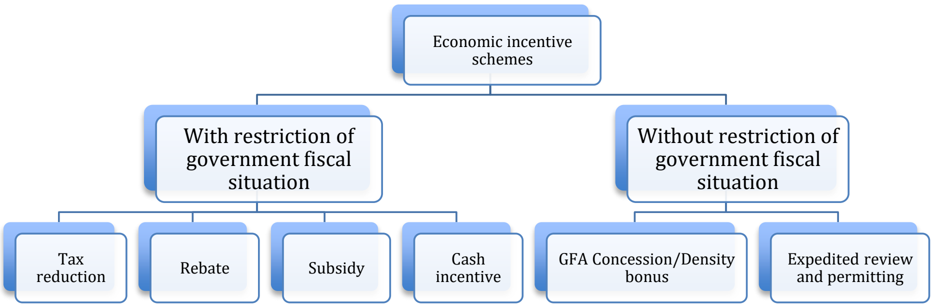


Figure 3 The existing economic incentive schemes (Sources: adopted from Gillingham and Palmer (2013); Yudelson Associates (2007))

(1) Economic incentive schemes with restrictions of government fiscal situation

This type of incentives relies on the financial income of government for compensating private sectors. As some economic incentives, such as subsidies, grants, and capital allowance, come from government revenue, the degree of benefits of stakeholders depends on government fiscal conditions. Therefore, the incentive supplied by the government may be insufficiently large to overcome high construction costs (Wade et al., 2003). This economic incentive scheme needs a consistent level of funding and provision of additional funding sources (Balachandra et al., 2010; Chan et al., 2009; Shen et al., 2016).

(2) Economic incentive schemes without restrictions of government fiscal situation

This type of incentives is implemented without the restriction of fiscal situation.

Stakeholders can obtain extra benefits by saving time or making extra money, such as GFA concession incentives and expedited review and permitting. The GFA concession incentive rewards developers with extra floor area, and expedited review and permitting saves considerable time of developers by simply shifting in permitting priority. This incentive scheme attracts developers and reduces the fiscal pressure from the government.

2.1.2 Comparison of economic incentives

Table 1 illustrates the aforementioned popular economic incentives, the benefits of stakeholders from the incentives, and the effects of the policies. From the data in the table, the possible improvements for the economic incentives can be established. The features of the economic incentives in Table 1 are summarized as follows:

- Most beneficiaries are developers and owners, and few countries reward professionals, such as architects and engineers;

- Incentive levels are based on the enhanced GB value (e.g., less property tax), GB cost, GB certification level, or building performance;

- Subsidies are provided for particular products or services.

Table 1 Comparison of economic incentives

Economic Incentives	Country or region	To whom	Degree of incentives	Bases	Effectiveness/Criticism	Reference
Tax reduction/exemption/rebates	Spain	Building owners	15%/25%/30%/40%/50% tax reduction, varying with the cities	Installation of solar thermal energy or photovoltaic systems, which have the corresponding approval of competent authorities	• Positive effect on the GB development • Highly visible • Significant cost reduction for GB development	Pablo-Romero et al. (2013) Shazmin et al. (2016);
	US	Building owners	A 100% property tax exemption	Increased property values, resulting from the installation of renewable energy devices.		Pablo-Romero et al. (2013)
	Malaysia	Companies	Tax exemption of 100% of statutory income for ten years	Generating energy from renewable resources used pioneer status	Significant for green building development, but not outstanding	Aliagha et al. (2013)
	US	Building owners	14%/10%-40%/18%-60%/20%-100% property tax rebate, varying with the levels of green certification, available for three to five years	Certified/Silver/Gold/Platinum of LEED	• Positive effect on the GB development	Shazmin et al. (2016); Pablo-Romero et al. (2013);
Subsidies	China	Developers	Buildings certified with two-star and three-star	• Green building rating standard and label has three tiers. Only two-star and three-star building could get subsidies. • The two-star green building award $ 45 per square meter, and the three-star green building award 80 RMB per square	From 2011 to 2013, the total GFA of two-star GB and three-star GB have increased 84% and 70% respectively.	de Blaauw and McGregor (2008)
	New Zealand	Home owners	• The level of the subsidy is calculated according to the ability of the homeowner to pay. For low-income households, the cost saving could reach to 30%. • \$3.50/m2 for ceiling or under floor heating; • \$500 towards a Clean Heat Project approved appliance e.g. an electric heat pump; • \$300 towards an electric night storage appliance; and \$100 towards sealing or removing an existing fireplace.	• To change to cleaner forms of heating	High uptake.	de Blaauw and McGregor (2008)
	Singapore	Private developers, and architects and M&E engineers in both public and private developments with GFA at least 2,000 square metres.	Cash incentives vary with the level of GM rating.	• The development is a new private development with a Gross Floor Area of at least 2,000 square metres. • The development must achieve BCA's Green Mark certification Gold rating or higher from 23 May 2008 onwards • For GM Gold plus buildings, minimum energy saving should be 25% . • For GM Platinum buildings, minimum energy saving should be 30%.	The fund is fully committed for 102 building projects, with 62 Green Mark Gold projects, 14 Green Mark Gold Plus projects and 26 Green Mark Platinum projects. 64.5% of experts think it is effective	Building and Construction Authority (2009) Hwang and Ng (2013)
Loan incentives	Malaysia	GB buyers	Reduced loan Interest rate or extended loan terms	NA	• The loan incentive is the most preferred from potential GB buyers' perspective • The existing incentive is not efficient and effective enough to make GB affordable	Ghodrati et al. (2012)
	US	Homeowers	Free-interest loan	• Purchase of the prescribed energy efficiency equipment	• Effective in terms of attracting consumers • Less effective than tax incentives	Ghodrati et al. (2012) Zhao et al. (2012)
GFA concession /density bonus	US	Developers	• To tie incentives to specific local public policy priorities, such as providing affordable housing, developing certain urban districts or certain types of buildings, and specific program requirements	In Arlington • For office buildings, those who own Silver certificates plus 20% energy efficiency could grant 0.20 FAR. Gold certificates plus 20% energy efficiency and Platinum certificates plus 20% energy efficiency could have 0.35 FAR and 0.45 FAR respectively. • Multifamily residential projects could request additional 0.05 FAR and must achieve 18% energy efficiency. Energy efficiency is based on LEED 2009.	• Main causes for the higher production of LEED certified residential buildings • The most significant incentive to green building (Yudelson, 2007) • Most common incentive to encourage energy efficiency	Sauer and Siddiqi (2009) Bond and Devine (2016)
	Hong Kong	Developers	• Subject to the GFA of green features	• BEAM Plus • Sustainable building design guideline • Green features •	Since it started in 2011, the number of registered HKBEAM projects has increased 416 until 2015, while before 2011, only 225 projects registered within 14 years.	HKGBC (2016) Building and Construction Authority (2014)
	Singapore	Developers	• Buildings certified with Green Mark Gold Plus or above; • GFA bonus varies with the grading of Green Mark	Green Mark Platinum could be awarded 2 % GFA bonus (subject to a cap of 5,000 sqm). Green Mark Gold plus could be awarded 1% GFA bonus (subject to a cap of 25,000 sqm)	After 4 years this scheme started (2009-2013), the total GFA of GM buildings increased 34.2 million m^2, while before that, the increased total GFA of GM buildings only increased 14.2 million m^2 within 4 years from 2005 to 2009.	Building and Construction Authority (2014)
Expedited permitting	US	Developers	Expedited Review/Permitting Processes;	Normal permitting may take months or above, leading to more construction costs, priority review may take as little as 7 days.	It is more attractive than monetary incentives	USGBC (2014), Yudelson (2007)
Rebate	US, Maryland	Homeowner	Rebate of \$200 and \$400 on the purchase of energy saving equipment in tier I and tier II		Reducing 5.3% of electricity usage	Alberini and Towe (2015)
Fee reduction	US	Developers and contractors	Fee reduction for permit review or other permitting processes	Conduct verifiable green building practices	Effective, but less effective than business-related incentives, like tax reduction and subsidies.	Bond and Devine (2016)
Grants	King County, US	Developers/building owners	Green buildings certified with LEED silver or above; Grants vary with the level of LEED grading.	Projects awarded LEED Silver will receive \$15,000, LEED Gold will receive \$20,000, and LEED Platinum will receive \$25,000. Fifty per- cent of the grant is awarded upfront, with 50 percent awarded at project completion. The grant money must be returned if the project does not achieve performance results.	Very popular, • 52% of local governments implemented.	Yudelson (2007) USGBC (2009)
	Pasadena, California, US	Developers/building owners	Green buildings certified with LEED; Grants vary with the level of LEED grading.	Pasadena's program provides \$15,000 grants for applicants who achieve LEED certification (\$20,000 for LEED Silver, \$25,000 for LEED Gold, and \$30,000 for LEED Platinum).		

2.2 Stakeholders of economic incentives of GB

The GFA concession scheme presents significantly different impacts and meanings for each individual group, such as developers and professionals. The scheme is critical for policy makers in understanding which costs and benefits are borne by each individual group (Kayden, 1978). Combining the CBAs of different stakeholders into one crucible can help in the tradeoff of disparate elements (Kayden, 1978). Stakeholders are decision makers at each stage of the GB development. This section reviews the role and importance of stakeholders in the GB development.

Developers and professionals

Koomey (1990) provided a list of 12 stakeholders in the GB market, namely, prospective building purchasers, prospective occupants, developers, builders, architects/designers, construction finance organizations, take-out lenders, brokers, appraisers, local, government officials, utility, and suppliers of efficient devices. Brambley et al. (1988) stated that developers and designers exert the largest influence on the total life cycle cost of new buildings. Developers, who have the most concerns with financial viability of the project, can influence subsequent participants; meanwhile, designers can influence the choice of building materials and systems (BD&C 1989b). Chan et al. (2009) claimed that building designers provide a link among the end users, the government, and the market with an objective view. Therefore, incentives for building designers can probably be effective.

Contractors

The design process and the role of contractor have been reshaped and changed by the demands for GB (Nobe & Dunbar, 2004). Integrated design is indispensable for a successful GB (Choi, 2009). The early involvement of the contractor in the design process is necessary (Rosenberg, Merson, and Funkhouser, 2003). Given that GB requires new technologies, contractors, engineers, and architects can reduce the risk of equipment failure (Hoffman and Henn, 2008). Therefore, contractors and professionals also play essential roles in the promotion of GB.

This paper would particularly focus on the costs and benefits of the above stakeholders.

2.3 Cost-benefit analysis

Limited government resources require the use of economic analysis tools for rationalizing government policies. CBA is a useful tool for evaluating policies and projects throughout the world (Hanley, 2001). CBA is an analytic procedure that evaluates the desirability of a project or a policy by weighing benefits against costs (Cowen, 1998; Posner, 2000). Such costs and benefits are regarded as aggregate changes in individual well-being that is induced by the evaluated project or policy (Kopp et al., 1997; Kornhauser, 2000). CBA can help policy makers and businessmen justify their decisions in a systematic, rigorous, and unambiguous way and thus ensure effective and efficient policy enforcement (Gramlich, 1981). Furthermore, the environmental impacts of policies or projects should be incorporated into the CBA framework to improve the quality of government decision making.

2.3.1 Comparing the CBA with other evaluation techniques

Apart from CBA, other common tools for evaluating policies or projects and helping in decision making of policy makers are also available; however, they present various degrees of comprehensiveness and focuses. Among them, CBA is a more common and comprehensive tool for evaluating projects and helping in public decision making (Chichilnisky, 1997; Hanley, 2001). Other common appraisal techniques that are compared with CBA are described below.

Environmental impact assessment

Environmental impact assessment (EIA) collects and measures the environmental impacts of policies or projects. However, the technique neglects non-environmental impacts and costs and is thus not as comprehensive as CBA. EIA can be regarded as an essential input to CBA (Bateman, 1999). EIA generally aims to search for ways to minimize negative environmental impacts without changing the benefits and costs of policies or projects.

Strategic environmental assessment (SEA)

Similar to EIA, strategic environmental assessment (SEA) also emphasizes on environmental impacts. However, SEA focuses mostly on the importance and alternatives of policies or projects. SEA is limited by ignoring costs and non-environmental impacts (Ness et al., 2007).

Life cycle analysis (LCA)

Life cycle analysis (LCA) is similar to EIA in identifying and measuring the environmental impacts of policies or projects (Ness et al., 2007). LCA differs from EIA by focusing on direct environmental impacts arising from policies or projects and environmental impacts of life cycle. Compared with CBA, LCA is the physical counterpart of the type of environmental impact analysis required by CBA (Pearce, D. et al., 2006).

Risk analysis

Risk analysis (RA) assesses the potential damages of a particular event or a series of events (Rotmans, 1998). The technique identifies the risks first and then assesses the quality and quantity of risks, thereby resulting in decisions on minimizing risks (Ness et al., 2007). Similarly, RA is not as comprehensive as CBA.

Cost–effectiveness analysis

Cost–effectiveness analysis (CEA) compares effectiveness (E) with cost (C). The common procedure is to produce CER (cost–effectiveness ratio) as follows:

$$CER=E/C.$$

The evaluation technique can only provide guidance on selecting the required alternative policy and can rank any set of policies (Pearce et al., 2006).

Multi-criteria analysis

Multi-criteria analysis (Fuerst & McAllister) is similar to CEA but involves multiple criteria of effectiveness. Ness et al. (2007) applied MCA in situations that contain competing evaluation criteria. Unlike CBA that adopts the increase in economic efficiency as objective, MCA presents no pre-ordained objectives. MCA identifies the objectives and seeks tradeoffs among them. Among the above-mentioned techniques, only MCA is as comprehensive as CBA or may even be more comprehensive as objectives may go beyond efficiency.

In summary, CBA is the appropriate technique for the current study because it focuses on economic efficiency. Considering environmental impacts only in evaluating the economic incentives of GB is insufficient because economic incentives also affect the construction industry in many ways. For example, economic incentives exert competitiveness impacts because constructing GB increases barriers to new entrants (Ahn et al., 2013; Pearce et al., 2006).

2.3.2 Types of CBA

There are two main types of CBA. One is ex ante CBA, which is commonly used when a project or policy is under consideration, assisting in the decision about if resources ought to be distributed by government to a certain policy or project or not. The other is ex post CBA, conducted at then end of project. Ex post CBA contributes to "learning" by politicians and academics about whether a project or policy is worthwhile (Boardman et al., 2011). At the early stage of a project or policy implementation, there are considerable uncertainties about the results, net benefits and their impacts. As the project is processing, more will be known. Therefore, ex post CBA is supposed to be more accurate than other types.

Cost-benefit analysis tries to consider all the benefits and costs to the society as a whole. It is a policy assessment method quantifying the value of all results of a policy to all members of society in monetary terms (Boardman et al., 2011). Ex post analyses offers information not only about a particular policy intervention, but more essentially, about future similar interventions as well. Ex post CBA analysis potentially give learning to policy makers and researchers about the value of a particular policy or project. This potential crucially rely on the extent to which the assessed policy is being replicated or could serve as a generic model for other policies (Greenberg & Mandell, 1991).

This paper would conduct ex post CBA. The selected economic incentive, “GFA Concession Scheme”, is one of the typical categories of economic incentives. It has been implemented in many counties and regions to promote green building. Also, the GFA Concession Scheme is usually used as planning tools to motivate developers to provide public amenities, such as park, affordable housing, etc. In this sense, the GFA Concession Scheme could serve as a generic model for other policies.

2.3.3 Application of CBA to the environmental policy

Arrow et al. (1996) summarized eight principles on applying CBA to environmental policy. 1) The favorable and unfavorable effects of policies are compared to help policy makers fully understand the implications of decision. 2) The relationship between benefits and costs is determined and the significant distributional consequences are identified. 3) Decision makers should consider the economic costs and benefits of different policies when designing regulations. 4) A core set of assumptions should be used when calculating economic costs and benefits relevant to environmental, health, and safety regulation. Some key variables, including the rate of social discount, the value of reducing risks of dying and accidents, and the value relevant to other improvements in health, should be considered. 5) When regulatory analyses are highly reviewed externally, they become better than before. 6) All major policy decisions should conduct CBA. 7) The CBA of policies should be quantified wherever possible.

Best estimates should be presented along with a description of uncertainties. 8) Agencies should be required to conduct CBA for decisions and explain the selection of these decisions.

The application of CBA to environmental policies arouses considerable discussion and critique (Farrow & Toman, 1999; Hahn & Dudley, 2004). Xu et al. (2011) summarized the strengths and weakness of the application of CBA to environmental policies (Table 2).

Table 2 The strengths and weakness of CBA application to the environmental policy, Source Xu et al. (2011)

Strengths	**Limitations**
• BCA is an economic appraisal tool to reach economic efficiency in resource allocation;	• It is difficult to monetize the non-market impacts of a policy, such as human health, environment and safety;
• BCA will promote a more objective and ever-handed decision-making process;	• The current practice of discounting may lead to undesirability of environmental protection and future generation;
• The process of BCA is transparent, which can promote the accountability of public decisions;	• BCA is lack of moral concern in policy-making process;
• BCA incorporates social values into its analysis process;	• Analysts generally have incomplete information about the data relevant to a decision;
• BCA take environmental effects into account;	• BCA is a time-consuming and expensive exercise;
• BCA adopts changes in well-being of society as the single evaluation indicator, which permits the comparison of policies;	• The choice of decision criterion is constrained by a variety of second-best considerations;
	• BCA is ineffectively adopted in environmental protection;

2.3.4 Measurement of CBA

The measurement of CBA is based on the willingness to pay. Benefits and costs are defined as increases and reductions in human well-being (utility), respectively, and are the sum of benefits and costs of individuals. Reducing the aggregated benefits and costs to a unique value is the net benefits or net present value, which is used as the evaluation criterion.

Benefits and costs should be evaluated to obtain accurate results, but such evaluation is difficult (Thomas & Callan, 2010). The Table 2 in the Chapter 2.3.3 shows that the monetary measurement of costs and benefits of non-market impacts results in problems, such as health and environment are not traded in the market and do not present direct economic value. Therefore, if important benefits or costs are not quantified, then whether the total net benefit is positive cannot be determined. Furthermore, conducting survey on willingness to pay of individual groups costs much time and money, which is another major drawback (Dasgupta, 1974).

Given the aforementioned shortages of CBA, Wijnmalen (2007), Wedley et al. (2003), Azis (1990), and Mitchell and Soye (1983) used AHP methods to measure the importance of costs and benefits. The AHP method combines all the costs and benefits and provides solutions to the problems of CBA. For example, the most prominent feature of AHP is that it can ensure that an answer for a group problem is made within a reasonable length of time (Mitchell & Soye, 1983).

This study will use AHP to measure the importance of costs and benefits. Data collection method would be presented in the Chapter 4. Apart from using AHP, this paper also selects a hypothetical case to study the real figures of cost and benefit, including transaction costs and hidden benefits, which would be presented in the Chapter 5.1.2. In terms of hidden benefits, some studies have measured benefits of and productivity of green buildings. For example, Kats et al. (2003) stated that cost savings of productivity and health represent 70% of all savings in life cost. Fisk and Rosenfeld (1997) estimated the potential benefits of improving health and productivity is $6 billion to $19 billion in the US from reduced respiratory disease. However, few studies measure the outdoor environmental benefits. This study will fill this gap by using computational fluid dynamics (CFD) model, which would be presented in the Chapter 5.1.2.

2.4 Transaction cost (TC) theory

2.4.1 Definition

The term of "transaction cost" was proposed by Arrow in 1969. Transactions costs (TCs) were defined as the costs of running an economic system, including exclusion costs and costs of communication (e.g. supplying and learning terms where transactions would be undertaken), and the costs of disequilibrium. The difference between TCs and production costs is that TCs varied with the modes of resource allocation while production costs relied on the technology and tastes, and would not change with economic systems (Arrow, 1969). Arrow's opinion linked TCs with institutions, which was supported by Cheung (1987), who claimed TCs were essentially institutional costs, and North (1990) who stated that transaction costs are the sources of power for social, economic, and political institutions. Williamson (1985) claimed that TCs were the costs of measuring and enforcing agreements. Measurement costs are those of measuring the valuable attributes (e.g. color, size, durability, robustness, performance, etc.) of what are being exchanged, while enforcement costs are those of protecting and enforcing agreements. Williamson (1985) further developed the concept of TCs. TCs comprised ex ante and ex post that the former occurred in drafting and negotiating agreements, while the latter included setup and the costs of running governance structure. TCs are equivalent to friction force in physical systems (Williamson, 1985). Similarly, Matthews (1986) stated that TCs comprised ex ante and ex post that were the costs of arranging contract, and monitoring and implementing it respectively. A more recent study stated that TCs are the costs relevant to search and information, policing and enforcement, as well as bargaining and decision-making processes. The exchange process was regarded as the major source of TCs (Furubotn & Richter, 2005).

2.4.2 Context and boundaries of transaction cost

Recent researchers try to define transaction costs in different context. For example, in the field of environmental policy, TCs are defined as the cost to produce and implement a policy (Coggan et al., 2013; Garrick et al , 2013). In the context of enforcing environmental regulations from the private sector's perspective, TCs refer to the cost to comply with the regulation (Wong et al, 2011). Kiss and Mundaca (2013) defined that TCs is understood as the cost of technology placement and implementation occurring ex-ante, and the cost of monitoring and enforcement occurring ex-post, in the analysis of technology innovation in the construction sector.

Due to the different definitions of transaction costs, there are a lot of applications in different transaction levels. For example, Hong et al (2007) believed that TCs comprised the ex ante and ex post compared the costs of two project delivery systems and divided them into three types, namely ex ante, construction cost, and ex post. Buitelaar (2004), compared TCs of different institutional arrangements in the land development process, and concluded that TCs, i.e. institutional cost, vary with the mode of institutions. McCann et al (2005) studied the boundary issues of TCs and divided them into three levels (Figure 4). Area A and B refer to TCs involved in the market transactions and resource allocation (institution) respectively. Further, TCs rely on the broader institutional arrangements, such as legal system (Area C in Figure 4) (Easter et al, 1998; Saleth and Dinar, 2003).

The TCs of implementing the GFA Concession scheme of this study falls into the area B (Figure 4).

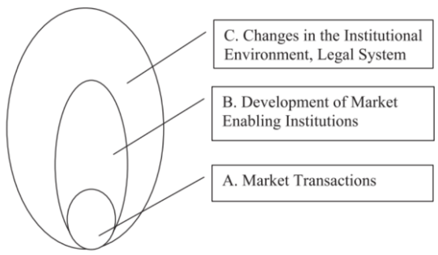


Figure 4 Boundary issues related to TCs, Source: McCann, Laura et al. (2005)

2.4.3 Existing studies on TCs

The previous literature has explored TCs typology in regard to implementation of the energy efficiency projects and environmental policies. For energy efficiency projects, TCs include monitoring and verification cost, information searching cost, trading cost, negotiation cost, and decision making cost, etc (Mundaca et al., 2013). With respect to implementing environmental policies, TCs include searching cost, approval cost, validation cost, negotiation cost, certification cost, monitoring costs, verification cost, transfer cost, enforcement cost, and contracting cost (Coggan et al., 2013; Dudek & Wiener, 1996; McCann, Laura et al., 2005; Ofei-Mensah & Bennett, 2013). Some of these TCs are overlapping because it is difficult to separate them clearly.

Application of TCs theory to green building and low-carbon technologies is relatively new. In the recent 10 years, there are only a few articles particularly focusing on this topic (Qian, Chan, et al., 2015b). Table 3 summarizes the latest studies with TCs determinants, types and measurements. The TCs determinants are crucial in principle because they provide clues on how to reduce TCs. Table 3 draws the following three findings: 1) TCs cannot be ignored; 2) TCs affect effectiveness negatively; 3) TCs vary with the project elements. This paper aims to enrich this research area and provide a TCs analytical framework appraisal GFA concession scheme implementation, by identifying different TCs typology and determinants, specific transactions with estimations how the TCs borne by different stakeholders.

Table 3 Review of TC applications on the projects and policies related to green building and low-carbon technology

Year	Author	Research topics	TCs Boundaries	TCs Determinates	TCs Types	TCs Measurement Method	Key Findings
2016	Kiss	Passive house-oriented retrofitting	A	• Extended pre-study; Searching for form of collaboration; Preparation of call for developer; Assessing developers' application; Assessment of subcontractors; Searching for assessment methods; Project formulation; Target setting; Preparation for the main call; Subcontracting under partnering; Monitoring	• Cost of due diligence • Cost of negotiation • Cost of monitoring	Estimating time spent on each TCs	• TCs is not negligible. • For individual case, the TC scale can account for 200% of traditional renovation.
2015	Qian, et al	Green building project	A	NA	• Ex ante: negotiating and establishing contract • Ex post: growth in prices	NA	• Negative relationship between TC and demand and supply of green building • False green building products or less trustworthy developers would lead to more TCs for end-users
2014	Joas&Flachsland	Climate policy	B	NA	• Assembling information on cost-effective abatement at the facility level • Monitoring, reporting and verification • Application for free allocation • Legal expenses • Trading permits	• Case studies, government reports, and consultant reports, • Interview and the authors' calculation	• Little differences of TC across policy instruments • Lower TC of standards than that of market-based instruments
2013	Qian, Chan and Choy	Building energy efficiency	A	• Bounded rationality • Opportunism • Contractual hazards • Asymmetrical information	• Costs for dealing with uncertainties in the process of developing BEE • Cost for searching information	NA	• Transaction cost would undermine BEE's advantage • A rational developer will develop a smaller amount of BEE due to TC
2013	Mundaca et al	Project of low-carbon technologies	A	NA	• Cost of searching for information • Negotiation cost • Approval and certification cost • Monitoring and verification cost • Trading cost	• Second data from literature review	• TC is highly specific to policy tools and technology project. • The source and scale of TC vary with technology size and performance, regulatory policy framework, quantification techniques • A common method is needed
2012	Qian	Building energy efficiency	A	• Economic Uncertainty • Market Uncertainty • Policy Uncertainty	N/A	N/A	• Government policies are needed to provide a positive investment environment and improve stakeholders expectations and confidence.
2011	Mundaca, L., Mansoz, &Neij	Low-carbon technology and policy	A & B	• Planning process • Implementation process • Monitoring and verification process	Cost of searching for information; negotiation cost; approval and certification cost; monitoring and verification cost; trading cost		• TCs are highly project- and context-speific • Scale and burden of TCs relevant to low-carbon technology are likely to differ due to the internal, external and intrinsic determinants.
2005	Michaelowa&Jotzo	Clean Development Mechanism	B	N/A	Searching cost; Negotiation costs; Project documentation cost; Approval cost; Validation cost; Registration cost; Monitoring cost; Verification cost; Certification cost; Enforcement cost; Transfer cost; Registry cost	Interview Project reports Online brokerages	• TC accounts for a large proportion of the total cost in CDM projects. • TC tends to increase with implementation costs. • There is trade-off between cost efficiency and development benefits in terms of CDM implementation.

2.4.4 Determinants and sub-determinants of TCs

Williamson (1985) proposed three dimensions, namely asset specificity, frequency and uncertainty, influence the amount of TCs, which are commonly used to analyse the decision-making of private sectors (Fill & Visser, 2000; Walker & Weber, 1984). If the asset specificity is huge, both sellers and buyers have to make special efforts to exchange, hence TCs will increase (Williamson, 1981, 1985). Specific asset poses more hazards than non-specific one because sellers cannot sell the product to the other buyers easily and buyers cannot turn to other alternatives without difficulties.

(1) Asset specificity

Asset specificity has four types, including site specificity, physical asset specificity, human asset specificity, and dedicated assets (Coggan et al., 2010). Table 4 shows the definition of these four types. To be more specific, site specificity, human asset specificity, and physical asset specificity exist for the environmental goods, in that their transaction value largely relies on the inputs (physical asset specificity) and the site (site specificity), and the transactions need investment in specific knowledge (human asset specificity).

Table 4 Definitions and measurements of three dimensions of TCs (Source: adapted from Williamson, 1985)

TCs determinants		Definition
Asset specificity	Site specificity	Site specificity will arise when specific investments have to be located on a particular site.
	Human asset specificity	The specialized skills, knowledge and learning-by-doing cannot be transferred to alternative transactions
	Physical asset specificity	The specialized instruments and equipment used in a particular transaction
	Dedicated asset	A discrete investment in generalized production for capacity to selling a number of products to particular buyers, such as expanding the existing plant for a specific customer

(2) Uncertainty

Williamson (1985) extracted uncertainties typology and Mettepenningen and

Huylenbroeck (2009) further explained them in the context of agri-environmental scheme. The primary type is the uncertainty due to the future state of nature. It means that the environmental outcome of certain transactions can have high uncertainty in the natural and physical environment. Lack of communications between contracting partners can result in the secondary uncertainty. This type of uncertainty is understood as the uncertainty resulted from implementing poorly specified contract. The third type of uncertainty refers to behavioral uncertainty attributed to opportunism. In the context of environmental scheme, it concerns the trust between contracting partners.

(3) Frequency

Frequency, refers to the frequency of transactions, that affects the TCs by recovering the costs of specialized governance structures (Williamson, 1985). TCs due to less effort on learning and collecting information can be cut down by repetitive transactions (Coggan et al., 2010; Mettepenningen & Huylenbroeck, 2009). However, TCs can be reduced only if the past experience is transferable to new experience(Coggan et al., 2015). Hence, TCs are essentially to be trimmed down due to the transferable past experience, such as transferable information, knowledge, skills and so forth. Incentive scheme design is required to contain more transferable knowledge or skills in order to reduce TCs.

2.4.5 TCs measurement

A number of sources have been used to identify the amount of TCs related to environmental issues, such as personal communication (Dudek & Wiener, 1996; Michaelowa & Jotzo, 2005), survey (Grover & Malhotra, 2003), project reports (Kiss, 2016; Mundaca et al., 2013), and internal data of government and companies (Pannell et al., 2013; Thompson, 1998). For researchers, interviews or survey are usually the best way to estimate TCs, which allows them to estimate different types of TCs (McCann, Laura et al., 2005). Moreover, time spent on extra activities was used to measure TCs by a number of researchers. For example, McCann, L and Easter (1999) interviewed civil servants in terms of the time spent on the various activities and use the standard value of time to measure TCs. Mettepenningen et al. (2009) conducted mass survey to investigate the time spent on certain activities and use the mean value to calculate TCs. Weber (2015) conducted interview to measure the working time allocation on each task relevant to TCs. In this study, 20 experts with specific knowledge of the GFA Concession scheme were interviewed on the time spent on the extra activity as the criteria to measure TCs.

This study would follow the three dimentions promosed by Williamson (1985) to identify determinants and sub-determinants of TCs in the implementation process of GFA Concession scheme, and use time to measure each type of transaction cost.

2.5 Costs and benefits of implementing GFA Concession schemes

2.5.1 Initial framework of cost-benefit analysis

The cost and benefit items of implementing the incentive scheme were collected through literature review and illustrated as follows:

(1) Actual costs and benefits

In general, GB requires comparably higher initial costs and extra risks to deliver, compared to traditional buildings. Some stakeholders will therefore decide to avoid voluntarily entering the GB market. Yu and Tu (2011) stated that GM buildings require a range of 1%-3% extra cost compared with non-GM buildings in Singapore. Building and Construction Authority (2015) stated that the cost premium for GM Platinum, and GoldPlus are 123$/m^2 and 97$/m^2 in residential sector. Kats and Capital (2003) claimed 0.66% extra cost for LEED certification, 2.11% for Silver, 1.82% for Gold, and 6.50% for Platinum in US. Davis Langdon (2007) suggested 3%-5% greater cost for 5 star and 6% for 6 star in Australia where a Green Star rating system is employed. In Hong Kong, under the Hong Kong Building Energy Assessment Methods (BEAM Plus), the cost premiums for Silver, Gold and Platinum building are 0.8%, 1.3% and 3.2% respectively (Burnett et al., 2008). It is widely acknowledged that a cost premium of GB exists and varies according to the level of GB ratings.

In terms of financial benefits to the developers, Fuerst and McAllister (2008) claimed that GBs have a price premium of 10% and 31% for GB certified by Energy Star and LEED respectively, if the market reflect its value. Miller et al. (2008) suggested 9.94% price premium for LEED and 5.76% for Energy Star per square foot. Yu and Tu (2011) stated that GM buildings do have price premium that increases according to the levels of the GM ratings. Burnett et al. (2008) studied the financial benefit of GB to end-users, such as a reduced sewage charge. Based on the literature review, Table 5 summarizes the actual costs and benefits of committing the GFA Concession scheme among the different stakeholders.

Table 5 List of actual costs and benefits of committing the GFA Concession scheme

Stakeholders	Actual Costs	Actual Benefits
Developers	More construction cost due to risk in longer construction time, new construction methods and new GB technologies o Increased architectural and engineering design time (Kats et al., 2003)	GFA Concession bonus Higher market selling price (Hebb et al., 2010)
	Costs of GB certification o Assessment cost o Survey cost Certification cost about HKD75000-150,000 depending on the project scale and complexity (Burnett et al., 2008)	Costs saving from efficient use of materials o Reduction of material use through modular design (off-site prefabrication, lean construction methods), reuse of building elements o Improved material management and On-site sorting
	Additional or increased Consultant fee (Häkkinen & Belloni, 2011) o Higher cost for green appliance design and energy-saving material at design stage (Sutherland, 1991)	
Professionals	Nil	Cash Incentive (Building and Construction Authority, 2009)
Contractor	More construction cost due to longer construction time Increased architectural and engineering design time (Kats & Capital, 2003)	Material saving

(2) Hidden benefits

Hidden benefits include improved health and productivity, reduction in demands for water and electricity infrastructure (Burnett et al., 2008). Isa et al. (2013) stated that developers can improve their corporate image by developing GB. A contractor's future competitiveness could be improved with the GB development and practice. However, the location and affordability and aspects such as culture, individual preference etc., still dominate buyers' considerations, especially in a residential sector where consumers are uncertain about GB performance and lack GB awareness (Burnett et al., 2008). It is possible that in an immature GB market with a lack of awareness from the public, hidden benefits of GB cannot be fully taken into account for decision-making by developers as well as consumers. Through this literature review, the hidden benefits to the stakeholders due to GFA Concession scheme are encapsulated in the Table 6.

Table 6 List of hidden benefits to the stakeholders due to GFA Concession scheme

Hidden (invisible) benefits to the stakeholders	**D**	**P**	**C**
Good company reputation/profile, Status, market power, job satisfaction, rewards, personal development (Isa et al., 2013)	X	X	X
Future business competitiveness over the long-term (Tan et al., 2011)	X	X	
Extra GFA bonus to sell more and gain more profits	X		
Reduction in construction pollution (BEAM Plus) o Reduction of pollution, resource depletion, energy and waste consumption (Addae-Dapaah & Chieh, 2011)			
Reduced demands on infrastructure (Pearce et al, 2007), public water-treatment, electricity demands, and landfill (Kats & Capital, 2003)			
(National) Savings of health care (Pivo & McNamara, 2005) o Reduced respiratory infections, allergies, and asthma o Decrease demand for health care facilities o Enhanced occupant productivity and health (Kats & Capital, 2003) o Reduced health care cost			
Create more job opportunities		X	X
Improved working efficiency and social productivity o Increased economic activities, e.g., activity associated with bonus GFA. (Kayden Jerold, 1978)			
o Green premium increase construction spending o Stimulate more consumers spend more in the long term, due to the savings from energy bills o Higher interest paid to bank on construction loans (Kats & Capital, 2003)			
Support from company to take training course (Ahn & Pearce, 2007), i.e., Professional certificate		X	
Get new professional skills in (Ahn & Pearce, 2007) o Serving new technology	X	X	X

o BEAM Pro o Life-cycle cost of GB o GB design process o Familiar with GB standard o Knowledgeable about low environmental impacts materials			
Better living quality from, for example: sky/podium garden, wider corridor, quality indoor environment, natural light and ventilation (Hebb et al., 2010), better site plan and design, less carbon emissions, etc (Kats & Capital, 2003)			
New knowledge and skills about green construction (Qian, Chan, et al., 2015a) o Basic knowledge and concepts of green construction and management o GB rating system o Life-cycle cost of GB o GB design process o General knowledge of sustainability in the built environment o GB materials and method	X	X	X

D-Developer; C-Contractor; P-Professionals; G-Government; AS- Asset Specificity; F-Frequency; U-Uncertain

(3) Transaction cost

From a transaction cost perspective, incentive schemes can be deemed as a governance structure shaping transactions among the key stakeholders (Finon and Perez, 2007). In regard to the GFA Concession scheme, TC sheds light on the implicit contractual relationship between the policy-maker and the real estate developers, given the extra costs and market uncertainty caused by committing to the GFA Concession scheme and GB. The TCs will not only decrease the effectiveness of the incentive scheme itself, but may also decrease the desire of stakeholders to participate in the (voluntary) GFA concession scheme or GB. Economists argue that the compliance-cost of incentives is more cost effective as they allow the stakeholders the flexibility to seek innovative and cost-saving solutions.

To date, no comprehensive study exists on the application of TCs analysis to GFA Concession Scheme. Therefore, this study conducted a wide range of TCs review associated with energy efficiency, green building, and environmental policy to identify the possible TCs in the process of GFA Concession Scheme implementation (Table 7). The list of possible TCs collected from literature review will be verified in the interviews presented below.

Table 7 Transaction costs associated with energy efficiency and green building promotion, and environmental policy implementation

Transaction cost items	Mundaca et al. (2013)	Hein and Blok (1995)	Dudek and Wiener (1996)	Coggan et al, 2010	McCann et al, 2005	LBNL, 2007	Michaelowa and Jotzo, 2005	Ofei-Mensah and Bennett, 2013	Singh, 2009	Hagemann et al, 2015	Joas and Flachsland, 2014;
Cost of information searching	×	×	×	×	×	×	×	×	×	×	×
Research cost				×		×		×			
Decision-making cost		×									
Implementation cost			×	×							
Negotiation cost	×		×			×	×	×	×		
Project documentation/Administration cost				×	×		×	×			×
Approval cost			×			×	×		×		
Validation cost							×		×		
Registration cost							×				
Monitoring and verification cost	×	×	×	×	×	×	×	×	×		×

Certification cost						×		×		
Enforcement cost		×	×	×		×	×	×	×	×
Trading cost	×						×			
Transfer cost						×				
Insurance cost		×			×					
Coordination cost									×	

2.6 Incomplete contract (IC) theory

2.6.1 Introduction of IC theory

Williamson is recognized for his economic analyses comparing markets with hierarchies, and the question of where to draw the organizational boundary of a firm engaged in complex production processes. For example, should a car manufacturer make all components in-house, or is it cheaper to sub-contract these to separate manufacturers? The incomplete contract theory was first established to model some of Williamson's assumptions about vertical integration, which analyzed the costs and benefits of vertical integration of firms and explained the economic logic when deciding on firms' boundaries (Grossman & Hart, 1986). The basic idea is that it is impossible to specify all the states of nature or all actions when designing the contracts, or that the third party cannot verify the states of nature or the actions ex post. This results in the hold-up problems or post-contractual opportunism that negatively influence contracting parties to enter contracts (Christensen et al., 2016). In these situations, the ownership of an asset (decision-power) must be allocated to one of the contracting parties. Grossman and Hart (1986) claimed that the optimal allocation of the ownerships is to minimize the efficiency losses and should follow the principle that the ownership ought to be allocated to the party who has more important investment even if this would discourage investment of the other party.

2.6.2 Residual right of control (RRC)

Due to the incompleteness of the contract, contractual rights have two types, namely specific rights and residual rights. When listing all the specific rights over assets costs a lot, it might be optimal to make one party purchase all the residual rights (Grossman & Hart, 1986). Through allocating the RRC to the party who has the more important asset, the optimal contract that minimizes the overall loss in surplus is realized. However, the allocation of the residual right of control is a zero-sum game. One party that has more RRC would lead to the other party having less. The RRC allocation determines the status quo in future renegotiations, and further influences the surplus division between two parties, which, in turn, negatively affects the ex ante investment of the party without RRC (Hart, 1988). In terms of the GB incentives, policy-makers naturally own the residual right of control (decision-power), which means they could take control over the renegotiations between private participants and government. This would discourage ex ante investment of the private sector, especially when the incentive is poorly specified.

2.6.3 The analysis of contractual incompleteness

Transaction cost is the reason for the incompleteness (Hart & Holmström, 1986). Because of the significant costs of obtaining information and measurement, contracts are incomplete (Brousseau & Glachant, 2002). Implementing the poorly specified contract results in uncertainties and induces transaction costs in return (Williamson, 1985). Saussier (2000) studied how transaction costs changed with the level of incompleteness of a contract. The results showed that there is a tradeoff between: (a) specification costs related to specifying performance obligations in detail in uncertain transactions; and (b) more flexibility but higher cost of building terms of ex post transactions.

Hart and Holmström (1986) proposed an analytical framework on contract incompleteness that the incompleteness arises from three dimensions: the state of the world, quality and the characteristics of what is exchanged or the actions (investment). The state of the world is very complicated and of high dimension, such as what other firms in the industry doing, the state of demand and technology, etc. It cannot be described and each party's obligations change with the state of the world. Specifying the ex ante and verifying ex post are extremely costly (Scott & Triantis, 2005). Similarly, quality is hard to describe in a precise and unambiguous way (Bull, 1987; Grossman & Hart, 1987). Also, it is difficult to specify the characteristics of what is exchanged or the actions (investment) that parties have to take (Hart & Holmström, 1986). This study will apply the framework to analyze the incompleteness of incentive schemes for Green Buildings.

2.6.4 Long-term and complex contracts

It is recognized that incomplete contract issues have significant implications for the efficiency of long-term contracts (Hart & Moore, 1988). Since it is hard to draft a complete contract, it is better to write limited term contracts with the purpose of renegotiating what happened when the contract ends. The critical issue is the contract should be long-term or short-term. In theory, long-term contracts encourage specific investment (Crawford, 1988). That is because the costs associated with specific investment could be reduced with a recurrence of transactions. However, short-term contract benefits renegotiations if the contract is too incomplete and has deficiencies. Saussier (1999) believed that the decision about the duration of the contract was viewed as an optimization process where the costs and benefits of extra length are trade-offs at the margin.

In practice, if the GB incentives are long-standing, it is the greatest concern of stakeholders (Qian et al., 2012). Previous studies argue that long-term incentive is more effective than the short-term one (Choi, 2009; Olubunmi et al., 2016; Rainwater & Martin, 2008). This paper will discuss the impacts of duration of contracts on stakeholders when the GB incentive is incomplete.

2.6.5 Application of the incomplete contract theory

After Hart and Holmström (1986), the subsequent developments of IC theory went in different directions, which came to examine the influences of the institutional framework on the contract design, focusing on the study of the impacts of allocation of property rights on the distribution of the residual surplus and on their incentives to make ex ante investment (Brousseau & Glachant, 2002). For example, Aghion, Phillipe et al. (2014) examined how the formal and real authorities are distributed and how this affects communication within the firm. Dessein (2002) studied situations when the agent has private information, and how to allocate control that could facilitate the incorporation of agent's information into decision-making. Beyond the topic of firms' boundaries, the IC approach was later extended to analyze the costs and benefits from privatization, firms' financial decisions, firm's internal organization and the organization of international trade (Aghion, Philippe & Holden, 2011). Few studies focused on the incompleteness of contract design and this thesis is among the few to include this approach to analyses the bonus GFA green building incentives.

2.7 Transitional gains trap

The theory of transitional gains trap was first mentioned by Tullock (1975), who stated that when government granted special privileges to a group of people, only transitional gains were made. The successors to original beneficiaries would make only normal profits because the initial benefits from the special privileges (rents) would quickly be fully capitalized into the asset required to receive the rents. However, they usually would suffer loss through cancellation of the scheme. The loss could function as a trap that results in the persistence of regulation (Tollison & Wagner, 1991; Tullock, 1975). Tollison and Wagner (1991), extending Tullock (1975) study, considered the costs and benefits over time and supported his statement that deregulation is never beneficial from the perspective of maximizing the social welfare. This theory has been explained and examined through a few cases, such as a taxi medallion monopoly, the Agricultural Adjustment Act protecting farm incomes (Tullock, 1975), enrollment of graduate schools (Shmanske, 2002), and a champagne monopoly scheme (Boone & Wilson, 2009). For example, in the case of taxicab medallions, a medallion was required to drive a taxi in New York and this could be transacted. With the limited number of medallions, there was a barrier to entry into the industry and so there were more than normal profits. The transitional gains are from the above-normal profits if a driver originally has a medallion. When the transitional period ends and all the stakeholders figure out what is going on, the transitional gains have been fully capitalized into the value of the medallion. In other words, the medallion's value is equal to the present value of all the future rents. Therefore, owners who enter the market late can only make normal profits. The trap appears in the form that late entrants suffer losses when the taxi medallion is terminated. Holcombe (2015) believed that the example of the taxi medallion could be generalized to any government program bringing rents to one group at the costs of others. It is expected that the theory of the transitional gains trap applies to GB incentive schemes.

2.8 Research gap

Economic incentives consume social resources to promote green buildings, but they do not reach their optimal effectiveness and efficiency. There are only few studies to evaluate the costs and benefits of economic incentives, and to explain how these costs and benefits change with the changes of mechanism of economic incentives. This paper would fill this knowledge gap. The followings are sub-items of research gap.

- New cost-benefits analysis of economic incentives of GB, including transaction cost and hidden benefit;
- Allocation of costs and benefits to stakeholders;
- Incompleteness of economic incentives of GB;
- Transitional gains trap caused by economic incentives of GB;
- Theoretical basis, formulated by the theories of transaction cost, incomplete contract, and transitional gains trap, associated with the costs and benefits in implementing economic incentives is developed to help policy makers fully understand the changes in costs and benefits with the changes of mechanism of economic incentives.

Traditional cost-benefit analysis does not consider transaction cost and hidden benefit. This study firstly fills this gap to collect all the costs and benefits including hidden ones together and looks at if these costs and benefits are fairly allocated to stakeholders. With the results of cost-benefit analysis, the theories of transaction cost, incomplete contract, and transitional gains trap are applied to explaining the mechanism of economic incentive of green building, focusing on GFA concession schemes.

Chapter 3 The GFA Concession schemes

There are some terminologies used in different regions in the world but sharing same meaning, namely GFA concession, GFA Incentive Scheme, density bonus, and FAR (floor area ratio) bonus. GFA concession in Hong Kong refers to the floor area of certain building characteristics allowed to be discounted from the maximum gross floor area of a development (Council on Sustainable Development, 2010). GFA Concession Scheme in Singapore refers to buildings that achieve the requirements of Platinum and Goldplus Green Mark could enjoy additional GFA. Density bonus and floor area ratio (FAR) bonus are used in North American, Japan, France, etc. (Paetz & Pinto-Delas, 2007). In US, it refers to increasing allowable density by raising floor area ratio or increasing allowable height for any developments guaranteeing LEED (Abair, 2008). All these concepts aim to encourage green building by granting additional floor area in a site. This section would review the GFA concession incentive implemented in the US, Hong Kong and Singapore because 1) US has long history and rich experience of implementing the GFA Concession Scheme; 2) Hong Kong and Singapore are dense city and country where GFA is a critical issue and attract developers a lot.

3.1 USA

(1) Criteria to grant the GFA concession

The US has a long history of implementing GFA concession incentives. State and local governments provide GB incentives to encourage private development. Owing to the large land area of the US and different conditions in each area, such as various fiscal levels and climate conditions, local governments could select policy instruments and bonus criteria by themselves. A few local governments issued density bonus incentive scheme with different granting requirements. For example, Arlington is the first one to grant developers GFA bonus in the US and one of the most famous advocates state-side of GB incentive scheme (Paetz & Pinto-Delas, 2007).

In 1999, Arlington County implemented density bonus programme to promote Green Building. In this programme, if the project obtains LEED certification at any level (Certified award level, Silver, Gold or Platinum), then builders could request a slightly larger building area than the allowable (Romero & Hostetler, 2002). This programme is a country-established and a voluntary one. Bonus structure has been updated in 2003, 2009, 2012 and 2015 based on the increase in knowledge and market demand for green buildings. The aim of this programme is to lead the market towards community goals instead of rewarding business practice (AIA, 2009).

Table 8 illustrates the development history of the GFA bonus incentive scheme in Arlington County. The adjustment of the GFA bonus incentive is based on the market transformation in which buildings frequently achieved low levels of LEED. Evidently, the assessment criteria and the calculation method of the GFA bonus incentive have become complicated from 1991 to 2015. The Table 8 indicates that the adjustment of GFA bonus could start from the following four aspects to reflect the market transformation: 1) expanding the range of GFA bonus, 2) reducing the level of GFA bonus, 3) improving the criteria to acquire GFA bonus by upgrading the green building assessment methods and providing additional conditions (such as energy efficiency), and 4) increasing GFA bonus to satisfy high GB rating or additional conditions and decrease bonus for low ratings. Since 2009, the incentive for office buildings has been separated from and less than that for residential buildings compared with office buildings that have more market demand. Additional government incentives were provided to the residential sector. In 2012, the energy efficiency requirement was added in the incentive scheme to further promote sustainability. In 2015, Energy Star certification became mandatory for the GFA bonus application of office buildings. Costs and benefits of developers were always considered when adjusting the incentive. For example, LEED version 4 leads to more construction cost than LEED 2009. Moreover, Energy Star certification is costly for developers. Therefore, the incentive level was slightly increased in 2015 to motivate developers to adopt new standards.

Table 8 The GFA bonus scheme in the US Source: Arlington County Government (2016), Chris Cheatham (2009), Arlington County Government (2014), Office of Sustainability and Environmental Management (2013) Note: ES-Energy Star

	1999	2003	2009	2012	2015	
Objective	To guide the building design and construction	To include all LEED levels and all the projects	To adjust the bonus to reflect market transformation	To focus on energy efficiency to align with the Community Plan goals, minor bonus adjustment	To encourage developers focusing on the incorporation of energy efficiency into the site plan and on the ongoing energy consumption	
Assessment criteria	• LEED Silver only (commercial office only)	• LEED Certified, Silver, Gold or Platinum	• LEED Certified, Silver, Gold or Platinum	• LEED 2009 Silver, Gold or Platinum • Energy efficiency for commercial office buildings	• LEED version 4 • Energy Star Building certification within four years of occupancy (commercial office building) • Community Priority credits (optional)	
Calculation of GFA concession	• Up to 0.25 FAR (floor area ratio)	• 0.15FAR (Certified) • 0.25FAR (Silver) • 0.35FAR (Gold) • 0.35FAR (Platinum)	**For office buildings** • 0.05FAR (Certified) • 0.15FAR (Silver) • 0.35FAR (Gold) • 0.45FAR (Platinum) **For residential buildings** • 0.10FAR (Certified) • 0.20FAR (Silver) • 0.40FAR (Gold) • 0.50FAR (Platinum)	**For office buildings** • 0.20 FAR (Silver+20% energy efficiency) • 0.35FAR (Gold+20% energy efficiency) • 0.45FAR (Platinum+20% energy efficiency) **For residential buildings** • 0.25 FAR (Silver) • 0.40FAR (Gold) • 0.50FAR (Platinum) **Multifamily residential buildings** • Additional 0.05FAR (LEED +18% energy efficiency	**For office buildings** **Silver** • 0.25 FAR (ES score of 75) • 0.275 FAR (ES score of 75+ one Community Priority credit) • 0.30 FAR (ES score of 75+ Two Community Priority credits) **Gold** • 0.35FAR (ES score of 75) • 0.375 FAR (ES score of 75+ one Community Priority credit) • 0.40FAR (ES score of 75+ two Community Priority credits) **Platinum** • 0.50FAR (ES score of 75) • 0.525FAR (ES score of 75+ one • Community Priority credit) • 0.55FAR (ES score of 75+ two Community Priority credits)	**For residential buildings** **Silver** • 0.25 FAR • 0.275FAR (one Community Priority credit) • 0.3 FAR (Two Community Priority credits) **Gold** • 0.35 FAR • 0.375 FAR (one Community Priority credit) • 0.4 FAR (Two Community Priority credits) **Platinum** • 0.50 FAR • 0.525 FAR (one Community Priority credit) • 0.55 FAR (Two Community Priority credits) LEED Gold plus Two Community Priority credits plus Net Zero Energy certification may earn extra density bonus above 0.55 FAR

In Arlington County, 42% of site plan buildings required LEED certification (AIA, 2009). Arlington Country staff stresses that building a strong relationship with developers is crucial for the county to spread awareness of its mutually beneficial density bonus. The success of Arlington is not only in creating density bonus and increasing the number of green buildings but also in generating a model for other jurisdictions in the US. Many other places completely copied their incentive scheme and applied it to their building codes (Department of Labour, 2010).

3.2 Singapore

The Building and Construction Authority (BCA) in Singapore and the Urban Redevelopment Authority (URA) jointly released the Green Mark (GM) GFA Incentive in 2009 with an effective period of 5 years, which stated that developers and building owners could apply for up to 2% GFA bonus (subject to a cap of 5,000 m^2) in exchange for constructing GM Goldplus building and 1% GFA bonus (subject to a cap of 2,500 m^2) for constructing GM Platinum buildings. During 2009–2013, the total GFA of green buildings increased by 34.2 million m^2, while the increase in total GFA of green buildings before this GFA scheme was only 14.2 million m^2 within four years (from 2005 to 2009).

In 2010, BCA announced that under government land sale programme, all new developments on lands sold on or after May 5, 2010 in the strategic growth areas should be designed to meet a high GM certification (Building and Construction Authority, 2014b). In the downtown core, buildings are required to reach GM Goldplus Rating. This policy could help improve building energy efficiency and release heat island effect in the city core. Therefore, constructing green building in the downtown core is mandatory.

Singapore started green building later compared with other developed countries (Liu and Lau, 2013). However, green building rapidly developed in Singapore. From 2005 to 2010, a total of 500 projects have been certified, thereby doubling the number of that in Hong Kong in less than 10 years (Figure 5). A dramatic increase in Green Mark Building is evident. From 2005 to 2008, only more than 200 projects were certified, while the total number of projects from 2008 to 2012 has increased to 1,247 and continues to grow. Liu and Lau (2013) argue that the dramatic growth of certified green buildings was motivated by mandatory requirements, such as laws claiming that all new large and major retrofitting public sector buildings must meet the standards of Green Mark. In new growth areas, high green building ratings (Platinum and Goldplus) are related to land sale conditions (Figure 6). Therefore, green building is tightly integrated into urban development (Liu and Lau, 2013). Given that the GM GFA incentive significantly promoted GB development, Singapore government decided to extend the incentive from 2014 to 2019 (Building and Construction Authority, 2017).

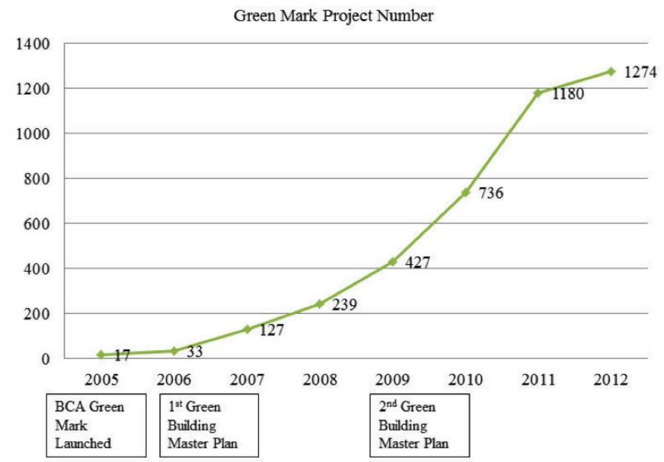


Figure 5 Number of Green Mark Projects in Singapore (Source: Liu and Lau, 2013)

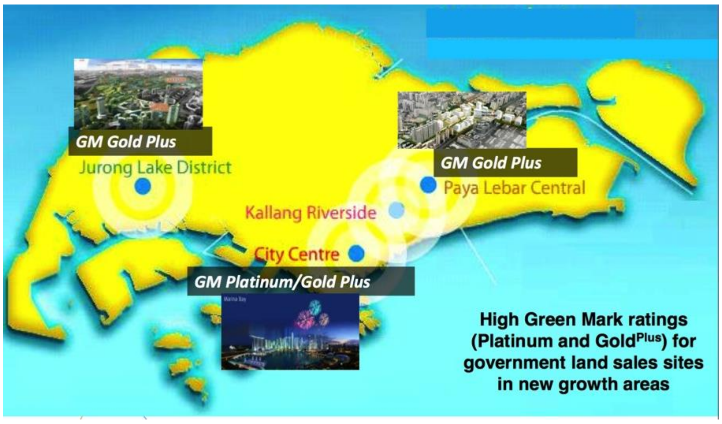


Figure 6 Government Land Sales Minimum GoldPlus rating Source: Chong (2007)

3.3 Hong Kong

To address climate change and promote green building (GB), Hong Kong has implemented Gross Floor Area (GFA) Concession scheme since 2011. The GFA Concession scheme is to grant GB developers the extra GFA (up to 10% allowable GFA bonus under the Building Regulations) to award their contributions to the green building (Council for Sustainable Development, 2010) .

This scheme is on a voluntary basis, and tailored for the Hong Kong built environment. It, however, mandates the green building design and construction features (by requiring twelve building design features) under the Sustainable Building Design Guidelines (SBDGs) and the Building Environmental Assessment Method (BEAM) Plus (GB labeling program in Hong Kong). Developers who would like to acquire the extra GFA have to comply with certain building features and SBDGs and BEAM Plus. In this way, environmental protection can be warranted to address climate change, especially building energy efficiency.

Buildings Department (Figure 7) shows that from 2011 to 2014 more projects were granted with GFA concession and fewer were disapproved. In 2014, the number of projects applied for GFA concession has reached to 50% of total development proposals, which indicated the GFA Concession scheme has been accepted by the private sector.

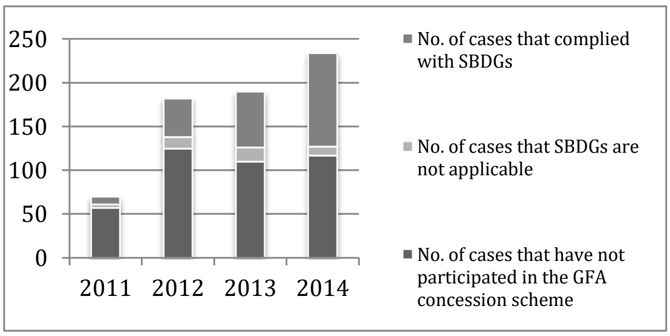


Figure 7 Statistics on development proposal from 2011 to 2014 (Buildings Department, 2014)

(1) Sustainable building design guidelines

Sustainable Building Design Guidelines aim to enhance built environment's quality and sustainability in Hong Kong, especially outdoor air ventilation to reduce canyon effect (Figure 8). It establishes three key building design parameters to enhance quality of outdoor environment, namely building separation, building setback and site coverage of greenery.

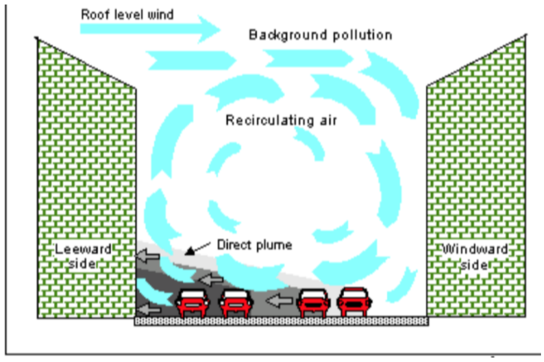


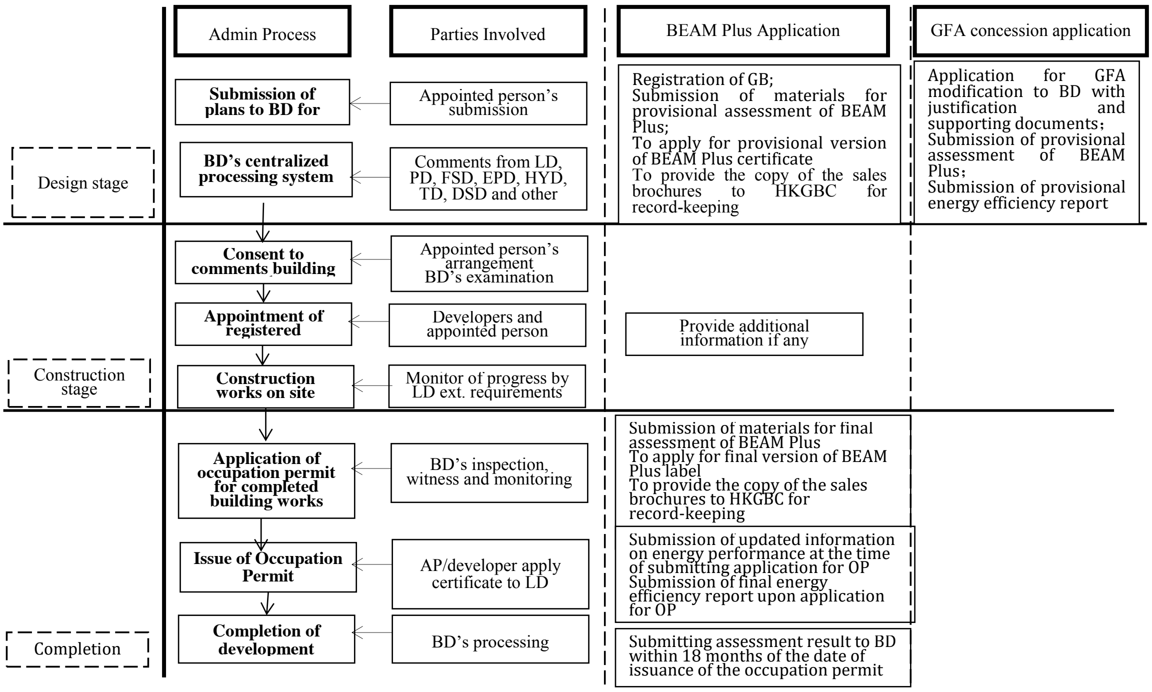
Figure 8 Canyon effect Source: Berkowicz (2000)

(2) New application process

As BEAM Plus and SBDGs are compulsory for developers who elect to proceed to the GFA Concession scheme, additional responsibilities are assigned to the relevant GB stakeholders, who have to go through a new application procedure (Figure 9). Apart from the normal administration process, participants have to do two additional applications, BEAM Plus certification (including provisional assessment and final assessment) and GFA concession, throughout the real estate development process. In order to apply for the GFA concession, architects need to integrate several of the twelve building features, five green features and seven amenity features, into the design scheme at the design stage according to the specific site context and building layout (Development Bureau, 2011). These features include balconies, wider common corridors and lift lobbies, utility platforms, non-structural prefabricated external walls, residential recreational facilities, covered walkways/trellis without provision of greenery, voids, management facilities, larger lift shaft areas, pipe ducts/air ducts/chimney shafts which are not part of the distribution network for mandatory services and environmentally friendly features, prestigious entrance, and non-mandatory plant rooms. These features benefit occupants numerously and include better personal and communal space, balconies, etc. Tam et al (2013) argued that maintaining these facilities added value to buildings that brings long-term economic benefits.

In the administrative process, building plans should also fulfill the SBDGs at the design stage and be submitted to the Buildings Department for approval (Figure 9). Sustainable Building Design Guidelines have three basic elements of green building design, namely site coverage of greenery, building separation, and building setback. To be more specific, for different assessment zones, there are different design requirements for each of the above-mentioned three elements, i.e., size of site, building length, and building height. For example, with respect of building separation, in the site with area less than 20,000 m^2, with the building length no less than 60m and building height no more than 60m, the permeability of buildings should be no less than 20%. These requirements contribute to mitigating the heat island effect, enhancing the environmental quality of living space, and better greenery and air ventilation around buildings. Buildings Department (2013) reported that from 2011 to 2013, about 25% of the total projects applied for GFA concession were disapproved due to the failure to meet the SBDGs.

In order to receive the BEAM Plus certification, the project needs to both pass provisional assessment at the design stage and go through the final assessment at the completion stage (Figure 9). BEAM Plus has four levels of ratings, namely Platinum, Gold, Silver, and Bronze. It is designed to monitor the process of building construction and operation in terms of indoor environmental quality, building site, energy use, material, and water use. However, the BEAM Plus only states the requirements of different rating levels, without explanation of how to achieve it. The Hong Kong Green Building Council (HKGBC) is the body to provide training, particularly to help professionals integrate GB standards and practices, and advise the project team on how to achieve the credits. Professionals who complete the training of BEAM Plus and pass the exam can receive the BEAM Pro certification for such practice. The training guarantees professionals' knowledge and experience of constructing green building. This group of professionals is, therefore, selected as the appropriate target interviewees for this study.



*Note: BD-Buildings Department; PD-Planning Department; FSD-Fire Services Department; EPD-Environmental Protection Department; HYD: Highways Department; TD: Transport Department; DSD: Drainage Services Department BO: Building Ordinances; OP: Occupation Permit; LD: Land Department

Figure 9 The procedure for processing applications of GFA concession and BEAM Plus (Source: constructed by the authors)

3.4 Comparison of the GFA Concession schemes

The three aforementioned countries and region, US, Singapore and Hong Kong, show that GFA bonus can influence the built environment positively and negatively depending on the design of the incentive scheme. GFA bonus can reshape the built environment; for example, density is increased in US suburban where urban sprawl emerges and enjoyable living space by sky garden is provided in Hong Kong. However, the scheme strengthens urban heat island in the city core by increased building bulk and height in Singapore and Hong Kong. Therefore, the government should design the scheme carefully and consider GFA bonus as an opportunity to reshape and improve the built environment.

3.4.1 Different stages of GB market

US has a longer history of GFA for promoting GB than that of Hong Kong and Singapore. The former has developed criteria to assess market transformation of GB and detailed methods for adjusting GFA bonus with the market transformation, and these criteria and methods are illustrated in the previous section. On the contrary, Hong Kong and Singapore are experiencing the period of trial and error. Understanding the market and improving the incentive scheme take time, especially for the construction industry with several years of construction period. Unlike Hong Kong and Singapore, Arlington County has insignificantly considered local built environment. The reason may be that Hong Kong and Singapore have high development density and land price. The amount of GFA bonus and the mechanism of incentive scheme significantly influence the market and the built environment.

3.4.2 Linking incentive scheme to urban development

Hong Kong and Singapore have integrated the GFA concession scheme into the development control system in a different way. In Hong Kong, the GFA concession scheme is subject to the floor area of certain building features that are illustrated in the Building Ordinance. BEAM Plus and SBDGs are the prerequisites of GFA concession grant. Obtaining BEAM Plus certification and fulfilling the SBDGs are insufficient to be granted with GFA concession. In Singapore, GM Platinum or Goldplus is the only requirement of obtaining GFA bonus. However, in the new growth strategic areas, achieving GM Platinum or Goldplus is mandatory because they are part of the land sale conditions. Therefore, the government in Singapore has included the plan of GB distribution in the Master Plan.

Different methods can be used to calculate the GFA concession in Hong Kong and Singapore, which is closely related to the development control, as shown in **Table 9**. In Singapore, GM GFA is relevant to land value, total GFA regulated in the Master Plan, and the prescribed green premium. As the prescribed green premium increases with the rating of GM and increases the GM GFA bonus (i.e., increasing salable area), developers are motivated to construct high ratings of GM. The land value and total permitted GFA are fixed and can be estimated, thereby reducing the risks for developers in participating in the GM GFA incentive scheme in Singapore. On the contrary, most land values in Hong Kong are determined by land auction and the number of GFA concessions that can be acquired by developers is uncertain, thereby bringing uncertainties to developers. Furthermore, not all the exempted floor areas can be salable areas. The salability depends on the property market and economic situations. Therefore, under the current systems, developers in Singapore have fewer risks than those of developers in Hong Kong if they participate in the GFA concession scheme. In other words, the system in Singapore provides less cost to developers.

The threshold (i.e., minimum standard to grant GFA concession) for participating in the GFA concession scheme in Hong Kong is lower than that in Singapore. Developers only need to register BEAM Plus that costs them lesser than reaching the high ratings of GB. This small extra cost can help them acquire GFA concession and make profits from it. Thus, after implementing the GFA concession scheme, the registered BEAM Plus projects have increased nearly one-third within one year (Liu & Lau, 2013). Unlike in those in Singapore, developers in Hong Kong do not have to provide security deposit to guarantee that they will achieve the certain rating of BEAM Plus that they committed when applying for GFA concession. This way largely decreases the investment risks for developers. With the increase in GB knowledge and market demand, the incentives should be adjusted to reflect the market transformation.

Table 9 Comparison of the GFA Concession Schemes in Hong Kong and Singapore

	Hong Kong **Gross Floor Area concession (since 2011)**	**Singapore** **Green Mark Gross Floor Area incentive scheme (Since 2009)**
Objective	To attract developers to construct BEAM Plus building and integrate sustainable building design guideline (SBDG)	To encourage the private sector to develop buildings that attain higher tier Green Mark ratings (i.e. Green Mark Platinum or Green Mark Gold PLUS)
Assessment criteria	• BEAM Plus Registration (Prerequisite) • Sustainable building design guideline (Prerequisite) • Building features illustrated in the Joint Practice Notes (e.g. green features, amenity features.)	• Green Mark Platinum could be awarded 2 % GFA bonus at most (subject to a cap of 5,000 sqm). • Green Mark Gold plus could be awarded 1% GFA bonus at most (subject to a cap of 25,000 sqm)
Calculation of GFA concession	GFA Concession = Exempted GFA + Disregarded GFA + GFA bonus	• GM GFA = [Proposed GFA (sqm) (subject to Master Plan allowable intensity)] * [Prescribed Green Premium ($/sqm)]/Land Value ($/sqm)
Mandatory / Voluntary basis	• Voluntary to participate in GFA concession incentive scheme; • Mandatory to acquire BEAM Plus certification and fulfill SBDG if developers want all the building features granted GFA concession	• Voluntary for new private development (non-public sector), redevelopments and reconstruction developments to join the scheme; • For the sites where the GM Platinum or Goldplus standards are mandated as part of land sales condition, it's mandatory to reach GM Platinum or Goldplus without GFA bonus. • For the sites where the Goldplus standard is mandated, it's voluntary for developers to attain the higher GM Platinum standard and acquire an incremental GFA incentive (the difference between GFA incentives for GM Platinum and GM Goldplus).
Enforcement	NA	• Security deposit to guarantee that developers achieve the GB grading they committed
Minimum standard to grant GFA concession	• BEAM Plus registration • Provision of prescribed green features • Fulfilling the SBDGs	• GM Gold Plus

3.4.3 Other key features

Other key features of the GFA concession scheme in the USA, Hong Kong, and Singapore are discussed as follows:

(1) Developers and government have common goals but different interests

The government should build a strong relationship with developers to promote GB. The GFA incentive scheme can enable the government and developers to share common goals but different interests. Developers can receive compensation from GFA bonus for they are usually not end users and cannot enjoy the benefits of energy efficiency but must pay all the initial costs and risks. Meanwhile, the government can save money to reduce energy consumption and deal with environmental protection issues by promoting GB.

(2) A cap of bonus is set

Singapore and Hong Kong have set a cap of GFA bonus to reduce the impacts of increased building bulk and height in the built environment as well as the speculation of developers. By setting a cap, inflated buildings are prevented and building bulk and height are controlled. The key in building the relationship between developers and the government is to motivate developers with sufficient GFA concession and minimize its negative impacts.

(3) The scheme is reviewed and its effectiveness is assessed

Given that the GFA concession incentive scheme for GB is new worldwide, the government usually lacks experience, especially on information about the incentive scheme design. Therefore, the government needs to review the scheme and collect feedback from the industry regularly. In Singapore, the government has reviewed the incentive scheme after 2 years of implementation to adjust a few details, such as streamlined GM GFA application process and revised definition of some terminologies. In Hong Kong, the government has also gathered feedback from the market to improve the scheme and assess its effectiveness. For example, they have conducted survey and public engagement to collect information on inflated buildings and feedback on sustainable building design guideline and revised the GFA concession incentive scheme.

(4) GFA scheme is linked to various planning objectives of GB technology and design practice

Planning objectives, certain GB technology, and green design practice can be realized by setting the requirements of GFA concession. For example, in Singapore, GFA bonus incentives help realize various planning objectives for the city, such as the balcony scheme that encourages tropical architecture and the lighting incentive scheme that enhances the city image (URA, 2011). In Hong Kong, the innovative green design can obtain additional points of BEAM Plus, and the GFAs of green features are allowed to be exempted.

Chapter 4 Research methodology

4.1 Applying the identified theories to the GFA Concession scheme

4.1.1 Framework of transaction cost analysis

(1) Asset Specificity

In transaction cost theory, Asset specificity, means durable investments that are undertaken in support of particular transactions. These specific investments represent sunk costs that have a much lower value outside of these particular transactions (Williamson, 1985), e.g. learning costs, incremental costs, and administration costs, etc. In the context of GFA Concession scheme, it refers to the specific investments due to the application and specific set-ups for the GFA concession projects. According to Coggan et al. (2010), there are three types of asset specificity in the GFA Concession scheme: site specificity, human (knowledge) asset specificity, physical asset specificity. Site specificity refers to the green building design according to the specific site. According to the GFA Concession scheme, the particular size, shape and surroundings, etc., of each site may restrict building design and construction differently. In order to adapt to the new rules, the traditional design pattern may be changed, which causes the extra research cost (usually borne by architects). Human (knowledge) asset specificity is understood as the specific knowledge and information required by the GFA Concession scheme. The applicants of the GFA Concession scheme have to learn the SBDGs, BEAM Plus and collect relevant information that induces learning cost and information searching cost. Physical asset specificity refers to the non-standard contract due to the application of GFA concession scheme that the stakeholders need to develop, do research and negotiate during the GB development process in order to clarify the responsibility, which induces the TCs.

(2) Uncertainty

In the context of GFA Concession scheme, uncertainty includes technological uncertainty; institutional uncertainty; and behavioral uncertainty. Technological uncertainty, exists mainly in the process of implementing BEAM Plus due to the uncertain performance of green equipment. For example, in order to achieve the credits from energy and water saving, it is necessary to provide evidence of energy efficiency rating, which generates verification costs. Institutional uncertainty arises due to the poorly specified official documents, ambiguous contracts or other government documents, etc. For example, BEAM Plus does not specify how to achieve the credits in the handbook, leading to extra communications between practitioners. Behavioural uncertainty, due to opportunism, also causes more inefficiency in communication due to the mistrust or lack of common understanding in the new partnership between the GB consultant and architects, GB consultants and contractors, and/or contractors and new suppliers, etc.

(3) Frequency

Frequency, refers to the experience, in terms of knowledge, skills, and information, accumulated from the repetitions of the previous GFA concession projects that, can be applied in the future projects. In other words, it is the transferable experience that can reduce TCs. Therefore, transferability is employed to measure to what extent the TCs in the GFA Concession scheme can be reduced. For example, the communication costs can be reduced if amongst practitioners, such as architects, contractors, and/or GB consultants, who have developed a common working pattern and language with trust in understanding the roles and responsibilities in the specified GFA concession project.

4.2 Applying incomplete contract theory to the GFA concession scheme

4.1.2 Framework of incomplete contract analysis

The IC theory argues that the incompleteness arises from three dimensions. Applying the framework to GB incentives, this paper would analyze the state of the world (i.e. state of property market, duration of GB incentives), GB quality requirements, and specific actions participants need to take, to see how the three dimensions of GB incentives affect costs and benefits.

(1) State of property market

There are a lot of market factors changing from time to time and affecting stakeholders' costs and benefits, such as the value of green building, land costs, etc. GB incentive model should be developed on the basis of the market factors (Shazmin et al., 2016). When the state of property market change, undefined situations occur and brings uncertainties to participants, which affects policy effectiveness and efficiency.

(2) Duration of GB incentives and TGT

Long-term contracts encourage specific investment (Crawford, 1988). That is because the costs associated with specific investment could be reduced with a recurrence of transactions. However, short-term contract benefits renegotiations if the contract is too incomplete and has deficiencies.

In practice, there are few GB incentives specifying the effective period. If the GB incentives are long-standing is the greatest concern of stakeholders (Qian et al., 2012). According to the theory of transitional gains trap, when the GB market reaches maturity, sudden termination of incentives or reduction of incentive level would make participants suffer losses. Therefore, this paper will also examine if the changes of GB incentives result in transitional gains trap.

(3) GB quality requirements

The GB assessment methods, such as LEED (Leadership in Energy and Environmental Design) in the USA and BEAM (Building Environmental Assessment Method) Plus in Hong Kong, set standards for GB construction. However, previous research questioned these methods. For example, both quantitative and qualitative approaches are applied to GB assessment. Qualitative approach heavily relies on experts' judgment on the level of fulfillment to GB requirements, which might be biased and inequitable (Ng, S. T. et al., 2013; Shapiro, 2011). Incompleteness arises when there is unambiguity in GB quality requirements.

(4) Specific actions participants need to take

The qualifications, such as BEAM Professional (Hong Kong), LEED

Professional (the USA), and Green Mark Professional (Singapore), ensure that professionals have knowledge and ability to construct green buildings. Due to bounded rationality, however, it is difficult to anticipate all the possible situations and specify all the actions professionals need to take. For example, Zhang (2015) stated that GB operational stage labels are much less than design stage labels in China because little is known about how to achieve green standard in the operational stage.

4.1.3 Framework of transitional gains trap

Transitional gains trap argues that participants benefit from the economic incentives at initiation that is transitional period. When the benefits are capitalized into the value of assets connected to incentive eligibility, such as GB certification and sustainable building design, new participants would pay more for the assets, bringing down returns on participating the incentive scheme. When the incentive is terminated, the asset price would fall. The analysis of the transitional gains trap would be based on the different stages of GB Concession Schemes, including transitional period, mature period and end of the incentive scheme, to analyze stakeholders' costs and benefits.

4.2 Data collection methods

4.2.1 Expert interviews

Expert interviews were conducted to understand the GFA concession practice in Hong Kong. Based on the literature review of costs and benefits (including hidden and TCs) and the analytical frameworks shown Section 2.5, the interview questions were developed (see Appendix). In-depth expert interviews were conducted with 33 experienced senior industry practitioners, to gain practical insights. The aim was to validate the identified list of costs and benefits (refer to Table 5, Table 6 and Table 7), and provide explanation of how these costs and benefits change with the changes of mechanism of GFA Concession Scheme. The profile of interviewees is shown in

Table 10. All of them are at the management level and actively involved with the GFA Concession scheme and GB practice, with a minimum of 10-years' experience in the building industry, and a wide knowledge of surveying, urban planning, law, finance and accounting, etc. Some of the interviewees are also Authorized Persons (AP) who are qualified to perform the duties and roles in accordance with Buildings Ordinance. They have a good overview of the costs and benefits due to participating in the GFA Concession scheme in practice. The decision to use 33 experienced experts who have been actively involved in implementing GFA concession scheme in Hong Kong yield insightful, highly relevant and more convincing views than a massive survey of people without necessary expertise and hands-on experience. After doing interviews with 33 experts with backgrounds of government officer, developer, professional and contractor, there are no new insights appearing. Therefore, the sample size of 33 experts is considered to be enough and they are informationally representative. The views from full range of stakeholders' perspectives are triangulated.

Table 10 Profile of interviewees

Profession	Qualification and Position
14 Architects	Authorized person; more than 20 years working experience; Director of Architectural firm
	Registered architects; Chairman of architectural firm
	Authorized person; Hong Kong Institute of Architects Fellow Member
	Senior architect; Working in leading architecture firm for 5 years in Hong Kong; All the projects the architect has worked on are green buildings.
	Doctor; Adjunct professor; Chairman of an architect and development consultants firm
	Registered architect; associate architect working in a leading design firm
	Principle of an international architectural design firm
	Registered architect; senior associate working in a leading architectural design firm
	Registered architect; member of Hong Kong Institute of Architects
	Manager, working in leading architectural firm that all the projects it did are green buildings.
	CEO in one of the leading real estate development firms in Hong Kong
	Specialist in green building design; over 20 years' working experience in a leading architecture firm
	Specialist in sustainable design; senior associate working in a leading architectural firm
	BEAM Pro; Director of a architectural firm
4 Building service engineers	Director in one of leading real estate development firms in Hong Kong; BEAM Pro; Authorized Person; over 25 years development experience
	Manager of a leading real estate development firm; BEAM Pro
	BEAM Pro; manager of a construction firm
	Manager of a construction firm
2 Civil engineers	Doctor; LEED AP; associate director of a development consultancy firm
	Senior manager of a construction firm
11 Surveyors	Member of Green Building Council; Director of consultancy firm
	BEAM Pro, working in leading contractor company in Hong Kong
	Authorized person; Project director of a consultancy firm
	Director of consultancy firm
	Chief Executive Officer (Asia) of design & consultancy firm
	Authorized person, Project manager of a real estate development firm
	Government officer, Building surveying specialist; over 30 years working experience
	General manager of a leading real estate development firm
	Authorized person, deputy project manager of a development firm
	J.D.; Over 17 years of expertise in project management
	Director of a consultancy firm; Over 10 years working experience in real estate development consultancy.
2 Professor	Full professor; Over 10 years working experience in project management and building control
	Adjunct professor; over 40 years practice in land use, real estate, environmental law and mediation

4.2.2 Analytical hierarchy process

AHP is an analytical tool that uses a deductive approach (Wong and Wu 2002) and criteria, sub-criteria, and alternatives by a series of pairwise comparisons to describe a decision problem and thus derive prioritized scales. The tool was first introduced by Saaty Thomas (1980). The main feature of AHP is its capability of systematically dealing with several hidden and non-quantifiable attributes as well as objective and tangible attributes (Shapira & Goldenberg, 2005). AHP has been successfully applied to the research areas of construction, such as advanced construction technology evaluation (Skibniewski & Chao, 1992), procurement selection (Cheung, S.O. et al., 2001), and alternative dispute resolution (Cheung, S.O. et al., 2004).

(1) Procedure of the analytical hierarchy process

AHP needs to decompose complexity by identifying the factors comprising a large problem. These factors are organized in a hierarchy-type structure. The highest level of the hierarchy is the primary goal of the issue. The second-level factors are criteria that contribute to achieving the primary goal. Each criterion possesses a set of subcriteria (Figure 10). After the hierarchy structure is constructed, the relative weights of criteria and subcriteria are determined by performing a pairwise comparison of expert interviews. Interviewees compare each attribute in a pairwise way on the basis of their knowledge and experience. The nine-point scale is used to measure the relative importance (Table 11).

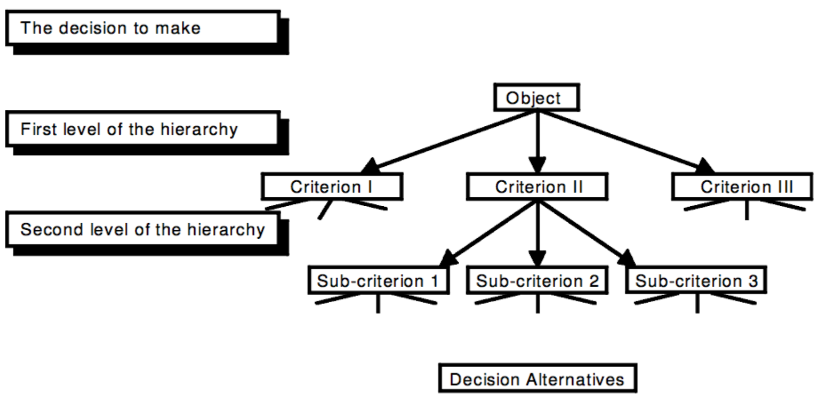


Figure 10 Hierarchy structure sample Source: Bender et al. (1997)

Table 11 9-point scale of pairwise comparison

Importance Index	Definition
1	Equal Importance
3	Moderate Importance of one criteria over the other
5	Strong Importance of one criteria over the other
7	Very Strong Importance of one criteria over the other
9	Extreme Importance of one criteria over the other
2,4,6,8	Intermediate Values of one criteria over the other

In conducting the pairwise comparison, judgments for comparing the criteria of level 1 are made first and are shown in Figure 10. Then, a 3×3 matrix is generated and shown in Figure 11, wherein the intensity of dominance of the criterion in the column heading over those in the row is presented. Second, the criteria of level 2 of hierarchy are compared in pairs. Thus, priorities are generated by eigenvector derivation procedure.

$$A = \begin{bmatrix} W_1/W_1 & W_1/W_2 & W_1/W_3 & \cdots & W_1/W_n \\ W_2/W_1 & & & \cdots & \\ W_3/W_1 & & & \cdots & \\ \vdots & & & \cdots & \\ W_n/W_1 & & & \cdots & W_n/W_n \end{bmatrix} \quad (1)$$

Figure 11 Pairwise comparison matrix Note: W_i is the pairwise comparison ratio.

The following equation holds:

$A*W=n*W$, (2)

where

$W= (W_1, W_2, W_3, \ldots, W_n)^t$

W is the relative weight vector and n is the number of elements.

The matrix A by empirical study will incorporate inconsistencies, indicating that it will not be a projection on a one-dimensional space. The eigenvalue will also be different from n (Bender et al., 1997). Nonetheless, calculating *W* as the eigen vector of the highest eigen value of the matrix A is possible.

$A'*W'= \lambda_{max} *W'$ (3)

where λmax is the largest eigenvalue of A'. When the matrix A' is completely consistent, $\lambda max = n$.

In general, the matrix A will involve inconsistent comparisons because the pairwise comparisons are conducted by personal judgments. A simple case is taken as an example. A person prefers A to B and B to C. Thus, he or she should prefer A to C. However, if this person prefers C to A, then inconsistency exists. Inconsistency can be easily identified if only three factors are present. Notably, the probability of inconsistency increases with the increase in the number of factors to be compared. To avoid inconsistency, the verification is incorporated by computing the consistency ratio (CR), which is one of the advantages of AHP (Ho, W., 2008). If CR exceeds the limit, then interviewees should revise the pairwise comparisons. When all the comparisons carried out at every level are consistent, the judgments can be synthesized to generate the priority ranking. CR was proposed by Saaty Thomas (1980) to measure the reliability of relative weights, and CR is defined as follows:

$CR = (CI/RI)*100$ (4)

Where CI is the consistency index:

$CI = (\lambda max - n)/(n-1)$ (5)

and *RI* is the random index shown in the Table 12.

Table 12 Random index sample in different numbers of hierarchy levels Source: Saaty Thomas (1980).

Criteria Nos.	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Figure 12 illustrates the basic procedure of AHP.

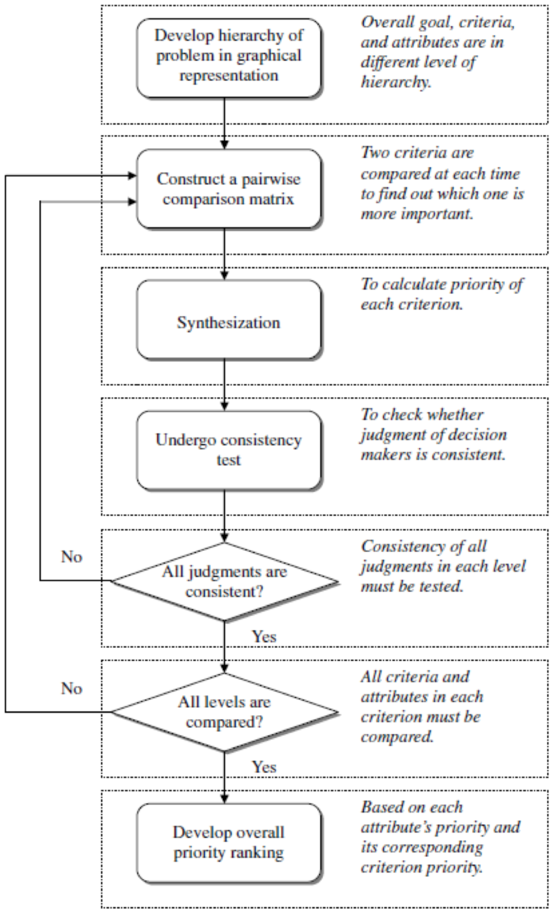


Figure 12 The procedure of the analytical hierarchy process (Ho, W., 2008)

(2) Application of the AHP in the real estate and related area

The AHP method has been applied to many research areas, such as housing selection, resource allocation of planning, housing quality, and built environment (Bender et al., 2000; Ho, D. et al., 2005; Kauko, 2003; Vaidya & Kumar, 2006).

For example, Kauko (2006) studied the housing consumer preferences of a location within a given housing market through AHP. The findings showed that tangible features are more important than the intangible ones for the physical surroundings. Bender et al. (2000) conducted a comparative study on the perceptions of environmental quality of residential properties in Switzerland using AHP. Eight environmental quality criteria for selecting a house are identified.

(3) Measuring costs and benefits by the AHP

The AHP method enables stakeholders to consider all the relevant quantitative and qualitative information (Mitchell & Soye, 1983). The AHP approach generally possesses two hierarchies that measure the project costs and benefits for the same projects (Wedley et al., 2003). The interviewed experts will be asked to provide the value ascribed to each benefit and cost (Forman and Selly, 2001). AHP will help prioritize the benefits and costs of incentive schemes in accordance with the value of priority vectors. However, this approach has been criticized because cost and benefit hierarchies produce priorities on different ratio scales that are often not commensurate (Wijnmalen, 2007). The benefit/cost–priority ratio has lost its relationship with the individual scales. Wedley et al. (2003) demonstrated that, when monetary costs are larger than monetary benefits, benefit priority–cost priority ratios may still be larger than unity. Therefore, benefit/cost–priority ratio cannot represent the effectiveness of project. The benefit and cost priorities can only illustrate the motives and concerns of individuals in participating in the incentive scheme and the degree of their motives and concerns. Thus, this study uses costs and benefits to improve the existing scheme.

In this study, the software Expert Choice version 11.5 by Expert Choice Inc. that was particularly designed for AHP method is used to measure costs and benefits, deal with statistical calculations and check the consistency in the interviews. Each interviewee was asked to do pairwise comparison and the data was input in the Expert Choice immediately to check the consistency. If the consistency is not acceptable, interviewee would be asked to do pairwise comparison again until the results are consistent. Detailed data

4.2.3 Computational fluid dynamics

The SBDGs was linked to the GFA concession to improve the quality of built environment, particularly the air ventilation in a high-density city. To fulfill the SBDGs costs participants of GFA Concession Scheme a lot. This study would assess the environmental benefits resulted from the SBDGs.

"CFD is the art of replacing the governing partial differential equations of fluid flow with numbers, and advancing these numbers in space and/or time to obtain a final numerical description of the complete flow field of interest." Hoffmann and Stein (2002)

CFD models are formulated to simulate the airflow patterns and predict air pollutant concentrations and thus evaluate the outdoor environmental benefits arising from different building and road configurations. The obtained air pollutant concentrations are subsequently used to estimate personal exposures owing to ambient air pollutants. In turn, the estimated personal exposures are used to estimate the number of different types of avoided health outcomes. The economic benefits of avoided health outcomes and losses in development floor areas and the dynamic investment payback period are evaluated by comparing the modified building configurations with the baseline ones.

Detailed procedure of conducting CFD model would be presented in the Chapter 5.2.1.

4.2.4 Validation by focus group forum

The findings were validated through a structured discussion forum (Focus Group Meeting) with an independent panel of 25 experts from industry, government and academic. Critiques and comments were reviewed and the recommendations were refined as necessary following the validation process.

The Professional Green Building Council was asked to issue invitation letters to ask any member of the Hong Kong Institute of Architects, Hong Kong Institution of Engineers, Hong Kong Institute of Planners, Hong Kong Institute of Landscape Architects, Hong Kong Institution of Engineers, and Hong Kong Institute of Surveyors to attend the group meetings. A total of 25 experts attended the focus group meetings in two sessions.

In the two focus group meetings, we presented our PPT with findings and results and sought their comments. Practitioners agreed that the GFA concession scheme leads to the increase in land value and suggested that Hong Kong can learn from Singapore in considering land price in the scheme and some other places requiring developers to achieve high ratings of GB to obtain GFA concession. They also questioned the TC for unclassified buildings and thought that it should be much lower than that of bronze buildings. In fact, either unclassified or bronze buildings can be granted with GFA concession if participants finish the SBDGs. This task is a major challenge and consumes much TC. Thus, if participants want GFA concession, then they must bear a large amount of TCs even if they only develop unclassified buildings. We suggested promoting high ratings of GB by differentiating GFA concession such as that in Singapore. Some practitioners were against it because they thought differentiating GFA concession will strengthen the benefits of large developers. Small developers will have a small space to survive because large developers can construct high level of GB and probably buy all the land in auctions. “Large” developers refer to those who are capable to obtain GFA concession with few uncertainties in the approval process of GFA concession application. They could usually acquire lower interest rates when they do project finance than those who have more risks in the approval process. They also commented that the BEAM Plus is improving continuously, which mean large and small developers must exert much effort to achieve the current ratings. In summary, they agreed that higher level of GB requirements should be promoted. However, achieving this task remains to be discussed. Apart from doing focus group with 25 local experts with various backgrounds, I also did interviews with experts in the US whose views are more objective. I triangulated views of different stakeholders to validate findings.

Chapter 5 Data analysis

5.1 Costs and benefits measurement

Given that measuring all tangible and intangible costs and benefits is difficult, this study uses the AHP method to evaluate the importance of each cost and benefit. The method uses one benefit hierarchy and one cost hierarchy.

After the importance of the cost and benefit criteria is evaluated, the monetary value of each actual cost and benefit item is extracted. Costs and benefits are affected by the project scale. Thus, this study uses a hypothetical case to measure costs and benefits scientifically. Time is used to measure TC. The key parameter of hidden benefits is environmental benefits. The CFD models are formulated to help predict the monetary value of environmental benefits.

5.1.1 Analyzing importance of costs and benefits

(1) Establishing hierarchy of costs and benefits

Costs and benefits are measured using AHP to determine what benefits and costs motivate and concern stakeholders, respectively, thereby helping policy makers in allocating resources effectively. This study establishes two independent hierarchies, namely, cost and benefit hierarchies (Figure 13 and Figure 14). The validated cost and benefit items are input into the two hierarchies to collect data on their importance.

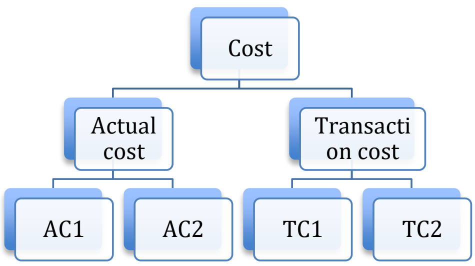


Figure 13 Cost hierarchy (Note: AC refers to actual cost, TC refers to transaction cost)

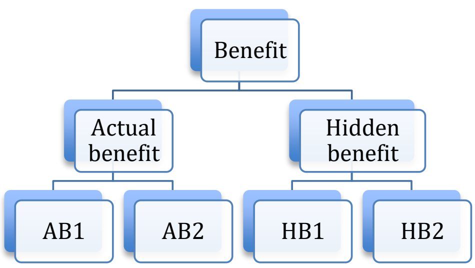


Figure 14 Benefit hierarchy (Note: AB refers to actual benefit; HB refers to hidden benefit)

Level 0 of the hierarchy: Goal

The goal of using AHP method in this study is to measure the degree of the motives and concerns of stakeholders. Motives and concerns are presented by benefits and costs.

Level 1 of the hierarchy: Categories

The traditional CBA framework is expanded by considering hidden benefits and TCs. Level 1 decomposes the "goal" into two categories.

Level 2 of the hierarchy: Factors

The key cost and benefit items of stakeholders, including developers, professionals, contractors, and end users (including the general public), are identified through literature review, validated by interview, and placed under each category in the two hierarchies.

(2) Pairwise comparison and consistency check

After the two hierarchies are established, a pairwise comparison of the interview. Interviewees are asked to measure the importance of benefit and cost items in a pairwise comparison way, which is illustrated in Figure 15.

Benefit measurement

To measure the importance of benefit items by making pairwise comparison

1. If you think ITEM 1 in Column A is 9 times more important than ITEM 2 in Column B, then please tick as follow (This means: Compared with water saving, Enhanced value of green building of Green Building has absolute importance):

A	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	B
1. Enhanced value of green building (green image)	✓																	2. Water Saving
																		3. Energy Saving

Cost measurement

To identify which cost item concerns participants more and how much more

2. If you think ITEM 1 in column A concerns you 9 times more than ITEM 2 in Column B, then please tick as follow:

A	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	B
1. Consultancy fee	✓																	2. Construction cost
																		3. Certification and assessment cost

Figure 15 Illustration of measuring the importance actual costs and benefits

The software Expert Choice version 11.5 by Expert Choice Inc. is used to deal with statistical calculations and check the consistency. The results are presented in the next section.

5.1.2 Measuring costs and benefits by a hypothetical case

The appropriateness of the existing incentive level is analyzed. For this purpose, actual costs and benefits are measured and presented in this section. As costs and benefits change largely with the scale of a project, this study adopts a hypothetical case to measure costs and benefits. The hypothetical case is the baseline model of the SBDGs (Figure 16), which is a typical building form in Hong Kong. The model is selected to extract relevant data on monetary costs and benefits in the interview. These data are used to analyze the effect of the changes in the incentive scheme on the costs and benefits of stakeholders.

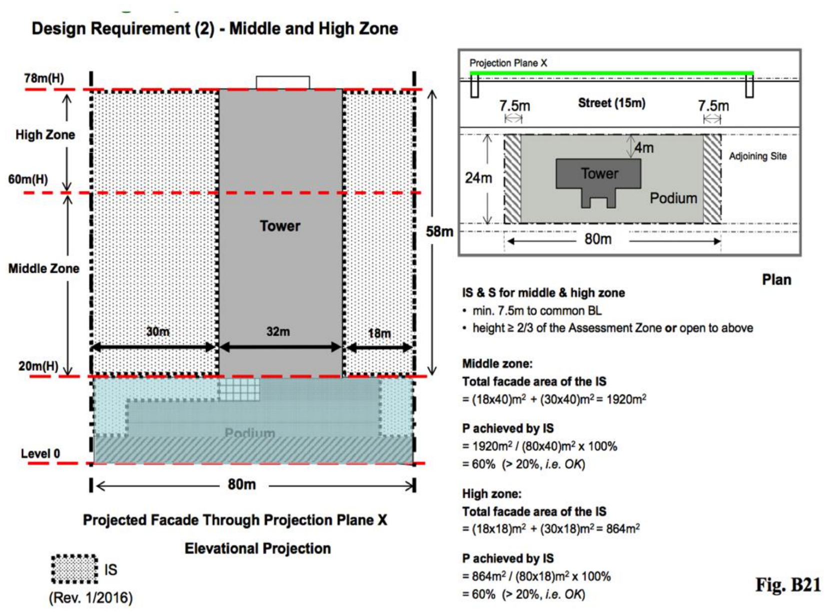


Figure 16 Hypothetical case (Source: the Sustainable Building Design Guidelines)

The actual costs and benefits, and hidden costs and benefits of the hypothetical case are as follows. Three firms provide the figures in the interview. On average, the result is like this. The actual cost data from firms are supported by real figures published by Quantitative Surveying firms. Extra energy savings and water savings are supported by credits of different level of BEAM Plus. The maximum energy saving of platinum GB in BEAM Plus is 40%. Triangulate the results. In terms of TC, TC of unclassified buildings is mainly incurred in the process of fulfilling SBDGs, but consultancy fee of unclassified buildings is nil. That is why participants, especially consultants, complained a lot about SBDGs. Among all the types of TC, approval cost takes most time. The main difficulty is to get approval of SBDGs. Therefore, to justify SBDGs, this study employs CFD to measure the environmental benefits incurred by SBDGs. Prof. CK Chau's team has done a lot of simulations by CFD with parametric variations of the baseline model and published journal articles on this topic (see Fan, M., Chau, et al. (2017)). His team helps on CFD modeling. All the results in this section had been validated in focus group and will be submitted for publication review (see Fan, K., Chan, et al. (2017)).

(1) Actual cost

Extra consultancy fee (percentage of the original fee)

Unclassified ___nil

Bronze/Silver 2%--4%

Gold /Platinum 5%--8%

Extra construction cost (original cost of baseline model: 300million)

Unclassified ___1%____

Bronze/Silver ___1%—3%____

Gold/Platinum ___5%--10%___

(2) Actual benefits

Extra energy savings (percentage of the original energy consumption)

Unclassified ___0-6%__

Bronze ___<10%___

Silver ___10%___

Gold 13%--15%___

Platinum ___15%__

Extra water savings (percentage of original water consumption)

Unclassified ___10%__

Bronze ___10%__

Silver 12%

Gold /Platinum 20%

(3) Transaction cost

When you participate in the GFA concession scheme and construct green building, how much extra time you will have to spend comparing with doing traditional building? (percentage of the time spent on traditional buildings)

Unclassified 4%

Bronze 6%

Silver 8%

Gold 12%

Platinum 15%

Note: Consultants get 4% unpaid TC

The general breakdown of the extra time (percentage of total extra time)

Information searching cost 6%

Research/Learning cost 7%

Negotiation/coordination cost 20%

Approval cost 45%

Monitoring cost 12%

Verification cost 10%

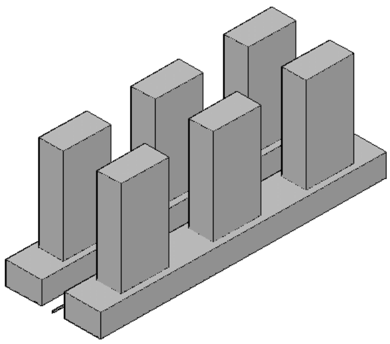
(4) Measuring key hidden benefit--Computational fluid dynamics (CFD) simulation models

The net-benefits of the key parameters are the outdoor environmental benefits in the CBA framework (see Fan, K., Chan, et al. (2017)). To estimate all the costs and benefits associated with implementation of the SBDGs, the baseline model case was used (Figure 16). The configuration of the baseline building was taken from the configuration of a typical residential building in the SBDGs. The key building design parameters were set according to the requirements of SBDGs. The changes in outdoor environmental benefits due to variation in key parameter values are considered as the benefits within the CBA framework. The economic benefits of avoided health outcomes and losses in development floor areas as well as the dynamic investment payback period were evaluated by comparing the modified building configurations with the baseline ones.

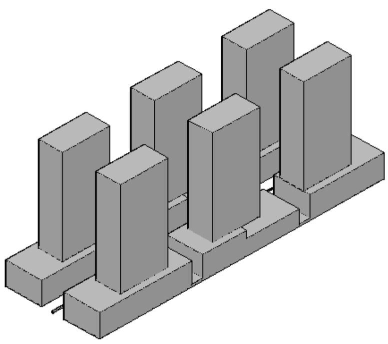
The following are the CFD modeling through the software ANSYS conducted by the team of Prof. CK Chau who is a co-investigator of the Construction Industry Council funded project, which partly support this PhD study. The technology part of the modeling results has been published in journal, (see Fan, M., Chau, et al. (2017)). The following (from here to the end of Chapter 5.1.2(4)) are extracts of the part of data that contribute to cost and benefits analysis of the GFA Concession scheme with the baseline model under the SBDGs.

The baseline building configuration is a sample case shown in the SBDGs. Building separation was placed at the podium with a permeability value of 23%. Building setback in recessed the lower part of the building located in a street with a width of 5.52 m to maintain the same permeability value with the separation case. Figure 17 shows the building configurations.

(a) Baseline building



(b) Building separation



(c) Building setback

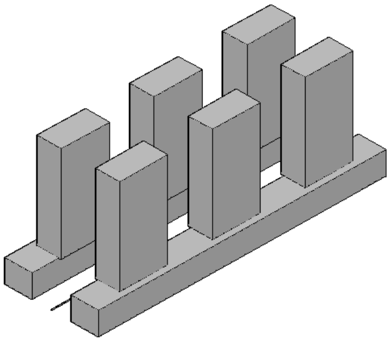


Figure 17 Sketches of the studied configurations, constructed on the basis of the hypothetical model

Numerical parameters

To estimate realistic health benefits of the proposed building configurations, the meteorological and site characteristics of the constructed models were defined according to a specific street canyon in the heart of Mongkok, which is an urban district in Hong Kong having a high population and road traffic density. Table 13 shows a summary of input parameter values together with the relevant street configuration parameters, and meteorological and traffic data.

Table 13 A summary of input parameter values, Source: Ng, W.-Y. and Chau (2014)

Category	Parameters	Values
Street configurations	Major canyon axis orientation (°)	337.5
	Canyon length (m)	192
	Building height (m)	78
	Canyon width (m)	15
	Pedestrian height (m)	1.5
	Pedestrian walkway width (m)	1
Meteorological data	Perpendicular wind probability (%)	40
	Parallel wind probability (%)	32
	Oblique wind probability (%)	28
	Average wind velocity (m/s)	4.01
	Reference height (m)	25

Traffic data	Total number of cars per hour	1467
	Total CO source generated (g/h)	6503.6

Simulation results

Predicted CO concentrations at pedestrian level are shown in Figure 18. It could be seen that pollutant concentrations in the baseline model were the highest among all configurations. Modified configurations were effective in lowering pollutant concentrations at the pedestrian level (z = 1.5 m) and building setback was more effective than building separation. A significant reduction in pollutants concentration achieved when the wind was blowing from the perpendicular direction (90°).

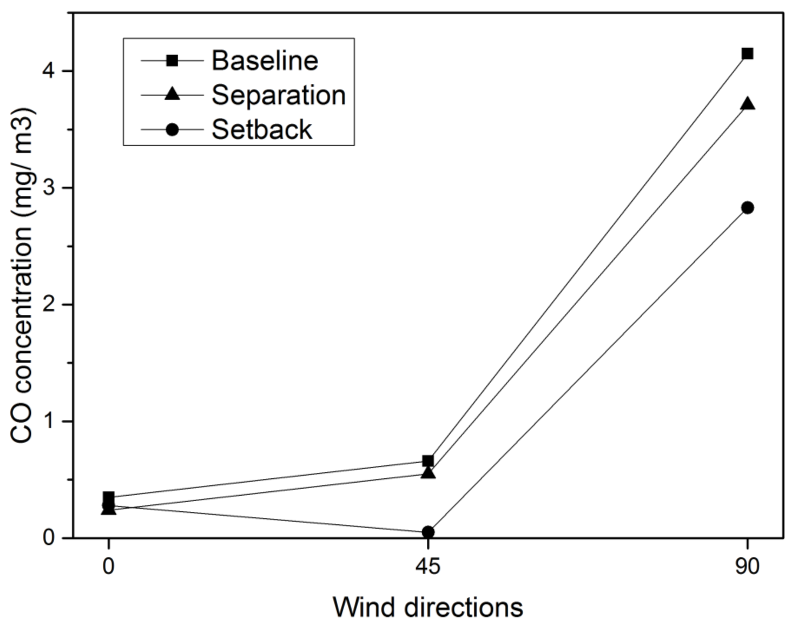


Figure 18 CO concentrations for different building configurations at the pedestrian level, Source: simulated by Prof. Chau's team using the software ANSYS, see Fan, K., Chan, et al. (2017)

Estimating the changes in health outcomes

The estimation of a change in mortality, morbidity and restricted activity days outcomes due to a change in CO concentration levels are based on the widely accepted Ostro's model (Ostro, 1994):

$$dH_i = b_i POP_i \Delta C_i \tag{4}$$

where dH_i is the change in health outcome i; b_i is the concentration-response coefficient (or more correctly the slope of the concentration-response curve); POP_i is the population who are suffering from the health outcome i; $\Delta C_{a,eqv}$ is the change in ambient CO concentration; and i is the specific category of health outcome, such as mortality, morbidity, and restricted activity days.

In this study, it was assumed that there were 3864 pedestrians to across a meter-wide outdoor pedestrian sidewalk each hour (Lam & Cheung, 2000) and they spend 2 h in the streets every day (Chau, C. K. et al., 2002). The concentration-response coefficient values (b_i) for different health outcomes are listed in Table 14.

Table 14 Concentration-response coefficients (bi) for different health outcomes, Source: Chau, C. et al. (2007); Chau, C. et al. (2008)

Health outcomes	**Disease codes (ICD-10)**	**C-R coefficients (b_i)**	**95% CI**
Hospital admissions			
Respiratory diseases	J00-J98	11.04	5.36-22.72
Cardiovascular diseases	I00-I99	22.5	15.73-32.93
Mortality			
Respiratory and cardiovascular diseases	I00-I99, J00-J98	22.5	12.92-39.20
Restricted activity day	I00-I99, J00-J98	0.303	-

Note: b_i refers to the increase in the incidence of the respective health outcomes (%) corresponding to a 10 mg/m^3 increase in CO.

Economic costs and benefits

The total economic benefit gains due to the avoided health outcomes after modifying the building configuration were estimated by

$$V_i = dH_i * uV_i \quad (2)$$

where V_i and uV_i are the total benefits and the unit benefits resulting from the reduced impact of a particular health outcome *i*, respectively; and dH_i is the change in population who are suffering from the health outcome *i* (Chau, C. et al., 2007, 2008). Table 15 shows the estimated monetary values of benefits for different health outcomes (uV_i).

Figure 19 shows the estimated annualized monetary benefits for proposed building configurations. Generally, building separations and setbacks were effective in removing the pollutants and reducing pedestrians' health risks. The amount of benefits gains varied with the building configurations. Building setbacks could provide monetary benefit gains twice as much as building separations.

Table 15 Values of monetary benefits for different types of health outcomes, Source: estimated by Prof. Chau's team, see Fan, K., Chan, et al. (2017)

Health outcome	**Estimate per case (HK dollars in 2014)**		
	Upper	**Lower**	**Central**
Premature mortality	$72,592,000	$2,503,000	$37,547,500
Respiratory diseases	$54,000	$27,000	$40,500
Cardiovascular diseases	$54,000	$27,000	$40,500
Restricted activity day	$1,687	$843	$1,265

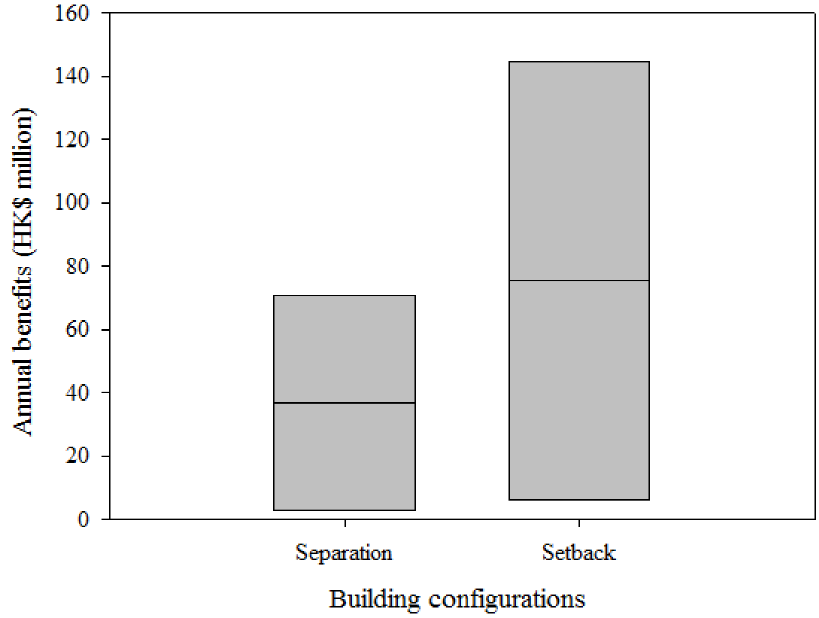


Figure 19 Annual benefit gains for different building configurations, Source: estimated by Prof. Chau's team, see Fan, K., Chan, et al. (2017)

However, building setbacks could induce more development floor area reduction than building separations. To identify the type of building configuration that could yield the highest health benefits, the ratio of total benefits (50 years, HK$) divided by floor area reduction (m^2) is shown in Figure 20. All the monetary costs and benefits were discounted at 5%.

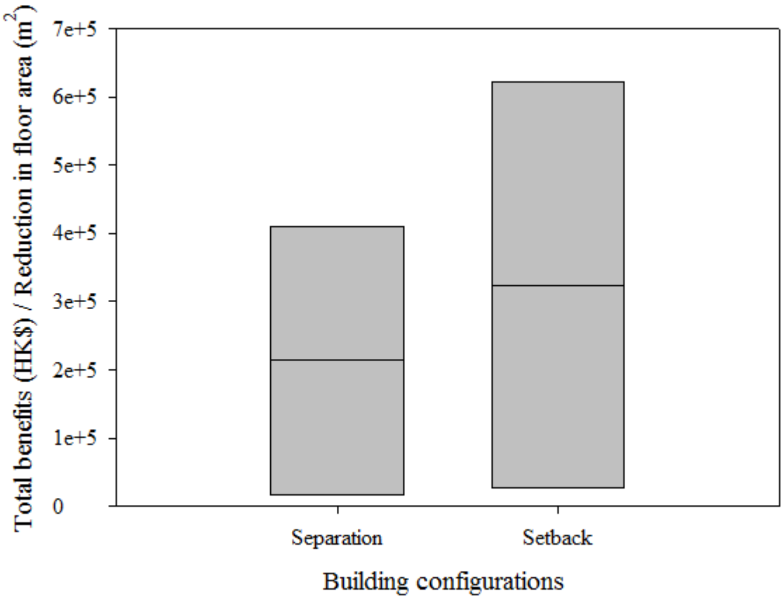


Figure 20 Total benefit gains per floor area reduction
(Note: 1e+5 is equal to 1*10^5+5), Source: estimated by Prof Chau's team, see Fan, K., Chan, et al. (2017)

In short, building separations and setbacks were effective in removing the pollutants and reducing pedestrians' health risks. The amount of benefits gains varied with the building configurations. Building setbacks could provide monetary benefit gains twice as much as building separations. However, building setbacks could induce more development floor area reduction than building separations. To identify the type of building configuration that could yield the highest health benefits, the ratio of total benefits (50 years, HK$) divided by floor area reduction (m^2) is used as shown in Figure 20. Building setbacks could still provide better monetary benefit gains than building separations but the effectiveness is about 1.5 times only.

5.2 Identification of the determinants of transaction costs in the GFA Concession Scheme

The interviews were transcribed and the transcribed materials were categorized according to the framework of transaction cost presented in the Chapter 4.1.1.

5.2.1 Asset specificity

Table 16 outlines the major remarks by various stakeholders on their specific investments owing to the application and specific setups for the GFA concession projects.

Table 16 Stakeholders' specific investment

Specific investment	Major remarks	Relevant stakeholders
Specific knowledge	• An architectural firm has policy to motivate architects to study new knowledge. • Architects are essential to obtain concession, but this issue is insignificant as the service of experienced architects can be easily obtained. • If architects know much about BEAM Plus, then the design process will be highly efficient.	Developers, consultants, contractors
Specific information	• The contractor sources the green products required by BEAM Plus from suppliers. • Information about green materials and their certificates are obtained.	Developers, consultants, contractors
Specific contract	• If developers do not specify the rating of BEAM Plus in the contract and the assessment result fails to reach their expectation, then they are usually flexible and consultants do not have to do extra work to fulfill their oral agreement. On the contrary, consultants are forced by the contract to fulfill the requirements. • If the rating of GB is specified in the contract, then designers and green pros must coordinate to guarantee the expected BEAM Plus rating. On the contrary, consultants only try to fulfill the expectation of clients. • Architects and BEAM pros must discuss the responsibility. Architects sometimes need to study green materials by themselves. BEAM pros are mainly responsible for preparing the document and applying for BEAM Plus.	Developers, consultants, contractors

Design for specific site	• When the SBDGs are too stringent, developers do minimum work and construction cost to obtain GFA concession. If developers do more than necessary, then it will not be beneficial. • A few projects cannot meet the prerequisites of BEAM Plus by nature. For example, if the site is odd, then this site may present difficulty in meeting the requirements of BEAM Plus.	Developers, consultants, contractors

5.3.2 Uncertainty

Table 17 illustrates the types of uncertainties and major remarks in the context of GFA Concession Scheme.

Table 17 Uncertainties

Uncertainties	Major remarks	Relevant stakeholders
Behavioural uncertainty	• Different BEAM consultancy firms have consultants with different capacities. For example, when two projects with the same rating of BEAM Plus pursue a bronze rating, two consultants usually provide two sets of requirements and different workloads to contractors. The contractor has to do much negotiation effort. • Cooperating and obtaining mutual understanding with green pros consume certain time.	Developers, consultants, contractors
Technology uncertainty	• The energy efficiency of equipment or technology presents large uncertainties even if supplier provides certificate to prove the performance. The reason is that the	Developers, consultants, contractors

	performance of equipment is influenced by the environment. • Consultants must conduct extra testing. • A few projects may present difficulty in complying with the method illustrated in BEAM Plus, thereby affecting the provisional assessment acquisition.	
Institutional uncertainty	• Every project needs supplementation when applying for BEAM Plus because the BEAM Plus handbook specify the credits but not the documents. • BEAM Plus does not specify the method for calculating energy saving • The project may be delayed, which is a significant uncertainty. If the project does not obtain the provisional assessment of BEAM Plus on time, then the developers may fail to obtain consent for commencing the construction. • Some developers usually attempt to apply for GFA concession, but other developers do not because the latter developers consider the uncertainties of approval.	Developers, consultants, contractors

5.2.3 Frequency

Table 18 shows the major remarks on frequency in the context of the GFA Concession Scheme.

Table 18 Major remarks on frequency

Frequency	Major remarks	Relevant stakeholders
Transferable knowledge	• BEAM Pro is familiar with green specifications, which are explained to	Developers, consultants,

and experience across projects	architects. The GB market is more mature than before. • The industry has developed a standard procedure for applying for GFA concession. The approval process can be controlled and constrained much better than five years ago.	contractors

5.3 Identification of the incompleteness of the GFA Concession Scheme

The interviews were transcribed and the transcribed materials were categorized according to the framework of the incomplete contract theory presented in the Chapter 4.1.2.

5.3.1 State of the world

Table 19 shows the major remarks on state of the world in the context of the GFA Concession Scheme.

Table 19 Major remarks on state of the world

The state of the world	Major remarks	Relevant costs and benefits
The state of property market	• GFA concession leads to the increase in land value. • The enhanced value of GB depends on the property market. Green features are not the major concern of consumers for residential building.	Land cost; Transaction cost associated with specific investment
Duration of incentives	• • If the government removes the concession, then the developers who bought land with GFA concession will	GFA concession

	lose much money.	

5.3.2 Quality

Table 20 shows the major remarks on quality in the context of the GFA Concession Scheme.

Table 20 Major remarks on quality

Quality	Major remarks	Relevant stakeholders
Requirements of GB quality	• The assessment process of BEAM Plus is not consistent with a result that usually depends on the assessors. The assessors have different measurements and may provide same projects with different ratings. Thus, developers prefer a bronze rating. • The ambiguous requirements of BEAM Plus influence building service engineering. For example, BEAM Plus do not specify the method for calculating energy saving.	Approval cost, negotiation cost

5.3.3 Investment actions

Table 21 shows the major remarks on investment actions in the context of the GFA Concession Scheme.

Table 21 Major remarks on investment actions

Investment actions	Major remarks	Relevant stakeholders
Actions participants need to take	• Much dispute arises as a result of different interpretations on the official documents. For example, different GFA measurements are available and not	Approval cost, negotiation cost, Research/learning cost,

	fully defined in the SBDGs. • In undefined situations, the private sectors must explore ways to design sustainable building and prove its sustainability. • Architects must negotiate with the Building Department on the design details of hotels because no clear guideline on commercial buildings exists and existing guidelines are incomplete. SBDGs provides only a few principles for dealing with special cases that are not mentioned in the guidelines.	Information searching cost

5.4 Identification of the transitional gains trap

The interviews were transcribed and the transcribed materials were categorized according to the framework of the transitional gains trap presented in the Chapter 4.1.3. Table 22 shows the major remarks on transitional gains trap in the context of the GFA Concession Scheme.

Table 22 Major remarks on transitional gains trap

Transitional gains trap	Major remarks	Relevant stakeholders
Transitional period	• If no GFA concession is available, then land price will decrease accordingly. • When developers bid for a land, they usually look at the features of the land and calculate the number of concessions they can obtain by designing in the site. On the basis of the building design and predicted market condition, developers will decide on the selling price. By calculating the	Developers

		development cost and selling price, developers will decide the land cost.	
Mature period	•	When all the developers realize the game after the transitional period, the extra benefits from GFA concession will shift to the land value.	Developers
Termination or reduction of incentive	•	The government does not remove GFA concession considering the pressure from developers. If the government removes the concession, then the developers who bought land with GFA concession will lose much money.	Developers

Chapter 6 Research results

6.1 Overview of the research results

This chapter would like to answer how these costs and benefits incurred and would change with the changes of mechanism of GFA concession scheme, and who gains and losses in the process. The parameters in the BEAM Plus and SBDGs are the basis of all the extra costs and benefits. Changes of these parameters would definitely lead to the changes of costs and benefits. However, it cannot fully explain stakeholders' gains and losses under the incentive scheme. The theories of transaction cost, incomplete contract, and the transitional gains trap provide complementary and critical explanations to better understand stakeholders' gain and losses.

The overview of the research results is showed in the Figure 21.The lists of hidden cost, actual costs and actual benefits lead the author to use the theories of transaction cost, incomplete contract and the transitional gains trap to explain how these costs and benefits were incurred and would change with the changes of mechanism of incentive scheme, and who would gain and loss in the process. The following sections explain it in detail. The research results also provide solid foundations for future discussions theory by theory.

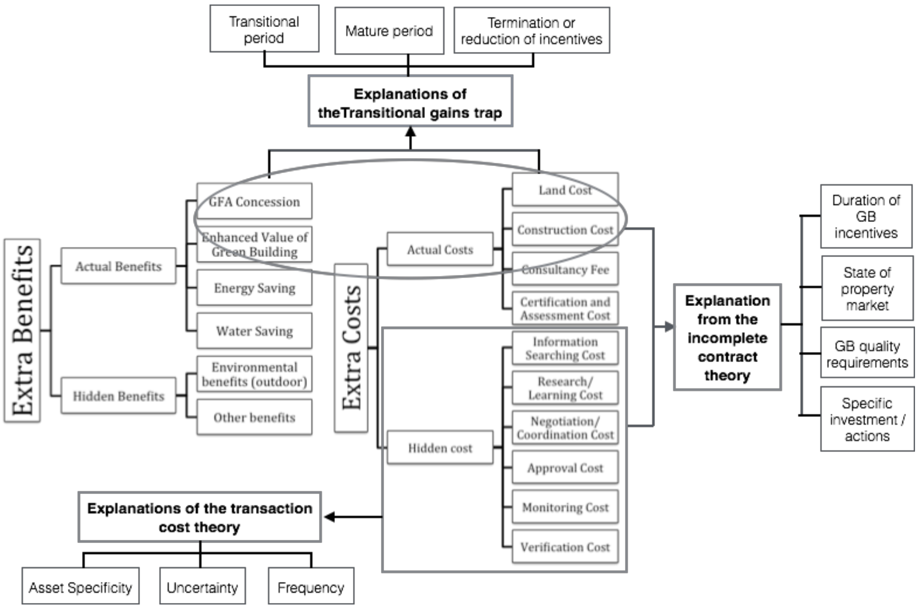


Figure 21 Overview of the research results

6.2 Cost-benefit analysis

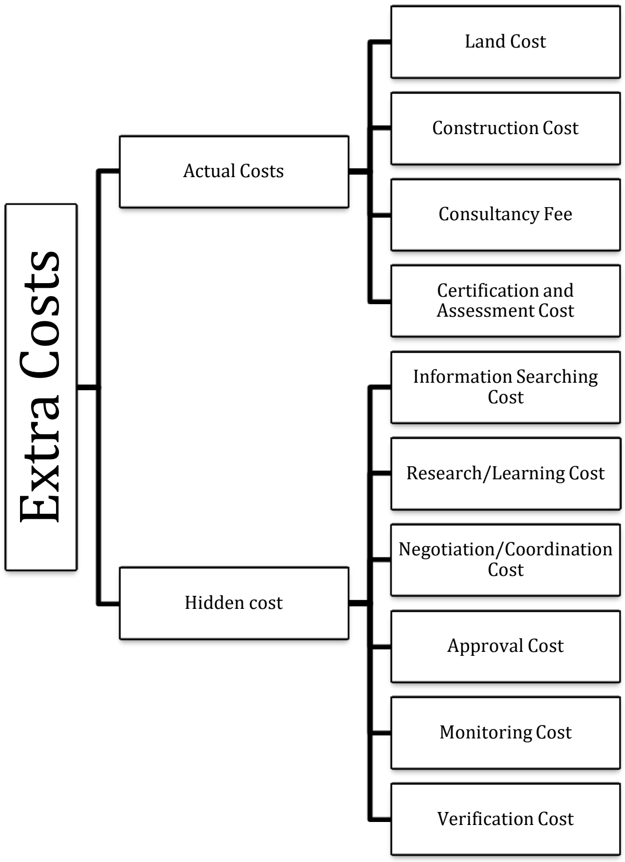


Figure 22 Extra costs

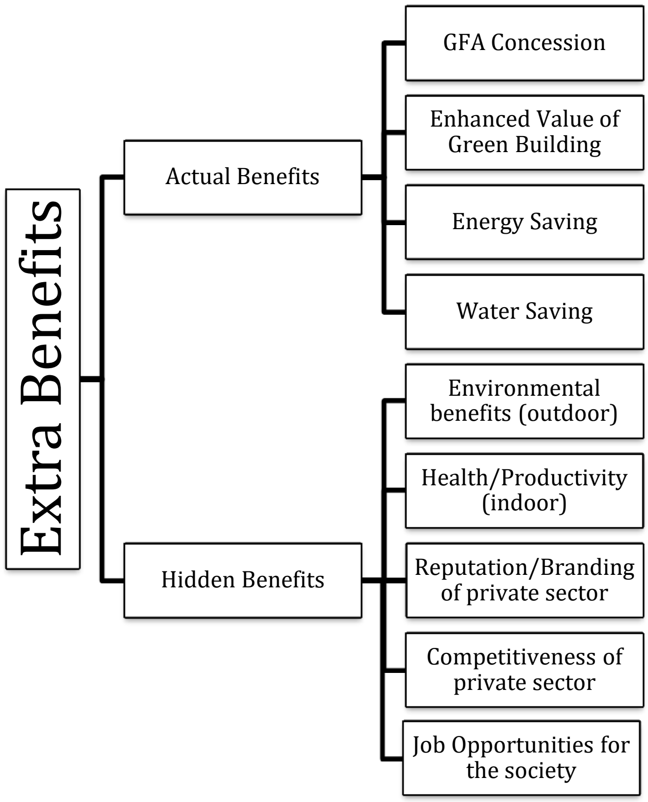


Figure 23 Extra benefits

Figure 22 and Figure 23 illustrate the extra costs and benefits of implementing the GFA Concession Scheme. These costs and benefits are borne by different stakeholders, including developers, professionals, contractors, residents of green building and general public.

6.2.1 Actual costs

Increased construction costs and land cost

The extra construction cost to acquire BEAM Plus certification depends on the level of green building and original provision of the project. Specifically, if the original provision of the project has no green features, then the extra construction cost could reach 8%–10%. The cost premium also appears in other GB assessment systems, such as LEED with extra costs from 0.66% to 6.5%, GM from 1%–3% and Green Star from 3%–6% (Kats et al, 2003; Yu and Tu, 2011; Davis Landon, 2007).

The uncertainties caused by GFA concession due to its complex design for approval by the government directly affect profit estimation of the developers, especially at the land bidding stage. Developers in Hong Kong must estimate the possible GFA concession granted and decide the maximum land cost that they could afford. Therefore, the GFA concession scheme results in an increase in land prices in Hong Kong, which, in turn, decreases expected profits of developers. This phenomenon also occurred in New York City. When the New York City government provided a density bonus for developers constructing moderate-cost housing, the land cost also increased. In this context, the planning agency began to calculate the profits of each specific GB project and control the bonus accordingly (Johnston et al., 1989), which inevitably generated administration costs.

In Singapore, the land cost is prescribed, thereby reducing the uncertainties of total costs. The granted GFA concession could be exactly calculated through the prescribed formula, in which GFA is calculated in reverse accordance with land price, that is, a high land price will lead to a low GFA bonus. A lesser amount of GFA bonus will be provided to the project in the city centre where land is usually expensive compared to the same project located in the suburban area. Thus, the GFA concession calculation method potentially reduces the negative impacts of extra GFA on the built environment. Moreover, this method considerably reduces the participation uncertainties in the GFA concession scheme and results in decreased corresponding TCs, such as information searching and research costs.

Consultancy fee

Owing to extra work, the consultancy fee of GB is larger than that of non-GB depending on the project scale and GB level. GB consultancy fee is normally 5%–10% more than non-GB. However, with the development of GB market in Hong Kong, an increasing number of GB consultants are becoming available in the job market, which reduces the human asset specificity and leads to a further decrease in consultancy fee. Although experienced consultants remain scarce, they can still enjoy extra 5%–10% salary.

A similar situation appears in Singapore as well. Hwang and Tan (2012) pointed out that conducting GB projects must engage specialised consultants, and the consultancy costs are an extra amount on top of non-GB projects.

Certification fee

BEAM Plus registration and assessment are required to apply for GFA concession. The certification fee must be paid by developers (See Table 23). In some cities and countries of America, the certification fee and building permit fee are reduced as incentives to promote GB (Work, 2007).

Table 23 Certification fee in Hong Kong

Project Scale	Construction Floor Area (sq.m.)	Registration fee (HK$)	Assessment fee (HK$)
Extra Small	≤2499	55,000	104,000
Small	2,500-24,999	110,000	197,400
Medium	25,000-49,999	150,000	275,800
Large	50,000-99,999	220,000	577,500
Extra Large	100,000-199,999	300,000	841,000
Mega	200,000-400,000	400,000	1,237,300
Exceptional Scale/Complexity		600,000	TBC
Credit Interpretation Request		NA	2,000 per credit
First/Final Appeal		NA	15,000 base charge+4,500 per credit

6.2.2 Actual benefits

Energy & water efficiency benefits

A few interviewees claimed that the new technologies are not cost-effective due to high upfront costs and low energy and water savings. Opposing views endorsed the energy and water efficiency benefits because governments could save the cost of energy and water infrastructure expansion. In short, GBs appear to generate energy and water efficiency benefits for the public, but developers must bear the upfront costs that may even be more than the lifecycle savings.

Hence, a few countries and regions have provided subsidies to compensate developers.

Enhanced value of GB

According to the interview, an apparent inconsistency on the perceptions of GB market value exists. A few interviewees state that GB does not have higher value than its counterpart, and developers construct GB mainly for GFA concession. Meanwhile, other interviewees believe GB has enhanced value, but the amount of enhanced value depends. In Hong Kong, the actual benefit of GB has not been reflected by the market price of BEAM Plus building compared to traditional ones. Green features and energy efficiency are not the main considerations of residents. For office buildings, a few international firms may prefer GB labelled office, which may provide GB with a few comparative advantages to the traditional buildings for rent or for sale. In addition, a slight price (in rent or sales) difference exists among the levels (Bronze, Silver, Gold and Platinum) of BEAM Plus ratings. A few interviewees stated that the GFA concession scheme does not help considerably improve the building quality. Thus, the public is not willing to pay extra.

6.2.3 Hidden benefits

Reputation/branding of the private sector

Developing GB could gain reputation for developers, but this is not the main reason for GB development. For developers who only achieve the BEAM Plus registration, participating in the GFA concession scheme is perceived as not enhancing their reputation or may even negatively influence their reputation. A few residents do not acknowledge the utility of concession features and regard them merely as instruments of developers to acquire extra GFA and make additional money.

Competitiveness of the private sector

Competitiveness of the private sector means increased business competitiveness with increasing project experience accumulated, which simply refers to profit margin. For private sectors, such as architects, contractors, suppliers and developers, early learning of new knowledge relevant to the GFA concession incentive scheme and entry to the green building market contributes to their competitiveness. Those who hesitate to enter the market will gradually fade out.

Environmental benefits (outdoor) and health/productivity (indoor)

Fulfilling the requirements of the Sustainable Building Design Guidelines (SBDGs) is one of the prerequisites of obtaining GFA concession. The SBDGs are tailored for the unique built environment of Hong Kong. Open space is very rare and precious in a place similar to Hong Kong, where high density is enjoyed, and the pace of life is rapid. The amount of time that people spend in open space is associated with the risk reduction of stress-related illness development. The environmental benefit changes with the design of SBDGs. For example, if the SBDGs require additional building setback and separation, then additional open space will be available and air ventilation will be improved but would harm profits of developers.

In addition, green building has good indoor air quality that is beneficial to the health of people and improves productivity. This hidden benefit increases with the GB levels.

Job opportunities

Over half of the interviewees mentioned that the GFA concession scheme created additional job opportunities. One of the interviewees specifically stated that his/her architect firm has employed an extra 20% employee to carry out BEAM Plus projects. New job positions created by the GFA concession scheme, including green professionals, environmental consultants, green material/equipment supplier, BEAM Plus assessor and energy simulation consultant, have become available. However, a few interviewees stated that in terms of the entire society, the GFA concession scheme does not create excessive job opportunities.

6.2.4 Hidden costs

Searching cost

Searching cost refers to the cost of collecting information. In this study, consultants collect specialised GB information, such as the green equipment performance and green building design information. Developers usually seek experienced architects and GB consultants and pay extra because experience of consultants considerably affects the amount of GFA concession grant to developers and the assessment results of BEAM Plus. According to the interview, a 20%–25% risk of obtaining unexpected results based on the experience of consultants exists. This finding is supported by Coggan et al. (2013) and Ducos et al. (2009), in which past experience could improve the decision-making ability and influence TC because experienced professionals spend less time collecting and processing information. Searching cost accounts for the additional time and money spent in the implementation process. However, two interviewees mentioned that a shortage of experienced consultants exists, which indicates that GB market still has room for further development.

Research/Learning cost

Research/learning cost means the time and resources spent on processing information and decision-making, such as analysing property market. In this study, at the time of land bidding, developers will make a rough building plan according to the land features to calculate the number of guaranteed GFA concessions. Owing to the uncertainties of GFA concession application, developers usually tend to be conservative in estimating the possible GFA concession achieved. With the estimated GFA concession, developers would calculate the maximum land cost to make the decision of land bidding. In this process, research cost is inevitable and will not disappear with the development of GB market.

Numerous considerations exist after developers bid the land and determine the building design scheme. For example, developers would project the market price for a certain period in the future (e.g. three years) and then decide on providing the appropriate number of facilities to acquire GFA concession (e.g. car park, podium garden and green features). Normally, the estimated price based on the location (i.e. users and other property prices in this area), economic situation, time, development cost, net floor area and the development standard would determine the design and green feature provisions. A struggle exists between GFA concession and market price. This indicates that the uncertainty of the GFA concession and property market leads to additional research costs.

Negotiation/Communication cost

Negotiation/communication cost refers to the cost of bargaining or communication to achieve the agreement or delivery information between parties. Four interviewees mentioned that due to the unclear and inconsistent BEAM Plus assessment process, this assessment is considerably dependent on assessors whose measurements vary, thereby leading to unexpected or inconsistent results. Generally, a 20%–25% risk of the application being rejected exists. This risk causes developers to negotiate or resubmit, which, in turn, increases the risk and time concern and leads to 20%–30% extra work. Similarly, uncertainties also exist in the process of GFA concession application. Negotiation and resubmission of application also cost 20%–30% extra work. If a few special designs exist, then the Buildings Department will hold a conference meeting to discuss the decision of GFA concession special design. Architects must negotiate and convince the government to accept their design with strong evidence of environmental benefits.

Negotiation/communication between design teams and developers or contractors can also generate transaction costs due to the complex requirements for building design in Hong Kong. Similarly, Singapore had an increased number of meetings with green specialists (Hwang & Ng, 2013), and the misinterpretation of clients' requests by the design team is a vital element influencing the project schedule (Hwang et al., 2015). This finding reflects that stakeholders have not yet developed a standard procedure of cooperation and tacit agreement, which usually takes additional time to establish.

Approval cost

Approval cost arises when the transactions must be approved by the government. Such condition may result in the delay of transaction completion and impose modifications. In this study, consultants need to prepare supporting documents for BEAM Plus registration/certification and GFA concession application. Additional information may be required as a supplement, and inadequate information may cause processing delay. In granting modification of or exemption from the provision of the building ordinance, conditions may be imposed by the building authority. If special designs are available, architects must prepare detailed relevant documents to support the GFA concession application.

Monitoring cost

Monitoring cost is the cost of monitoring policy compliance, contract implementation and its outcome. Site monitoring and reporting on the execution of the instructions must be conducted to provide evidence for BEAM Plus certification. Two interviewees mentioned that contractors must monitor and work long hours, and the cost would be reflected in the total construction cost. Before the GFACS, a few developers constructed GB due to its high monitoring costs. Similarly, monitoring the project progress by consultants in Singapore ranked 4 out of 36 significant factors that affect schedule performance in GB projects (Hwang et al., 2015).

Verification cost

Verification cost refers to the cost to verify the effectiveness of green materials or equipment. Three interviewees pointed out that the information of green material or equipment effectiveness provided by suppliers may not be complete; hence, developers must conduct a few tests to verify the effectiveness. Replacing the material and equipment is common if information is lacking before procurement. This observation is echoed with the findings stated by (Lam et al., 2009) and (Pearce, A. R. & Vanegas, 2002) that the reliability of new product protects consultants from specifying the green materials that result in the unattainable clauses in green materials, which may lead to delay or conflict of interest between stakeholders. Lam et al. (2011) suggested that green materials should be tested by an accredited laboratory to ensure their effectiveness. Thus, the green specification could be detailed in the contract, and the verification costs could be reduced.

6.2.5 Overview of stakeholders' costs and benefits

The identified costs and benefits, which are borne by different stakeholders, are shown in Table 24. Developers bear all the extra costs and most benefits, including actual and hidden benefits. However, professionals and contractors bear most TCs but no actual benefits from the incentive scheme.

If professionals are good at constructing GB, then they will have extra consultancy fee. However, whether extra consultancy fee can cover extra TCs remains unclear. The possibility depends on the capability of the consultancy firm. For example, an architectural firm has a policy to motivate architects to study new knowledge. Thus, the fee for this firm is higher than that of other architectural firms. Meanwhile, large firms usually charge high fees from developers because their technical capability is highly valued by developers. Developers view technical capability and consultancy fee in a certain balance. Firms with high technical capability can charge high fees within a reasonable range. For architectural firms, the hidden costs are covered.

Table 24 illustrates the extra costs and benefits of implementing the GFA concession scheme. These costs and benefits are borne by different stakeholders, including developers, professionals, contractors, residents of green building and the public.

Table 24 Stakeholders' costs and benefits

Extra cost and benefit		Developer	Professionals	Contractor	Occupants	General public
Actual Cost	Consultancy fee	√				
	Construction cost	√				
	Land cost	√				
	Certification cost	√√				

Transaction Cost	Information searching cost	√√	√√√	√		
	Research cost	√√	√√√	√		
	Negotiation cost/coordination cost	√√	√√√	√		
	Approval cost	√√	√√√	√		
	Monitoring cost	√	√√√	√√		
	Verification cost	√	√√	√√		
Actual Benefit	GFA concession	√				
	Energy saving	√				
	Water saving	√				
Hidden benefit	Reputation	√√	√	√		
	Competitiveness	√√	√	√		
	Job opportunities		√	√		√
	Health/Productivity	——	——	——	√√	
	Environmental benefits	——	——	——		√√

Note: √ refers to degree.

6.2.6 Importance of costs and benefits--results of AHP

This section presents the results of measuring what benefits and costs motivate and concern stakeholders, respectively. Given that GFA concession is the major benefit that stakeholders aim for and that land cost is the major cost component that is controlled by the government, the two items of high importance are ignored. The two items are removed in the AHP measurement to guarantee a scientific pairwise comparison.

(1) Actual costs and hidden costs

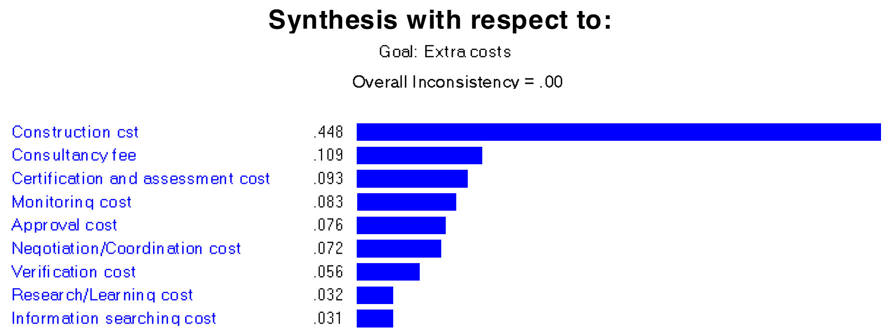


Figure 24 Weights of cost criteria

Figure 24 Weights of cost criteria shows the weights of cost criteria. Construction cost is more important than other cost criteria, and actual costs are more significant than hidden costs. This finding indicates that, among all the costs, the high upfront cost of GB should be mainly considered by the private sectors. However, such case is not always true. In the interview, a few large developers claimed that hidden costs highly concern them because they have sufficient financial budget to deal with actual costs but cannot anticipate all the uncertainties in the development process, especially when they want to construct something special and innovative for sustainability. Moreover, interviewees mentioned that the certification and assessment costs change with GB assessment methods. For BEAM Plus, this cost is one-off payment and does not concern developers significantly. However, other schemes, such as WELL, that require regular assessments of building performance usually cost much money. In terms of TCs, monitoring cost ranks first because BEAM Plus requires much monitoring work in the construction process. Developers, contractors, and professionals must conduct on-site monitoring to apply for BEAM Plus. Monitoring cost is nearly fixed in that many works can be done owing to BEAM Plus. Approval and negotiation costs rank second and third, respectively. Unlike monitoring cost, the two cost items vary with the project experience and capability of participants. Experienced and capable individuals fully understand the SBDGs and BEAM Plus and can reduce uncertainties in the approval process. Moreover, participants of a mature team have developed common language and working pattern. They usually have efficient communications and less negotiation cost. Interviewees claimed that, when they first constructed GB, contractors and GB consultants had different understanding on BEAM Plus. They spent nearly two months discussing ways to obtain credits. Therefore, approval and negotiation costs can be reduced. Unlike monitoring cost, verification cost is nearly fixed as well because documents and green equipment performance can be easily verified. Research/learning and information searching costs are the least significant, which indicate that industry people are becoming familiar with the GFA concession scheme and spend less time on research/learning and searching information. Therefore, the policy should be improved.

(2) Actual benefits and hidden benefits

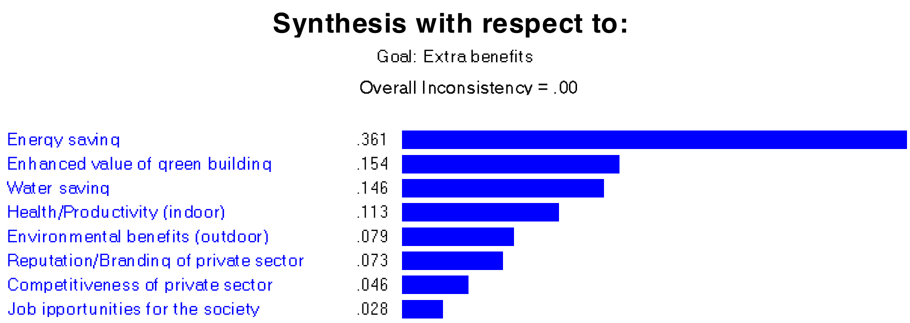


Figure 25 Weights of benefits criteria

Figure 25 illustrates the weights of benefit criteria. Energy saving is the most important factor and is more important than other benefit items. The reason is that energy use is the most vital assessment aspects in BEAM Plus with more credits (42 credits) and higher weighting (35%) than those of the five other assessment aspects. The enhanced value of GB ranks second, which suggests that participants expect that GB can enjoy price premium in the property market. Interviewees also mentioned that office buildings can easily obtain price premium because GB benefits the reputation of tenants. On the contrary, residential buildings present difficulty in obtaining high selling price because the general public does not value green features and tariff of energy and water is costly. This situation occurs in the USA. Experts from the USA claimed that residential buyers are not sophisticated. High selling price of GBs means high mortgage for residents. Theoretically, if residents save much energy in their home, then much money can be saved to afford financing costs.

Unlike energy use, water use possesses only nine credits in BEAM Plus. This credit value is less than that of the five other assessment aspects. This factor also presents 12% weighting, which is less than that of the four other assessment aspects. Health/productivity (indoor) and environmental benefits (outdoor) are more significant than the reputation/branding of the private sector and competitiveness, suggesting that participants highly value sustainability. With regard to job opportunities, nearly all interviewees claimed that the GFA concession scheme does not create too many jobs for the society.

6.3 How the GFA Concession Scheme determines stakeholders' transaction costs—analysis of transaction cost theory

The transaction cost theory explains how the transaction costs change with the mechanism of GFA Concession Scheme. Starting with the TCs determinants in the GFA Concession Scheme, through literature review and expert interview a list of TCs are identified, and mapped on the stakeholders who bear them (Table 25). According to the Table 25, the information searching cost, research/learning cost, coordination/negotiation cost, approval cost, monitoring cost, and verification cost exist in the process of the GFA Concession Scheme implementation due to the specific knowledge, specific information, specific contract, design for specific site, behavioural uncertainty, institutional uncertainty, and technological uncertainty embedded in the GFA Concession Scheme design. Specifically, consultants bear the TCs most frequently in the transactions, followed by developers. However, this frequency does not mean that consultants bear the highest TCs because each type of TCs may cost different in time.

Also, the Table 25 illustrates key transactions under each TC determinant, extracted from the interview data (Table 16, Table 17). Table 25 contributes to discussions of how to improve the incentive scheme.

Table 25 Analysis results of transaction cost in the GFA Concession Scheme (Source: Interview)

TCs' determinants	Sub-determinants regarding the GFA Concession scheme	Specific transactions under each determinant	TCs generated by GFA Concession scheme implementation						Borne by Stakeholders		
			I	II	III	IV	V	VI	D	Cons	Cont
Asset Specificity	Specific knowledge	Learning the Sustainable Building Design Guidelines, BEAM Plus, and building features granted GFA concession		✓					✓	✓	✓
	Specific information	Searching information to fulfil BEAM Plus and the Sustainable Building Design Guidelines	✓						✓	✓	✓
	Specific contract	Developing contract documents, detailing the green specifications and elaborating contracting practice		✓					✓	✓	✓
		Extra coordination between participants to fulfil the contract;			✓				✓	✓	✓
		On site monitoring and reporting the execution of the contract or instructions					✓		✓	✓	✓ `
	Design for specific site	Compliance with different design requirements for specific land use, site shape and location		✓					✓	✓	✓
		Communicating with clients/consultants about site plan and building layout			✓				✓	✓	---
		Preparing or verifying documents for GFA concession approval and to demonstrate compliance with BEAM Plus						✓	✓	✓	✓
		Revision of building plan required by the Buildings Department (BD) or Hong Kong Green Building Council (HKGBC) if any				✓			✓	✓	----
Uncertainty	Behavioural uncertainty	More coordination between practitioners to avoid misinterpretation and get used to working pattern, such as coordination among architects, GB consultant, contractors and suppliers			✓				✓	✓	✓
		Carefully selecting partners who are capable of doing green projects	✓						✓	✓	✓
		Client's flexibility and ability to make decisions cause more negotiations, such as negotiating the amount of GFA concessions/designed green features, and the			✓				✓	✓	✓

		cost/time constrains									
	Technology uncertainty	Extra testing of green equipment compliance with the BEAM Plus standards						✓	✓	✓	✓
	Institutional uncertainty	More coordination/negotiation between participants to clarify the requirements/standards			✓				✓	✓	✓
		Extra work to verify or revise the documents due to unclear and incomplete instructions of BEAM Plus or Sustainable Building Design Guidelines				✓			✓	✓	✓

*Note: I: Information searching cost; II: Research/learning cost; III: Coordination/Negotiation cost; IV: Approval cost; V: Monitoring cost; VI: Verification cost; D: developers; Cons: consultants; Cont: contractors

6.3.1 Asset specificity

According to the four types of asset specificity, the specific knowledge, information, contract, and the design for specific site were identified as the sub-determinants of transaction costs regarding the GFA Concession Scheme, resulting in the information searching cost, research/learning cost, coordination/negotiation cost, approval cost, monitoring cost, and verification cost. The knowledge, information, contract and design are the inherent elements that participants have to invest in. For example, the SBDGs and BEAM Plus are new knowledge to stakeholders. Therefore, they have to invest their time in learning new knowledge and practice it. Under each sub-determinant, the specific transactions were identified, which incur TCs directly borne by the transactors to different extents. It would be explained in Table 26 in Chapter 6.3.4.

6.3.2 Uncertainty

The uncertainties of behavior, technology, and institution and the specific transactions under each type of uncertainty are identified. These uncertainties lead to the information searching cost, coordination/negotiation cost, and approval cost, borne by developers, professionals and contractors. The behavioral uncertainty happens in the interactions of participants and would be reduced through developing common language and working pattern and know each party better. The technology uncertainty is due to the limitation of the current technology and could be reduced by developing advanced technology. In this sense, participants have little to do with this type of uncertainty. The institutional uncertainty happens in the interaction between private participants and government. The level of institutional uncertainty depends on the clarity and completeness of the incentive scheme. For example, there are a lot of uncertainties in the approval process (see Figure 9). Participants spend a lot of time to revise the documents due to the unclear and incomplete instructions of BEAM Plus or SBDGs. For developers, all the money is borrowed from the bank and developers have to pay the interests. They do not want the project to be delayed. Nowadays, developers usually do financing especially the large projects. Therefore, the less money and shorter period they borrow, they more profit they can earn. That means the money they save by shortening the development period and reducing construction costs is more than the profits they earn from the GFA concession. If they have a hard case to argue for the GFA concession, developers may go for traditional buildings. Figure 26 illustrates the process to apply for the GFA concession in detail. It is obvious that there are many uncertainties involved.

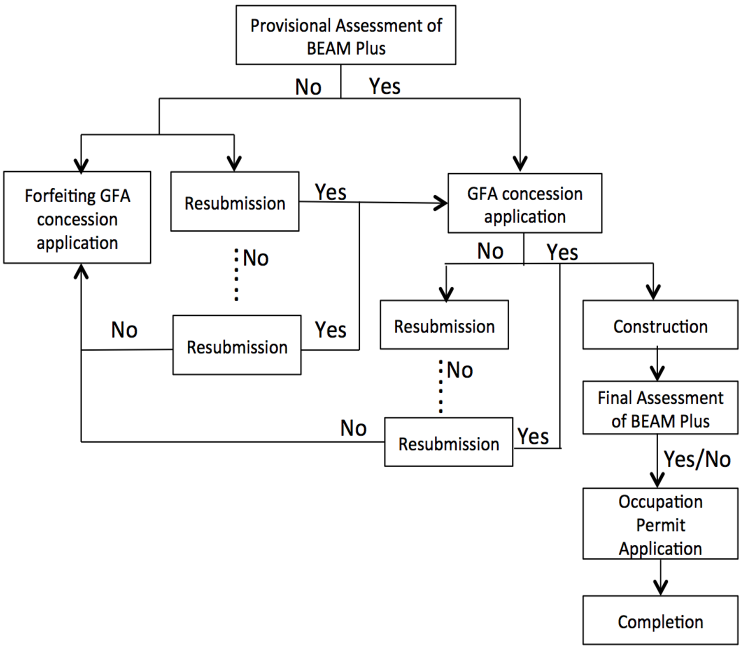


Figure 26 Uncertainties in the approval process (Source: constructed by author)

6.3.3 Frequency

As discussed before, frequency influences TCs by reducing the time spent on the collecting information and learning knowledge in the repeated transactions, but only the transferable experience, (information and knowledge gained in previous transactions) can reduce TCs. For example, the time spent on searching for green materials could be reduced evidently with frequent practice of the GFA Concession scheme, while the time on designing a scheme has less potential to be reduced due to the site and project specificity. Therefore, transferability should be employed to measure the potential of the GFA Concession scheme to reduce TCs. This could indicate that how efficient the GFA Concession scheme could be implemented when the market becomes mature.

6.3.4 Importance of each key transaction

This section measures the importance of each key transaction under different types of TCs and how much time each extra task demands the stakeholders in the GFA concession scheme application. Interviewees were grouped according to interviewees' roles in the real estate development process. For example, if an architect works in a consultancy firm, his/ her role is as a consultant to design buildings. If an architect works in a development firm, his/her role is as a developer (representative) to manage the construction process and apply for government approval. The interviewees were asked to provide information on how much time each additional task demands due to the application of GFA concession scheme. Each task was rated on a 5-point scale, ranging from no time "1" to a considerable amount of time "5". The interviewees were further asked to estimate the time in the percentage that each task consumed by the individual stakeholder.

Table 26 reveals the TCs borne by each stakeholder in details. It explains (1) how different types of TCs affect each stakeholder differently (the column of specific tasks under each TCs determinant); (2) which task(s) take(s) them more time comparing the others (the column of ranking); and (3) who spend more time on each specific tasks (the first three columns from the left).

The finding shows that, the commonly agreed top 3 tasks that consume most time to the stakeholders, are 1) Extra work to verify or revise the documents due to unclear and incomplete instructions of BEAM Plus or Sustainable Building Design Guidelines; 2) Extra coordination between participants to fulfill the contract; 3) On site monitoring and reporting the execution of the contract or instructions. These tasks are highly relevant to the negotiation cost, approval cost and monitoring cost. In particular, consultants spend much more time, therefore bear more TCs, on these three tasks than developers and contractors. The 3 tasks that cost stakeholders the least time, are 1) Carefully selecting partners who are capable of doing green projects; 2) Learning Sustainable Building Design Guidelines, BEAM Plus, and building features granted GFA concession; 3) Searching information to fulfill BEAM Plus and Sustainable Building Design Guidelines, which are closely related to the information searching cost and research/learning cost. The data also show that for most of the transactions, the consultants spend over 50% time, more than developers and contractors.

Table 26 Importance of each key transaction

Transaction cost	**Specific transactions under each determinant**	**Weighted Average**	Ranking	**Developers**	**Consultants**	**Contractors**
	Searching information to fulfill BEAM Plus and the Sustainable Building Design Guidelines	2.87	12	30%	50%	20%
I	Carefully selecting partners who are capable of doing green projects	2.47	14	80%	10%	10%
II	Learning the Sustainable Building Design Guidelines, BEAM Plus, and building features granted GFA concession	2.73	13	30%	60%	10%

	Developing contract documents, detailing the green specifications and elaborating contracting practice	2.93	11	20%	70%	10%
	Compliance with different design requirements for specific land use, site shape and location	3.2	9	20%	70%	10%
III	**Extra coordination between participants to fulfill the contract**	**3.67**	**2**	**20%**	**60%**	**20%**
	Communicating with clients/consultants about site plan and building layout	3.33	6	30%	70%	----
	More coordination between practitioners to avoid misinterpretation and get used to working pattern, such as coordination among architects, GB consultant, contractors and suppliers	3.47	4	30%	50%	20%
	Client's flexibility and ability to make decisions cause more negotiations, such as negotiating the amount of GFA concessions/designed green features, and the cost/time constrains	3.33	6	40%	50%	10%
IV	Revision of building plan required by BD or HKGBC if any	3.4	5	30%	70%	-----
	Extra work to verify or revise the documents due to unclear and incomplete instructions of BEAM Plus or Sustainable Building Design Guidelines	**3.8**	**1**	**30%**	**60%**	**10%**
V	**On site monitoring and reporting the execution of the contract or instructions**	**3.53**	**3**	**10%**	**40%**	**50%**
VI	Preparing or verifying documents for GFA concession approval and to demonstrate compliance with BEAM Plus	3.2	9	20%	70%	10%
	Extra testing of green equipment compliance with the BEAM Plus standards	3.27	8	20%	40%	40%

*Note: I: Information searching cost; II: Research/learning cost; III: Coordination/Negotiation cost; IV: Approval cost; V: Monitoring cost; VI: Verification cost4.2 Incomplete contract analysis

6.4 Incompleteness analysis of the GFA Concession Scheme

Table 27 shows the analysis results of the incomplete contract theory. It illustrates how the three dimensions of the incompleteness affect developers TCs and actual cost. The interviewees were encouraged to share their views beyond the framework of the incomplete contract theory presented in the Chapter 4.1.2, which is believed to be essential to capture any novel factors. The discussion also included the relevant background knowledge that is not shown in the website or publications, and the future perspective of GFA Concession scheme in their views. The comprehensive views of the interviewees in market practice of the GFA Concession scheme help to verify and complement the theoretical framework of this paper from practical perspectives.

Table 27 Interview results: Analysis of incompleteness based on the framework of Hart and Holmström (1986)

Three dimensions of incompleteness	Determinants of incompleteness in the GFA concession scheme	Effects	TC (hidden costs)	Actual cost
State of the world	• State of property market • The duration of the incentive scheme	Increased land price Affecting specific investment	Cost related to asset specificity Research/learning cost; Information searching cost	Increased land cost of all the developers no matter going for GFA concession or not
GB quality requirements	Qualitative Green building assessment method (BEAM Plus)	Different interpretations among stakeholders as well as GB assessors	Approval cost; Negotiation cost	More assessment cost of BEAM Plus; More consultancy fee
Actions participants need to take	Fulfilling the Sustainable Building Design Guidelines; Designing the prescribed building features	Different interpretations between stakeholders and Buildings Department; In undefined situations, the private sectors have to explore ways to design sustainable building and prove its sustainability.	Approval cost; Negotiation cost; Research/learning cost; Information searching cost	Cost of Project delay if any

6.4.1 States of the property market

Regarding the GFA Concession scheme, land cost, construction cost, and selling price of green building are the major cost-benefit components, and change with the states of the property market. Developers have to carefully assess the anticipated amounts of GFA concession, selling price of property and land affordability. In Hong Kong where land is owned by government, the land price is determined by the land auction. Against this background, developers who are capable of obtaining any GFA concession would like to pay more for the land, which increases the land cost of all the developers participating in the land auction, no matter going for GFA concession or not.

On the contrary, Singapore, implementing a similar incentive scheme but more comprehensive than Hong Kong, specifies the formula of calculating GFA concession and land value, and prescribes the construction cost of each rating of green building. The formula is:

*GM GFA = [Proposed GFA (sqm) (subject to Master Plan allowable intensity)] * [Prescribed Green Premium ($/sqm)]/Land Value ($/sqm)*

Also, the prescribed construction cost would be updated regularly. In this way, all the market information is transparent and certain, which controls land price and reduces investment risks and TCs (e.g. information searching cost, research cost). Therefore, there is no increased land cost and the corresponding transitional gains trap due to transparent information.

6.4.2 Duration of the incentive scheme

The effective period of the incentive scheme has not been specified by Hong Kong government, which itself causes uncertainties for investment by the private sectors. On the contrary, Singapore has specified the timing of review of the incentive scheme, thus reducing investors' risks. If the incentive scheme is suddenly terminated, developers in Hong Kong who bought the land at a higher price would suffer a large amount of financial loss in that they cannot obtain any GFA concession but have paid for higher-cost land. Also, the transaction costs associated with asset specificity would be sunk costs. To inform stakeholders in the private sector on the timing of review would help reduce their investment risks.

6.4.3 Green building assessment methods (BEAM Plus)

BEAM Plus is to assess the rating of green buildings, which illustrates the credits that need to be achieved. However, there are no detailed instructions to explain how to achieve the credits and the assessment method is over-qualitative, which leads to the different interpretations among participants. Hence, participants have to negotiate and communicate more to achieve agreement. Also, they have to do resubmissions several times for approval and pay more assessment costs. Interviewees mentioned that to better understand the BEAM Plus, they even pay assessors extra fees to ask for a report explaining the assessment results. From the perspective of IC theory, assessors representing GB authority naturally have a residual right of control in the renegotiations when undefined situations happen. However, the difficult problem is that not every assessor understands the BEAM Plus in the same way. Thus, they probably give different interpretations to the same situation.

6.4.4 Completeness of the Sustainable Building Design Guidelines

(1) Specification of building types

The design of SBDGs is more suitable for the residential building, neglecting the characteristics of commercial buildings. For example, the SBDGs require that building should be separated if its length is more than 60m. However, if the building is commercial, such as hotels and large shopping malls, building separation would increase the supply of corresponding infrastructure and facilities, and the operation costs of building owners would increase as well. Interviewees claimed that the SBDGs were designed particularly for residential buildings. There are no appropriate guidelines for designing sustainable commercial buildings.

One case mentioned by interviewees was that the architect spent 10 months to negotiate with the Buildings Department on the design details of a hotel because there were no clear guidelines on the commercial buildings. Furthermore, the SBDGs does not provide principles for dealing with special cases. No government officers in Buildings Department are able to make rules on this kind of issues. Different officers may offer different suggestions to applicants. This arouses more troubles for developers.

(2) Specification of site conditions

The SBDGs requires building setback, building separation and site coverage of greenery that are closely affected by site conditions. If the site is in the urban core, like the Causeway Bay or the Central, and adjacent to a narrow street, buildings have to set back from the centerline of the narrow street. Thus, the buildings set back would make developers lose ground floor areas that mean a lot of value in commercial areas. Only 10% of the GFA is not enough to compensate for the lost economic value. Besides, if the building and the lot itself are very small, and the design goes for setback, it cannot accommodate any M&E (mechanical and engineering) equipment. In this sense, going for GFA concession is not worthwhile.

The critical point is that before doing research, developers do not know if any particular site is appropriate to go for GFA concession, or they may even ignore this issue. They have to devote a lot of resources to derive its value. The method to reduce losses is to make the scheme more complete.

6.5 Stakeholders' transitional gains and trap caused by the GFA Concession Scheme

6.5.1 Transitional period and mature period

As mentioned, the GFA Concession scheme leads to the increase of land value. This means that the participants of the incentive scheme obtain normal profits in the end, such that the benefits of GFA concession are covered by the increased land costs. This finding is consistent with the theory of transitional gains trap. Transitional gains come from the GFA concession during the transitional period. When all the participating developers realize the incentive scheme well, they will all bid a new piece of land in auction by taking the incentive gains into account, the gains have been capitalized into the land value and thus late entrants can only make normal profits. In this situation, the market tends to be mature.

6.5.2 Termination or reduction of the incentives

Furthermore, to decrease the level of GFA concession or terminate the scheme would reduce the land value. Thus, developers who bought the land under the GFA Concession Scheme at a cap of 10% may suffer loss. This is how developers are entrapped.

Interviewees stated that if there is no GFA concession, the land price would decrease accordingly. The reason that government has not removed or reduced the GFA concession is due to the pressure from developers. Developers who bought land with GFA concession would lose a lot of money. As long as at the time of land bidding, government stated the construction conditions in advance, developers would not lose money. However, if the private sectors transact lands, changing GFA concession would largely influence developers' profits. Government is not responsible for considering private transactions. In this situation, government could learn from the USA implementing the "grandfather policy", which means that if the land was bought under the GFA Concession Scheme, it could enjoy the incentive even if the scheme is changed.

In short, transitional gains and trap could be generalized to any GB incentives bringing developers financial benefits. This is because the benefits of the GB incentives would be eventually reflected in the land value. In Hong Kong where land is owned by government, it is the government that gains in the end. Government does not have to financially pay for the green building promotion but gains from the land bidding.

Chapter 7 Discussion and conclusion

7.1 Justification of GFA concession scheme

The GFA concession scheme indeed improves GB market penetration (Figure 7), even if it causes a lot of transaction costs. The urgent and necessary issue of Hong Kong is to improve air ventilation around buildings, where the SBDGs contribute very well. The CFD model demonstrates that the environmental benefits (borne by general public) of SBDGs could justify the cost of losing floor area. Therefore, GFA concession is needed to facilitate the private sector to apply SBDGs. Besides, research results show that green buildings have no price premium in property market. If the market is not willing to pay for green design or green features, developers will not have to provide these design/features. Therefore, government policy is needed to provide incentive to kick start the market and educate the consumers. When the market is mature enough, it is time to consider removing the incentive or making use of the incentive to push for higher performance requirements.

7.2 Scenarios to improve the existing scheme

In accordance with the theoretical analysis and data of the hypothetical case on costs and benefits, this study proposes three scenarios to improve the existing GFA concession scheme. The pros and cons of the three scenarios are illustrated as follows.

(1) Scenario 1: reducing GFA concession

The reduction in GFA concession does not affect any cost and benefit, as shown in Figures 24 and 25. However, the reduction in GFA concession decreases land price. Interviewees mentioned that, after implementing the GFA concession scheme, land price increases because the profits of GFA concession are capitalized into land cost. The increase in land price indicates that the benefits from GFA concession are more than the offsetting costs of constructing GB. Therefore, the reduction in GFA concession may exert no effect on the GB promotion and only change land value (Figure 27). However, developers who bought land under the GFA concession scheme at a cap of 10% may suffer loss, thereby trapping the landowners. In this situation, the landowners should enjoy the grandfather policy commonly used in the USA in which they can continue to apply for GFA concession at a cap of 10% to protect their interests. The decrease in GFA concession leads to less land value. This situation is true to countries wherein the government owns the land.

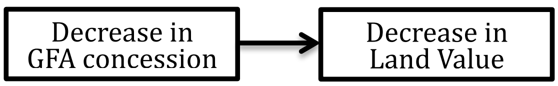


Figure 27 Impact of less GFA concession

The original intention of granting GFA concession is to compensate the incremental cost of constructing green projects for developers. If the profit of

GFA concession is equal to incremental costs, then the direct impact of the reduction in GFA concession is that developers will have less salable area and less potential revenue. Specifically, platinum projects will be few but unclassified and bronze projects will increase. The reason is that construction cost concerns developers most among all the extra costs (Figure 22), and platinum projects are more costly than unclassified and bronze projects (Chapter 5.1.2). With the decrease in GFA concession, a large number of developers may construct low level of GBs to save construction costs.

In summary, the GFA concession in Hong Kong is too much but is not quantified. This scenario is feasible to promote GB but cannot obtain the exact figure of GFA concession.

(2) Scenario 2: improving the threshold for obtaining GFA concession

Given that the government owns the land, the GFA concession scheme can promote high level of GBs. The impacts of improving the level of GB are summarized in Figure 28. If platinum certification becomes the prerequisite to be granted GFA concession of up to 10%, then construction cost will increase. Therefore, land cost will decrease because more benefits of 10% GFA concession goes to construction cost. Accordingly, the number of platinum projects will increase because developers who previously constructed Unclassified or Bronze buildings would construct Platinum buildings. Meanwhile, the consultancy fee and TCs (hidden costs) will increase (see Chapter 5.1.2). In other words, professionals must absorb much TC without extra payment.

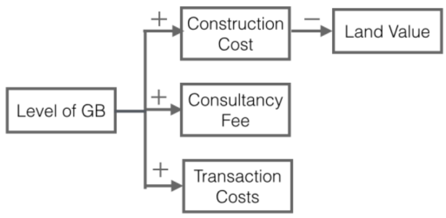


Figure 28 Major impacts of improving level of GB on stakeholders (Note: “+” refers to positive relationship; “-“ refers to negative relationship)

(3) Scenario 3: differentiating GFA concession

GFA concession can be differentiated in accordance with the level of GB because costs of high level of GB are high. Similar to Scenario 1, this scenario will not affect any cost and benefit in the CBA framework. However, the best GFA concession will be visible because this scenario can result in a dynamic land market. For example, a developer proposes a platinum project with a land price. Another developer proposes a bronze project with another land price. Each of the developers has different costs and benefits and can afford different land costs. As a result, the government will provide many different offers on price for the same land. Therefore, the land market is probably less confusing. With regard to extra costs (Chapter 5.1.2), the construction costs of bronze and silver projects are close. This case is also true for gold and platinum projects. Differentiating GFA concession leads to the increase in silver and platinum projects (Figure 29).

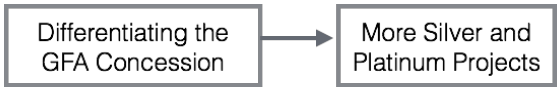


Figure 29 Impact of differentiating the GFA concession

7.3 Incentive design and the transaction costs

(1) Transferable knowledge and experience

Frequency influences the transferable experience (information and knowledge gained in previous transactions) by reducing the time spent on collecting information and learning knowledge from the repeated transactions, therefore reduces TCs. For example, the time spent on searching for green materials could be reduced evidently with frequent practice of GFA Concession scheme; on the contrast, the time on the design scheme has less potential to reduce TCs due to the site and project specificity. Therefore, transferability can be employed to measure the potential of reducing TCs of the GFA Concession scheme. This indicates the efficiency of GFA Concession scheme implementation when the market becomes mature.

The empirical findings show that the learning/research cost and information searching cost concern stakeholders less than other TCs. The accumulated knowledge and experience from the previous projects are applicable to the new projects. The more frequent one participate in GFA Concession scheme, the more familiar one gets the relevant knowledge and information. Interviewees mentioned that after 5 years of implementing the GFA Concession incentive, the industry knows the green building requirements and application information much better.

(2) Distribution of costs and benefits

Policy design often ignores TCs incurred in the implementation process. Table 26 in the Chapter 6.3.4 clearly illustrates the TCs distribution to each group of stakeholders. All the stakeholders bear certain extra TCs. Given that the GFA concession incentive scheme is designed to reward developers only, the incentive scheme seems not fair to other stakeholders, especially consultant, who absorb more TCs than developers or contractors (Table 26). A good example in this regard is, the GFA incentive scheme in Singapore, which particularly set aside funding to reward consultants for their contribution on green building design and construction (Building and Construction Authority, 2005).

(3) Negotiation and approval costs in the approval process

(a) The approval process of the BEAM Plus and GFA concession

After the submission of BEAM Plus application, the Hong Kong Green Building Council (HKGBC) will review the documents and provide feedbacks. In case the architects do not accept the decision from HKGBC, they will negotiate with HKGBC for several times to finally reach an agreement and resubmit the application. This process arise lots of uncertainty and induce transaction costs.

Interviewees mentioned that some developers hesitate to go for GFA concession because the approval process would take them too much time and lead to the project delay. They prefer to construct traditional building to save construction cost and time (extra financing cost) as illustrated in by Figure 30.

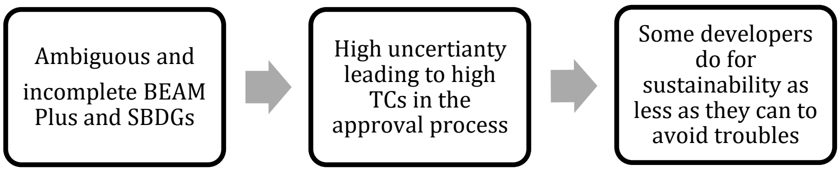


Figure 30 How the guidelines induce TCs and affect stakeholders' decision-making

(b) Qualitative assessment nature of BEAM Plus

All the interviewees agreed that the assessment nature of the BEAM Plus is rather qualitative and the assessment results mainly depend on the individual assessors' preference which causes a lot of uncertainty in negotiation and approval time. Ng, S. T. et al. (2013) stated that BEAM Plus (HK) is the most qualitative one among the popular GB assessment systems, including LEED (the US), Green Mark (Singapore), Green Star (Australia), and BREEAM (the UK). Interviewees who have conducted BEAM Plus projects and LEED projects claimed that LEED is more standardized and much clearer in guidance than BEAM Plus. It is possible to follow the instruction of LEED and finish the project alone; however for BEAM Plus, they need to hire the consultants to acquire more information and do the communication work.

(4) Sustainable Building Design Guidelines

(a) Specified contract

There are many uncertainties in the approval process due to incompleteness of the GFA concession scheme, particularly due to the ambiguity of BEAM Plus and lack of specifications in SBDGs. In Table 26, the extra work to verify or revise the application due to the unclear and incomplete instructions of BEAM Plus or Sustainable Building Design Guidelines is what concerns the stakeholders most.

(b) Detailed descriptions in the SBDGs

Too many described building features allow the floor area to be exempted, which causes the measurement of floor area sensitive and rather a work of art. The applicants, i.e. Developers, of GFA concession usually have to negotiate with the Buildings Department to strive for more GFA concession, because even a little measurement difference would result in the loss of large amount of profits in building project due to high property price.

(c) Baseline model in the SBDGs

For the commercial building, such as shopping mall and hotel, it is unreasonable to separate building to meet the Guidelines if the building length exceeds 60m. In such a situation, if developers would like to apply for the GFA concession, architects have to do much more modeling and prepare for extra documents to prove the environmental benefits in order to convince the Buildings Department for approval.

7. 4 Incentive design and the incomplete contract theory

(1) Changing property market

For GB incentives that aim to compensate developers for extra cost of constructing GBs, the critical issue is to determine the optimal level of incentives. Too small incentives would make it difficult to achieve desired results, while too large incentives would lead to the waste of social resources. In this sense, the level of incentives should consider market-based costs and benefits of GB.

Costs of construction and land largely affect developers' profits, and change with the states of the property market. In Hong Kong, the benefit of GFA concession seems more than the extra construction cost of GB, because it leads to the increase of land value (see Chapter 5.4 and Chapter 6.5.1). On the contrast, in Singapore, the level of GFA concession entails both construction cost of GB and land cost that are updated regularly according to property market. This approach seems more scientific.

Another critical issue is the price premium of GBs. Given that the GB incentives aim at compensating developers for extra costs of developing GB, the level of GB incentive should be decreased accordingly when GBs can enjoy price premium in the property market. In short, market-based costs and benefits are critical to the optimal level of incentives.

(2) Long-term or short-term incentives

In Hong Kong, there is no specified effective period of the GFA Concession Scheme. Sudden termination or reduction of the GFA concession would lead to financial losses of developers who bought a land under the GFA Concession Scheme at a cap of 10%. On the other hand, the GFA Concession Scheme itself has deficiencies and needs to be revised. Long-term incentive is not good for renegotiations to adjust the unsuitable items. Therefore, this paper suggests implementing the long-term GFA Concession Scheme with regular reviews. Furthermore, the timing of the regular reviews should be well informed to the private sector for reducing their investment risks.

(3) Incompleteness of the GFA Concession Scheme

(a) Describing GB quality in a precise and unambiguous way

Similar to what discussed in the Chapter 7.2, the BEAM Plus was criticized by the interviewees for its ambiguity. In the undefined situations, participants have to renegotiate with government and resubmit the application. Government representing social welfare naturally has the residual right of control in the renegotiations. However, officers often have no consistent understanding of the BEAM Plus and SBDGs, which gives rise to inequitable application results. Therefore, GB quality should be described as precisely as possible to reduce undefined situations. Similar situation also happens in the implementation process of agri-environmental contracts.

(b) Designing the complete Sustainable Building Design Guidelines

Hong Kong has tied the GB incentive to SBDGs to better improve the built environment. In this situation, government incentives are intended as the forces for participants to meet the specified requirements (Olubunmi et al., 2016). If these requirements were not well designed, it would diminish the effect of GB incentives. The problem Hong Kong has encountered is the incomplete SBDGs, which causes transaction costs for participants and might lead to project delay. For example, the design of SBDGs is more suitable for the residential building, neglecting the characteristics of commercial buildings. The parameters of building setback and separation are not suitable for commercial buildings, such as hotel and shopping mall. Architects have to do a lot of extra simulations and negotiate with the Buildings Department. Future review of the GFA Concession Scheme should improve the completeness of the SBDGs.

7. 5 Incentive design and the transitional gains traps

The theory of transitional gains trap indicates policy-makers how to design the optimal level of economic incentive and how to terminate or reduce incentive. In the countries and regions where land is owned by government, the land value is a critical indicator for the level of incentive. If the incentive level is too much, the extra benefits from incentive would go to land cost. However, if the incentive level is not enough, few stakeholders would participate in the scheme. Cost-benefit analysis is necessary to make policy-makers better understand the impacts on stakeholders when they would like to revise the incentive scheme.

Chapter 8 Conclusion

8.1 Summery of findings and recommendations

Few studies have focused on the effectiveness and efficiency of the economic incentives of GBs. This study aims to analyze the costs and benefits of different stakeholders of GB economic incentives to fully understand their mechanisms and improve the design of economic incentives. First, economic incentives and their costs and benefits are reviewed, particularly the GFA concession scheme implemented in Hong Kong. Second, a CBA framework and the associated theoretical basis are developed to explain the effectiveness of the GFA concession scheme. With the established framework and theoretical basis, this study evaluates the extent to which policy makers consider the costs and benefits of stakeholders. The costs and benefits associated with the mechanism of the GFA concession scheme are also measured. Finally, suggestions for effectively designing economic incentives, particularly the GFA concession scheme, are proposed.

Expert interview, AHP, and CFD simulation are used to collect and analyze data. Then, focus group forum is conducted to validate the data analysis results. The key research findings are as follows. Construction cost is the major concern for the private sectors and actual costs are more important than hidden costs according to CBA. GB incentives should continue to focus on reducing the cost pressure of stakeholders. Among actual benefits, energy saving and the enhanced value of GB are highly valued by participants of the GFA concession scheme. In terms of hidden benefits, environmental benefits from the SBDGs show that building separations and setbacks are effective in removing pollutants and reducing the health risks of pedestrians. The rate of environmental benefit gains varies with building configurations. Building setbacks can provide monetary benefit gains twice as much as building separations. The benefits of the SBDGs justify costs and should be kept.

Second, transaction cost is a significant cost component that affects efficiency of the incentive scheme and cannot be ignored. The professionals bear a lot of transaction cost but get no benefit from the incentive scheme. The findings of TC analysis indicate that: 1) additional knowledge, information and practical experience transferable across projects may help reduce information searching cost and research/learning cost; 2) Policy design needs to take TCs into consideration to fairly distribute benefits and allocate the costs amongst the involved stakeholders. The unfair allocation of the costs and benefits may cause the consequence of reluctance amongst the stakeholders due to the ones who absorb too much hidden TCs, but most the benefits may go to one particular stakeholder. 3) Policy-makers can reduce uncertainties of project approval by making the assessment criteria more specified, easy to comply and/or complete with quantifiable criteria so as to reduce approval cost and negotiation cost. Some standard modeling/assessment methods or practice can be shared with the building industry. (4) Policy design needs to balance with flexibility between leaving space for innovation and setting clear criteria measurable for building design appraisal.

Third, the incentive scheme is made by government and could be regarded as the contract between government and stakeholders in the private sector. The results also highlight the significant impacts of incompleteness of GB incentives on stakeholders and prove that government did not fully consider stakeholders' costs and benefits when it designed the contract. The findings include: 1) incompleteness of the incentive scheme apparently affects transaction costs and actual costs of stakeholders; If the GB incentive is too incomplete, stakeholders would hesitate to participate in the policy due to too many or too great uncertainties; 2) the residual rights of control belonging to government make developers minimize ex ante investment, which leads to the efficiency loss and affects GB promotion; 3) a short-term incentive scheme is good for renegotiations at the time of scheme ending but discourages specific investment. It is suggested implementing long-term incentive scheme with regular reviews and informing stakeholders on the review time, to reduce their investment risks.

Regarding the current incentive level, 10% GFA concession is too much for GB promotion, which leads to the increase of land value. Developers would only suffer loss at the time of scheme termination or reduction of incentive level. This supports the theory of the transitional gains trap. It is government that gains from the incentives in the end and does not have to financially pay for green building promotion. It solves the problem that government lacks the consistent level of funding to incentivize private sector the private sector. Therefore, the GFA Concession Scheme is helpful to release government financial pressure, especially when government has limited resources for promotion and has encountered the priority of economic development.

8.2 Contribution

8.2.1 Theoretical contribution

This study fills the knowledge gap on costs and benefits in implementing economic incentives of GBs. The traditional CBA framework is expanded by considering hidden costs (TCs) and hidden benefits. TC theory is used to explain how the TCs are incurred in the process of implementing the incentive scheme. Unlike previous studies on TC analysis of environmental policy, this works not only identifies the types of TCs and their determinants but also analyzes the specific transactions under each determinant and measures the cost of different stakeholders. This study also contributes to the knowledge of administrative process and approval process of policy design and explains how TCs are induced in the process and assigned to different stakeholders. Accordingly, a full picture of the policy implementation is provided.

A new perspective, that is, incomplete contract, is provided for designing government incentives. The concept is an effective instrument for evaluating the incentive scheme and provides policy makers with a new thinking on incentive design. This theory can be applied to any other incentive scheme of GB. The theory of transitional gain trap is supported, which can be generalized to any economic incentive implemented in countries and regions where land is owned by the government and is usually ignored by policy makers.

Three analytical frameworks, namely, TC theory, incomplete contract theory, and transitional gain trap, are used to determine the changes in the identified costs and benefits with the mechanism of economic incentives. In this way, policy makers can improve economic incentives and predict the corresponding impacts on stakeholders in the private sector. This study not only fills the knowledge gap on the effectiveness and efficiency of economic incentives of GB but also contributes to the analytical techniques of policy evaluation.

8.2.2 Practical contribution

This study also has practical contribution to industry. In general, stakeholders only see their own interests. This study paints a whole picture of costs and benefits allocation and proposes to fairly allocate costs and benefits among stakeholders. Through analyzing the effectiveness and efficiency of the GFA Concession Scheme on the basis of transaction cost theory, incomplete contract theory and the theory of transitional gains trap, this study provides recommendations for the incentive design for policy makers. Additionally, three scenarios to improve the existing GFA Concession Scheme were proposed, and the corresponding pros and cons were discussed on the basis of research findings.

8.3 Limitations and future studies

This research ignores financing issues because of limited resources. For example, whether obtaining GFA concession in the building plan approval process can significantly affect the financing cost of developers is not discussed. Further study can address this problem. Meanwhile, the CFD simulation in this study focuses more on evaluating the health benefits of improved air quality than on the development costs related to the other parameters. This part of technical study is considered exploratory in nature, which provides indicative trends after running a set of parametric studies on individual parameters. With the identified indicative trends, in-depth technical study can be conducted accordingly. The scheme can also be adjusted. Three scenario recommendations are provided but they needs more in-depth study from the industry perspective.

Appendix I

Interview questions

Actual costs:

- What's extra construction cost to get BEAM Plus certification? $/sqm. Or %
- Has the extra cost ever changed? If changed, what's the possible reason?
- What's the consultancy fee to get each rating of BEAM Plus? (In percentage)
- Has the consultancy fee changed because professionals are more familiar with BEAM Plus or there are more and more BEAM consultants?
- Is employing BEAM Professionals mandatory to do BEAM Plus projects? Is it difficult to employ BEAM Pro.?
- Is the land price higher under this scheme? Why?

Hidden cost:

- If you want to participate the GFA incentive scheme, who do you have to employ specially? Is it difficult to employ this kind of person? (e.g. difficult to identify qualified person, pay more consultancy fee)
- If BEAM PLUS application is rejected or needs resubmitted, how much it would cost you to negotiate and re-submission or even appeal (considering time, energy, and money)? (In percentage)
- What's the probability that SBDG rejected? What are the possible

reasons? How much extra work you have to do? Is it the major barriers to GB?

- What are the difficulties to do GFA concession projects compared with the non-GFA concession ones, such as more complex design scheme, or more negotiation/communication with clients, higher risk of disapproval of building plan?

Actual benefits:

- How much is market price of BEAM Plus building higher than that of traditional building? (In percentage)
- What's the price difference of each rating of BEAM Plus? (Bonze, Silver, Gold, and Platinum)? (In percentage)
- If the granted GFA concession depends on the rating of BEAM Plus, what percentage of GFA concession should be granted for each rating (Bonze, Silver, Gold, and Platinum)
- Do you agree that certifying BEAM Plus help reduce energy and water consumption?
- Please give some comments on the GFA concession scheme. How it influences developers costs and benefits?

Hidden benefits:

- How many job opportunities BEAM Plus created? What percentage of total workers are new recruits due to BEAM Plus in your firm?

Would constructing green building bring developers good reputation and increase developers or other participates' competitiveness?

Questionnaire survey

1 AHP measurement

Instructions:

This research aims to gather professionals' opinions about the importance and concerns of the costs and benefits of implementing GFA concession incentive. By pairwise comparison, we would like to identify the proportion of each cost and benefit.

Example:

1	3	5	7	9	2,4,6,8
Equal importance	Weak importance of one element over another	Essential importance of one element over another	Very strong importance of one element over another	Absolute importance of one element over another	Intermediate values between two adjacent degrees of importance

The Scale of relative importance:

Benefit measurement

To measure the importance of benefit items by making pairwise comparison

(1). If you think ITEM 1 in Column A is 9 times more important than ITEM 2 in Column B, then please tick as follow (This means: Compared with water saving, Enhanced value of green building of Green Building has absolute importance):

A	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	B
1. Enhanced value of green building (green image)	✓																	2. Water Saving
																		3. Energy Saving

Cost measurement

To identify which cost item concerns participants more and how much more

(2). If you think ITEM 1 in column A concerns you 9 times more than ITEM 2 in Column B, then please tick as follow:

A	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	B
1 Consultancy fee	✓																	2. Construction cost
																		3. Certification and assessment cost

1.1 Benefits

(1). **Actual Benefit**

How much more important is each item in column A than each item in column B?

A	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	B
1. Enhanced value of green building																		2. Energy Saving
																		3. Water Saving
2. Energy Saving																		3. Water Saving

Note: Enhanced value of green building means the green building can enjoy higher market price than traditional building. Competitiveness of private sector means the increased business competitiveness of private sector if they construct green building

(2). **Hidden Benefit**

How much more important is each item in column A than each item in column B?

A	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	B
1. Reputation/ Branding																		2. Competitiveness
																		3. Job Opportunities
																		4. Health/Productivity/Comfort
																		5. Environmental benefits
2. Competitiveness																		3. Job Opportunities
																		4. Health/Productivity
																		5. Environmental benefits
3. Job Opportunities																		4. Health/Productivity
																		5. Environmental benefits
4. Health/Productivity																		5. Environmental benefits

(3). Overall comparison of actual benefit and hidden benefit

Comparing actual benefit and hidden benefit in total, which one is more important and how much more

Actual Benefit in total	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	**Hidden Benefit in total**
1. Enhanced Value of Green Building 2. GFA Concession 3. Energy Saving 4. Water Saving																		1. Reputation/Branding 2. Competitiveness 3. Job Opportunities 4. Health/Productivity 5. Environmental benefits

1.2 Costs

(4). Actual Cost

Comparing the items in column A and B, which one concerns you more and how much more?

A	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	**B**
1. Consultancy Fee																		2. Construction Costs
																		3. Certification and Assessment Cost
2. Construction Costs																		3. Certification and Assessment Cost

Note: Consultancy fee refers to the extra consultancy fee in total, including building design, building service, environmental protection etc.
Construction cost: extra construction cost compared with traditional building
Certification and assessment cost: the cost to do green building assessment and the cost to ask assessors to give report on the assessment results.

(5) **Comparison of Hidden Cost**

Comparing the items in column A and B, which one concerns you more and how much more?

A	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	**B**
1.Information Searching Cost																		2. Research/Learning Cost
																		3. Negotiation/Coordination Cost
																		4. Approval Cost
																		5. Monitoring Cost
																		6. Verification Cost
2. Research/Learning Cost																		3. Negotiation/Coordination Cost
																		4. Approval Cost
																		5. Monitoring Cost
																		6. Verification Cost
3. Negotiation/Coordination Cost																		4. Approval Cost
																		5. Monitoring Cost
																		6. Verification Cost
4. Approval Cost																		5. Monitoring Cost
																		6. Verification Cost
5. Monitoring Cost																		6. Verification Cost

Note: Research/learning cost: the extra time and efforts participants spend on learning and doing research on green building
Negotiation/coordination cost: the extra time and efforts spent on negotiation and coordination among participants, such as developer, architects, engineers, contractors, BEAM Pro, BEAM Society, and Building Department.
Approval cost: the extra time and efforts spent on the getting approval from BEAM Society and Building Department, such as

preparing documents and do submission.
Monitoring cost: the extra time and efforts spent on the site monitoring
Verification cost: the extra time and efforts spent on the document verification

(6). **Comparison of Actual Cost and Hidden Cost**

Comparing the total actual cost and total hidden cost, which one concerns you more and how much more?

Actual Cost in total	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1	2	3	4	5	6	7	8	9	**Hidden Cost in total**
1. Consultancy Fee 2. Construction Costs 3. Certification and Assessment Costs																		1. Information Searching Cost 2. Research Cost 3.Negotiation/Coordination Cost 4.Approval Cost 5. Monitoring Cost 6.Verification Cost

2 Transaction cost measurement

How much each transaction concerns you in terms of time?

Transaction cost	Transactions	1 Much less	2 Somewhat Less	3 Fine as is	4 Somewhat more	5 Much more
Research/learning cost	Learning Sustainable Building Design Guidelines (SBDGs), BEAM Plus, and building features granted GFA concession					
	Developing contract documents detailing the green specifications and elaborate contracting practice					
	Compliance with different design requirements for specific land use, site shape and location					
Information searching cost	Searching information to fulfill BEAM Plus and SBDGs					
	Carefully selecting partners who are capable of doing green projects, e.g. architects, BEAM consultants, contractors.					
Negotiation/Coordination cost	• More negotiation to clarify the responsibility of architects, contractor and GB consultants, etc. • More coordination between participants to fulfill the contract					
	Communicating with clients about site plan and building layout					
	More coordination between practitioners to avoid misinterpretation and get used to working pattern, such as coordination among architects, GB consultant, contractors and suppliers					
	Client's flexibility and ability to make decision cause more negotiations, such as negotiating the amount of GFA concessions/designed green features, and the cost/time constrains					
	More coordination/negotiation between participants to clarify the requirements/standards of BEAM Plus and APP 151 and 152					
Approval cost	Revision of building plan required by BD or BEAM Society if any					
	Extra work to verify or revise the documents due to unclear and incomplete instructions of BEAM Plus or Sustainable Building Design Guidelines					
Monitoring	On site monitoring and reporting the execution of the contract or instructions					

cost						
Verification cost	Preparing and verifying documents for GFA concession approval and to demonstrate compliance with BEAM Plus					
	More testing of green equipment compliance with the BEAM Plus standards					

- When you construct green building, how much <u>extra</u> time and efforts you will spend comparing with constructing traditional building? (In percentage)
  - Classified ________
  - Bronze ________
  - Silver ________
  - Gold ________
  - Platinum ________

- The following items are the breakdown of extra work to construct green building. In general, how much time and efforts each extra work costs you? (In percentage; adding up all of them, the result should be 100%)
  - Searching information ________
  - Doing research/learning ________
  - Negotiating or coordinating with other participants, e.g. architects, clients, contractors, engineers, and beam pros. ________
  - Doing submission, resubmission and revision to get approval from BEAM Society and Building Department ________
  - Site monitoring and other monitoring work ________
  - Verifying documents or the performance of green equipment ________

- If each specific transaction takes all the stakeholders 1 unit time, how much time it takes each stakeholder? (In percentage)

Transaction cost	Specific transactions under each determinant	Developers	Consultants	Constractors
Information searching cost	Searching information to fulfill BEAM Plus and the Sustainable Building Design Guidelines			
	Carefully selecting partners who are capable of doing green projects			
Research/learning cost	Learning the Sustainable Building Design Guidelines, BEAM Plus, and building features granted GFA concession			
	Developing contract documents, detailing the green specifications and elaborating contracting practice			
	Compliance with different design requirements for specific land use, site shape and location			
Negotiation/ coordination cost	**Extra coordination between participants to fulfill the contract**			
	Communicating with clients/consultants about site plan and building layout			
	More coordination between practitioners to avoid misinterpretation and get used to working pattern, such as coordination among architects, GB consultant, contractors and suppliers			
	Client's flexibility and ability to make decisions cause more negotiations, such as negotiating the amount of GFA concessions/designed green features, and the cost/time constrains			
Approval cost	Revision of building plan required by BD or HKGBC if any			
	Extra work to verify or revise the documents due to unclear and incomplete instructions of BEAM Plus or Sustainable Building Design Guidelines			
Monitoring cost	**On site monitoring and reporting the execution of the contract or instructions**			
Verification cost	Preparing or verifying documents for GFA concession approval and to demonstrate compliance with BEAM Plus			
	Extra testing of green equipment compliance with the BEAM Plus standards			

3 Extra costs and benefits of constructing green building

Assumption:

There is a high-rise and average standard residential building with only one tower (Figure B21). How much extra costs and benefits you have to pay for constructing green building comparing with constructing traditional building?

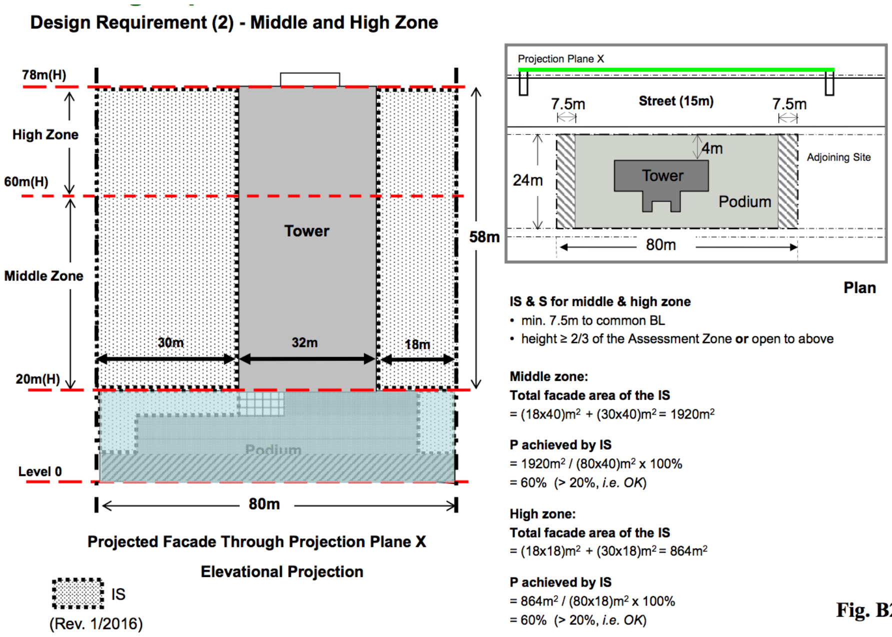


Fig. B21

Extra costs

- **Extra** construction cost (In percentage)
  - Classified ________
  - Bronze _________
  - Silver _________
  - Gold _______
  - Platinum _________
- **Extra** consultant's fee __________HK$/M^2 **or** _______ % of total construction cost (including extra construction cost)
  - Classified ________
  - Bronze _________

- Silver ________
- Gold ______
- Platinum ________

Extra benefits

- Energy savings (In percentage)
  - Classified _______
  - Bronze ________
  - Silver ________
  - Gold ______
  - Platinum ________
- Water savings (In percentage)
  - Classified _______
  - Bronze ________
  - Silver ________
  - Gold ______
  - Platinum ________

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