Green building for office interiors: challenges and opportunities

Background

Green interiors are a ramification of green building that refers to efficiently using resources and improving occupant health and productivity. The increased interest in the green building concept resulted in a number of green building standards and rating systems such as LEED (Leadership in Energy and Environmental Design), which help government regulators, building professionals and consumers embrace green building with confidence (Yudelso, 2008). Aiming at the fit-out, renovation and refurbishment of interior spaces, green building rating systems for interiors are launched. For example, LEED for Commercial Interiors (LEED CI) enables project teams, who may not have control over whole building operations, the opportunity to develop indoor spaces that are better for the environment as well as for occupants. Similar green interiors' rating systems are Hong Kong Building Environmental Assessment Method (previously known for BEAM, now BEAM Plus) for Interiors, Singapore Green Mark for Interiors, Australia Green Star for Interiors and so on.

Although research tends to be sceptical about the green building rating system, it is undeniable that these standards or rating systems provide practical methods and guidelines for designing and assessing building performance through a user-friendly checklist. Real estate research repeatedly reported strong business cases for green buildings in the commercial sector, such as lower operation costs and higher market performance (Dermisi, 2009, Fuerst and McAllister, 2009, Kuziemko, 2015, Gou et al., 2013, Hui et al., 2015). The business senses plus governmental policies make the green building revolution swipe across the world in the past two decades. By the end of 2014, more than 7000 building projects covering 1.5 billion gross floor areas applied LEED as the design guideline for sustainability (USGBC, 2014). Among all green building projects, the contribution of green interiors cannot be ignored. As shown in Figure 1, the number of LEED CI projects increased rapidly with other LEED projects in the past decade. Three countries, U.S., China and India, accounted for more than 90% LEED CI projects, as shown in Table 1.

Insert Figure 1

Insert Table 1

The rating systems for interiors aim at three project types: commercial interiors, retails, and hospitality. Office premises are usually the major client for the green interior certification. Many international companies include LEED certification in their corporate sustainability missions. Therefore, when they relocate or open new offices, LEED CI is adopted for showcasing their sustainability commitment. For example, Bloomberg has 17 LEED-CI certified offices. These offices are located in U.S. as well as overseas (Hong Kong, Dubai, Kuala Lumpur, Singapore, London, Mumbai, Oslo, Seoul, Shanghai, etc.). Bank of America is another LEED dedicated company who has more than 17 local and overseas LEED-CI certified offices. CB Richard Ellis has more than 15 LEED CI offices. Many architectural companies such as HOK are actively renovating their local and overseas offices for LEED-CI certification. LEED is seen as an important business strategy for these companies. However, their offices are usually located in a multi-tenant commercial building where they do not have control over the whole building design and major renovation. LEED-CI, therefore, is a sensible choice to guide interior retrofitting to increase employees' work performance, as well as to strengthen the corporate social and business image.

Objective

Retrofitting usually refers to interventions to adjust, reuse, or upgrade a building to suit new conditions or requirements (Wilkinson, 2012, Mansfield, 2002). Building retrofitting is proved to be an effective intervention to reduce carbon footprint, energy consumptions and improve occupant satisfaction (Forsythe and Wilkinson, 2015, Lo et al., 2014, Atkins and Emmanuel, 2014, Gohardani and Björk, 2012, Miller and Buys, 2008, Baccarini and Bateup, 2008, Kok et al., 2012). Most building retrofitting strategies involve building envelope, Heating Ventilation and Air-conditioning (HVAC) system; renewable energy, lighting, elevators, even building roofs and surroundings (Zhang et al., 2014). However, since most office buildings today are occupied by multi-tenants, tenants usually do not have control over the whole buildings for retrofitting. Interior retrofitting is a common means for tenants to recreate their spaces. Normally, interior retrofitting refers to work of redesigning and reconstructing the existing space in order to incorporate new technologies (e.g. building services, informational and communication technologies) which were not foreseen in the

original design. Derived from the concept of green building, green building for interiors incorporates a number of strategies covering energy and water efficiency, waste reduction and management, low environmental impact materials, and effective building operation and facility management. It more stresses a life-cycle and multi-scale perspective from urban planning to specific material selection. It is beyond the scope of a normal interior retrofitting project which is usually confined to the indoor space for its spatial function, furnishing and decoration. The question is: to what extent can an interior retrofitting project achieve green building principles such as reducing resource uses and enhancing users' experience? This article is to find out challenges of implementing green building concepts in interior retrofitting projects, based on which opportunities are expected to be found.

Methodology

To enquire the research question, this article conducts multi-examinations on green building rating systems for interiors and their certified interior projects.

Firstly, green building rating systems for interiors are reviewed and compared to identify what sustainability attributes compose a green building and what are requirements for an interior project to meet the green building principles and targets. Although there are dozens of green building rating systems for new constructions or whole building certifications, few have the systems for interiors. This article selects and compares four major green building rating systems for interiors: U.S. LEED (USGBC, 2013), Hong Kong BEAM Plus (HKGBC, 2013), Australia Green Star (GBCA, 2012), and Singapore Green Mark (BCA, 2012).

Basically, these systems for interiors are based on their main systems for new constructions, with add hoc sustainability attributes for interiors. Their reference guides or technical toolkits are included in this review.

Secondly, LEED CI certified projects are examined in terms of their scorecards, aiming to identify commonalities of these interior retrofitting projects. Examining certified interior projects can help to identify how these projects achieve green building certification and what green design practices are used in the interior retrofitting. Although there are more and more rating systems for interiors being launched for the multi-tenant commercial office building market, LEED is dominant in terms of the number of certified projects. USGBC (U.S. Green

Building Council) lists out all LEED certified projects in the project directory (<http://www.usgbc.org/projects>) that is accessible to the public. After sampling and filtering, 27 LEED CI certified projects are selected for analyses (Table 2). The project owners and clients are world top interior design companies who are passionate about showcasing sustainability in their own office design. These projects represent cutting-edge sustainable interior design concepts and technologies. All the selected LEED CI projects are certified according to LEED 2.0. Although there are different versions of LEED for interiors (e.g. LEED CI 1.0, 2.0, 2009 and 4.0), only LEED CI 2.0 certified projects are published with their certification details. These projects are widely distributed across the world, especially in financial cities where interior design is well developed and the market is prosperous.

Insert Table 2

Last but not least, LEED CI certified offices are surveyed to find out whether the office interiors with green intent can actually enhance occupants' working experience which is one of key objectives of green building principles and is also the main driving factor for tenants to pursue green interiors. This article presents an interview study of three LEED CI Gold offices (Figure 2). The host buildings of the three offices are located in central urban areas. The tenants are three leading architectural companies: HOK, M Moser and NBBJ. The three companies tested their sustainable design ideas and strategies in their offices. The design intent of the three surveyed offices was not only to showcase the firms' dedication to sustainable design but also to create the best work environment for employees, for example, the open-plan layout for maximum outdoor views and daylight penetration, individual task lights, low-emitting materials and so on. Many studies on green building use experience tended to use standard survey methods to investigate the level of comfort or satisfaction (Gou et al., 2012, Baird and Lechat, 2009); while this article mainly presents a focused group interview to understand users' needs and expectations of a sustainable workplace. Five participants from each office were face-to-face interviewed. The interviewees were architects or designers. The interview was semi-structured and conducted in a step-by-step manner so that respondents could reply conveniently. It started from a simple question "Do you know that fact that it is a certified green office?" After that, a number of structured questions were asked. These questions cover indoor environmental qualities such as thermal comfort,

lighting and acoustics, as well as other issues related to work performance, e.g. facilities, space, behaviour, etc. (Lai and Yik, 2007, Leaman, 1995, Leaman, 1990).

Insert Figure 2

Green Building Rating Systems for Interiors

Figure 3 summarises the major categories in each system for interiors. The common categories shared in the four systems are: energy, indoor environment quality, materials. LEED, BEAM Plus and Green Star also include water as a category for interiors. Table 3 compares weightings for these categories in the selected rating systems for interiors. Obviously, Green Mark and LEED give more weighting to Energy; while Green Star and BEAM Plus allocate more weightings to Material. The commonality is that Indoor Environmental Quality (IEQ) is considered equally important in these rating systems.

Insert Figure 3

Insert Table 3

The category of Energy usually encourages passive design (natural ventilation and daylighting), high performance building systems (Heating Ventilation and Air-conditioning, abbreviated HVAC), energy management systems (metering and monitoring) and renewable energy uses (photovoltaics, wind turbines, etc.). It rewards projects that reduce the amount of greenhouse gas emissions from operations by addressing issues of energy demand, use efficiency, and supply of energy from alternative sources. The category of Material encourages and rewards interior projects that reduce, reuse and recycle building materials. The majority of materials used in a building are usually sourced outside the site; therefore any effort to reduce imported material contributing to lower environmental impacts is rewarded. The category of Water encourages and rewards initiatives that reduce the interior project's consumption and reliance on potable water. The category assesses the efficiency of projects' fixtures and water reuse strategies, and rewards the substitution of potable water with alternative water sources such as stormwater after being appropriately treated. The category of Indoor Environmental Quality mainly refers to aspects or attributes such as indoor temperature, air quality, lighting, etc., which may impact occupant comfort, health and productivity. The category encourages adopting design strategies that enhance the occupant

comfort and productivity, and rewards selecting low-emitting interior materials that help reduce indoor pollutants' concentrations. There are other different categories covered in these rating systems. The category of Management included in BEAM Plus and Green Star for interiors encourages and rewards the adoption of sustainable development principles in management practices from design, implementation and operation. The other categories such as Transport, and Land Use and Ecology in Green Star and Location and Transportation in LEED for interiors address the choice of a sustainable base building for hosting the interior project. The category of Innovation is aimed to reward innovative or exceptional performance in sustainable design.

The design of a green building highlights a variety of practices, techniques, and technologies to reduce and ultimately eliminate the impacts of buildings on the environment and human health. In practice, it often advocates planning the site for ecology, locating the project in a dense and well connected urban area, designing open spaces with trees and greenery, designing rain gardens and permeable pavements, using water efficient fixtures, selecting high performance HVAC, lighting and other systems, using renewable resources through photovoltaic panels and wind turbines, selecting low emitting building materials, using building materials from local sources and so on. Some of these green building design practices are within the footprint or boundary of a building; while others are related to a building's interface areas and surroundings. The important fact is that these strategies or interventions are interrelated within the host building in which the interior project is located. The most effective way, obviously, is to select a host building with better sustainability attributes and performance levels in terms of the building's location, design, construction, and management. So, all rating systems encourage the selection of a host building that has been certified as a new construction or major renovation, or alternatively has integrated best practice environmental sustainability measures into its design and daily management. Otherwise, the project designers need assess the host building's performance and find out opportunities for retrofitting to meet the requirements in the green rating systems.

LEED Scorecard Analyses

Scorecards for these selected projects are collected and compiled. As shown in table 4, the scorecard lists all credits under each category and indicates the achievement of these projects (N=27).

Insert Table 4

Under the category of Site, most interior projects can satisfy the credits for *Development Density and Community Connectivity*, and *Public Transportation Access*; while they perform less well on the credits for *Bicycle Storage and Changing Rooms*, and *Parking Availability*. This is because most of these offices are located in cities' downtown areas or central business centres (CBD) where buildings are densely planned and well connected to local services and public transits; however, cycling is not encouraged in the planning of these urban central areas and storage and changing rooms for bicycles are seldom considered in the design of these commercial towers. There are only two credits in the category of Water. More than half of these projects satisfy the credits through changing water fixtures for higher efficiency. The credits under the category of Energy show significant variances. The best performance is found on the *Energy Star Equipment and Appliances* that are under the direct intervention of the project designers by selecting and using Energy Star certified office equipment and appliances; while the worst performance is found on the *HVAC Improvements* that are not under the direct control and are largely dependent on the host building since most modern office buildings are centrally controlled. Half of the selected interior projects get the credit on Green Power through purchasing electricity from offsite renewable sources instead of adding solar panels or using wind turbines on the site of their projects.

Under the category of Material, most interior projects can develop and implement a construction waste management plan that diverts construction, demolition, and packaging debris from landfill disposal and redirects recyclable recovered resources back to the manufacturing process or appropriate sites. These projects reuse parts of existing furniture and furnishings such as case pieces, seating, filing systems, decorative lighting and accessories; they also use furniture and furnishings with recycled content and building materials that are manufactured within the region. However, few projects maintain interior non-structural components (walls, flooring and ceilings) and less projects use salvaged, refurbished or reused materials (such as beams and posts, flooring, doors and frames, cabinetry, and brick). This is because these interior elements are usually fixed before occupancy and are out of control of the tenant and interior designers. Few projects use rapidly

renewable materials made from plants that are typically harvested within a short cycle, such as bamboo flooring, wool carpets, straw board, cotton batt insulation, linoleum flooring and others. These projects neither use certified wood based on the Forest Stewardship Council's Principles and Criteria. This is because there are few office furniture or furnishings made from these environmental-friendly materials.

Under the category of Indoor Environmental Quality (IEQ), most projects select low emitting materials such as adhesives, paints, carpets and so on. The interior design makes most seated workstations have direct contact of outdoor views through the open-plan layout. However, few interior projects monitor air delivery and provided individual ventilation control. They also find it difficult to satisfy the requirement on indoor chemicals and pollutant source control that must either employ permanent entryway systems from entering the building or change the ventilation, filtration or drainage systems. These strategies are beyond the design scope of these interior projects if the host buildings are not designed and operated taking into account these requirements. It is interesting to find that even though these interiors have direct outdoor views for most workstations, they can hardly achieve equivalent daylighting performance. The performance of daylighting for an interior depends on three factors: daylight availability on the building envelope, physical and geometrical properties of windows, and physical and geometrical properties of the interior space (Lam, 1977). The open-plan layout and high reflectance furnishing that are used in these interior projects can only maximally utilize the portion of penetrated daylight while it cannot change the daylight availability on the building envelope and windows.

Through analyses of the 27 LEED CI projects and their scorecards, it is found that their achievements on green credits are confined to the direct interventions on interior elements while other green credit achievements are largely dependent on the host building and its urban context. In other words, the green design is rather opportunistic. If the interior project is not appropriately located, many green attributes may not be achieved at any costs or design efforts. For example, because most office buildings are centrally air-conditioned, few green interior projects could be able to improve HVAC performance which would significantly impact indoor environments and energy efficiency. If the office is not appropriately located, it is hard to encourage employees to use bicycles; it is also difficult to acquire daylighting.

Users' Experience

Most interviewees were aware of their office certified by LEED and they thought the most appreciable green feature in their offices was abundance of daylight in their workstations. Their specific responses on the indoor environmental qualities as well as work performance are shown in Table 5. They perceived that the daylighting design brought more openness in their offices, which engendered a more collaborative environment. The most positive features that help their work in these certified offices are resulted in by daylighting and open-plan design, too, for collaboration and outdoor views. The lighting retrofitting also successfully provided individual controllability to adjust workstation lighting according to their task performance (computer work or paper work). They also perceived that they were more adaptive since working in their offices. For example, to tackle unstable temperature, they changed their clothing; to avoid distract others, they tended to lower their voices; to be physically in contact with outside, they were more likely to take break for an outside walk. Many negative experiences came from air quality and temperature, which is mainly due to the instability of the centralised HVAC system in the host buildings. Some perceived the glare reflected by the surroundings. Responses on acoustics mainly refer to the much noise from inside due to the open plan layout and air-conditioning operation while less noise from outside because of the sealed building envelope. The negative confirmed with the fact that the environmental performance of interiors such as thermal comfort and air quality, are largely dependent on the host building (Baird et al., 2012, Miller and Buys, 2008), especially when the building is sealed with a central air-conditioning system. Negative experiences also came from lack of space to conduct work. Because most of them are designers who need space to draw and store files. They also tended to be critical of space quality. For example, there is a lack of different scales of space for collaborations. It is interesting to see that respondents unanimously expressed their needs for shower and fitness facilities. These facilities which are of importance to employees' health and well-being, usually can't found in an office building, but can be easily found nearby if the building is appropriately located.

Discussion

An interior retrofitting project is usually confined to its indoor space; while green building highlights a larger scale environmental assessment covering at least five categories: Site, Water, Energy, Material and Indoor Environmental Quality. Each of these categorises or aspects contain specific credits. To acquire the green building certification, the interior

project shall meet as many as possible credits under each category. As shown in Figure 4, some of these credits are within the tenant interior space; some are largely dependent on the host building's condition as well as its urban context. Interior designers are primarily associated with the role of interior space design and the selection of finishes, furniture, and fixture that has a significant influence on healthy environments and energy and water efficiencies. However, the wide spectrum of green building rating systems and their design credits requires an interior retrofitting project to look beyond the interior space and also requires tenants and designers to think and operate more strategically. What is the urban context? Whether is it situated in a well-connected urban area with a pedestrian-friendly access to public services, transit and so on? How much daylight available on the building's envelope? What is the building's HVAC system? Whether can the HVAC system be improved in terms of energy performance and indoor pollutants' control? How much can existing furnishings or furniture be maintained? There are many questions posed for an interior project that aims for green building rating and certification. The tenants and designers need to insert themselves in the questioning phase before a project has a clear position. Through the questioning phase, the interior project can wisely choose a host building with better sustainability attributes and performance levels in terms of the building's location, design, construction, and management, which makes the interior retrofitting more effectively minimize its environmental impacts and enhance employee's work experience.

Insert Figure 4

Through empirical studies of LEED scorecard and interviews, it is obvious that interior retrofitting had limited interventions over the base building and its urban context. For example, few projects could improve their HVAC performance for energy efficiency or air quality, which resulted in negative building occupants' experience according to the interview study. The occupants also reported a lack of amenities in workplaces. If the base building is not designed or operated in an environmental-friendly way or the base building's surroundings are not equipped with facilities, the interiors would fail most key sustainable features. The failure of achieving some significant green credits raised some question marks or critiques for green interior retrofitting projects. Although these designers and clients of these projects are top architecture and interior design companies in the world, their

retrofitting efforts tended to be low-hanging fruits such as interior fitouts. It needs to be pushed further to embrace more significant green features and credits. On the other hand, these offices are located in prestigious modern office buildings in urban downtown or CBD areas. The failure might also point to a question mark: whether today's office buildings can allow an effective retrofitting? This may refer to some technical issues as well as some rental or lease legislation issues. The effectiveness of green retrofitting should be interrogated in real estate and properties management research.

Conclusion

The green building credits for interiors fall into three relational layers: the urban context, the host building and interior fitouts. Most projects under study performed well on credits for interior fitouts (e.g. low emitting materials, energy efficient equipment and appliances, etc.) while underperformed on credits for its host building (e.g. air-conditioning systems, ventilation, etc.). The latter might more significantly affect occupant satisfaction. The other aspects such as daylight availability, facilities accessibility might be subject to its location and urban context. If an office is located in a host building designed and managed in an environmental friendly way, especially with high performance Heating Ventilation and Air-conditioning system, the energy efficiency and employees' environmental comfort can be easily achieved; furthermore, if the host building is located in urban areas with good connections to public transits and services, the reduction of employees' carbon footprint and needs of facilities can be easily met. So, the host building and its location are most important in the retrofitting process, and should be prioritized in green building rating systems for interiors. This article recommends that tenants should be proactively involved in the early stage of location and host building selection.

The study selected 27 LEED CI offices for a scorecard analysis and 3 LEED CI offices for an interview study. All of them are design companies. The study of their offices is expected to represent most innovative design concepts and strategies. On the other hand, the study might be biased due to the singular sample type, especially for the interview. The obvious bias is that the design professionals might be more critical about space, such as the quantity and quality of space. However, responses to other questions such as temperature, air quality, facilities, and so on are supposed to be based on common office work experience. The article

suggests that the retrofitting as a strategy to implement green building should be further interrogated from other perspectives such as real estate, property management, etc.

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Table 1. Top 3 countries where LEED CI certified projects are located

No.	Area	Number of Projects	Percentage
1	United States	3556	84.0%
2	China	206	4.8%
3	India	133	3.1%
Accumulated Percentage			91.9%

Table 2. Selected LEED CI projects

No.	Project	City	Year of Certification	Level of Certification
1	Callison Dallas office	Dallas	2009	Certified
2	Callison New York	New York	2010	Gold
3	GENSLER NEW YORK OFFICE	New York	2007	Silver
4	Gensler - Boston Offices	Boston	2008	Gold
5	Gensler office-Houston	Houston	2008	Gold
6	Gensler London Office	London	2009	Silver
7	Gensler Phoenix Office	Phoenix	2009	Silver
8	Gensler Dallas Office	Dallas	2008	Silver
9	Gensler Seattle Office	Seattle	2010	Gold
10	HDR Architecture San Francisco	San Francisco	2010	Silver
11	HOK Singapore Office	Singapore	2007	Silver
12	HOK Shanghai Office	Shanghai	2008	Silver
13	HOK Chicago Office	Chicago	2009	Platinum
14	HOK Miami Office	Miami	2010	Certified
15	HOK HK Office	Hong Kong	2009	Gold
16	M Moser Guangzhou Office	Guangzhou	2009	Gold
17	M Moser Hong Kong Office	Hong Kong	2009	Gold
18	NBBJ Seattle Office	Seattle	2007	Gold
19	NBBJ LA Office	Los Angeles	2009	Silver
20	SmithGroup - San Francisco Office	San Francisco	2009	Gold
21	SOM Chicago Office	Chicago	2009	Silver
22	Flad Architects Atlanta Office	Atlanta	2010	Gold
23	DLR Group - MSP Office	Minneapolis	2010	Certified
24	EwingCole Philadelphia Office	Philadelphia	2008	Gold
25	Vocon Cleveland Office	Cleveland	2010	Gold
26	Space Matrix New Delhi Office	New Delhi	2010	Platinum
27	RTKL Chicago Office	Chicago	2008	Silver

Table 3. Aspects covered in each green building rating systems for interiors

Hong Kong BEAM Plus	Australia Green Mark	Singapore Green Star	U.S. LEED
<ul style="list-style-type: none"> • Green Building Attributes • Management • Materials Aspects • Energy Use • Water Use • Indoor Environmental Quality • Innovation 	<ul style="list-style-type: none"> • Energy Efficiency • Water Efficiency • Sustainable Management and Operation • Indoor Environmental Quality • Other Green Features 	<ul style="list-style-type: none"> • Management • Indoor Environmental Quality • Energy • Transport • Water • Materials • Land Use and Ecology • Emissions • Innovation 	<ul style="list-style-type: none"> • Integrative Process • Location and Transportation • Water Efficiency • Energy and Atmosphere • Material and Resources • Indoor Environmental Quality • Innovation • Regional Priority

Table 4. The LEED scorecard and project achievements

<i>Aspects</i>	<i>Credits</i>	<i>Requirements</i>	Projects that get the credit (N=27)	
			Number	Percent
Sustainable Sites	Credit 1	Site Selection	20	74%
	Credit 2	Development Density and Community Connectivity	26	96%
	Credit 3.1	Public Transportation Access	26	96%
	Credit 3.2	Bicycle Storage & Changing Rooms	10	37%
	Credit 3.3	Parking Availability	17	63%
Water Efficiency	Credit 1.1	Water Use 20% Reduction	18	67%
	Credit 1.2	Water Use 30% Reduction	15	56%
Energy & Atmosphere	Credit 1.1a	Lighting Power 15% Below Standard	18	67%
	Credit 1.1b	Lighting Power 25% Below Standard	15	56%
	Credit 1.1c	Lighting Power 35% Below Standard	8	30%
	Credit 1.2	Lighting Controls	15	56%
	Credit 1.3A	HVAC Equipment Efficiency	9	33%
	Credit 1.3A	HVAC Appropriate Zoning Controls	1	4%
	Credit 1.3B	HVAC 15% Improvement	2	7%
	Credit 1.3B	HVAC 30% Improvement	0	0%
	Credit 1.4a	Equipment & Appliances 70% Energy Star	24	89%
	Credit 1.4b	Equipment & Appliances 90% Energy Star	21	78%
	Credit 2	Enhanced Commissioning	7	26%
	Credit 3a	Energy Use Sub-metering	15	56%
	Credit 3b	Energy Costs Paid by the Tenant	15	56%
	Credit 4	Green Power	14	52%
Materials & Resources	Credit 1.1	Tenant Space Long-Term Commitment	16	59%
	Credit 1.2	Maintain 40% of Interior Non-Structural Components	7	26%
	Credit 1.3	Maintain 60% of Interior Non-Structural Components	6	22%
	Credit 2.1	Divert 50% Construction Waste From Landfill	21	78%
	Credit 2.2	Divert 75% Construction Waste From Landfill	17	63%
	Credit 3.1	5% Resource Reuse	4	15%
	Credit 3.2	10% Resource Reuse	3	11%

	Credit 3.3	30% Furniture and Furnishings Reuse	17	63%
	Credit 4.1	10% Recycled Content	20	74%
	Credit 4.2	20% Recycled Content	15	56%
	Credit 5.1	20% Materials Manufactured Regionally	19	70%
	Credit 5.2	10% Materials Extracted and Manufactured Regionally	8	30%
	Credit 6	Rapidly Renewable Materials	3	11%
	Credit 7	Certified Wood	3	11%
Indoor Environmental Quality	Credit 1	Outdoor Air Delivery Monitoring	4	15%
	Credit 2	Increased Ventilation	11	41%
	Credit 3.1	Construction IAQ Management Plan During Construction	21	78%
	Credit 3.2	Construction IAQ Management Plan Before Occupancy	11	41%
	Credit 4.1	Low-Emitting Adhesives & Sealants	23	85%
	Credit 4.2	Low-Emitting Paints and Coatings	27	100%
	Credit 4.3	Low-Emitting Carpet Systems	25	93%
	Credit 4.4	Low-Emitting Composite Wood and Laminate Adhesives	14	52%
	Credit 4.5	Low-Emitting Systems Furniture and Seating	15	56%
	Credit 5	Indoor Chemical & Pollutant Source Control	4	15%
	Credit 6.1	Controllability of Lighting	16	59%
	Credit 6.2	Controllability of Temperature and Ventilation	4	15%
	Credit 7.1	Thermal Comfort Compliance	21	78%
	Credit 7.2	Thermal Comfort Monitoring	15	56%
	Credit 8.1	Daylight 75% of Spaces	16	59%
	Credit 8.2	Daylight 90% of Spaces	10	37%
	Credit 8.3	Views for 90% of Seated Spaces	26	96%

Table 5. Main responses to the interview

Questions	Main Responses
Air quality	<ul style="list-style-type: none"> • Not enough fresh air • The air is a little stuffy • Ventilation is ineffective
Thermal Comfort	<ul style="list-style-type: none"> • The temperature is always too cold or too cold
Lighting/Daylighting	<ul style="list-style-type: none"> • Discomfort glare during morning makes it hard to focus on screen • Lots of natural light • Reflected glare from outside • Too much sun during the day, not enough light at night • Artificial lighting is unchanged day and night, and it needs more natural variety
Acoustics	<ul style="list-style-type: none"> • Noise from nearby colleagues when they are on the phone • Noise from air-conditioning and ventilation. • Too much noise from inside and no noise at all from outside makes me feel disconnected
Space at work	<ul style="list-style-type: none"> • Larger desk space is needed to accommodate sketching/drawing requirements • Lack of filing and storage space • Potential storage space on and below that desk has not been fully utilised
Meeting Space	<ul style="list-style-type: none"> • Need more team meeting areas • More small meeting rooms for 2-4 people • Lack of variety of space (large, medium and small meeting rooms) to accommodate different needs
Ergonomics	<ul style="list-style-type: none"> • Table height and chair is only suited for a taller person • Chairs are not ergonomically for tall people
Facilities	<ul style="list-style-type: none"> • Need a fitness room • Need shower facilities
Things that help work	<ul style="list-style-type: none"> • Adjacency to other team members • Good open plan enhance communication • Abundance of natural light and lots of windows to look out • Task lighting control • Good workstation for computer work

Things that hinder work	<ul style="list-style-type: none"> • Not enough intermediate gathering and interactive space • Excessive sunlight experience in the morning with the translucent blinds • Lack of desk space for filing and drawing • Noise and distraction • Stuffy air • No control over air-conditioning and operable windows
Change of behaviours	<ul style="list-style-type: none"> • Bring extra clothing, so that when the temperature is too cold, there is still sufficient clothing • Maybe drink for water if too hot to work inside the building • Lower voice when talking on the phone, afraid to cause interruption to other people • Sometimes noise so I put on earphones • When I see everyone focusing on work then make me more stay focused • No natural ventilation, I take the advantage of lunch time for fresh air and I have to make aware of influenza

Figure 1. Numbers of LEED CI certified projects in the past decade

Figure 2. Three LEED CI offices (1. NBBJ Shanghai Office; 2. M Moser Hong Kong Office; 3. HOK Hong Kong Office). All photos taken by the author.

Figure 3. Weightings of the five major categories

Figure 4. The spectrum of green building credits for interiors