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Transaction Cost and Agency Perspectives on Eco-Certification of Existing Buildings: A Study of Hong Kong

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Abstract: Eco-certification schemes are usually launched with various incentives provided by local governments to facilitate green building development and building energy retrofits. A number of barriers to building energy retrofitting have been identified in previous literature, while the barriers to the eco-certification of existing buildings are under-researched. Drawing on a set of building data retrievable from the BEAM Society and other sources, we carried out an analysis and found the building energy retrofitting, as well as the certification process, were unwelcomed in multi-owned residential buildings. The identified shortfall is put forward from the perspectives of transaction cost theory and agency theory. The findings reveal that high transaction costs incurred during negotiations and coordination among a large number of co-owners within a typical apartment building can outweigh the benefits of retrofitting and eco-certification. Besides, the remuneration structure of third-party property management agents discourages agents from facilitating co-owners to initiate retrofitting. This study provides significant implications for policymakers to understand the concerns of building owners and managers over the decisions and the processes of both the building energy retrofits and eco-certification. The problems and barriers unveiled in this study will facilitate the refining of current energy efficiency policies and related incentives designs.

Keywords: building energy performance; building energy retrofits; green building certification; transaction costs; agency theory; incentives

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1. Introduction

In 2019, building construction and operations accounted for 35% of final energy consumption and 38% of energy (and process-related) emissions [1]. The latest global energy consumption data suggest that building energy use remains a significant proportion of overall energy demand. The percentages of building energy consumption against total final energy consumption in different areas are shown as follows: 57% in Africa, 40% in Europe, 26% in ASEAN, China, and India, and 24% in Central and South Africa [1,2]. Many governments across the world have made significant efforts in promoting energy efficiency in their built environments, providing various initiatives to drive building owners or operators to retrofit their existing buildings. The United States has launched and planned 203 energy-efficiency related policies for the building sector, followed by Australia and Canada, with 94 energy efficiency policies, respectively [3]. China has launched and planned 236 energy efficiency policies, with 59 being relevant to the building sector, varying from regulatory instruments, building codes and standards, minimum energy performance standards, economic instruments, strategic planning, etc., to fiscal/financial incentives.

To promote energy efficiency initiatives in Hong Kong, where buildings account for 90% of electricity consumption, the Hong Kong government has adopted both statutory and non-statutory approaches to enhance the city's overall building energy performance. In Hong Kong, Leadership in Energy and Environmental Design (LEED) and BEAM Plus (a green building rating tool managed by the Hong Kong Green Building Council) are two major environmental building rating and certification schemes. They have been well received by the construction industry in Hong Kong. In the past decade, the two voluntary schemes have significantly facilitated green building development and fostered building energy reduction in Hong Kong. The two schemes include a set of rating systems for the design, construction, operation, and maintenance of buildings and neighbourhoods, based on which, the building owners have their buildings/projects certified to obtain eco-certification. Among the 42,000 existing buildings in Hong Kong, 1.5% (approximately 630 buildings) have accredited or registered to the BEAM plus certification system, and 0.34% (approximately 142.8 buildings) have accredited or registered to the LEED certification system [4]. In recent years, two main concerns for the Hong Kong government—to achieve energy reduction targets of 40% in the built environment by 2025—involved enabling existing buildings toward energy retrofitting, and obtaining certification under energy-efficiency related schemes [5]. In 2019, BEAM Plus New Buildings (BEAM Plus NB) and BEAM Plus Existing Buildings (BEAM Plus EB) were launched to foster a sustainable built environment in Hong Kong.

It is easier to have an aged building eco-certified if it has undergone energy retrofitting. However, in reality, the reasoning and decision-making processes for existing building energy retrofitting and eco-certification can be complicated. For example, the barriers to eco-certification of existing buildings would affect the decisions of building energy retrofits, especially when the building owners' decisions are motivated by the incentives brought by the eco-certification scheme [6]. In this light, investigating the patterns of eco-certification of existing buildings would help deepen the understanding of the barriers toward building energy retrofits. In this study, an inductive approach is adopted to examine the characteristics of the existing buildings that are eco-certified. The factors that hinder implementing the building energy retrofits and the eco-certification are identified and discussed from a transaction cost theory and an agency theory perspective. The findings of this study will help policymakers understand the concerns and behaviours of building owners regarding the process of eco-certification application, enable building owners and operators to evaluate the costs occurred by the barriers, and make rational decisions to overcome possible barriers in the future.

The paper is organised as follows: Section 2 provides a literature review on the barriers to building energy retrofits and the eco-certification of existing buildings. Section 3 introduces the methodology of this study followed by a detailed presentation of the findings in Section 4. Section 5 elaborates the discussion based on the findings and Section 6 presents the conclusion of this study.

2. Context of the Research

In practice, local governments support eco-certification by launching various incentives in both statutory and non-statutory forms (e.g., policy incentives, tax incentives, funding assistance, etc.) [6]. Furthermore, eco-certification organisations also integrate incentives into the design of the eco-certification schemes and their certification processes, such as reducing the cost for volume certification, creating different application pathways, etc. The benefits of these incentives are attractive to developers and building owners and, to a certain extent, serve as a huge motivation for them to apply for eco-certification for new projects.

The barriers to green building development have been profoundly discussed in numerous studies. Darko and Chan [7] provided a comprehensive review of the barriers to green building adoption and identified 37 barriers in the literature. Arguably, these barriers also hinder the eco-certification of new buildings. Perspectives derived from the transaction cost theory (TC) [8,9] and cost–benefit analysis [10–12] have been used to analyse the developers' behaviour and the development process of green building development. Moreover, eco-certification of new dwellings may not be considered because homebuyers may pay little attention to the eco-certification or energy labels in their home purchase decisions [13,14].

Yet, the extant literature does not distinguish the barriers to green building development and barriers, to obtain eco-certification for buildings. In other words, discussion on the barriers to eco-certification of new buildings is usually mixed, regarding the barriers to green building development. Even worse, there has been a dearth of literature on the barriers to eco-certification and energy retrofits of existing buildings. The factors that incentivise or dis-incentivise existing buildings' eco-certification and energy retrofits could be different from those associated with new buildings. Therefore, it is worthwhile to study the factors that shape decision making for eco-certification and energy retrofits in our existing building stock.

The focus of this study is to investigate the possible barriers to building energy retrofits through examining the issues that affect the eco-certification of existing buildings based on the database of eco-certification of existing buildings in Hong Kong. Thus, the target of the investigation is the management of existing buildings, such as the decision on whether to implement building energy retrofits and apply for eco-certification, the selection of the certification pathway, etc.

2.1. Barriers to Building Energy Retrofits and Eco-Certification of Existing Building

Building energy retrofitting works generally involve "replacements, modifications, and refurbishments of existing buildings to enhance the energy efficiency, conservation, and savings" [15]; the minimization of energy consumption and the maximization of economic benefits are the two prime objectives of retrofitting. Building control improvement and building component implementation are two major energy-retrofitting strategies to increase energy efficiency and reduce the energy demand of the building [16]. The process of building energy retrofits involves multiple stakeholders from different professional backgrounds and with different intentions towards the retrofitting decisions. Among the involved stakeholders, building owners play an important role in building energy retrofitting and eco-certification decision-makings. A number of barriers regarding the stakeholders' perceptions towards building energy retrofits, as well as their expected outcomes, are identified in the literature. For example, building owners may have an aversion to energy efficiency refurbishment measures because of the lack of interest in energy efficiency issues, financial means, long-term perspectives, and trust towards contractors [17]. As far as municipalities are concerned, factors, such as unawareness about the energy problem, difficulties with goal setting and data collection, and lack of expertise in the municipalities to analyse the data and develop an effective plan, hinder government-led energy retrofit projects [18].

Hong et al. [19] studied the commercial building energy retrofitting projects in China and suggested that a lack of expertise and resources to identify and evaluate cost-effective energy retrofit strategies are major barriers for owners when it comes to pursuing energy retrofitting. Hou et al. [20] identified a number of issues that would decrease building owners' willingness to retrofit their buildings, including unclear stakeholder obligations, difficulties in coordinating multiple parties, and complexity of retrofit implementation. Aside from individual research projects by academic scholars, international associations also put effort into identifying the barriers to building energy retrofitting. Building Performance Institute Europe identified four barriers to building energy retrofits, categorizing them into four categories: (1) financial; (2) institutional and administrative; (3) awareness, advice, and skills; and (4) separation of expenditure and benefit [21]. Climate Policy Initiative also identified four barriers to building energy retrofits, namely: (1) embryonic markets; (2) lack of information; (3) misaligned financial incentives; and (4) undervaluing energy efficiency [22].

As a significant number of existing buildings are aging and facing an urgent need to upgrade their operational, economic, and environmental performance worldwide, the pursuit of green certification for existing buildings has become an inevitable trend [23]. Aktas and Ozorhon [24] only focused on the green building certification process and identified three major barriers to existing the eco-certification process of buildings in developing countries—unavailability of approved materials, poor design of buildings, and difficulties with the documentation process. One of the findings from their study was that the building owners do not perceive the cost as a barrier to 'green' their existing buildings. The possible reason is that the building owners (owners of commercial buildings) see the certification as an opportunity to enhance their corporate image. Thus, they are more flexible with the budget on green implementation of existing buildings.

2.2. Building Energy Retrofits and Eco-Certification in Hong Kong

2.2.1. Statutory Regulations and Policy Incentives for Building Energy Retrofits

In Hong Kong, the Building Energy Efficiency Ordinance (BEEO) (Cap. 610) was formulated to enforce certain prescribed types of buildings to comply with building energy codes (BECs) and/or the energy audit code (EAC). In addition, the Hong Kong Energy Efficiency Registration Scheme for Buildings (HKEERSB) was introduced to recognise buildings that outperform the statutory requirements under the BEEO. The HKEERSB was officially launched in 1998 in order to promote the adoption of the BECs by providing the certification to a building complying with one or more of the BECs [25].

In 2018, the Hong Kong government launched a tax incentive scheme to further encourage building owners to pursue the application of HKEERSB: as long as the building owners have their buildings certified by BEAM Plus (managed by the Hong Kong Green Building Council) or other internationally recognised building environmental assessment systems, such as LEED, they are eligible to apply for relevant tax deductions [26,27]. Building owners and building managers are familiar with the BEEO. The newly launched tax incentives have drawn the attention of policymakers to the barriers of building energy retrofits and the eco-certification process for existing buildings in Hong Kong.

2.2.2. Background of the BEAM Plus

Building Environmental Assessment Method (BEAM) Plus is the prevailing rating tool for green buildings in Hong Kong. BEAM Plus, conceived in 1996 as a voluntary private sector initiative, has developed into an internationally recognised green building rating tools for new buildings (NB), existing buildings (EB), interiors (BI), for shops, office, retails, and neighbourhood (ND) [28]. To achieve the target set out in the Energy Saving Plan by 2025, the Hong Kong Green Building Council (HKGBC) issued the new version of BEAM Plus Existing Building (BEAM Plus EB) V2.0 in 2016 [5,29]. It includes the new assessment framework with two certification pathways: a comprehensive scheme and a selective scheme. In order to have the building certified under the comprehensive scheme of the BEAM Plus EB, the building performance shall be assessed under all seven aspects, including management, energy use, indoor environment, water use, materials and waste aspects, site aspects, and innovation and additions. The applicant can also choose to have the building performance assessed under one or more specific aspects through the selective scheme pathway. Based on the assessment scores by BEAM professionals, the buildings are awarded certain ratings (e.g., platinum, gold, silver, and bronze) that reflect the actual performance of the building. The four-level rating system applies to both a comprehensive scheme and a selective scheme [29,30].

In order to promote and facilitate the certification of BEAM Plus EB, a volume certification mechanism was introduced to provide a faster and more economical manner for certification application. The applicants can choose to have all buildings or multiple buildings certified by a portfolio assessment mechanism in one go, at a lower cost, through a volume certification approach. This study focuses on the buildings that are certified under the

BEAM Plus EB and analyses their background information, including the application mechanism (comprehensive or selective scheme), the certification rating, the building ownership status, the building/estate development information, and the geographical information.

2.3. A Transaction Cost (TC) and Agency Perspectives towards Building Energy Retrofits

Transaction cost (TC) theory has been widely used to analyse the externalities that occur within a firm, in the interaction between a firm and the market, and the process of public policies implementation [31–33]. Transaction costs impact economic performance because high transaction costs can lead to failure of an institutional arrangement [34,35]. Prohibitively high transaction costs tend to inhibit collective actions [36,37]. "Transaction cost" has been discussed and measured in numerous studies on public policies to promote green buildings [7,8,10,38]. It is the main idea of these works that certain types of TCs would occur with different stakeholders in the process of development, certification, and management of the green construction project, and these TCs would undermine the policy's effectiveness and implementation efficiency. It is commonly found that some common barriers exist during the implementation of green building development-related policies, such as information gathering [39,40], internal and external negotiation [39,41,42], innovative technology acceptance, and adoption [43,44]. These studies conceptualised the identified "barriers" with TCs and used TC theory to transform the vague phenomenon into a tangible concept. Qian et al. [8] adopted the transaction cost theory with support of the empirical data from expert interviews to examine the cost and benefits (both actual and hidden ones) in the process of implementing the gross floor area (GFA) concession incentive scheme in Hong Kong. With a similar approach, Fan et al. [9] used the transaction cost theory to measure three dimensions of transaction costs involved in the scheme implementation, namely asset specificity, uncertainty, and frequency. With the theoretical base on transaction cost theory, Fan et al. [11] conducted a case study using empirical data to support the hidden costs and benefits of the same scheme.

Agency theory is often used to explain and resolve disputes over priorities between principals and their agents. The difference in agreement between the principals and agents during the transaction process leads to agency problems. The agency problems generally result from the conflicting goals of the principals and agents, intensified by the information asymmetry [45,46]. The principal–agent dilemma may also stem from moral hazards and adverse selections. A moral hazard occurs when an agent attempts to make a profit on a contract because the principal is unable to observe the agent's behaviour after entering into the contract [47]. On the other hand, uncertainty concerning an agent's characteristics and preferences prior to creating a contract could lead to an adverse selection [48].

In the past decade, agency theory has been increasingly employed to analyse green management strategies in organisations [49–51]. Yet, studies using agency theory in investigating energy efficiency are still rare. Kumbaroğlu and Madlener [52] attempted to analyse building energy efficiency problems, focusing on investigating the benefits and conflicts of interests between investors and users based on agency theory. Liang et al. [6] adopted agency theory to explain the agency problems in energy-efficiency retrofits and developed a principal–agent model to map out the problems of two sets of principal–agent relationships: government vs. building owners and building owners vs. tenants. They argued that "incentives" play an important role in the benefit–cost analysis in energy retrofitting decisions. The model illustrates the economic relationships among the three stakeholders (government, building owners, and tenants) under four scenarios. In building energy retrofitting and the eco-certification process, property management companies play the 'agent's' role, implementing the tasks (building energy retrofitting and eco-certification) for the building owners, who play the 'delegator' role, according to the principal–agent relationship. Although both sides in the contractual relationship receive certain incentives from the eco-certification schemes, their interests appear to be imbalanced under certain circumstances. This study aims to identify the possible causes that hinder property management companies from facilitating building owners to implement building energy retrofits and gain eco-certification.

3. Research Methodology and Data

An indicative approach was adopted for this empirical study. Secondary data about eco-certification under BEAM Plus were first collected from various sources. The data were then consolidated and analysed to see if there were any specific patterns regarding eco-certifications of the existing building in Hong Kong. Possible explanations were then tendered to explain the patterns. In the stage of data collection, a list of certified existing buildings was captured on 21 May 2021, from the HKGBC BEAM Pro Project Directory. (https://www.hkgbc.org.hk/eng/beam-plus/beam-plus-dir-stat/BEAMPlusDirectory.jsp, accessed on 21 May 2021) Only the valid and certified BEAM Pro existing buildings projects available on the online project directory on the captioned date were selected for investigation. In total, the project directory contained 193 existing building projects and 201 valid BEAM Pro existing building certifications. The number of building projects and certifications did not reconcile because a few building projects obtained more than one BEAM Plus certification in BEAM Plus V2.0 (Selective Scheme).

Figure 1 outlines the data collated for desk study with their sources. We principally examined three main categories of information, including (i) Hong Kong BEAM eco-certification figures (certification scheme, project rating, certification year); (ii) background information of each BEAM Plus certified building; and (iii) property governance matters (e.g., ownership status and owner's information). After the data collection, all relevant data were compiled into a project-specific database for further processing. The skeleton of this project-specific database was primarily connected to two local green building databases—HKGBC's BEAM Project Directory and BEAM Society Limited's BEAM Plus Certified Building Database. We also amassed other necessary project data, such as the completion year and the property management company, in diverse sources. Trustworthy databases managed by the government sectors, property consultant agencies, and the local property management professional bodies were utilised. In addition, we reviewed the websites and publications, such as annual reports and environmental, social, and governance (ESG) reports of the property owners and management companies to ensure information accuracy. All information had undergone further validation by cross-checking to ensure data precision.

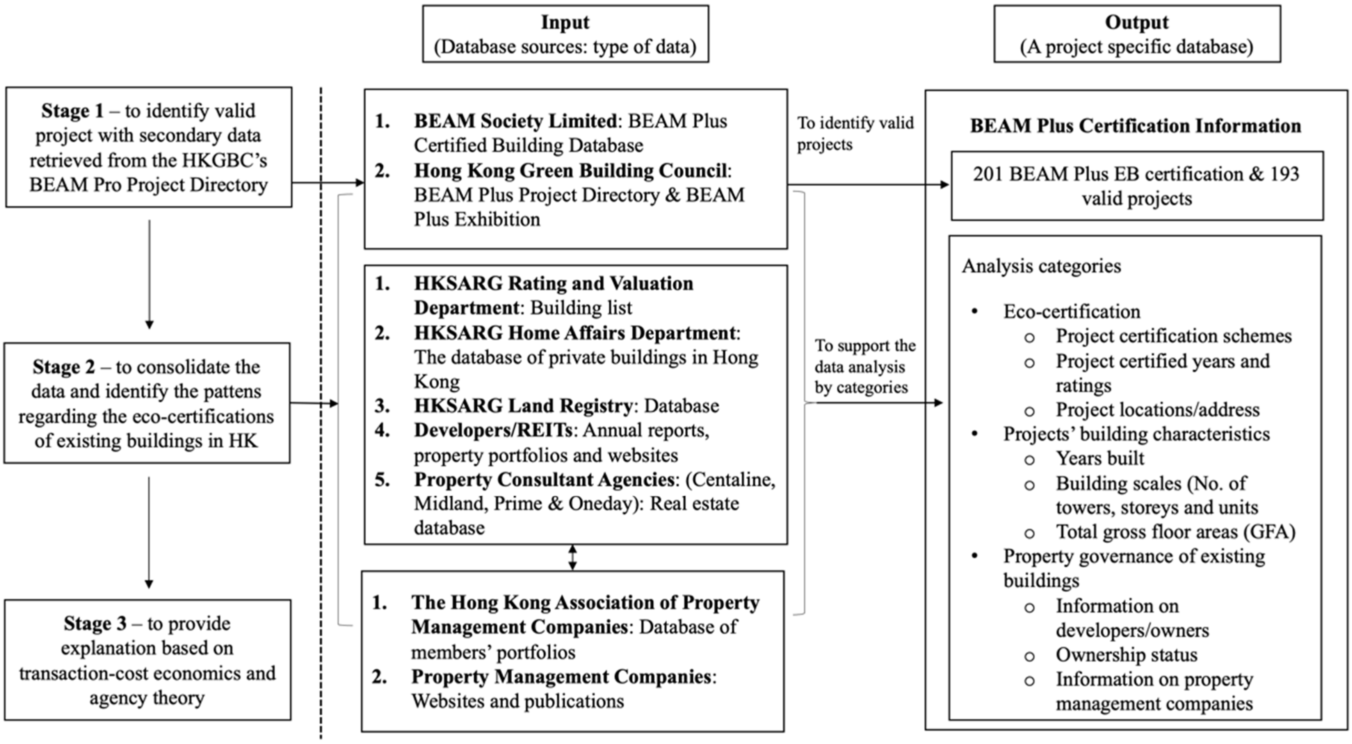


Figure 1. Research design, data retrieving, and analysis process.

To prevent ambiguity, the term "buildings" in the results section refers to "building projects" (the building or a group of buildings) with respect to BEAM Plus certification records.

4. Results

This section will present the analytical results of the eco-certification existing buildings in Hong Kong.

4.1. By Certification Schemes and Ratings

Table 1 shows that only 41 buildings in Hong Kong are completely certified with six sustainable building areas. (This figure aggregates 40 building projects that achieved BEAM Plus comprehensive certification and an NGO headquarter, which gradually achieved all six performance aspects through BEAM Existing Buildings Version 2.0 Selective Scheme.) Approximately 20% of the certifications were recognised through the comprehensive scheme, while more than 80% of BEAM EB certifications were awarded in the selective scheme. Most BEAM-certified existing buildings were rated in the management aspect only. This kind of certification contributed to nearly 90% of the certifications in selective schemes and 71% of all types of certifications (including comprehensive scheme and selective schemes). Although energy use and site aspects were the second and third most prevalent aspects rated in the selective schemes, they respectively contributed to 6.2% and 2.5% of selective certifications across six sustainability fields. Excluding an outlier project where the headquarters of a non-governmental organization (NGO) was certified in all six aspects of the selective scheme, i.e., equivalent to a comprehensive certification, no selective certification was recognised in the area of material and waste aspects or indoor environmental quality. The proliferation of management certifications also skewed the overall distribution of the green EB certification rating, as shown in Table 2.

Table 1. Breakdowns of certifications by schemes (N = 201).

Certification Scheme	No. and Percentage	Aspect	No. and Percentage
BEAM EB Version 1.1 and Version 1.2	10 (5.0%)	-	-
BEAM EB Version 2.0 (Comprehensive Scheme)	30 (14.9%)	-	-
BEAM EB Version 2.0 (Selective Scheme)	161 (80.1%) [1]	Management	143 (88.8%) [2]
		Site	4 (2.5%)
		Materials and Waste	1 (0.6%)
		Energy Use	10 (6.2%)
		Water Use	2 (0.6%)
		Indoor Environmental Quality	1 (0.6%)

[1] ()—the percentage of participated scheme in respect of all BEAM Plus certifications. [2] ()—the percentage of participated aspect in respect of BEAM EB Version 2.0 Selective Scheme.

Table 2. Breakdowns of certifications by pathways and ratings (N = 201).

Rating	No. via Individual Certification	No. via Volume Certification	Overall
Final platinum/excellent	57 (85.1%)	10 (7.5%)	67 (33.3%)
Final gold/very good	4 (6.0%)	0 (0%)	4 (2.0%)
Final silver/good	3 (4.5%)	124 (92.5%)	127 (63.2%)
Final bronze/satisfactory	3 (4.5%)	0 (0%)	3 (1.5%)
Total	67 (100%)	134 (100%)	201 (100%)

In general, over 97% of BEAM existing buildings were awarded a silver/good rating or higher. For the volume certification of the property portfolio submitted by the two major developers (Sun Hung Kai Properties and Link REITs), and their subsidiary property management companies, more than 60% of the certifications are classified into "Final Silver/Good". A small proportion of applications (1.5%) are assigned to a satisfactory classification.

On the other hand, the final ratings of the projects through the two certification pathways are different. There is a significant relationship between the final rating and certification pathway ($\chi^2 = 149.54$; $p < 0.01$). If solely considering the final rating by individual certification, it is revealed that around 85% of the certifications are given with the highest rating (final platinum or excellent). It implies that applicants applying local green building schemes through individual certification may focus on the sustainability dimension qualities (maximum credits achieved). Yet, why do the individually certified have higher ratings? Do project types and building uses also affect BEAM certification methods? Moreover, as it is hypothesised that buildings with single ownership pay fewer transaction costs for green building retrofitting, what are the implications of different ownership statuses on BEAM EB certifications? We analyse property management governance of BEAM-certified buildings by their ownership status, building uses, and owner types.

4.2. By Building Ownership Status, Project Types, and Sectors

The previous section showed that the majority of BEAM-certified existing buildings were assessed only based on the aspect of sustainable building management. It is equally important to examine the ownership status, building type, and sector in unpacking the potential barriers of sustainable building retrofits in Hong Kong. Generally speaking, developers, property owners, and property management companies are imperative in regard to building governance and sustainable building retrofit. Collective actions are necessary for co-owners to initiate building energy retrofits. From the transaction costs and agency perspectives, it is expected that existing buildings in multiple ownerships are less likely to be eco-certified. This is because high transaction costs are usually incurred in the negotiations and coordination among co-owners of multi-owned properties when it comes to initiating certification or improving common areas of buildings. Besides, co-owners in multi-owned properties often need to rely on property management companies in eco-certification or energy retrofit projects. The companies may not act in the best interests of the co-owners.

Table 3 breaks down the certifications by ownership status, project types (or building uses), and owner types. Regarding ownership status, it is found that nearly 72.5% of certified existing buildings in Hong Kong are owned by a single owner (hereafter: single-owned), while the rest (27.5%) are owned by multi-owners (hereafter: multi-owned). Regarding the certification pathways—a difference in terms of ownership status can be seen. The ownership status ratio (i.e., number of certified single-owned buildings to that of certified multi-owned buildings) surged to about nine to one (90% single-owned versus 10% multi-owned) if cases where volume certification was excluded. (Contrasting ownership status outcomes are observed if we separate the samples concerning certification pathways. Regarding ownership status per application type, around 35% of projects via portfolio certifications are multiple-owned (whereas 63.6% are single-owned correspondingly). By contrast, about 11.7% of projects via individual certifications are multiple-owned (and 88.3% of projects are single-owned).) This implies that more single-owned buildings applied the BEAM certification via individual application than via volume application.

Table 3. Cross-table showing the breakdowns of certified projects by project types, ownership status, and owner types (N = 193).

Project Type/Ownership Status		No. of Projects				Percentage of Projects			
		Public	NGO	Private	Overall	Public	NGO	Private	Overall
Commercial	Total	0	0	133.5 [4]	133.5	0%	0%	100%	100%
	SO [1]	0	0	119	119	0%	0%	100%	89.1%
	MO [2]	0	0	14.5	14.5	0%	0%	100%	10.9%
Residential	Total	1	1	27.5	29.5	3.4%	3.4%	93.2%	100%
	SO	1	1	1	3	33.3%	33.3%	33.3%	10.2%
	MO	0	0	26.5	26.5	0%	0%	100%	89.8%
Industrial	Total	0	0	15	15	0%	0%	100%	100%
	SO	0	0	3	3	0%	0%	100%	20.0%
	MO	0	0	12	12	0%	0%	100%	80.0%
Government/Institution or Community (GIC)	Total	10	2	0	12	83.3%	16.7%	0%	100%
	SO	10	2	0	12	83.3%	16.7%	0%	100%
	MO	0	0	0	0	0%	0%	0%	0%
Other Types [3]	Total	0	0	3	3	0%	0%	100%	100%
	SO	0	0	3	3	0%	0%	100%	100%
	MO	0	0	0	0	0%	0%	0%	0%
All	Total	11	3	179	193	5.7%	1.6%	92.7%	100%
	SO	11	3	126	140	7.9%	2.1%	90.0%	72.5%
	MO	0	0	53	53	0%	0%	100%	27.5%

[1] SO: single ownership; [2] MO: multiple ownership; [3] others included freight forwarding centres, data centres, and technology parks. [4] Some projects count as half (0.5) for a particular property use. For example, a mixed-use project (residential-cum-commercial project) counts as 0.5 for "commercial" and 0.5 for "residential".

By project type, nearly 70% of BEAM-certified existing buildings are commercial properties, while 15% are residential buildings. Industrial buildings, government/institution or community (GIC) buildings, and buildings of other types only account for approximately 8%, 6%, and 2% of the whole sample, respectively. All 15 industrial buildings were certified through volume certification through the selective scheme ("Management" aspect) by a major developer. The figures in Table 3 indicate that the BEAM-certified existing buildings in Hong Kong are predominantly single-owned commercial use. As far as the owner type is concerned, more than 92.7% of the eco-certified projects belong to the private sector, whereas the public organizations or NGOs own less than 10%. There is a significant relationship between the project type and sector (owner type) (χ^2 = 168.42; p <

0.01). The reason behind such findings is straightforward. The GIC projects predominately belong to the public sector while nearly all commercial, residential, and industrial projects are from the private sector.

Moreover, a significant relationship is found between the sector (owner type) and certification pathway ($\chi^2 = 34.28$; $p < 0.01$). Moreover, projects certified via volume certification have an average score significantly higher than those certified individually (*t*-statistics = 15.08; $p < 0.01$). That means volume certification generally results in less superior eco-labels. Table 4 enumerates the BEAM-certified projects by the project's key owners or property developers. Sun Hung Kai Properties has the greatest number of BEAM-certified existing buildings projects (75 projects in total or 38.8%), followed by Link REIT (50 projects or 25.9%), Swire Properties (13 projects or 6.7%), as well as Nan Fung Group (12 projects or 6.2%). However, 96% of Sun Hung Kai Properties projects were granted through the volume certification pathway under the selective scheme ("management" aspect). Similarly, all projects managed by Link REIT and Nan Fung Group were certified via volume certification under the selective scheme ("management" aspect). For Swire Property, HKSAR Government and Hongkong Land, have the most BEAM-certified existing buildings through the individual certification pathway citywide. For the Swire Property and Hongkong Land, all their certified projects are single-owned Grade A commercial buildings with the highest performance grading (Final Platinum). The records of these buildings were traced against the HK-BEAM system (HK-BEAM certification is the oldest version of BEAM tool). It reveals that all of them were previously certified in either/both HK-BEAM new or/and existing buildings, and nine of them were HK-BEAM-accredited new buildings with the highest rating (Platinum) (certified between 1996 and 2005). In other words, these BEAM-credited existing buildings are either pre-existing green buildings certified by HK-BEAM certification before, or buildings that were managed in a sustainable manner in previous years. Single ownership and engagement of a subsidiary property management agent facilitate the sustainable building retrofitting and eco-certification process.

Table 4. Breakdowns of certified projects by developers or property owners (N = 193).

Property Owner/Developer (Parent Organization) [1]	HKGBC Patronship	No. of BEAM-Certified Existing Buildings			Average Rating Score [2]
		via Individual Certification	via Volume Certification	All	
Public Sector		**11**	**0**	**11**	**1.46**
HKSAR Government	-	8	0	8	1.38
University of Hong Kong	Marble	1	0	1	1.00
Vocational Training Council	-	2	0	2	2.00
NGO		**3**	**0**	**3**	**1.67**
Business Environment Council	-	1	0	1	1.00
Hong Kong Housing Society	-	1	0	1	3.00
Tung Wah Group of Hospitals	-	1	0	1	1.00
Private Sector		**45**	**134**	**179**	**2.43**
CK Asset Holding	-	1	0	1	1.00
Ever Gain Plaza Management	-	1	0	1	2.00
Gammon Construction	Marble	1	0	1	1.00
Great Eagle Holdings	Silver	1	0	1	1.00
Hang Lung Group	Gold	4	0	4	1.25
Henderson	Gold	1	0	1	1.00
HKEX	-	1	0	1	1.00
Hongkong Land	Gold	6	0	6	1.00
Hysan Development	Gold	2	0	2	1.00
Link REIT	Gold	0	50	50	1.67
Mapletree	-	1	0	1	3.00

MTR Corporation	-	1	0	1	1.00
Nan Fung Group	Gold	0	12	12	2.00
New World Development	Platinum	3	0	3	3.00
Pacific Century Premium Developments	-	1	0	1	1.00
Paramatta Estate Management	-	1	0	1	1.00
Shui On Group	-	1	0	1	4.00
Sino	Gold	3	0	3	2.00
Sun Hung Kai Properties	Gold	4 [3]	72 [3]	75	2.64
Swire	Platinum	13	0	13	1.00
Total		60 [3]	134 [3]	193	–
Average Rating Score		2.86	1.25	2.36	–

[1] Regarding Joint Venture Project or ownership status with complicated situations, this table regards the major developers as (1) the company who carried out BEAM certification as main developers if equally shared; (2) the one with the largest ownership share. [2] This refers to the arithmetic mean of BEAM Plus ratings of all projects in the portfolio of a particular organization, with 1 = final platinum/excellent; 2 = final gold/very good; 3 = final silver/good; and 4 = final bronze/satisfactory. [3] The energy use certification of Sun Hung Kai Centre was obtained through the individual application while the management certification was through volume application. We count this project in both certification pathways.

We should note that that many applications for certifications were lodged by the property management agents rather than the property owners. Furthermore, there are vigilant affiliations between the owners/developers of the certified buildings and the property management agents managing the buildings. Among the BEAM-certified existing buildings owned by the private sector, 99% (178 out of 179) of the BEAM-certified buildings are developed and managed by companies that belong to the same groups. In many cases of multi-owned private buildings, the property management companies concerned are subsidiaries of the developers. For single-owned buildings, the building owners often dedicate the property management tasks to their own specialised in-house property teams or subsidiary property management companies. Table 5 enlists the building owners (or developers) and property management companies that have close relationships.

Table 5. Reciprocal relationships between developers and property management companies.

Property Owners/Developers (Parent Company)	Property Management Company (PMC)	No. of Projects under the Same Group
CK Asset Holding Limited	Goodwell Property Management Ltd.	1
Gammon Construction	Gammon Construction Ltd.	1
Great Eagle Holdings	Keysen Property Management Services Ltd.	1
Hang Lung Group	Hang Lung Properties Ltd.	4
Henderson	Henderson Sunlight Property Management Ltd.	1
HKEX	Hong Kong Exchanges and Clearing Ltd.	1
Hongkong Land	Hongkong Land Group Ltd.	6
Hysan Development	Hysan Property Management Ltd.	2
Link REIT	1. Link Asset Management Ltd. 2. Link Property Management Services Ltd.	50
Mapletree	Mapletree North Asia Property Management Ltd.	1
MTR Corporation	MTR Corporation Ltd.	1
Nan Fung Group	1. Hon Hing Enterprises Ltd. 2. Main Shine Development Ltd. 3. Mount Nicholson Property Management Ltd. 4. Nan Fung Property Management New Charm Management Ltd.	12
New World Development	Urban Property Management Ltd.	3

Pacific Century Premium Developments	Island South Property Management Ltd.	1
Paramatta Estate Management	Paramatta Estate Management Ltd.	1
Shui On Group	Shui On Centre Property Management Ltd.	1
Sino Group	Sino Estates Management Ltd.	3
Sun Hung Kai Properties	1. Hong Yip Service Co. Ltd. 2. Kai Shing Management Services Ltd. 3. Royal Elite Service Company Ltd. 4. S.H.K. Real Estate Management Co. Ltd. 5. Sun Hung Kai (Harbour Centre) Ltd. 6. Supreme Management Services Ltd.	75
Swire	Swire Properties Management Ltd.	13
Total		178

4.3. By the Building/Estate Development Scale

The development scales of certified projects of residential buildings can be measured with two indicators: (i) the number of residential units; and (ii) the gross floor areas (GFAs) of the projects assessed by BEAM professionals. Two classification methods with equal intervals and Jenk's natural breaks were adopted to estimate the number of residential units, and the estimation was undertaken using the geospatial thematic classification with the aid of the software QGIS 3.

Table 6 shows the breakdowns of BEAM-certified projects for residential uses by the number of residential uses using two different intervals. For the 29 BEAM-certified existing buildings for residential uses, a total of 25,096 residential units were identified, comprising about 0.85% of the total housing stock in Hong Kong (the total number of residential units in Hong Kong as at 2020 was about 2,924,000 [43].) However, most of the residential buildings were certified under the selective scheme with regard to the management aspect, and their certification applications were driven by the property management companies. Among the 29 samples, one project, a senior staff quarters tower for a government-funded university (renovated in 2016), was assessed under the comprehensive scheme, while 4 (out of 29) residential projects were certified via the individual certification pathway.

Table 6. Number of residential units of BEAM-certified projects for residential uses (N = 29).

Equal Interval		Natural Break (Jenks)	
No. of Residential Units	**No. (%) of BEAM EB Residential Projects**	**No. of Residential Units**	**No. (%) of BEAM EB Residential Projects**
10–916	20 (69.0%)	10–264	11 (37.9%)
917–1823	5 (17.2%)	265–723	9 (31.0%)
1824–2729	2 (6.9%)	724–1159	4 (13.8%)
2730–3636	0 (0%)	1160–2771	3 (10.3%)
3637–4542	2 (6.9%)	2772–4542	2 (6.9%)
Overall	29 (100%)	Overall	29 (100%)

By Jenk's natural break classification, over one-third of the BEAM-certified projects had less than 265 residential units. Three projects were low-rise luxury terrace-type residences, and another seven were single/twin high-rise towers. Furthermore, one large-scale estate (City One Shatin) was certified via individual certification under the selective scheme ("Management" aspect). In this project, the management company only selected 3 out of 52 blocks in the estate (536 out of 10,642 units or 5.3%) for BEAM Plus certification application. The possible reason behind this might relate to the collective decision-making issue, which is that the agreement among residents was difficult to seek. This situation may affect the decision-making of green building retrofitting in the estate. This helps explain why no multi-owned large-scale housing estates are awarded or registered for BEAM eco-certification by their individual applications. This phenomenon will be further discussed in Section 5.

Unlike their residential counterparts, many non-residential projects often have an open-plan design. It is thus impracticable to compare project scales solely based on the unit numbers. Yet, it is still envisaged that an existing building with a larger GFA is likely to have more owners or tenants than the one with a smaller GFA. Therefore, the number of the owners or tenants involved in a project can be roughly estimated by the assessed GFAs. As indicated in Table 7, about one-third of the 155 BEAM-certified projects are small-scale developments. Five projects are classified as developments with an exceptional or mega-large scale.

Table 7. Assessed GFAs of BEAM-certified projects (N = 155) [1].

Project Scale [2]	Corresponding Construction Floor Area (sq. m.) [2]	No. (%) of BEAM Plus EB Projects	No. (%) of Projects Achieving BEAM "Energy Use" Performance [3]
Extra small (ES)	≤2499	2 (1.3%)	2 (1.3%)
Small (S)	2500–24,999	49 (31.6%)	10 (6.4%)
Medium (M)	25,000–49,999	37 (23.9%)	8 (5.2%)
Large (L)	50,000–99,999	40 (25.8%)	15 (9.7%)
Extra large (EL)	100,000–199,999	22 (14.2%)	7 (4.5%)
Mega large (MG)	200,000–400,000	4 (2.6%)	2 (1.3%)
Exceptional Scale	>400,000	1 (0.6%)	0 (0%)
Overall		155 (100%)	44 (28.4%)

[1] The information of assessed GFAs of the certified projects in the database of the BEAM Society Ltd. was last updated in early 2020. By then, the information of assessed GFAs was available for 155 out of 193 certified projects only. [2] The categorization of the project scale follows the scale adopted in the determination of the BEAM Plus application fee. Due to limited available clarification on the BEAM's assessed GFA, we assume that the construction floor area (CFA) equals the assessed GFA. [3] Projects achieving "energy use" performance refer to those projects certified under the comprehensive scheme or selective scheme ("energy use" aspect).

4.4. By Regions and Districts

Table 8 presents the breakdowns of certified projects by building uses and regions. Figure 2 shows the geographical distribution of BEAM-certified projects by building uses (in dots of different colours) and the proportions of projects certified via individual certification pathways in each district. Figure 2 indicates a high concentration of the certified projects in and around Hong Kong's central business district (CBD). This can be explained by the findings in Section 4.2, which is that most of the certified projects are commercial projects. BEAM-certified single-owned Grade A office buildings are clustered in the CBD areas where Central, Admiralty, Wan Chai, and Tsim Sha Tsui districts are located. On the other hand, from Figure 2, we can also find certified projects in different districts. This can be explained by the practices of volume certification adopted by the large developers or landlords whose green properties in their portfolios scatter citywide.

Table 8. Breakdowns of BEAM-certified projects by building uses and regions.

Region	% of Projects via Individual Certification (N = 60)						% of Projects (All Pathways) (N = 193)					
	C	R	I	GIC	OU	All	C	R	I	GIC	OU	All
Hong Kong Island	73.2%	40.0%	0%	8.3%	0%	55.0%	30.5%	40.7%	14.3%	8.3%	0%	29.0%
Kowloon	19.5%	40.0%	0%	58.3%	0%	28.3%	30.5%	30.5%	50.0%	58.3%	0%	33.2%
New Territories	7.3%	20.0%	0%	33.3%	100%	16.7%	39.0%	28.8%	35.7%	33.3%	100%	37.8%
Overall	100%	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Notes: C = commercial; R = residential; I = industrial; GIC = government, institution, or community; O = other uses.

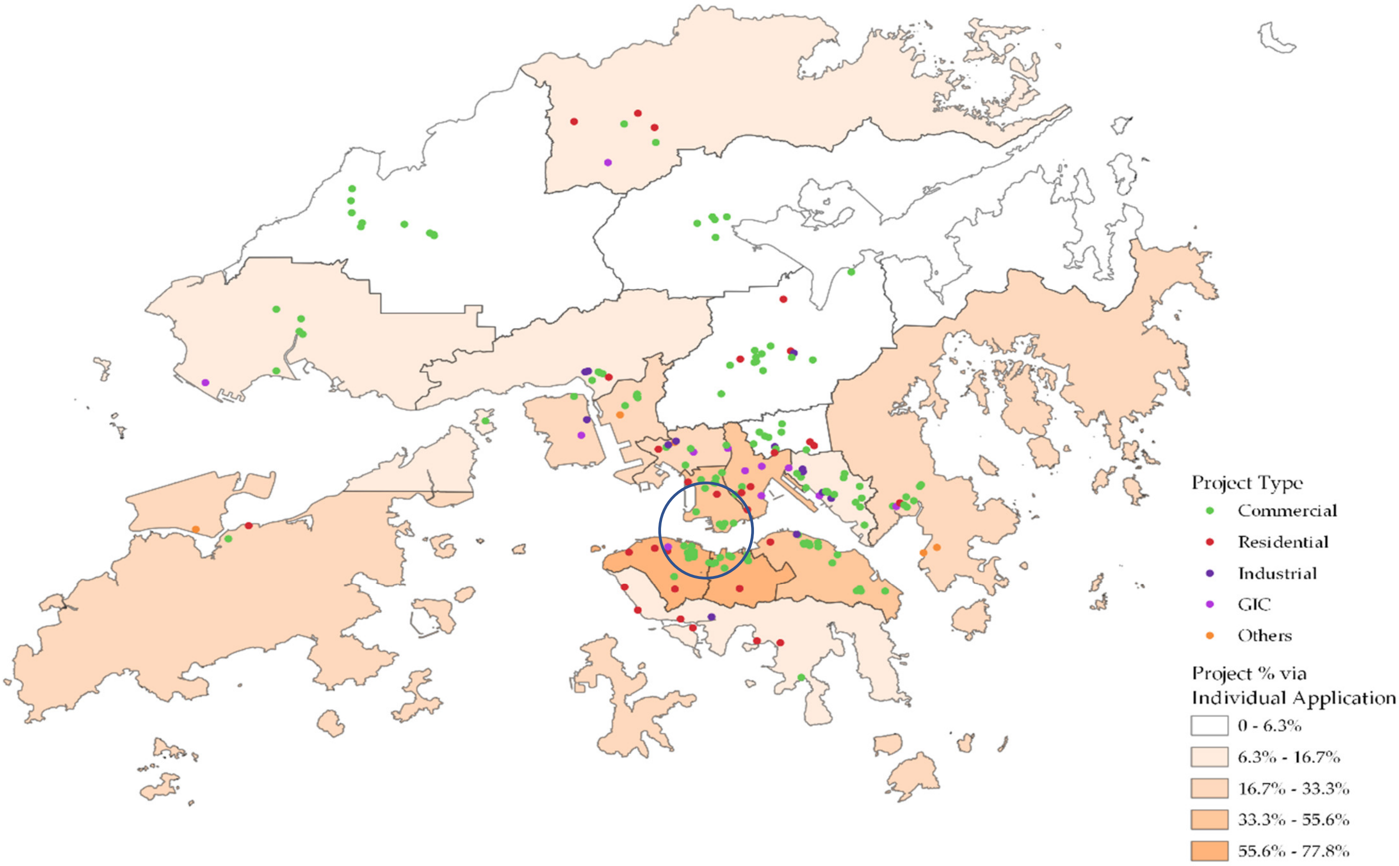
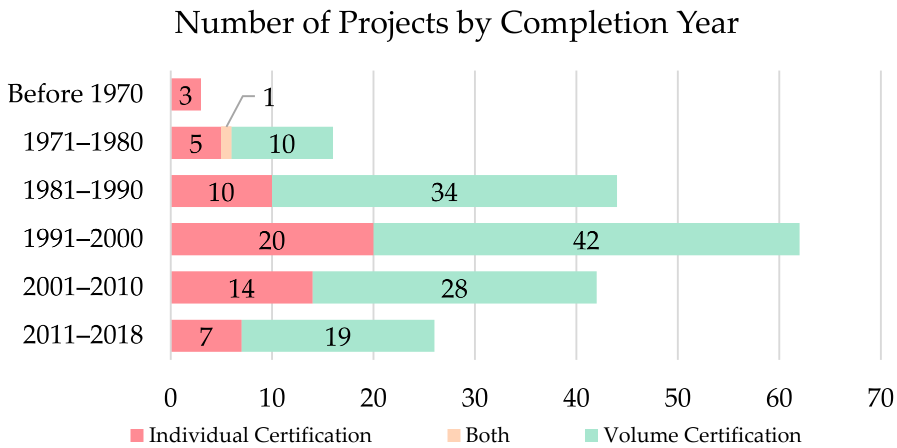


Figure 2. Map showing the project distribution in Hong Kong. Notes: (1) the blue circle indicates the proximate location of Hong Kong's CBD [53]. (2) Boundaries of districts in the figure follow the delineation adopted in 2016 Population By-census [54]. (3) The map was produced using QGIS 3.

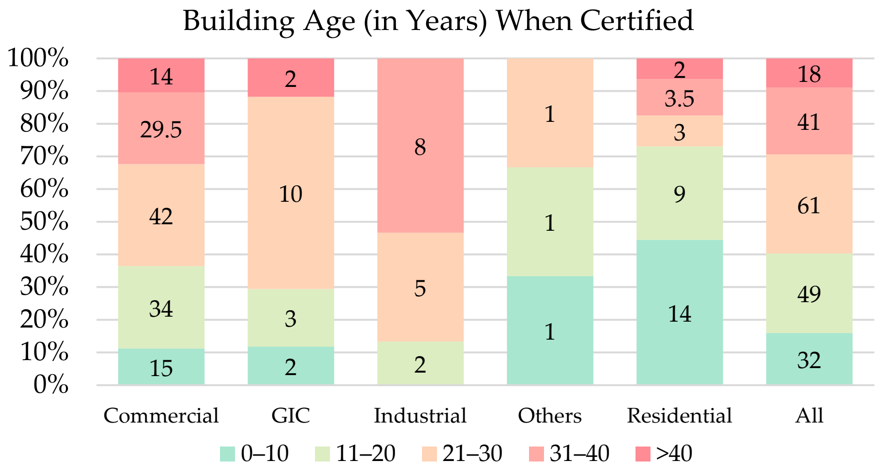
4.5. By Completion Years and Building Ages upon Certification

Figure 3 presents two charts, illustrating the completion years of BEAM-certified existing buildings and the information of building ages when the current certifications were obtained. Overall, the building ages of existing buildings when eco-certified are rather diverse though the certification pathway, exerting no significant impact on the building age group distribution (t-statistic = 0.62; $p > 0.1$). Moreover, 75% of the certifications were granted to the buildings between 11 and 40 years of age. A significant difference between commercial and residential projects can be identified by comparing the building age groups of the two sets of projects (t-statistic = 3.88; $p < 0.01$). That is, eco-certified residential buildings tend to be "younger" than their commercial counterparts. Moreover, 73% of BEAM EB certifications were issued to residential projects under 20 years old. Particularly, 44% of certified residential buildings were completed less than 10 years before certification. On the contrary, only 11% of commercial buildings were less than 10 years when awarded the BEAM certification. Over half (53.2%) of the eco-certified existing buildings were commercial buildings between 21 and 40 years of age. Existing buildings built before 1970 were the HK-BEAM-certified existing Grade-A office with longstanding sustainable building maintenance (as discussed in Section 4.2) or renovated in the 2010s. To conclude, comparing the BEAM-certified residential buildings, more "old" commercial buildings are certified under BEAM Plus existing buildings. Thus, building age may be a potential barrier to sustainable building retrofits of residential buildings in Hong Kong.

Generally speaking, more architectural and structural constraints may be encountered in the retrofitting projects of the "older" buildings. Higher costs are usually incurred in the building energy retrofits of the old buildings. Furthermore, sufficient evidence shows that the governance of old buildings (such as the old Chinese tenements) is notoriously complicated, particularly when these buildings are so-called the "three-nil buildings" (i.e., buildings not managed by any owners' corporation, residential organization, or external property management agent) [55]. This phenomenon well echoes the findings from the data analysis by completion years and building ages upon certification.



(**a**)



(**b**)

Figure 3. (**a**) Project by completion year; (**b**) building age when certified by project types.

5. Discussion

Drawing on the findings above, disparities have been found in the eco-certification of the existing buildings in Hong Kong. In this section, these disparities will be discussed from various perspectives, particularly the transaction cost theory and agency theory.

5.1. Certification of Multi-Owned Properties Impeded by Institutional Settings

For buildings in multiple ownership, the decision to apply for eco-certification or to undergo building energy retrofits necessitates collective actions among the co-owners. Co-ownership is often regarded as a barrier to the implementation of building energy retrofits [56,57]. The difficulty to initiate eco-certification and retrofits increases with the number of co-owners involved. This echoes the classic Olsonian view that collective actions are less likely to succeed when the group size increases [36]. From a neo-institutional economics perspective, the transaction costs incurred during the negotiation and coordination could be prohibitively high when a large group of co-owners is involved. The transaction costs for initiating eco-certification applications and/or retrofit projects are lower for single-owned projects, which explains why over 70% of the certified EB projects are held in single ownership.

Besides, most BEAM-certified residential projects are of smaller scales. This also goes along with the transaction cost perspective above. The larger is the project scale, the more will be the interested parties (i.e., co-owners) involved. Higher transaction costs will then impede collective actions to partake in eco-certification. Although there are a few large-scale projects in multiple ownership certified under BEAM Plus, these certifications were initiated by the property management companies rather than the co-owners themselves. The agent-led applications for eco-certification can be explained by lower transaction costs incurred in the coordination and lobbying processes. Most other cases of multi-owned residential properties of smaller scales were certified under the selective scheme ("management" aspect) only. The applications were made through volume certifications by the property management companies who managed large portfolios of residential properties throughout the territory. This understanding that greening existing multi-owned properties is more challenging than single-owned properties echoes many previous west studies [58].

The government intends to regard larger housing developments as more resourceful so less subsidization is provided to the large-scale housing developments to initiate building improvement projects. However, the findings of the current research may suggest that in the light of high transaction costs, which impede collective actions, more subsidization should be institutionalised to incentivise co-owners of large-scale housing developments to participate in building eco-certification and retrofit projects.

5.2. Agency Problems of Eco-Certification

As discussed above, property management companies may initiate the eco-certification exercises themselves. They can obtain different "selective benefits" by choosing to participate in the eco-certification. First, the BEAM certificates can showcase their CSR initiatives for fulfilling the ESG requirements. Second, the BEAM certifications obtained by the property management companies in selected projects can serve as marketing tools for promoting the companies. Third, large property management companies have many projects in their management portfolios so they can enjoy discounts in application fees through volume certification. Fourth, as shown in Table 4, some property management companies and/or their parent groups are patron members of the HKGBC who administrates the BEAM Plus scheme. Their participation in the eco-certification exercise can demonstrate their genuine supports to the council and the scheme.

On the other hand, private sector projects tend to get less superior BEAM certifications than the projects owned by the public sector or NGOs. The private sector projects have an average score significantly higher than their non-private sector counterparts (t-statistics = 5.36; $p < 0.01$). Besides, most of the private sector projects are eco-certified under the selective scheme ("management" aspect) only. These findings may indicate that property management agents are not so willing to pay efforts in achieving real energy savings. It is because their managers' remunerations (or profit margins) are set as a certain percentage (usually 10–15%) of the total operating expenses of the building (including utility charges for the common areas and facilities) [59]. In Hong Kong, electricity charge comprises a very large proportion of the expenditure in daily building management [60]. There is a strong incentive for the property management agents to keep the electricity charges high in order to maximise their managers' remunerations. Agency problems exist between the property management agents and their clients (i.e., building owners). In the lack of check and control mechanisms, the agents strive to maximise their own profits at their clients' expenses [61,62]. The agency cost of multi-owned property management is higher when more 'decision power' is dedicated to a property management agent [63]. The high agency cost, intertwined with the high transaction costs of co-owner-led certification, impedes the eco-certification of existing multi-owned buildings or developments.

Moreover, the findings of the current study may suggest that the major developers or sizeable landlords in Hong Kong are more active in eco-certification of their existing properties because of the lower agency costs incurred in the decision-making and execution of eco-certification. In many BEAM-certified EB projects, the property management agents and the developers, landlords, or building owners have close relationships (or they are in the same groups). The parties share compatible or aligned goals, so the agency costs of eco-certification or energy retrofit are comparatively lower.

One of the means to solve the agency problems is to alter the remuneration mechanism for property management agents. Instead of using a cost-plus-margin approach, a fixed amount of service fee for remunerating a property management agent can reduce its disincentive to initiate building energy retrofits. The agent can be further incentivised to retrofit with a bonus contingent on savings in energy consumption or other aspects of environmental performance improvement.

5.3. Greater Drives for Certification of Privately Owned Commercial Properties

Apart from the transaction cost theory and agency theory, we attempt to draw insights in the decision making for eco-certification of existing buildings from other perspectives. In Table 3, one can see that approximately 70% of the certified existing building projects are commercial properties. Residential properties account for only 15% of the certified projects. Apparently, incentives for going green are more significant for commercial properties compared with other building uses. There are several reasons behind the unevenness across building uses. First, many commercial properties, such as offices and retail properties in Hong Kong are for leasing. It has been widely documented that green credentials help landlords attract tenants, particularly institutional tenants, to rent their properties [64,65]. Large companies, especially U.S.-based ones, are very committed to lease eco-certified properties [66,67]. Moreover, rental premiums brought about by the building eco-certifications are quite evident in the commercial property sector [68–70]. Moreover, landlords of single-owned commercial properties may be rewarded as they take the certification as CSR evidence. These drives seem to outweigh the disincentives created by the oft-mentioned dilemma of split incentives for landlords to have their properties go green [71–73].

5.4. More Eco-Certifications with Building Energy Retrofits in the Non-Private Sector

The project type (or building use) is highly related to the sector and ownership type. For instance, GIC buildings, in most circumstances, are single-owned by the government departments (public sector) or NGOs. The non-private organizations tend to have their existing building projects accredited under the comprehensive scheme or selective schemes for various aspects rather than merely "Management" aspects. The non-private sector is more willing to undertake energy retrofits to their buildings, going beyond simply taking sustainable building management practices. Apart from the agency perspective discussed above, the pattern can be explained by the motive of the public sector and NGOs. The non-private organizations would like their BEAM-certified projects to be "demonstration projects" to showcase the applications of new technologies and construction practices, to achieve sustainable building. It is important for the diffusion of such technologies and practices to the whole building sector in Hong Kong.

For the public-owned BEAM-certified buildings, they share at least one of the following features: (i) the building serves as a departmental headquarters; (ii) the building is geographically located in Kowloon East under the environmentally sustainable second CBD agenda (Energizing Kowloon East), and (iii) the building has been recently allocated public funding for refurbishment or infrastructure upgrading. The public sector projects can undergo building energy retrofits with sufficient financial resources being granted. Payback is not a necessary consideration for these public sector projects. Therefore, fewer barriers are expected in public sector projects than in private sector buildings.

Of three EB projects owned and managed by NGOs, two are headquarters buildings, one is for a business sustainability organization, and one is for a charity group. Specifically, the two buildings are single-owned and perform as role models for other organizations to follow in retrofitting their existing premises. The remaining one belongs to the Hong Kong Housing Society, a local public housing agency established in a non-governmental institutional setting. It is an old public rental housing estate renovated with the incorporation of green roofs, the use of environmentally friendly and energy-saving materials, and the introduction of an environmental and energy management system.

On the other hand, private enterprises may just target the signalling effects of the BEAM certification or take the certifications as evidence for ESG reporting. They are inclined to pick the most cost-effective options to fulfil the ESG requirements. Therefore, we can see many private enterprises applied for BEAM certification under the selective scheme for the "management" aspect only because this route necessitates minimal financial inputs. Besides, a high proportion of private enterprises opt for certification through the volume certification pathway, which offers discounts in application fees. To further promote energy retrofits among existing buildings in the city, the Hong Kong government should offer more incentives to the building owners. Apart from the current policy that capital expenditure on the installation of environmentally friendly machinery and equipment can be tax-deductible—the government may consider subsidizing building owners to apply for eco-certification under the comprehensive scheme. The rationale is that existing buildings usually need to be retrofitted first to get eco-certified under the comprehensive scheme.

6. Conclusions

The research findings demonstrate the imbalance in the popularity of eco-certification among different types of existing buildings in Hong Kong. They offer insights into the areas in which the promotion of retrofits is needed. Furthermore, this study opens up a new avenue for broadening the research area of eco-certification of existing buildings. The current research unveils that there are fewer eco-certified existing buildings in multiple ownership and with larger scales. Such finding echoes the transaction cost economics and the classic Olsonian view of collective actions. Besides, agency problems are found to occur in the eco-certification of existing buildings. Property management agents tend to obtain less superior classes of eco-label or certification. This phenomenon reflects that the property management agents are reluctant to initiate energy retrofit projects with the existing buildings because real energy savings are in contradiction with their profit maximization initiatives. Based on the empirical findings, there is a need to rethink the subsidization strategy and redesign the incentive structures for third-party property management services in order to stimulate more existing buildings to be eco-certified.

While we discussed the principal–agent relationship between building owners and property management agents in the current article, agency problems in building energy retrofits also exist between the government and building owners [6]. How these agency problems shape the landscape of eco-certification remains unanswered. Furthermore, there could be some cases where the building owners may want to retrofit their properties but not pursue third-party certification of the projects [74]. There is a possible gap between energy retrofits and eco-certification, particularly for non-investor or non-corporate building owners. Thus, further investigations targeting these issues are warranted.

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