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RESEARCH PAPER

Regulatory incentives for green buildings: gross floor area concessions

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Incentive schemes formed by regulatory or administrative instruments are measures to promote green building (GB) and increase the motivation of developers to meet higher standards. The hidden costs to different stakeholders during the GB transaction are often ignored. Understanding these hidden transaction costs (TCs) helps appraise the costs and benefits of GB and policy effectiveness. The example of a gross floor area (GFA) concession scheme is used systematically to explore and understand the fundamental issues of TCs' typology and chronology in the GB development process. The GFA concession scheme is a popular incentive due to its indirect compensation to developers by allowing additional floor area without expenditure by government to implement GBs. A TCs' framework is used critically to review and evaluate the costs and benefits of the GFA concession scheme. Its particular implementation in both Hong Kong and Singapore is explored. Hong Kong is used as a case study, complemented with in-depth expert interviews on GFA concession in Hong Kong. The key contribution is to establish the parameters for estimating the optimum GFA bonus that could both motivate various stakeholders and minimize the negative impacts on the built environment in future.

Keywords: concession scheme, density bonus, economic instruments, governance, green building, gross floor area, incentives, regulatory systems, transaction costs

Introduction

Buildings account for over 40% of global energy consumption and one-third of greenhouse gas (GHG) emissions (UNEP, 2007). In 1950, 30% of the world's population resided in urban areas. By 2014, this rose to 54%; and it is projected to be 66% by 2050 (UNDESA, 2014). Taking China as an example, with rapid urbanization, building energy consumption has steadily increased due to increased affluence in living (Cai, Wu, Zhong, & Ren, 2009; World Bank, 2005). Worldwide, the way the new buildings are conceived and built will be decisive for influencing the level and pattern of energy consumption, therefore they will affect the climate and natural environment.

Green building (GB) is the practice of creating and using more resource-efficient models of construction, renovation, operation, maintenance and demolition. GB brings together a vast array of practices and techniques to reduce the impacts of buildings on energy consumption, environment and human health. Energy-saving measures such as solar photovoltaics, sun-shading devices, low-emissivity glass, energy-efficient air-conditioning systems, and building-space planning and orientation have become the common design considerations for GB. Sophisticated technologies have been developed ready for GB implementation through good management and policy support. For example, Leadership in Energy and Environmental Design (LEED)-certified buildings can lower the operating costs by 8–9% compared with regular buildings, and these savings can pay for higher initial costs in the relatively shorter payback period (Cole, 2015).

Reports of past attempts to save energy (WBCSD, 2009) agree that with the technology then available,

the energy-efficiency level could be increased by 40%, yet this did not happen and even today does not happen. It is assumed that underlying reasons prevent or inhibit the GB market from realizing this implementation and this raises the question of whether the current incentives are appropriate and sufficient to act as drivers for the take-up of energy-efficient buildings. The objectives for instituting GB incentives (Ocampo, 2011; Qian, Chan, & Choy, 2013) are:

- to correct for external costs
- to supply information
- to reduce investors' risk in a new technology
- to accelerate the pace of adoption of efficient technologies

To fulfil these objectives, the incentives should be attractive to business and also to be administratively easy for government to implement. A disregard of the role of hidden transaction costs (TCs) affects the economic effectiveness of policy implementation and market efficiency (Simmons, 2015).

One example of an economic incentive is gross floor area (GFA) concessions. This has been widely used worldwide to motivate the private sector to provide public amenities in exchange for additional GFA (Tang & Tang, 1999). This mandates GB construction to some extent, and has achieved success in promoting GB. The design of the GFA concession scheme was connected with development control measures, such as sustainable building design guidelines (SBDGs) (Hong Kong), GB labelling programmes (Hong Kong, Singapore, US, etc.), and government land sale conditions (Hong Kong and Singapore), etc. Recently, the idea has also been applied as an effective instrument for long-term practices defined to promote an aspect of the public good – typically by creating the incentives and conditions for the market to bear the costs. For example, the affordable housing programme in the US, Australia and UK, renewable energy of buildings in New Zealand, Japan, France and US (Paetz & Pinto-Delas, 2007), and provision of new parks and plazas in New York.

The GFA concession scheme can be particularly beneficial for high-rise, dense cities with high land prices and property/rent prices, *e.g.* Hong Kong and Singapore. More saleable GFA means more profits for developers. In a high-rent place, a density bonus could be easily used to encourage developers (Küçükmehmetoğlu & Büyükgöz, 2013). In Hong Kong, due to the limited provision of development land each year (maximum 50 ha), a higher building density arising from a GFA concession can increase the profitability of a project, which appeals to local developers (Fan, Qian, & Chan, 2015; Liu & Lau, 2013; Qian, 2010). Therefore, in Hong Kong, the GFA concession scheme has motivated developers actively to commit to GB investment, and the registered GB has increased almost one-third within one year since the scheme was launched in 2011 (Liu & Lau, 2013).

On the other hand, the additional GFA bonus could cause negative impacts to the built environment, particularly in a dense city (*e.g.* Hong Kong). Research has shown that an excessive GFA concession resulting in the increase of building bulk and height has brought the negative impacts (*e.g.* lack of daylight, views and air ventilation problems, *i.e.*, canyon effect), which reduces the effectiveness of air ventilation and strengthens the concentration of pollutant at a pedestrian level (Council for Sustainability Development, 2010; Fan et al., 2015; Feiock, Tavares, & Lubell, 2008). The drawback could be arguably compensated to a certain extent by the fact that the GFA incentive requires the building to meet the sustainable building guidelines and GB certification. These require the building to have separating gaps, a setback from street, permeability in building block, open green areas and other GB features that contribute to 'environmental friendliness' and the reduction of energy use. However, the balancing point between the environmental advantages and disadvantages is not clear. Therefore, when designing this economic instrument, a government must carefully decide how much GFA bonus could be granted. For example, in Hong Kong, a 10% cap of GFA concession was set to reduce its impacts. However, in Singapore, the maximum bonus of GFA is only 2%. The key research question that arises is: what is the optimum GFA bonus that could motivate developers and also minimize the negative impacts on the built environment? What is the appropriate amount of GFA bonus with a GB market progressing towards maturity? By employing an incentive scheme, a government's intention is to compensate developers for extra cost of GB, rather than give them more profits, as the cost is eventually borne by government and taxpayers/GB buyers. This implies a need to understand what the hidden costs (TCs) are and what extra works are caused by the GFA concession scheme to the key stakeholders. Without this information, it is impossible to predict whether the optimum GFA bonus will motivate the stakeholders and leverage the market system. It will also be impossible to design the incentive and fair distribution among the participating stakeholders without knowing their costs and benefits (actual and hidden). Therefore, the aim of the current research presented in this paper is to explore the extra work during the property (real estate) development process due to the commitment to the GFA concession scheme, with due consideration of TCs.

The research design of this study is summarized in Figure 1. First, the GFA concession schemes are

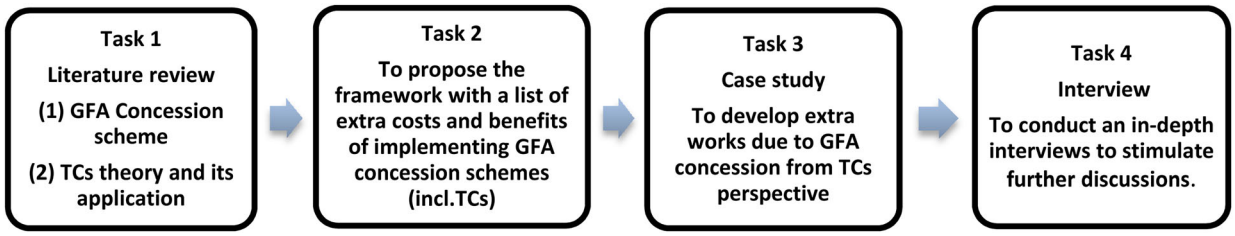

Figure 1 Research design

reviewed, using the bonus GFA concession schemes in Hong Kong and Singapore to provide an overview of the scheme (Task 1 in Figure 1). Then TCs theory is explained and applied to it to examine the hidden TCs and extra costs and benefits of committing to the GFA concession (Task 1). Both the tangible and intangible costs/benefits are mapped for the key stakeholders. A comprehensive analytical framework is provided (Task 2) that forms a basis for an empirical study in Hong Kong (Tasks 3 and 4). The Hong Kong case study is used to collect a list of extra works entailed by the incentive scheme during the real estate development process using the RIBA Plan of Work. A comparison is made between GB and traditional building (Task 3). The list of the extra tasks is verified by in-depth expert interviews. Finally, the interview results are complemented to verify the theoretical framework from the views of practitioners (Task 4 in Figure 1).

Background

GFA concession scheme

A variation in terminologies exists in different regions that share a similar meaning and intent, *e.g.* GFA concession, GFA incentive scheme, DB (density bonus), and FAR (floor area ratio) bonus. The DB and FAR bonus are used in North American, Japan, France, etc. (Paetz & Pinto-Delas, 2007). Density bonus, one of the most attractive incentives for developers in the US, refers to increasing allowable density by FAR or increasing allowable height for LEED-certified buildings (Abair, 2008; Miller, Spivey, & Florance, 2008). In Hong Kong, the GFA concession scheme refers to the floor area of certain green features and extra bonus floor area could be discounted from the total GFA calculation under the building regulations. In Hong Kong, this entails the prerequisite requirement of obtaining the BEAM Plus certification, and meeting some specific SBDGs (Building Department, 2011; Council for Sustainable Development, 2010). The Green Mark (GM) GFA incentive scheme in Singapore refers to buildings that attain the Platinum and Goldplus GM standards, which are then entitled to additional GFA. The principle underpinning these schemes is to encourage GB by granting additional bonus GFA to the particular site.

GFA concession scheme in Singapore

In 2009, Singapore implemented its GM GFA incentive scheme to reward the developers who acquire the certificates of GM Goldplus and Platinum. The Singapore Building Construction Authority (BCA) report showed the total number of registered GBs labelled with GM was 17 in 2005 and the number increased to 1696 by 2012 (BCA, 2014). The GFA concession scheme in Singapore has four levels of GB ratings, which makes the incentive scheme more flexible. It links the GFA concession scheme to the development control system. In Singapore, the GM Platinum or Goldplus certification are tied to the land sale conditions in certain new development sites. Generally, these sites are located within the new strategic growth areas, such as the Marina Bay and Downtown Core. By regulating land sale conditions, GB is a prerequisite for urban development

GFA concession scheme in Hong Kong

The GFA concession scheme in Hong Kong has four levels according to the GB ratings as well, which allows some flexibility. Similar to Singapore, it links to the development control system. However, in Hong Kong, GB design is stipulated in joint practice notes and SBDGs that are developed under building regulations. According to the GFA concession scheme, if there is no BEAM Plus certification, only a few green features that are mandatory in building regulations could receive any GFA concession. Therefore, BEAM Plus certification becomes mandatory if developers want to ensure all the green features can receive a GFA concession. The Hong Kong GFA concession scheme has been implemented since 2011. The total number of registered BEAM Plus projects increased from 225 (before the implementation of the GFA concession to 416 by 2015 (HKGBC, 2015).

Differences between Singapore and Hong Kong

Key differences between the Singapore and Hong Kong GFA concession schemes are that Hong Kong aims to promote sustainable building design and green features that were formulated according to its unique built environment. GFA concession will be granted only if the green features required under the SBDGs can comply with the minimum level of BEAM Plus certification. In contrast, Singapore's GM incentive scheme

promotes the attainment of higher tiers of GM building. Only projects certified with GM Goldplus or above can acquire GFA bonus. Also, the methods to calculate GFA concession are different. In Singapore, the GM GFA is sensitive to land value with the total GFA regulated in the master plan and green premium. If the project is located in a city centre that has a high land value, then the GM GFA will be less than that of the same project located in suburban areas. This calculation restricts the GFA bonus in high land-value areas that usually have high density in order to reduce negative impacts of increased density on the surroundings. In Hong Kong there are three types of GFA concession: exempted GFA, disregarded GFA and GFA bonus, subject to the building features. Some building features, *e.g.* those deemed beneficial to the community, are not set with a cap of GFA concession. This in turn encourages developers to provide as much as possible. However, green features and amenity features (*e.g.* balcony and utility platform[1]) are subject to the cap of 10% GFA concession.

Other differences are:

- Singapore implemented incentive schemes to promote higher-tier GB ratings. A higher bonus is given to higher-tier GB ratings in Singapore. In Hong Kong, the GFA concession scheme does not distinguish the rating levels of BEAM Plus, as long as the project meets the minimum rating level.

- Singapore's GM GFA incentive schemes have a strong emphasis on energy efficiency in order to achieve the reward. This entails professionals spending additional time working on energy efficiency.

- Singapore has special financial incentives for architects and engineers to get paid for their additional efforts and time spent on GB. This explicitly recognizes the importance of design stage. In contrast, the reward from Hong Kong's GFA concession scheme is only targeted at the developers.

Transaction costs theoretical application

The term of 'transaction cost' was proposed by Arrow (1969). 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 (1990b) who stated that TCs are the sources of power for social, economic and political institutions. North (1990a) claimed that TCs were the costs of measuring and enforcing agreements. Measurement costs are those of measuring the valuable attributes (*e.g.* colour, 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).

From a transaction cost economics (TCE) perspective, incentive schemes can be deemed as a governance structure shaping transactions among the key stakeholders (Finon & Perez, 2007). TCs occur during the process of incentive implementation to both the government and the involved parties who are willing to take part in the incentives, which will eventually be borne by the government and citizens (tax payers) (Andersen & Sprenger, 2000; Qian, 2012; Qian, Chan, Visscher, & Lehmann, 2015a). With regard to the GFA concession scheme, TCE 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 also may 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 review of TCs associated with energy efficiency, GB and environmental policy to identify the possible TCs in the process of GFA concession scheme implementation (Table 1). The list of possible TCs will be verified in the interviews presented below.

Table 1 Transaction costs associated with energy-efficiency and green building promotion, and environmental policy implementation

Transaction cost items	Mundaca, Mansoz, Neij, and Timilsina (2013)	Hein and Blok (1995)	Dudek and Wiener (1996)	Coggan, Whitten, and Bennett (2010)	McCann, Colby, Easter, Kasterine, and Kuperan (2005)	LBNL (2007)	Michaelowa and Jotzo (2005)	Ofei-Mensah and Bennett (2013)	Singh (2009)	Hagemann, Prager, and Bartke (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										×	

Costs and benefits of the GFA concession

Transaction costs of implementing GFA concession

Williamson (1985) further developed this theory of TCs with three dimensions, namely asset specificity (AS), frequency and uncertainty, which are the three determinants of TCs in the GFA concession application. AS refers to the durable investment to support the particular transactions. Coggan et al. (2010) and Rørstad, Vatn, and Kvakkestad (2007) stated that AS influences TCs via information collection, administration, contracting, monitoring and implementation.

In the current study, AS refers to the specific investment for the particular transaction in the process of implementing the GFA concession scheme as well as achieving GB. For example, developers may need to undertake extra work and deploy extra facilities or staff to get access to capital, GFA concession/GB design, and government approval, etc. (Chai & Yeo, 2012). The administrative burden will increase due to the need for documentation and additional contracts. Moreover, the SBDG in Hong Kong provide instructions for building design in different sizes and shapes of sites. Thus site-specific building design must be performed by architects to fulfil the requirements of the SBDG. Also, specialized GB knowledge and equipment are needed to acquire BEAM Plus registration or certification. These lead to the non-standard contracting and building design scheme as well as TCs in exchange. In the event of a shortage of human and technical capacity, the TCs would rise for the information searching cost and contract negotiation cost (Mundaca et al., 2013). Coggan et al. (2010) also stated that non-standard contracts would generate more TCs than the standard ones.

Frequency (F) refers to how often stakeholders performed a particular practice with the GFA concession scheme. The more often this happens with one particular practice/transaction, the less extra costs will arise due to the economies of scale. Frequency would affect TCs because when the transactions are recurrent. TCs could be reduced through repeating transactions that reduce learning costs and create a fixed, appropriate contract that reduces the efforts involving the collection of information (Nilsson, 2009). In this study, frequency means the how frequently stakeholders participate in the GFA concession scheme. Apparently, participating frequency is higher when the GFA concession scheme is mandatory.

Uncertainty (U) refers to market, policy and economic uncertainty in this context. For example, this can include: GB assessment uncertainty, technique uncertainty, incentive expiration after a period of time, economic downturn, etc. Technique uncertainties include the uncertainty about the extent of efficiency improvement (Chai & Yeo, 2012). The impacts of uncertainty on TCs are conditional and only if there is AS, can the degree of uncertainty influence TCs (Williamson, 1981). Uncertainties contribute to TCs via information collection, clarifying and negotiating contracts, monitoring and enforcement actions (Coggan et al., 2010). In this study, uncertainty exists particularly in the process of application of GFA concessions and BEAM Plus registration or certification.

This study also aims to map both the tangible and intangible costs/benefits among the key stakeholders in real estate development projects, which include developers (D), contractors (C), professionals (P) and government (G). Table 2 provides the list of TCs (with the three dimensions of AS, F and U) assigned to the stakeholders due to the GFA concession scheme.

Actual costs and benefits

In general, GB requires comparably higher initial costs and extra risks to deliver compared with 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. BCA (2015) stated that the cost premium for GM Platinum, and Goldplus are \$123\$/m^2 and \$97\$/m^2 in the residential sector. Kats, Alevantis, Berman, Mills, and Perlman (2003) claimed 0.66% extra cost for LEED certification, 2.11% for Silver, 1.82% for Gold and 6.50% for Platinum in the US. Davis Langdon (2007) suggested 3–5% greater cost for five star and 6% for six 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, Chau, Lee, & Edmunds, 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 3 summarizes the actual costs and benefits of committing the GFA concession scheme among the different stakeholders.

Hidden benefits

Hidden benefits include improved health and productivity, reduction in demands for water and

Table 2 Barriers causing transaction costs (TCs) to the stakeholders due to the gross floor area (GFA) concession scheme

TCs items	AS	F	U	D	C	P	G
Costs of access to capital and budget (Chai & Yeo, 2012) • Internal constraints on the budget • Problems with external financing	×			×			
BEAM Plus certification • Evidence that credit has been achieved • Time pending for assessment of results Costs of calculating costs and benefits of different efficiency levels	×			×			
Opportunity cost: priority over GB/GFA (Qian et al., 2015a) • Lack of time priority (Chai & Yeo, 2012) • Attraction (business/policy) of counterparts over GB/GFA • High sunk costs	×		×	×			×
Opportunity costs of planning incentives • Plan alternative incentive programmes, *e.g.* promote the provision of affordable housing, public open space.	×		×				×
New implementation process (Meacham, 2010) • Barriers of internal organization • Additional testing and inspection in construction	×			×		×	
Contracting organization (Walker & Chau, 1999) • Information gathering • Contract involve more elements (new contract) with different (often more) stakeholders	×			×		×	
Cooperation and working relationships between the more parties within the specific project (Love, Niedzweicki, Bullen, & Edwards, 2011)	×			×	×	×	
Delays may occur due to the capability of contractors to implement the specifications relating to GB technology.			×	×	×		
Additional working time without reward • Additional coordinating and analytic effort • High-standard design details (BEAM Plus) • Demonstrating in a credible way that a new building will reduce prospective energy costs	×			×	×	×	
Administrative burden (Ahn & Pearce, 2007) • Paperwork • Documentation and photographic evidence (BEAM Plus) • Assessment costs/certification costs • Additional contracts	×			×		×	×
Monitoring costs and report on construction activities, material use.	×			×		×	
Cost of technology innovation and management innovation (Qi, Shen, Zeng, & Jorge, 2010) • Managing equipment and materials • Negotiate with suppliers • Lack of information, awareness or expertise to achieve sustainable measure • Barriers of internal structure and interaction	×		×	×	×	×	
New process, green technology and working methods (Häkkinen & Belloni, 2011) • Possible risks and unforeseen costs due to the new adoption • Unfamiliar techniques/lack of experience • Speed of arrival of new technology • Inadequate, untested or unreliable sustainable materials, products or systems • Misunderstanding of green technological operations • Limited availability and accessibility of green technology, suppliers and lack of quality and performance information (Chai & Yeo, 2012) • The extent of efficiency improvements of new technologies • Concern over the high price of new technology deployed now will drop drastically in short due to the market economy of scale • Information and learning costs of green technology and energy efficiency measure (Chai & Yeo, 2012)	×	×	×	×	×	×	
Costs of training the workforce with specialized knowledge of GB/GFA • Employing suitably qualified person to report and document • Learning costs of the professionals and key stakeholders	×			×	×	×	

(*continued*)

Table 2 Continued

TCs items	AS	F	U	D	C	P	G
Unfamiliarity of the design team and contractors with GB methods Lack of manufacturer and supplier support Credibility and reliability of new suppliers and subcontractors Costs of identifying project, new networks/supply chain (Walker & Chau, 1999) Mistrust and dispute resolution costs and time		×	×	×	×	×	
Costs of increased congestion (Kayden, 1978)		×	×				×
Increased building bulk and height • Influence air ventilation, visual effects, city image		×	×				×

Note: AS = asset specificity; F = frequency; U = uncertainty to the key stakeholders: D = developer; C = contractor; P = professionals; G = government.

Table 3 List of actual costs and benefits of committing the gross floor area (GFA) concession scheme

Stakeholders	Actual costs	Actual benefits
Developers	More construction cost due to risk in a longer construction time, new construction methods and new GB technologies (Rehm & Ade, 2013) • Increased architectural and engineering design time (Kats et al., 2003)	GFA concession bonus
		Higher market selling price (Hebb, Hamilton, & Hachigian, 2010)
	Costs of GB certification • Assessment cost • Survey costCertification cost about HKD75 000–150 000 depending on the project scale and complexity (Burnett et al., 2008)	Costs saving from efficient use of materials • Reduction of material use through modular design (off-site prefabrication, lean construction methods), reuse of building elements • Improved material management and on-site sorting
	Additional or increased consultant fee (Häkkinen & Belloni, 2011) • Higher cost for green appliance design and energy-saving material at design stage • The design fee rises from around 9–10.5% of total cost (Larsson & Clark, 2000)	
Government	Professional training – continuous professional development (CPD) course	Tax revenues derived from the extra floor area (Kayden, 1978) • Tax from additional housing units transactions • Tax from extra construction activities
Contractor	More construction cost due to longer construction time Increased architectural and engineering design time (Kats et al., 2003)	Material saving
End-users	Higher property price	Operational cost saving (quantity depends on building performance) • Energy and water saving (Kats et al., 2003) Higher property value (resale)

electricity infrastructure (Burnett et al., 2008). Isa, Rahman, Sipan, and Hwa (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 Table 4.

Table 4 Hidden benefits to the stakeholders due to the gross floor area (GFA) concession scheme

Hidden (invisible) benefits to the stakeholders	D	G	P	C	E
Good company reputation/profile, status, market power, job satisfaction, rewards, personal development (Isa et al., 2013)	×		×	×	×
Future business competitiveness over the long-term	×		×		
Extra GFA bonus to sell more and gain more profits	×				
Energy efficiency and environmental protection can help GB sell quicker (Bartlett & Howard 2000)	×				
Reduction in construction pollution (BEAM Plus) • Reduction of pollution, resource depletion, energy and waste consumption (Addae-Dapaah, Hiang, & Sharon, 2009)		×			
Reduced demands on infrastructure (Pearce, DuBose, & Bosch, 2007), public water treatment, electricity demands, and landfill (Kats et al., 2003)		×			
(National) savings of healthcare (Pivo & McNamara, 2005) • Reduced respiratory infections, allergies and asthma • Decrease demand for healthcare facilities • Enhanced occupant productivity and health (Kats et al., 2003) • Reduced healthcare cost		×			×
Create more job opportunities		×	×	×	×
Improved working efficiency and social productivity • Increased economic activities, *e.g.*, activity associated with bonus GFA (Kayden, 1978)		×			×
• Green premium increase construction spending • Stimulate more consumers spend more in the long-term, due to the savings from energy bills • Higher interest paid to bank on construction loans (Kats et al., 2003)		×			
Support from company to take training course (Ahn & Pearce, 2007), *i.e.*, professional certificate			×		
Obtaining and using new professional skills (Ahn & Pearce, 2007) • Serving new technology • BEAM Pro • Life-cycle cost of GB • GB design process • Familiar with GB standard • Knowledgeable about low environmental impacts materials	×		×	×	×
Better quality of life from, for example, sky/podium garden, wider corridor, quality indoor environment, natural light and ventilation (Hebb et al., 2010), better site plan and design, fewer carbon emissions, etc. (Kats et al., 2003)		×			×
New knowledge and skills about green construction (Qian, Chan, & Bin Khalid, 2015b) • Basic knowledge and concepts of green construction and management • GB rating system • General knowledge of sustainability in the built environment • GB materials and method	×		×	×	

Note: D = developer; C = contractor; P = professionals; G = government; E = end-users; AS = asset specificity; F = frequency; U = uncertainty.

Methods

GFA concession in Hong Kong

Hong Kong aims to promote sustainable building design and green features that were formulated according to its unique built environment.[2] After building plan approval and before consent to commence building works, developers need to provide provisional assessment result of BEAM Plus rating to the buildings department. A GFA concession will be granted only if the green features are provided as required under the SBDGs and supported with the minimum level of BEAM Plus certification.

With due reference to the TCs barriers to stakeholders in Table 2, the framework used (Qian et al., 2015b) to ascertain the TCs in delivering GB projects is extended here to consider extra work (considering TCs) due to committing to the GFA concession scheme during the real estate development process. The RIBA Plan of Work (2007/08) provides the structure to consider all stages of a development project in order to identify the extra tasks involved with the GFA concession scheme (when compared with its traditional counterpart). The extra work to meet the GFA concession scheme will incur

additional costs. Therefore, interviews were designed to collect additional information and verify the review results.

Expert interviews

In order to support the case study, 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) shown in Tables 3 and 4, as well as the extra work/TCs in Table 5 due to GFA concession in the RIBA plan, the interview questions were developed. In-depth expert interviews were conducted with 10 experienced senior industry practitioners, *i.e.*, architects, surveyors, green consultants, developers and professors, to gain practical insights. The aim was to validate the identified list of costs and benefits, and provide explanation for each item of costs and benefits and the effectiveness of the GFA. The profile of interviewees is shown in Table 6. All 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 the costs and benefits due to participating in the GFA concession scheme in practice. The decision to use 10 experienced experts who have been actively involved in implementing the GFA concession scheme in Hong Kong will yield insightful, highly relevant and more convincing views than a massive survey of people without necessary expertise and hands-on experience.

The structured interviews were designed to discuss the extra costs and benefits due to participating in the GFA concession scheme. The interview questions were divided into three parts:

- the actual costs and benefits (Table 3)
- the TCs (Table 2)
- the hidden benefits (Table 4)

The interviewees were encouraged to share their views beyond this framework, 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.

Results and discussion

Increased construction costs and land cost

As already noted above, various studies have estimated the increased cost for different GB schemes to vary between 0.6% and 6.5% This may be offset by increased market value, market share or reduced risk.

The uncertainties caused by GFA concession due to the complex design to be approved by the government, directly affects the estimation of the developers' profits, especially at the land bidding stage. Developers in Hong Kong have to estimate the possible GFA concession granted and decide the maximum land cost they could afford. Therefore, the GFA concession scheme causes land prices in Hong Kong to be increased, which in turn decreases developers' expected profits. This also happened in New York City. When the New York City government provided a density bonus for developers constructing moderate-cost housing, the land cost increased as well. In this context, the planning agency began to calculate the profits of each specific GB project and control the bonus accordingly (Johnston, Schwartz, Wandesforde-Smith, & Caplan, 1989), which inevitably generated administration costs.

In Singapore, the land cost is prescribed and this reduces 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, *i.e.* a higher land price will lower the GFA bonus. The GFA bonus will be given less to the project in the city centre where land is usually expensive compared with the same project located in the suburban area. Thus, this calculation method of the GFA concession potentially reduces the negative impacts of extra GFA on the built environment. It also largely reduces the uncertainties to participate in the GFA concession scheme and results in decreased corresponding TCs, such as information searching costs and research costs.

Uncertainty results in higher negotiation and approval costs

The interviewees mentioned that BEAM Plus assessment largely depends on the variation between assessors, which leads to the unexpected or inconsistent results. The evaluation can have different subjective measurements that may give the same/similar projects different ratings, depending on who is the assessor and the assessor's measurement approach. For example, the BEAM Plus assessor may have a biased view due to conflict of interests of working in a rival firm. The BEAM Plus assessment process is perceived by the interview participants to lack transparency and consistency. Generally, there is 20–25% rejection

Table 5 Extra work arising from the gross floor area (GFA) concession scheme mapped onto the RIBA 2007 Outline Plan of Work

	RIBA Stage of Work	Tasks to be done for traditional projects	Extra work with TCs incurred (in concern of GB/GFA concession scheme)
Briefing	A: Inception	Set up client organization for briefing. Consider requirements, appoint architect. *Developer's key actions:* Identify opportunities (property/need/use/idea); assemble co-developer; identify and review information; identify seed money; evaluate investment climate	(1) Appoint an authorized person and involve special stakeholders for proposing the GFA concession options (2) Set up extra organization for briefing on GB in terms of granting GFA concession, *e.g.*, new offices, new staff (3) Consider extra GB-related market and policy requirements: market study in GB; policy study in GB (4) Need JV or co-developer for such special project? (5) Undertake extra studies of market requirements, potential and expectation on GB (considering local community need/supply/competitiveness) (6) Extra GB planning, design and cost, etc., in terms of GFA concession, as necessary to reach decisions (7) Extra effort to identify potential users (8) Study the extra financial risk (9) Consideration of extra legal liability risk of the GB product in terms of GFA concession (10) More careful review of available information on GB (11) Decision process for determining the level of BEAM Plus certification (12) Identification process(-es) for specialist expertise and assembling the project team (13) Registration process for the BEAM Plus (14) Others
	B: Feasibility	Carry out studies of user requirements, site conditions, planning, design and cost, etc., as necessary to reach decisions. *Developer's key actions:* preliminary market analysis (community/supply/competitive); assemble technical team; identify potential users; consider alternative site; preliminary financial plan; formal analysis (site/building/market/design/financial/appraisal); investment threshold; legal issues; public participation; review available information; review objectives	
Sketch plans	C: Outline proposals	Develop the brief further. Carry out studies on user requirements, technical problems, planning, design and costs as necessary to reach decisions *Developer's key actions:* obtain control of the land/property; preliminary plans and specifications; negotiation with government for approval	(1) Extra work about site planning and design, building material and equipment selection to reach the requirements of the expected GFA concession approval (2) Special user requirement study (3) Explore special technical solutions (4) Special concept/design that need negotiation with government for approval (5) Design leading to non-efficiency use of floor area (6) Special cost study for using new design features (7) Submission to HKGBC for BEAM Plus provisional assessment (8) Supplementing additional information if required by HKGBC (9) Inadequate information will cause the delay of process of BEAM Plus registration (10) Examination of sustainable building design and green features design and their integration into the building design (11) Discussion of the different design scenarios more with clients and reach agreement with cost consideration (12) Submission of application for GFA modification to Building Department with supporting documents (13) Others.
	D: Scheme design	Final development of the brief, full design of the project by architect, preliminary design by engineers, preparation cost plan and full explanatory report. Submission of proposals for all approvals	

(*continued*)

Table 5 Continued

	RIBA Stage of Work	Tasks to be done for traditional projects	Extra work with TCs incurred (in concern of GB/GFA concession scheme)
Working drawings	E: Detail design	Full design of every part and component of the building by collaboration of all concerned. Complete cost checking of designs. *Developer's key actions*: finalize plans and specifications; revise financial projections; financial negotiations (mortgage/loan/ construction loan); tax consideration	(1) Financial negotiations for new design feature (consideration of mortgage/Loan/construction loan) (2) Limited number of available contractors with expertise reduces competition (3) Learning cost of new professional qualification and skills who are lack of experience in GB and GFA concession scheme (4) Risk of rejection by HKGBC or building department and need for resubmission (5) Appointment of contractor with endorsement of an authorized person (6) Inadequate information will cause the delay of process of BEAM Plus registration (7) In granting modification of or exemption from the provision of the building ordinance, conditions may be imposed by the building authority (8) Negotiation with government for special building plan approval (9) Others
	F: Production information	Preparation of final production information, *i.e.*, drawings, schedules and specifications	
	G: Bills of quantities	Preparation of bill of quantities and tender documents.	
	H: Tender action	Compile a list of tenders; issue tender documents; check and open tenders	
Site operation	J: Project planning	Notify acceptance of tender; check all contract document are in order; brief all project personnel of the project requirement and procedure for administer the project ; check approvals and site condition to ensure the project can be carried out on site *Developer's key actions*: acquire property; select construction company; marketing and leasing; initial financing; assemble construction management team; tenant involvement	(1) Extra effort to brief all project personnel of the project requirement and procedure for administering the project (2) Special promotion strategy and materials for marketing and leasing (3) Additional consideration of tenant for GB products (4) Extra requirement on testing and commissioning of service installations to obtain green labelling etc. (5) Special effort to prepare maintenance manual (6) Extra fee for certificates involving green items (7) Extra administration: paperwork and time for preparation, and BEAM Plus application (8) Documentation and photographic evidence to apply for BEAM Plus (9) Cost of paperwork related to the application of BEAM Plus (10) Speed of arrival of new technology (11) Uncertainty of efficiency improvements of new technologies (12) Cost of managing and monitoring, *e.g.* to monitor and report on construction activities, like material use; to manage equipment and materials (13) Cost of negotiation, *e.g.* negotiate with suppliers (14) Speed of arrival of new technology (15) Submission of materials for project assessment of BEAM Plus to HKGBC for final assessment within six months of the date of issuance of the occupation permit by the building authority (16) Supplementing additional information if required by HKGBC (17) Inadequate information will cause the delay of process (18) Risk of rejection by HKGBC and need resubmission (19) Others
	K: Operations on site	Setting out the building on site; site meetings; supervision and site visits; financial monitoring of each construction stages; testing and commissioning of service installations; prepare maintenance manual	
	L: Completion	Check works ready for completion; hand-over inspection; rectify defects; final inspection and final certificate *Developer's key actions*: inspection; certificate of occupancy; permission to sell/rent	

(*continued*)

Table 5 Continued

	RIBA Stage of Work	Tasks to be done for traditional projects	Extra work with TCs incurred (in concern of GB/GFA concession scheme)
Feedback and maintenance	M: Feedback	Analysis of job records. Inspections of competed buildings. Studies of building in use. *Developer's key actions*: prepare property management plan; revise marketing plan; oversee marketing or leasing	(1) Special property skill requirement for property management plan (2) Special strategy and materials for overseeing marketing or leasing (3) Operation: keep building running effectively and under good repair (4) Set up and manage ownership entity (5) More green items require special care for property maintenance and improvement (6) Easy to sell or rent property (7) Management of additional guarantee certificates (8) Others
	N: Maintenance	*Developer's key actions*: set up and manage ownership entity; property improvement; property disposition; closing ownership entity	

Table 6 Profile of interviewees

Profession	Qualification and position
Architect	Authorized person; more than 20 years' working experience; director of architectural firm
	Registered architect; chairman of architectural firm
	Authorized person; Hong Kong Institute of Architects fellow member
	Senior architect; working in leading architecture firm for five years in Hong Kong; all projects the architect has joined are green buildings
	Manager, working in leading architecture firm that all the projects it did are green buildings
Developer	Chief executive officer (CEO) in one of leading real estate development firms in Hong Kong
Surveyor	Green building professional, environmental officer working in leading construction firm. Familiar with LEED and BEAM Plus
	Authorized person; project director of consultancy firm
	Director of consultancy firm
Professor	Full professor; over 10 years' working experience in project management and building control

risk to all applications. Developers whose applications are rejected have to negotiate or resubmit. This process increases the risk and leads to 20–30% extra work. This explains why developers usually prefer to aim for attaining a lower standard (BEAM Plus at Bronze level) and not a higher level as it is perceived to contain a higher level of risk.

Similarly, uncertainties also exist in the process of GFA concession application. If there are some special designs, the Hong Kong Buildings Department will hold a conference to discuss the decision of GFA concession of special design. Architects have to negotiate and convince the municipal government to accept their design with strong evidence of environmental benefits. Negotiation between design teams and developers or contractors can also generate TCs due to the complex requirements for building design. In Singapore there was also an increased number of meetings with green specialists (Hwang & Ng, 2013). The misinterpretation of clients' requests by the design team is a vital element that negatively influences the project schedule (Hwang, Zhao, & Tan, 2015). This reflects that stakeholders have not developed a standard procedure of cooperation and tacit agreement, which usually takes much time to build.

In order to be granted a GFA concession, BEAM Plus registration and assessment are required, together with the additional administration fee to be paid by developers. An approval cost arises when the transactions must be approved by government. It may result in the delay of transaction completion and impose modifications. Consultants need to prepare supporting documents for BEAM Plus registration/certification and GFA concession application. Additional information may be required may cause the delay of processing. In granting a modification or exemption from the provision of the buildings ordinance, conditions may be imposed by the buildings authority. If there are special designs, architects have to prepare relevant documents in detail to support the application of the GFA concession. It is worth noting that in some US cities and counties the certification and building permit fees are reduced as incentives to promote GB (Olubunmi, Xia, & Skitmore, 2016).

Market uncertainty and GB property value

According to the interviews, there is an apparent inconsistency about the perceptions of market value of GB. The majority of the interviewed Hong Kong experts agree that in Hong Kong GBs generally do not attain a higher market value than their counterparts, and that the GFA concession scheme is the main driver causing developers to construct GBs. Some disagree by acknowledging that GB does indeed enhance the building value but the actual enhanced value depends on many factors. Green features and energy efficiency are not the main considerations of residents. For office buildings, some international firms may prefer a GB-labelled office which gives GB a competitive market advantage to the traditional buildings. However, there is little difference in rental or sale prices between the levels (Bronze Silver, Gold and Platinum) of BEAM Plus ratings. The interviewees stated that the GFA concession scheme does not help improve the building quality much, which is the main reason why the general public is reluctant to pay more.

After developers bid on the land and determine the building design scheme, many other factors need consideration. For example, they would project the market price for a certain period in future (*e.g.* three years), and then decide to provide the extent of facilities to acquire the GFA concession (*e.g.* car park, podium garden and green features). Normally, the

estimated property price that depends on the location (*i.e.* the uses and price of comparable property in the area), economic situation, time, development cost, net floor area and the standard of development would determine the design and green feature provisions. A clear conflict exists between the GFA concession and market price. This indicates that the uncertainty of the GFA concession and property market arise more research costs.

Extra workload to professionals

All the interviewees agree that GFA concession is the main factor attracting developers to participate. However, to acquire a 10% GFA concession is difficult, and may not be cost-effective. Indeed, a few interviewees questioned whether some of the building features getting GFA concessions are really environmentally friendly. They suggest that government should distribute GFA concessions to a wider array of quality features.

The searching cost refers to the cost of collecting information. In this study, consultants collect specialized information of GB such as the performance of green equipment and GB design information. Developers usually commission experienced architects and GB consultants because these consultants' experience largely affects the amount of GFA concession granted to developers and the assessment results of BEAM Plus. According to the interviews, there is 20–25% risk of obtaining unexpected results, depending on the consultants' level of experience. This is also supported by Coggan, Buitelaar, Whitten, and Bennett (2013) and Ducos, Dupraz, and Bonnieux (2009) that past experience could improve the ability of decision-making and influence TCs, because experienced professionals spend less time and effort collecting and processing information. The searching cost accounts for the more time and money spent in the implementation process. However, two interviewees mentioned that there is a shortage of experienced consultants, which indicates that the GB market still has much room to develop.

Costs associated with negotiation, communication and approval

The validation cost includes the cost of review and revision of project document by operational parties. When the results of application of BEAM Plus registration/certification or GFA concession are not satisfactory, a review and revision of the application has to be conducted to reach the relevant requirements. This results in extra time and effort expended by consultants, and it will be reflected in the consultancy fee. The same situations also occur in Singapore such that mistakes or delays in preparing design documents significantly affect the schedule performance of GB (Hwang et al., 2015).

High monitoring costs and verification costs

The monitoring cost is the cost of monitoring policy compliance, contract implementation and the outcome. Site monitoring and reporting on the execution of the instructions have to be conducted to provide evidence for BEAM Plus certification. Some interviewees mentioned that contractors have to monitor and work longer – this cost would be reflected in the total construction cost. Likewise, in Singapore, monitoring the project progress by consultants is ranked fourth out of 36 significant factors that affect schedule performance in GB projects (Hwang et al., 2015).

Verification cost refers to the cost to verify the effectiveness of green materials or equipment. Three interviewees stated that the information provided by suppliers on the effectiveness of green materials or equipment may not be complete. Hence, the consultants have to undertake research or testing to verify the effectiveness. The replacement of material and equipment is common if there is lack of information before procurement. Green materials have to be tested by an accredited laboratory to ensure its effectiveness (Lam, Chan, Poon, Chau, & Chun, 2010). If the green specification could be specified in the contract, the verification costs could be reduced.

Benefits

- *Reputation*
  Developing GB could gain a reputation for developers, but this is not the main reason for GB development. For the 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. Some residents do not acknowledge the utility of concession features and regard them merely as developers' instruments to acquire extra GFA and make more money.

- *Faster sales*
  Only two interviewees stated GBs are comparatively easier to sell than the traditional ones. On the contrary, eight interviewees stated that there is no difference between GB and non-GB because this is not the main consideration of buyers. Further, they suggested that Hong Kong people do not have a strong awareness of 'green' or a willingness to choose 'green' products, supported by Chan, Qian, and Lam (2009).

- *More flexible design for environmental benefits*
  Though there are inconsistent views about the

flexible approach to design, some opine that the building regulations tend to restrict design innovation, while the GFA concession incentive scheme provides designers more flexibility to innovate and design for environmental reasons. The GFA concession encourages architects to give greater consideration to users and the general public. For example, without the GFA concession scheme, a sunshade device would be calculated on total coverage, and developers may support the design. However, with GFA concession scheme, they could apply for GFA exemption, the buildings department will permit the concession as long as the innovative design is justified. On the other hand, three interviewees pointed out that the GFA concession scheme restricts building design and discourages innovation due to the cap of 10% GFA concession. Even if architects could negotiate with the Hong Kong Buildings Department to apply for a concession of innovative design, it is still perceived as a risk and not worth trying. Overall, it is felt that the GFA concession scheme is designed to encourage innovation and provide design flexibility for architects, but the potential risks and uncertainties prevent architects actually doing it.

- *Job opportunities*
  Over half the interviewees mentioned that the GFA concession scheme created more job opportunities. One interviewee specifically stated that his/her architect firm has employed an extra 20% of employees to do BEAM Plus projects. There are 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.

- *Energy and water efficiency benefits*
  Some interviewees claimed that the new technologies are not cost-effective because of high upfront costs and low energy and water savings. Opposing views endorsed the energy and water-efficiency benefits because government could save the cost of energy and water infrastructure expansion. In short, it seems that GBs do generate energy and water efficiency benefits for the public, but developers have to bear the upfront costs that may be even more than the lifecycle savings. That is why some countries and regions have provided subsidies to compensate developers.

- *Increased land price*
  Through indirectly providing financial aid by GFA bonus, the government can save money or even generate more money through the incentive scheme. For example, the GFA concession scheme in Hong Kong makes developers willing to pay more for the land, as discussed above. Since all land transactions bring levies/duties to the government, the increased land price becomes government's additional income, while developers' actual benefits are less than the profits of 10% GFA concession due to the increased land cost.

Mandatory or voluntary GFA concession scheme

Hong Kong and Singapore have each integrated their voluntary scheme with the regulatory system in a different way. Therefore, different costs and benefits are generated and distributed. Whether the GFA concession scheme is mandatory or voluntary would affect the frequency of implementing the scheme. Apparently, a mandatory scheme has a high participation rate and could reduce TCs soon, as more experience of participating is quickly accumulated. In Singapore, the GFA concession scheme is connected with the land sale conditions in designated areas. This forces developers to participate in the GFA concession scheme and allows them to gain experience. In Hong Kong, BEAM Plus registration is a mandatory requirement for obtaining the GFA concession, which helps to increase the frequency of GB construction. Both Singapore and Hong Kong take the built environment into consideration when they integrate the GB labelling scheme into their respective regulatory system. In Singapore, the features and needs of the built environment were addressed by connecting the GFA concession scheme with the land sale conditions, which make GFA concession scheme mandatory for all sites. Key development areas that usually have a high density are forced to construct GB. In contrast, the GB labelling scheme and building design guidelines in Hong Kong were integrated to facilitate GB registration with the promotion of a specific requirement of GB design tailored for the unique built environment. The concession scheme is free for developers to adopt by complying with a combination of administrative and regulatory requirements administered jointly by self-governing non-governmental organizations (NGOs) and government authorities.

Conclusions

After the GFA concession scheme is implemented, as in Hong Kong and Singapore, GB becomes a popular market practice. It is time to revisit the rationale underpinning the GFA concession scheme to assess the costs and benefits to industry and society. The clear and certain requirements in the GFA concession scheme reduce the approval and communication costs. The GFA concession scheme in Hong Kong encourages innovative designs, but it requires more time and effort from government, developers and architects in the approval process. This paper provides a theoretical

framework to analyze the extra costs and benefits for stakeholders participating in the GFA concession scheme. Extra costs comprise additional construction costs, administration costs, consultancy fees and financing costs, etc., together with TC considerations. Benefits consist of GFA concession, enhanced property value as well as the hidden benefits such as future business competitiveness, etc. A theoretical framework was established to test and explain the effectiveness of a concession scheme, which provides the foundation to find the optimum GFA concession in future studies.

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References

Abair, J. W. (2008). Green buildings: When it means to be green and the evolution of green building laws. *Urban Law*, *40*, 623–632.

Addae-Dapaah, K., Hiang, L. K., & Sharon, N. Y. S. (2009). Sustainability of sustainable real property development. *Journal of Sustainable Real Estate*, *1*(1), 203–225.

Ahn, Y. H., & Pearce, A. R. (2007). Green construction: Contractor experiences, expectations, and perceptions. *Journal of Green Building*, *2*(3), 106–122. doi:10.3992/jgb.2.3.106

Andersen, M. S., & Sprenger, R.-U. (Eds.). (2000). *Market-based instruments for environmental management*. Cheltenham: Edward Elgar.

Arrow, K. (1969). *The limits of organization, the Fels lectures on public policy analysis*. New York: Norton.

Building and Construction Authority, Singapore (BCA). (2014). Retrieved January 16, 2016, from https://www.bca.gov.sg/greenmark/others/sg_green_buildings_tropics.pdf

Building and Construction Authority, Singapore (BCA). (2015). Retrieved January 16, 2016, from http://www.bca.gov.sg/greenmark/others/Green_Premium_Rates_(updated_Mar_2016).pdf

Building Department, Hong Kong. (2011). *New practice notes to foster a quality and sustainable built environment*. Retrieved January 16, 2016, from http://www.info.gov.hk/gia/general/201101/31/P201101310250.htm

Burnett, J., Chau, C., Lee, W., & Edmunds, K. (2008). Costs and financial benefits of undertaking green building assessments: Summary report of the CII-HK research project.

Cai, W., Wu, Y., Zhong, Y., & Ren, H. (2009). China building energy consumption: Situation, challenges and corresponding measures. *Energy Policy*, *37*(6), 2054–2059. doi:10.1016/j.enpol.2008.11.037

Chai, K., & Yeo, C. (2012). Overcoming energy efficiency barriers through systems approach—A conceptual framework. *Energy Policy*, *46*, 460–472. doi:10.1016/j.enpol.2012.04.012

Chan, E. H. W., Qian, Q. K., & Lam, P. T. I. (2009). The market for green building in developed Asian cities—the perspectives of building designers. *Energy Policy*, *37*(8), 3061–3070. doi:10.1016/j.enpol.2009.03.057

Cheung, S. N. (1987). Economic organization and transaction costs. *The New Palgrave: A Dictionary of Economics*, *2*, *55*. Retrieved from http://www.dictionaryofeconomics.com/article?id=pde1987_X000658

Coggan, A., Buitelaar, E., Whitten, S., & Bennett, J. (2013). Factors that influence transaction costs in development offsets: Who bears what and why? *Ecological Economics*, *88*, 222–231. doi:10.1016/j.ecolecon.2012.12.007

Coggan, A., Whitten, S. M., & Bennett, J. (2010). Influences of transaction costs in environmental policy. *Ecological Economics*, *69*(9), 1777–1784. doi:10.1016/j.ecolecon.2010.04.015

Cole, R. (2015). *Understanding regenerative design challenging the orthodoxy of current green building practice*. Retrieved January 16, 2016, from https://www.reminetwork.com/articles/understanding-regenerative-design/

Council for Sustainable Development. (2010). *Building design to foster a quality and sustainable built environment*. Hong Kong: Council for Sustainable Development, Hong Kong Government.

Davis Langdon Australia. (2007). *The cost and benefit for achieving green buildings*. Retrieved September 14, 2016, from http://www.aecom.com/What+We+Do/Program+Cost+Consultancy/Davis+Langdon

Ducos, G., Dupraz, P., & Bonnieux, F. (2009). Agri-environment contract adoption under fixed and variable compliance costs. *Journal of Environmental Planning and Management*, *52*(5), 669–687. doi:10.1080/09640560902958248

Dudek, D. J., & Wiener, J. B. (1996). *Joint implementation, transaction costs, and climate change*. Paris: OECD.

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.

Feiock, R. C., Tavares, A. F., & Lubell, M. (2008). Policy instrument choices for growth management and land use regulation. *Policy Studies Journal*, *36*(3), 461–480. doi:10.1111/j.1541-0072.2008.00277.x

Finon, D., & Perez, Y. (2007). The social efficiency of instruments of promotion of renewable energies: A transaction-cost perspective. *Ecological Economics*, *62*(1), 77–92. doi:10.1016/j.ecolecon.2006.05.011

Fuerst, F., & McAllister, P. (2008). Green noise or green value? Measuring the price effects of environmental certification in commercial buildings. Working Papers in School of Real Estate & Planning, University of Reading, Reading, UK.

Furubotn, E. G., & Richter, R. (2005). *Institutions and economic theory: The contribution of the new institutional economics*. Ann Arbor: University of Michigan Press.

Hagemann, N., Prager, K., & Bartke, S. (2015). Costs of implementing agricultural soil protection policies—Insights from two German cases. *Journal of Environmental Policy & Planning*, 1–17. (ahead-of-print).

Häkkinen, T., & Belloni, K. (2011). Barriers and drivers for sustainable building. *Building Research & Information*, *39*(3), 239–255. doi:10.1080/09613218.2011.561948

Hebb, T., Hamilton, A., & Hachigian, H. (2010). Responsible property investment in Canada: Factoring both environmental and social impacts in the Canadian real estate market. *Journal of Business Ethics*, *92*(1), 99–115. doi:10.1007/s10551-010-0636-5

Hein, L. G., & Blok, K. (1995). *Transaction costs of energy efficiency improvement*. Paper presented at the Energy Efficiency Challenge for Europe. ECEEE summer study.

Hong Kong Green Building Council (HKGBC). (2015). Retrieved January 16, 2016, from https://www.hkgbc.org.hk/eng/BEAM PlusStatistics.aspx

Hwang, B.-G., & Ng, W. J. (2013). Project management knowledge and skills for green construction: Overcoming challenges. *International Journal of Project Management*, *31*(2), 272–284. doi:10.1016/j.ijproman.2012.05.004

Hwang, B.-G., Zhao, X., & Tan, L. L. G. (2015). Green building projects: Schedule performance, influential factors and solutions. *Engineering, Construction and Architectural Management*, *22*(3), 327–346. doi:10.1108/ECAM-07-2014-0095

Isa, M., Rahman, M. M. G. M. A., Sipan, I., & Hwa, T. K. (2013). Factors affecting green office building investment in Malaysia. *Procedia – Social and Behavioral Sciences*, *105*, 138–148. doi:10.1016/j.sbspro.2013.11.015

Joas, F., & Flachsland, C. (2014). The (ir)relevance of transaction costs in climate policy instrument choice: An analysis of the EU and the US. *Climate Policy*, *16*(1), 26–49.

Johnston, R. A., Schwartz, S. I., Wandesforde-Smith, G. A., & Caplan, M. (1989). Selling zoning: Do density bonus incentives for moderate-cost housing work. *Wash U Law Journal of Urban & Contemporary Law*, *36*, 45–61.

Kats, G., Alevantis, L., Berman, A., Mills, E., & Perlman, J. (2003). *The costs and financial benefits of green buildings. A Report to California's Sustainable Building Task Force*. Report by Lawrence Berkeley National Laboratory, USA. Retrieved from http://www.usgbc.org/Docs/Archive/General/Docs1992.pdf

Kayden, J. S. (1978). *Incentive zoning in New York City: A cost-benefit analysis*. Cambridge, MA: Proquest Information & Le.

Küçükmehmetoğlu, M., & Büyükgöz, A. (2013). *Consensus building via cooperative game theory in the process of urban redevelopment*. ERSA conference papers, European Regional Science Association.

Lam, P. T., Chan, E. H., Poon, C., Chau, C., & Chun, K. (2010). Factors affecting the implementation of green specifications in construction. *Journal of Environmental Management*, *91*(3), 654–661. doi:10.1016/j.jenvman.2009.09.029

Larsson, N., & Clark, J. (2000). Incremental costs within the design process for energy efficient buildings. *Building Research & Information*, *28*(5–6), 413–418. doi:10.1080/096132100418573

LBNL. (2007). *Assessing transaction costs of project-based greenhouse gas emissions trading*. Berkeley, CA: Lawrence Berkeley National Laboratory.

Liu, Y., & Lau, S. (2013). *What is green policy? An anatomy of green policy through two Asian cities: Hong Kong and Singapore*, The World Sustainable Building (SB) Conference, Research Publishing, 323.

Love, P. E., Niedzweicki, M., Bullen, P. A., & Edwards, D. J. (2011). Achieving the green building council of Australia's world leadership rating in an office building in Perth. *Journal of Construction Engineering and Management*, *138*(5), 652–660. doi:10.1061/(ASCE)CO.1943-7862.0000461

Matthews, R. C. (1986). The economics of institutions and the sources of growth. *The Economic Journal*, 96(384), 903–918.

McCann, L., Colby, B., Easter, K. W., Kasterine, A., & Kuperan, K. V. (2005). Transaction cost measurement for evaluating environmental policies. *Ecological Economics*, *52*(4), 527–542. doi:10.1016/j.ecolecon.2004.08.002

Meacham, B. J. (2010). Accommodating innovation in building regulation: Lessons and challenges. *Building Research & Information*, *38*(6), 686–698. doi:10.1080/09613218.2010.505380

Michaelowa, A., & Jotzo, F. (2005). Transaction costs, institutional rigidities and the size of the clean development mechanism. *Energy Policy*, *33*(4), 511–523. doi:10.1016/j.enpol.2003.08.016

Miller, N., Spivey, J., & Florance, A. (2008). Does green pay off? *Journal of Real Estate Portfolio Management*, *14*(4), 385–400.

Mundaca, T. L., Mansoz, M., Neij, L., & Timilsina, G. R. (2013). Transaction costs analysis of low-carbon technologies. *Climate Policy*, *13*(4), 490–513. doi:10.1080/14693062.2013.781452

Nilsson, F. O. L. (2009). Transaction costs and agri-environmental policy measures: Are preferences influencing policy implementation? *Journal of Environmental Planning and Management*, *52*(6), 757–775. doi:10.1080/09640560903083723

North, D. C. (1990a). *Institutions, institutional change and economic performance*. Cambridge, UK: Cambridge University Press.

North, D. C. (1990b). A transaction cost theory of politics. *Journal of Theoretical Politics*, *2*(4), 355–367. doi:10.1177/0951692890002004001

Ocampo, J. A. (2011). *The transition to a green economy: Benefits, challenges and risks from a sustainable development perspective: Summary of background papers*. Report to Second Preparatory Meeting for United Nations Conference on Sustainable Development, Division for Sustainable Development UN-DESA, UNEP, UN Conference on Trade and Development.

Ofei-Mensah, A., & Bennett, J. (2013). Transaction costs of alternative greenhouse gas policies in the Australian transport energy sector. *Ecological Economics*, *88*, 214–221. doi:10.1016/j.ecolecon.2012.12.009

Olubunmi, O. A., Xia, P. B., & Skitmore, M. (2016). Green building incentives: A review. *Renewable and Sustainable Energy Reviews*, *59*, 1611–1621. doi:10.1016/j.rser.2016.01.028

Paetz, M. M. D., & Pinto-Delas, K. (2007). *From red lights to green lights: Town planning incentives for green building*. Talking and Walking Sustainability International Conference, February, 2007.

Pearce, A. R., DuBose, J. R., & Bosch, S. J. (2007). Green building policy options for the public sector. *Journal of Green Building*, *2*(1), 156–174. doi:10.3992/jgb.2.1.156

Pivo, G., & McNamara, P. (2005). Responsible property investing. *International Real Estate Review*, *8*, 128–143.

Qi, G. Y., Shen, L. Y., Zeng, S. X., & Jorge, O. J. (2010). The drivers for contractors' green innovation: An industry perspective. *Journal of Cleaner Production*, *18*(14), 1358–1365. doi:10.1016/j.jclepro.2010.04.017

Qian, Q. K. (2010). Government measures in China for promoting Building Energy Efficiency (BEE): A comparative study with some developed countries. *The International Journal of Construction Management*, *10*(4), 119–138. doi:10.1080/15623599.2010.10773157

Qian, Q. K. (2012). *Barriers to Building Energy Efficiency (BEE) promotion: A Transaction Costs (TCs) perspective* (PhD thesis). The Hong Kong Polytechnic University.

Qian, Q. K., Chan, E. H. W., & Bin Khalid, A. G. (2015b). Challenges in delivering green building projects: Unearthing the Transaction Costs (TCs). *Sustainability*, *7*, 3615–3636. doi:10.3390/su7043615

Qian, Q. K., Chan, E. H. W., & Choy, L. H. T. (2013). How transaction costs affect real estate developers entering into the Building Energy Efficiency (BEE) market? *Habitat International*, *37*, 138–147. Retrieved February 23, 2012, from http://www.sciencedirect.com/science/journal/aip/01973975 doi:10.1016/j.habitatint.2011.12.005

Qian, Q. K., Chan, E. H. W., Visscher, H. J., & Lehmann, S. (2015a). Modeling the Green Building (GB) investment decisions of developers and end-users with Transaction Costs (TCs) considerations. *Journal of Cleaner Production*, in Press. doi:10.1016/j.jclepro.2015.04.066

Rehm, M., & Ade, R. (2013). Construction costs comparison between 'green' and conventional office buildings. *Building Research & Information*, *41*(2), 198–208. doi:10.1080/09613218.2013.769145

RIBA, Outline Plan of Work. (2007/08). Retrieved March 18, 2015, from http://www.architecture.com/Files/RIBAProfessionalServices/Practice/Archive/OutlinePlanofWork(revised).pdf

Rørstad, P. K., Vatn, A., & Kvakkestad, V. (2007). Why do transaction costs of agricultural policies vary? *Agricultural economics*, *36*(1), 1–11. doi:10.1111/j.1574-0862.2007.00172.x

Simmons, R. (2015). Constraints on evidence-based policy: Insights from government practices. *Building Research & Information*, *43*(4), 407–419. doi:10.1080/09613218.2015.1002355

Singh, G. (2009). *Understanding carbon credits*. New Delhi: Aditya Books.

Tang, B., & Tang, R. M. (1999). Development control, planning incentive and urban redevelopment: Evaluation of a two-tier plot ratio system in Hong Kong. *Land Use Policy*, *16*(1), 33–43. doi:10.1016/S0264-8377(98)00035-0

United Nations, Department of Economic and Social Affairs, Population Division (UNDESA). (2014). World urbanization prospects: The 2014 revision, highlights (ST/ESA/SER.A/352).

United Nation Environment Programme (UNEP). (2007). *Buildings & climate change: Status, challenges and opportunities*. Retrieved from http://www.unep.fr/pc/sbc/documents/Buildings_and_climate_change.pdf

Walker, A., & Chau, K. W. (1999). The relationship between construction project management theory and transaction cost economics. *Engineering, Construction and Architectural Management*, *6*(2), 166–176. doi:10.1108/eb021109

WBCSD. (2009). *Transforming the market: Energy efficiency in buildings world business council for sustainable development*. Geneva: World Business Council for Sustainable Development.

Williamson, O. E. (1981). The economics of organization: The transaction cost approach. *American Journal of Sociology*, *87*, 548–577. doi:10.1086/227496

Williamson, O. E. (1985). *The economic institutions of capitalism*. New York, NY, USA: The Free Press.

World Bank. (2005). *Project document on a proposed Global Environment Facility (GEF) grant of US$ 18 million to the PRC for the heat reform and Building Energy Efficiency Project* (Report No. 20747-cn), 1–9.

Yu, S. M., & Tu, Y. (2011). *Are green buildings worth more because they cost more?* IRES Working Paper Series IRES2011-023.

Endnotes

[1]The 'utility platform' is a unique feature in Hong Kong high-rise living as there is often no outdoor or semi-outdoor space for activities such as washing or drying laundry. The utility platform is designed for residential buildings, providing space for residents to wash and dry clothes. It is often in the form of a balcony, but has different design restrictions of size, location and GFA concession. For example, the maximum area to be exempted for a utility platform is 0.75 m^2, but the total area should not be less than 1.5 m^2. For the balcony, the maximum GFA concession is 3 m^2.

[2]The Hong Kong Green Building Council (HKGBC) is responsible for GB promotion, leading the GB market transformation. BEAM Plus is the product of integrating HKBEAM and the Comprehensive Environmental Performance Assessment Scheme (CEPAS).