# BUILDING SUSTAINABILITY ASSESSMENT METHOD (BSAM)

***For Countries in Sub-Saharan Region (Africa)***

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## BUILDING SUSTAINABILITY ASSESSMENT METHOD

This section discusses the eight (8) sustainability indicators and its sub-levels' attributes and sub-attributes (see Figure 1) which are used to develop the sustainability evaluation index and cloud-based sustainability decision support system (S-DSS) for buildings in this study.

For each sustainability sub-attributes, the following will be highlighted in this chapter: (i) description and aim of the sub-attribute (ii) allocation of points based on certain metrics (quantitative and qualitative) met; (iii) evidence to be assessed and verified to ascertain the fulfilment of the sub-attributes; (iv) whether the sub-attribute is an optional or required sub-attribute and (v) assessment stage where the sub-attribute is to assessed and verified for computation. Assessment must be done by a third-party independent assessor, and not all sub-attributes is applicable to every building type or each assessment stage. The assessment stages are preliminary design, design, construction, pre-occupancy to ≤ 1yr post-occupancy, and post-occupancy (>1year).

For '(iv)' above, it is not a function of whether the sub-attribute should be assessed for a building sustainability performance or not; but it is considered most especially when comparing two or more building designs or the completed building itself. In a situation, when two or more building designs have sustainability indicators (A-H) of the same factor index (SI) or have SI of close values, then the SI values of their sub-attributes will be considered (sub-attributes which are marked "required" are first compared before those marked "optional" are compared.

| Indicators | (A) Sustainable Construction Practices | (B) Site and Ecology | (C) Energy | (D) Water | (E) Material and Waste | (F) Transportation | (G) Indoor Environmental Quality (IEQ) | (H) Building Management |
|---|---|---|---|---|---|---|---|---|
| Attributes | Project Site & Design | Site Selection | Energy Performance | Water Efficiency | Sustainable Purchasing Practice | Alternative Means of Transport | Visual Comfort | Operation & Maintenance |
| | Societal Engagement | Site Management | Energy Management | Water Management | Efficient Use & Selection of Materials | Community Accessibility | Indoor Air Quality | Security |
| | Safety & Health | Reduction of Heat Island Effect | Energy Efficient Systems & Equipment | Water Efficient Systems & Equipment | Waste Management Practice | Transport Management | Thermal comfort | Risk Management |
| | Ethics & Equity | | | | Ease of Conversion of Building Functions | | Acoustic Performance | Green Innovations |
| | Construction Material & Waste | | | | | | Hygiene | |
| | Project Management | | | | | | Building Amenities | |

***Figure 1: Sustainability indicators (A-H) and its attributes***

## 1. SUSTAINABLE CONSTRUCTION PRACTICES (A)

Sustainability indicator A promotes and encourages the clients, developer, designers, project teams, and other key stakeholders to manage the construction project sites in a social, environmentally considerate manner (see figure 2). It also encourages and monitors the continual implementation and improvements in the project.

| Indicators | (A) Sustainable Construction Practices | | | | | |
|---|---|---|---|---|---|---|
| Attributes | Project Site & Design | Societal Engagement | Safety & Health | Ethics & Equity | Construction Material & Waste | Project Management |
| Sub-Attributes | Land use | Engagement of local firms | Operational safety and wellbeing | Compliance with labour standards | Locally sourced materials | Project brief & design |
| | Integration of cultural heritage in design | Local employment opportunities | Reduction of site disturbance | Compliance with social standards | Construction site waste management | Engagement of sustainability-conscious contractors & suppliers |
| | Construction method | Enhanced local economy | Safe neighbourhood | Education & skills development | Proper material handling | Site emergency response plan |
| | Buildability (ease of construction) | Public participation | Space accessibility & availability | Compliance with safety standards | Reuse of construction materials | Engagement of sustainability-conscious project management team |
| | Enhanced watershed features | | Reduction of site pollution | Compliance with client requirements | Storage facilities & space | Site management plan |
| | Reduction of ecological impacts | | | Environmental statutory requirements | | Commissioning & handover |

***Figure 2: Sustainable construction practices (indicator A)***

### *A1 – Project Site and Design*

This sustainability attribute comprises of six sub-attributes which as land use, integration of cultural heritage in design, construction method, buildability (ease of construction), enhanced watershed features, and reduction of ecological impacts.

#### A11 – Land use

This sub-attribute intends to assess the utilization of the physical land, water, and its resources, and various alternative land uses (while considering the social and economic constraints) towards selecting and adopting the best land use option. It ensures the optimal management and transformation of the natural environment towards protecting the natural resources. It also supports development on infill site and to ensure the project can be served by existing social amenities. A11 is a *required* sub-attribute. A maximum of three points are attainable from this sub-attribute based on the *following rating points*. A- Use of greenfield lands without adequate consideration for the natural environment (0 point); B- Use of greenfield lands with adequate consideration for the natural environment (2 points); and C-

Use of brownfield lands (3 points). *Documentary evidence* required include a report by the designers, project team or local authority on the land use options available to the project.

**A12 – Integration of cultural heritage in design**

Sub-attribute A12 is used to check and evaluate the level of integration of cultural heritage and knowledge (historical artistic designs, works of arts, and landscapes) of the local community or region in building designs and structures. It aims to enhance social capital and identity (Murzyn-Kupisz & Działek, 2013; Pérez-Gracia et al., 2013). A12 is an *optional* sub-attribute. A maximum of three points is achievable based on the *following rating points*. Q1- Is cultural heritage ideas included in the building design? (Yes- 1 point; No- none); Q2- What is the level of compatibility of design with local heritage values? (0-30% = 0.5 point; 31-50% = 1 point; 51-74% = 1.5 points; >75% = 2 points). Points accruable are based on summation of Q1 and Q2 are: A- 0point, B- 0.5point, C- 1 point, D- 1.5 points; E- 2 points, F- 2.5 points, and G- 3 points. *Documentary evidence* required includes an itemized list and description of relevant built cultural heritages applicable to the local context, photographic evidence, and the building design plans.

**A13 – Construction method**

A13 evaluates whether the selected construction method is suitable for the project site and for the structure to be built. It ensures the adoption of low-impact construction site techniques. A13 is a *required* sub-attribute. A maximum of four points is achievable based on the *following rating points*. A- Selected construction method not suitable (0 point); B- Selected construction method suitable for the project site only (1 point); C- Selected construction method suitable for the building or structure (2 points); and D- Selected construction method suitable for both the building and project site (4 points). *Documentary requirements* includes a technical or expert report by a team consisting of at least a member each of structural engineer, architect, project manager and land surveyor to certify the suitability of the selected construction method. Also, a description of the selected construction method; the building plans and site layout plan.

**A14 – Buildability (ease of construction)**

A14 identifies and assesses the building designs and construction techniques to ensure ease the efficiency to which the structure can be built. It identifies issues that might cause delays, overruns or errors during the building construction. A14 is a *required* sub-attribute. Three points are available for this sub-attribute based on the *following rating points*. A- 0-30% level of buildability (0 point); B- 31-59% level of buildability (1 point); C- 60-79% level of buildability (2 points); and D- ≥80% level of buildability (3 points). Two *documentary requirements* to certify the fulfilment of A14. Firstly, a detailed assessment report prepared by the project team,

designers or consultants evaluating the buildability of the buildings taken into consideration the following details as highlighted by Wong et al. (2006)- (a) site-specific factor (b) below ground factors (c) weather (d) design information (e) building detailing (design clashes, repetitive items, tolerances) (f) building flexibility (g) tools, plants and equipment (h) materials, fittings, products, and sub-assemblies (i) use of resources (j) site layouts access and environment (k) safety (l) material system (use of materials to fulfil performance and prevent wastages) and (m) installation sequence. Another evidence needed is the building and site layout plans.

**A15 – Enhanced watershed features**

The sub-attribute evaluates the control, measures, and management practices deployed to preserve water resources on the project site. It reduces the pollution of the water resources and bodies. Three watershed control measures (WCM) that can be adopted in a project include low impact development, green streets, and implementing minimum control measures. A15 is an *optional* sub-attribute. Two points are attainable by projects based on the *following rating points*. A- No WCM is implemented (0 point); B- One of the three WCMs is implemented (0.5 points); C- Two of the three WCMs are implemented (1 point); and D- All the three WCMs are implemented (2 points). *Documentary requirements* include a detailed report of the WCMs implemented in the project and the site layout plans.

**A16 – Reduction of ecological impacts**

A16 aims to reduce the effect of human activities and construction project activities on the natural habitats. It assesses the ecological implications and impacts of the proposed project at the various stages of the building development and to preserves irreplaceable natural and agricultural resources towards enhancing the ecological value of the site. A16 is an *optional* sub-attribute. A maximum of two points are achievable by projects based on the *following rating points*. A- No assessment of ecological impacts carried out (0 point); B- Implementation of containment measures to enhance ecology (1 point); and C- Technological tools deployed with containment measures to contain ecological impacts and enhance ecology (2 points). A report on the likely ecological impacts of the proposed project and the recommended containment measures is necessary to certify the fulfilment of this sub-attribute.

### *A2 – Societal Engagement*

Four sustainability sub-attributes constitute attribute A2 which are engagement of local firms, local employment opportunities, enhanced local economy, and public participation.

**A21 – Engagement of local firms**

A21 aim to assess the extent of the involvement of local or regional-based firms in the project. It focuses on supporting and promoting local businesses and jobs; and encourages them to be part of the project supply chain. It evaluates to what extent social capital is enhanced. A21 is an *optional* sub-attribute. Two points are attainable by projects using the *following rating points*. A- No local firm employed (0 point); B- 10-40% of engaged firms are competent local firms (1 point); and C- More than 40% of engaged firms are competent local firms (2 points). A detailed report of the leadership structure of the selected local and foreign firms and the level of experience of their staff.

**A22 – Local employment opportunities**

The sub-attribute evaluates the social benefits offered to the local communities through job opportunities, training, and the development of local skills and expertise. It aims to contribute to local economic growth. A22 is an *optional* sub-attribute. Two points are achievable under this sub-attribute using the *rating points below*. A- No employment of local communities' residents or indigenes (0 point); B- 10-30% of employees are from local communities (1 point); and C- More than 30% of employees are from local communities (2 points). A documentary evidence of the competency and residential record of all employees.

**A23 – Enhanced local economy**

A23 assess the level at which the construction project contributes to the sustainable economic growth and development of the local economy. It considers the corporate social responsibility (CSR) services render by participating construction organizations (HKGBC, 2016). A23 is a *required* sub-attribute. Two points are available under this sub-attribute which are rated as follows. A- No contribution made (0 point); B- Non-sustainable economic contributions (1 point); C- Sustainable economic contributions (2 points). Documentary evidence include an assessment report on the economic contribution of the project to the local economy and assessment team must contain at least 40% from the local communities and 20% from the local authority.

**A24 – Public participation**

The sub-attributes assess the participation level and input of the local communities and authorities in the concept, design, decisions, and other relevant areas of the building development. It encourages the responsiveness of the community to the project (USGBC, 2018b). According to (USGBC, 2018d), the public and local communities must be engaged in the predesign, preliminary design, construction phases, and post-occupancy. A24 is an

*optional* sub-attribute. Two points are attainable under this sub-attribute using the following the rating points. A- No input by the public/local communities (0 point); B- Inputs by the public/local communities with little or partial implementations of recommendations (1 point); and C- Inputs by the public/local communities with full implementations of recommendations (2 points). *Documentary requirements* include minutes of the meetings held with the public and other stakeholders as well as the report of the deliberations and implementation of the decisions reached.

### *A3 – Safety and Health*

The attribute A3 aim to improve and promote the on-site and off-site health and safety. It also considers the impact of construction process and resources on the project site, human's wellbeing, and the natural environment. The fulfillment of this attribute has diverse benefits ranging from financial, social, and environmental benefits for the projects and its neighborhood. It is composed of five sub-attributes as discussed below.

#### A31 – Operational safety and wellbeing

It assesses the proactive policies, strategies, and management practices put in place on a project site to protect, improve and safeguard the wellbeing of site workers, communities, and site visitors against workplace hazards. It involves the continuous monitoring of the health and safety plans to reduce the risks to workers' health and safety, and to enhance productivity. A31 is a *required* sub-attribute. A maximum of two points are available which are allocated as follows. A- No working plan or policies to safeguard workers and visitors' safety and wellbeing (0 point); B- Proactive plan to safeguard workers and visitors' safety and wellbeing (1 point); and C- B *plus* engagement of a line manager in charge of workers and visitors' safety and wellbeing and policy guidelines (2 points). A documentary requirement in form of policy guidelines for the site's operational safety and wellbeing.

#### A32 – Reduction of site disturbance

It aims to minimize the amount of site clearing, grading, and soil disturbance involve during construction on project site. It intends to limit development to previously developed portions of the site as much as possible. It encourages the conservation of existing natural areas (non-invasive trees, native plants etc.) and restore damaged areas. It excludes land or areas designated by law or that are not buildable. A32 is an *optional* sub-attribute. Two points are attainable under this sub-attribute which are allocated as follows. A- Less than 30% of the site undisturbed (0 point); B- 30-50% of the site undisturbed (1 point); C- 51-80% of the site undisturbed (1.5 points); and D- >80% of the site undisturbed (2 points). A plan of the site

layout and site areas is required as well as a survey of identified trees and identification of any heritage trees and monument of special interest to the locality.

**A33 – Safe neighborhood**

It assesses and ease the disruption to the adjoining or neighboring houses, people or communities due to ongoing construction activities or movement of project trucks. It ensures the development footprint of the locality is not increased and promote efficiency in transportation and walkability during the construction stages and promote health and wellbeing of residents. A33 is a *required* sub-attribute. One point is available for allocation according to the following rating points. A- No provision of plans to ensure safe neighborhood (0 point); and B- Detailed arrangement and plans to ensure safe neighborhoods (1 point). Two documentary evidence are required and include: (i) assessment of ways the project and associated activities could impact safe neighborhoods; (ii) results of the investigation undertaken to check the project site for contamination.

**A34 – Space accessibility and availability**

It evaluates the site layout planning and arrangement to ensure it allows for ease of access to persons, materials, and movements of plants and equipment. A34 is a *required* sub-attribute. One point is available under this sub-attribute and allocated as follows. A- No site layout planning and arrangement (0 point); and B- Adequate and feasible project site layout arrangement (1 point). A detailed site layout plan and arrangement is required as a documentary requirement.

**A35 – Reduction of site pollution**

It mitigates, reduces, and prevent site pollution at its source of generation through increased efficiency in the utilization and management of project resources. It intends to increase workers' productivity and encourages the incorporation of best practices into the developed mitigation measures. Sources of site pollution include airborne (dust, soil erosion, waterway, sedimentation) (USGBC, 2018d), light pollution, vibration, land, air and water pollution (BRE, 2018). A35 is a *required* sub-attribute. One point is achievable by projects under this sub-attribute. A- No mitigation measures against site pollution (0 point); and B- Implementation of effective mitigation measures against site pollution (1 point). A bi-monthly evaluation of the overall pollution level of the project site is a required documentary evidence for assessment.

### *A4 – Ethics and Equity*

It encourages every project stakeholder involved in the project to promote the ideals of social equity by integrating guidelines that addresses the social and economic needs of the local

communities and project workers and tackles any arising disparities. It also encourages to comply with relevant statutory, regulatory standards and requirements. It promotes the concept of CSR by the construction firms' top management, product manufacturers, contractors, consultants, and other key stakeholders (LEED, 2009). It verifies the financial stability of participating construction organizations; and focus on equity in the ownership, design, and construction of the project (LEED, 2009). Ethics imposes both legal and moral obligations on the project (McCaffrey, 2011) and contents of professional ethics include integrity, objectivity, confidentiality, honesty, transparency, and fairness. A4 comprises of six sustainability sub-attributes (A41 to A46) as discussed below.

**A41 – Compliance with labor standards**

The sub-attribute promote compliance with relevant and applicable labor standards which include issues such as fair and equitable workforce pay packages, paid leaves, bonuses, and benefits. It considers fair working hours, good working conditions, and compensations. A41 is a *required* sub-attribute. Two points are achievable under this sub-attribute. A- Project does not comply with relevant labor standards (0 point); B- ≥70% of the contractors and sub-contractors meet or exceed the prevailing labor standard requirements (1 point); and C- B *plus* a report on the compliance to the labor standard and verification by labor unions or government departments (2 points). Documentary evidence needed includes (i) a copy of the applicable labor standard and (ii) compliance report and verification by an independent assessor.

**A42 – Compliance with social standards**

It promotes diversity and equal opportunity and disallows discrimination. It should also promote right of freedom of association and encourages the concept of corporate social responsibility by project organizations and key stakeholders. It involves community's participation, gauging of societal impacts and preparing a social responsibility report. A42 is a *required* sub-attribute. Three points are achievable under this sub-attribute. A- Project does not promote diversity and equal opportunity and other social standard requirements (0 point); B- ≥70% of the contractors and sub-contractors meet or exceed the social standard requirements and promote diversity and equal opportunity (2 points); and C- B *plus* a report signed and endorsed by the project team or client detailing the social impacts target met (3 points). Documentary evidence needed includes (i) a copy of the applicable social standards or requirements and (ii) compliance report and verification by an independent assessor.

**A43 – Education and skills development**

It ensures the participating organizations in the construction project promote skill development of their staff. It also places emphasis on the education and practical skill development of students through the provision of internship opportunities to students and encourages construction firms to sponsor their staff to seminars, workshops to keep them abreast of recent trends in the industry. A43 is a *required* sub-attribute. Two points are attainable by projects based on the following rating points. A- No priority was given for education and skills development of project staff, workers and interns (0 point); and B- Priority was given for education and skills development of project staff, workers and interns (2 points). Documentary evidence such as the record or schedule of courses, seminars, workshops attended by project workers and records of interns engaged during the project and contact details of the training provider.

**A44 – Compliance with safety standards**

It ensures the project complies and apply relevant safety and health requirement to the project site. It also addresses the development and provision of relevant safety guidelines and ensuring the concerns of key project stakeholders are addressed. A44 is a *required* sub-attribute. Two points are achievable under this sub-attribute. A- Project does not comply with relevant safety standards (0 point); B- Project comply with relevant safety standards (1 point); and C- B *plus* a report on the compliance to the safety standard (2 points). Documentary evidence needed includes (i) a copy of the applicable safety standard and (ii) compliance report and verification by an independent assessor.

**A45 – Compliance with client's requirement**

It addresses the need for the project to comply with the client's requirement and specifications during the planning, design, construction and post-construction stages of the project. The project team and key stakeholders responsible to the clients for all project decisions should ensure decisions and recommendations reached fit within the project's objectives, budget and schedule constraints. A45 is a *required* sub-attribute. A maximum of two points are available which are allocated as follows. A- No compliance with the client's requirements (0 point); B- Project team complies with 60-70% of the itemized client's requirements (1 point); C- Project team complies with >70% of the itemized client's requirements and decisions reached have no adverse effects on project's objectives, budget and schedule targets (2 points). Documentary evidence include a copy of the itemized client's requirement and a compliance report.

**A46 – Environmental statutory requirements**

It ensures the project complies with relevant and applicable environmental standards, regulations, and other requirements. It involves monitoring the project design and construction for compliance with the environmental standards; and such relevant environmental laws and standards must address the concern of the community and their priorities and reflect their values. The project team should ensure the day-to-day site operation complies with the relevant standards. It addresses the need for an environmental impact assessment brief. A46 is a *required* sub-attribute. Three points are attainable under this sub-attribute using the following the rating points. Q1- Project not complying with relevant environmental statutory requirements; Q2- Preparation of an environmental impact assessment brief; Q3- ≥70% of participation construction firms comply with the environmental standards along with continual compliance monitoring. A- Q1 (no point), B- Q2 *or* Q3 (2 points), and C- Q2 *plus* Q3 (3 points). Documentary evidence include (i) an environmental impact assessment brief and (ii) a copy of applicable environmental laws and standards.

### *A5 – Construction Material and Waste*

It encourages the adoption of sustainable material use strategies such as reuse and recycling, reclamation, energy-to-waste, and other management practices (off-site production, circular economy etc.) to minimize material wastage and reduce resultant construction costs. One-third of the waste in United Kingdom (120 million tonnes of waste per year) is produced by the construction and demolition sector (BRE, 2018). A5 is composed of five sustainability sub-attributes (A51 to A55) as discussed below.

**A51 – Locally sourced materials**

It encourages the use of locally sourced construction materials and products that have verifiable sustainable credentials with reduced life-cycle cost and environmental impact. Also, the sourcing of the local products must be investigated to ensure it is sourced in a responsible and sustainable way (reuse, recycle, salvaged, reclamation, refurbished materials. (USGBC, 2017) define a local source as those within 100miles (160km) of the project site. A51 is an *optional* sub-attribute. Two points are achievable under this sub-attribute which are allocated as follows. A- ≤30% of materials used in the building construction are locally sourced materials (0 point); B- >30% of materials used in the building construction are locally sourced materials but not sustainable (1 point); and C- >30% of materials used in the building construction are locally sourced materials and are sustainable (2 points). Records of materials purchased, and its individual sources are required documentary requirement.

**A52 – Construction site waste management**

It addresses the minimization of waste related to construction works and their disposal to landfills and other facilities. It takes into consideration reuse and recycling system or waste-to-energy system deployed in the project. A52 is an *optional* sub-attribute. Two points are available under this sub-attribute. A- <50% reduction in construction site waste when compared to building construction of comparable size (0 point); B- ≥50% reduction in construction site waste when compared to building construction of comparable size (1 point); C- A *plus* adoption of an appropriate sustainable site waste management practice (2 points). Equation below shows the construction waste calculation (USGBC, 2017). Documentary requirement includes record or logs of waste generation from the project site and the volume of recycle construction waste.

$$Construction\ waste\ (kg) = Total\ waste\ generated\ - (Recycled\ waste\ \times 0.25) - -eqn\ (i)$$

(*Assume 296kg per cubic metre → to convert volume to weight*)

**A53 – Proper material handling**

It focuses on the formulation and application of appropriate material handling manual. The manual should contain among others detail procedure on handling the bulky, hazardous, and chemical materials on site. This sub-attribute is vital to the safety and proper functioning of the construction site as the safe handling of construction materials is necessary to prevent injuries or fatal accidents, and its attendants' cost in medical benefits and insurance premium. It involves the transportation, handling, and securing of the materials from the point of delivery to the site's storage facilities. It promotes adherence to safety guidelines or any local and regional safety requirement for material handling. A53 is a *required* sub-attribute. Two points are available for allocation according to the following rating points. Q1- Availability and use of material handling and safety guidelines on project site; Q2- Training of project workers and staff on safe material handling; and Q3- Adherence to safe use of material handling equipment. A- Neither Q1 *or* Q2 *or* Q3 (0 point); B- Q1 *or* Q2 *or* Q3 (1 point); C- Q1 *plus* Q2 or Q1 *plus* Q3 (1.5 points); and D- Q1, Q2 *plus* Q3 (2 points). Documentary evidence include a copy of the applicable material handling and safety guidelines.

**A54 – Reuse of construction materials**

It addresses the efficiency in the use of construction materials and resources through the adoption of resource management strategies (RMS) such as reuse, recycling, refurbishing, and waste sorting etc. A54 is an *optional* sub-attribute. Three points are attainable by projects based on the following rating points. Q1- Development and provision of a resource

management strategy; Q2- Implementation of the RMS; and Q3- Adopting innovative technologies or tools to implement the RMS. A- Neither Q1 *or* Q2 (0 point); B- Q1 *or* Q2 (1 point); C- Q1 *plus* Q2 (2 points); and D- Q1, Q2 *plus* Q3 (3 points). Documentary requirements needed include a copy of the resource management plan and detail of any innovative tool deployed in implementing the RMS.

**A55 – Storage facilities and space**

It focuses on issues relating to material storage and arrangement measures of the storage facilities. It ensures construction materials are stored in an orderly manner and in a way no to endanger the safety of workers and as prescribed for each material. There must be regular cleanup, pest eradication and security against theft and falling objects. There must be easy access to the storage facility, provision of fire extinguishing equipment at marked points in the storage facility. It considers the safe disposal of construction debris in designated disposal units and promote adherence to safety guidelines or any local/regional safety requirement for material storage. A55 is a *required* sub-attribute. Two points are achievable under this sub-attribute. Q1- Availability and use of appropriate storage space and its safety guidelines; Q2- Provision of safety gadgets (fire extinguishers etc.) for use in the material storage facilities; Q3- Safe disposal and storage of the construction debris. A- Neither Q1 *or* Q2 *or* Q3 (0 point); B- Q1 *or* Q2 *or* Q3 (1 point); C- Q1 *plus* Q2 or Q2 *plus* Q3 or Q1 *plus* Q3 (1.5 point); and D- Q1, Q2 *plus* Q3 (2 points). Documentary evidence include photographic evidence of the storage facilities, safety gadgets, and storage safety plan.

### *A6 – Project Management*

It promotes and encourages the involvement and integration of an integrated project team consisting of key stakeholders with a commitment to sustainable design and construction works. The project team must be constituted of a minimum of five construction professionals such as the architect, building services team, green building consultant, civil and structural engineers, and urban planners, etc. It also encourages the implementation of sustainable management practices throughout the project development phases (concept design, developed design, construction, commission and handover, in-use occupation) (BRE, 2018). A6 includes six sustainability sub-attributes (A61 to A66) as discussed below.

**A61 – Project brief and design**

It ensures that sustainability objectives are outlined and implemented in the project as part of the project brief, and the project stakeholders are engaged and well-managed. It addresses the setting out of the design specifications, project timeline, encourage an integrated design, and implementation of sustainable strategies early at the planning and design stage to

influence critical decisions while minimizing cost (BRE, 2018). It ensures necessary occupant's requirements and other functional requirements are rectified and considered. A61 is a *required* sub-attribute. Three points are attainable by projects based on the following rating points. Q1- Provision and development of the project sustainability objectives, plans, and delivery process; Q2- Stakeholders' engagement and consultation. A- Neither Q1 *or* Q2 (0 point); B- Q1 *or* Q2 (1 point); C- Q1 *plus* Q2 (2 points); and D- Q1 *plus* Q2 *plus* continuous monitoring and feedback (3 points). A copy of the project sustainability brief and design is a required evidence.

**A62 – Engagement of sustainability-conscious contractors and suppliers**

A62 rewards project wherein the project teams or clients engaged contractors and suppliers with verifiable sustainability record in ways the construction materials are sourced or procured, and the construction processes employed. Also, there must be continual commitment to meeting acceptable sustainable standards throughout the project. A62 is an *optional* sub-attribute. A maximum of three points is achievable based on the following rating points. A- Involvement of ≥65% sustainable conscious contractors and sub-contractors only (1 point); B- Involvement of ≥65% sustainable conscious suppliers only (1 point); C- Involvement of ≥65% sustainable conscious contractors, sub-contractors, and suppliers (2 points); and D- C *plus* a commitment to meeting sustainable standards (3 points); E- Neither A *or* B (0 point). Documentary evidence: a copy of past records and the engagement of the contractors, subcontractors, and suppliers and their implementation of sustainability practices in previous jobs.

**A63 – Site emergency response plan**

It involves the development of risk management plans and emergency response procedures to tackle any project site contingencies. The contingencies must be act of nature, defects, injuries, accidents which might affect project productivity. The site emergency response plan should be developed before work commences on the project site and include the provision of emergency contact details of personnel (internal and external staff) to handle emergency issues on site and provision of communication systems. It addresses mapping out evacuation routes to be used during emergencies and mapping out of the location of first-aid kits, extinguishers etc., which must be known and accessible to all site workers. Examples of site emergencies include explosion, serious injuries, flood, fire hazards, chemical spills, structural collapse (DBW, 2018). It also considers proper identification and classification of construction site hazards and its assessment as well as the simulation of the project site vulnerability to the site hazards.

The emergency response plan should outline steps to follow when handing such unexpected site emergencies. An adequate emergency response plan will minimize the loss of human lives, reduce economic losses, and protect the natural environment. A63 is a *required* sub-attribute. Two points are attainable under this sub-attribute using the following the rating points. Q1- Provision and use of the site emergency response plan; Q2- Provision of site map showing evacuation routes and the equipment; and Q3- Training of workers on site emergency procedure. A- Neither Q1 *or* Q2 *or* Q3 (0 point); B- Q1 *or* Q2 *or* Q3 (1 point); C- Q1 *plus* Q2 or Q1 *plus* Q3 or Q2 *plus* Q3 (1.5 point); and D- Q1, Q2 *plus* Q3 (2 points). A copy of the site emergency response plan and a copy of the site map showing the evacuation routes and location of emergency equipment is required as part of the documentary evidence.

**A64 – Engagement of sustainability-conscious project management team**

This sub-attribute intends to reward projects wherein the project teams or clients engage project team members with verifiable track record of implementing sustainable practices in the project. There must be a commitment to continually meet acceptable sustainability standards throughout the project. It also considers the environmental credentials of the project team and the relevant green building certification (BCA, 2015). A64 is an *required* sub-attribute. Two points are achievable under this sub-attribute. A- Project team lacks track record of implementing sustainable practices (0 point); B- Involvement of sustainability-conscious project team (1 point); and C- A *plus* a commitment to meeting applicable and relevant sustainability standard (2 points). Documentary evidence: a copy of past records and the engagement of the project team members and their implementation of sustainability practices in previous jobs.

**A65 – Site management plan**

It ensures the development and availability of an adequate and efficient site management plan. The plan should contain the project goals, responsibilities of each project stakeholder, the schedules of site meetings, process of identifying problems, and the procedure of formulating solution (USGBC, 2017). It includes the plans to involve the project team in the planning and design development, specification writeup, and integrating sustainable practices in the overall building development by drawing on the expertise of the project team. A65 is a *required* sub-attribute. One point is available for allocation according to the following rating points. A- No site management plan (0 point); B- Provision and availability of site management plan (0.5 point); and C- B *plus* proper implementation of the site management plan (1 point). Documentary evidence: a copy of the site management plan.

**A66 – Commissioning and handover**

It evaluates the procedures and action plans implemented to meet the client's requirement for the building. The procedures should cover the design and construction phases, and the operation and maintenance of the facility. The action plan might include a review of the construction documents, the roles played by each project stakeholder, identification and correction of any construction or operational errors, evaluation of overall building performance, verification of the building operational manual, and schedule of maintenance. It addresses investigating the project site carbon footprint after completion and ensures that building defects whether in the building elements, services or system are identified and rectified.

It allows the facility manager to adequately understand the operational procedure of the building towards ensuring its optimal performance. A66 is a *required* sub-attribute. One point is available for allocation according to the following rating points. A- No commissioning and handover procedure undertaken for the building (0 point); and B- Commissioning and handover procedure properly undertaken for the building (1 point). Documentary requirements for this sub-attribute include (i) the commissioning and handover guide and (ii) a copy of the as-built drawings.

## 2. SITE AND ECOLOGY (B)

It addresses the attempts to identify and understand the opportunities and ecological issues related to the project site and building, and to assist in making strategic decisions (see figure 3).

| Indicators | (B) Site and Ecology | | |
|---|---|---|---|
| Attributes | Site Selection | Site Management | Reduction of Heat Island Effect |
| Sub-Attributes | Prior green certification | Environmental policy and purchasing plan | Heat island reduction in non-roofed areas |
| | Adaptive reuse and preservation of historic landmarks | Environmentally purchasing practices | Heat island reduction in roof areas |
| | Regional priority | Building exterior and hardscape management plan | Exterior walls finishing materials |
| | | Landscape management plan | Consideration of wind movement and building exterior design |
| | | | Greening & ecological enhancement |

***Figure 3: Site and Ecology (indicator B)***

### *B1 – Site selection*

It promotes and encourages the appropriate use of land and the protection of the habitat, biodiversity, and historic landmarks. B1 is composed of three sustainability sub-attributes (B11 to B13) as discussed below. It also encourages the use of brownfields or contaminated land and prevent the use of undisturbed lands. It gives social and economic benefits to the project, and its neighborhood communities (BRE, 2018) and encourage use of environmentally preferable sites for construction works (USGBC, 2017). It considers and assesses the site attributes- building location and building design characteristics.

#### B11 – Prior green certification

It intends to encourage the implementation of sustainability practices in the design, construction, and operation of a building. This sub-attribute is assessed when a part of the project, say 60percent of the main structure or a whole structure which is associated (but not attached) has been certified (USGBC, 2018d) using any of the available green building rating standard. B11 is a *required* sub-attribute. One point is attainable by projects based on the following rating points. A- Building has no prior green certification (0 point); and B- Building

has a prior building certification (1 point). Record of any green certification of the building or associated structure is a documentary requirement.

**B12 – Adaptive reuse and preservation of historic landmarks**

It addresses the need to preserve the historic landmarks and theme of the region or community in which the building is to be located. Also, it promotes reuse of old or heritage buildings without making significant alteration to its historical values or design. B12 is an *optional* sub-attribute. One point is available for allocation under this sub-attribute. A- No consideration for B12 (0 point); and B- Adequate consideration for B12 (1 point).

**B13 – Regional priority**

It focuses on the geographically inclined priorities which might range from social equity, health and wellbeing, employment, environmental issues, and heritage. It encourages the project to fulfil any itemized priorities agreed upon between the client, government agencies, project team, and the local communities. B13 is an *optional* sub-attribute. One point is attainable by projects based on the following rating points. A- No commitment towards fulfilling regional priorities (0 point); B- <60% fulfilment of itemized regional priorities (0.5 point); and C- ≥60% fulfilment of itemized regional priorities (1 point). A copy of the itemized regional priorities is a documentary requirement.

### *B2- Site management*

It addresses the need to promote a hygiene, clean, safe and well-maintained building exterior, and its landscape while optimizing the performance of building operations. B2 is composed of four sustainability sub-attributes (B21 to B24) as discussed below. It encourages the integration of sustainable site management practices and preserve the integrity of the diverse ecology (USGBC, 2018c).

**B21 – Environmental policy and purchasing plan**

It assesses the presence of an environmental-friendly policy document and purchasing plan. It ensures that the project secures sustainable material, products, and equipment. It also encourages the building occupants to purchase sustainable products or energy-efficient equipment in their apartments. B21 is a *required* sub-attribute. Three points are available for allocation according to the following rating points. Q1- Existence of an environmental policy; and Q2- Provision and implementation of environmental-friendly purchasing plan. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (2 points); and C- Q1 *plus* Q2 (3 points). Documentary evidence are (i) a copy of the environmental policy document and (ii) a copy of the environmental purchasing plan.

**B22 – Environmentally purchasing practices**

It encourages the procurement of environmental-friendly building materials and products for the building and it is assessed over a one to one-and-a-half-year period. Some of the environmental-friendly practices are energy-efficient equipment, low emission materials and products, locally procured products, and renewable materials. B22 is an *optional* sub-attribute. One point is available for allocation under this assessment. Q1- No compliance with environmentally purchasing practices; Q2- Compliance with environmentally purchasing practices; and Q3- ≥60% of the building materials, products, and equipment through sustainable means. A- Q1 (0 point); B- Q2 *or* Q3 (0.5 point); and C- Q2 *plus* Q3 (1 point). A copy of the document detailing the environmentally purchasing practices is a documentary requirement.

**B23 – Building Exterior and hardscape management plan**

It addresses the implementation of sustainability practices in the management of building exteriors and hardscapes (parking spaces and sidewalks). It involves the prevention of pollution (air, noise), reduction of water and solid wastes, avoid the use of harmful chemicals, and optimize the building energy use. It also considers the provision and implementation of a hardscape management plan. B23 is an *optional* sub-attribute. Two points are available for allocation under this assessment. Q1- Existence and implementation of a building hardscape management plan; and Q2- Application of sustainable practices in the management of building exterior envelope. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); and C- Q1 *plus* Q3 (2 points). A copy of the building hardscape management plan is a required documentary evidence.

**B24 – Landscape management plan**

It involves the provision and application of landscape management plan which focuses on erosion control, pest, chemical management, planning or installing features to enhance flora and fauna on building site. It also helps to maintain and enhance the ecological value of the building site. B24 is an *optional* sub-attribute. One point is achievable by projects under this sub-attribute. A- No provision or application of a landscape management plan (0 point); and B- Provision and implementation of the landscape management plan (1 point). A copy of the landscape management plan is required as a documentary requirement.

### *B3 – Reduction of heat island effect*

It evaluates and considers the influence of the strategic design and management practices to reduce the impact of heat island effect. B3 comprises of five sustainability sub-attributes (B31

to B35) as discussed below. It minimizes the impact of the building and the project site on the environment and human wellbeing.

**B31 – Heat island reduction in non-roofed areas**

It considers the use of trees to provide shading and ensure than a larger proportion of the hardscape areas are covered with vegetated cover or structure (USGBC, 2018a). The shading area is calculated when the sum is overhead (USGBC, 2017). B31 is a *required* sub-attribute. One point is available for project under this assessment. A- <55% of non-roofed areas covered with vegetated structure or its equivalent (0 point); B- 55-80% of non-roofed areas covered with vegetated structure or its equivalent (0.5 point); and C- >90 of non-roofed areas covered with vegetated structure or its equivalent (1 point). Documentary requirement include (i) calculations of the non-roofed areas (ii) the site plan highlighting the non-roof and its measurement, landscape, and hardscape areas (USGBC, 2018a) and (iii) maintenance schedule for the vegetated covers.

**B32 – Heat island reduction in roof areas**

It focuses on minimizing the effect of heat islands on human, microclimates, and wildlife (USGBC, 2017). It considers the use of non-absorptive materials (high reflectance surface, e.g. aluminum cladding) in roof areas or the use of shades, vegetated cover, and engineered grass pavers. The non-absorptive material must have a solar reflectance (SR) value of at least 0.28 (USGBC, 2017), or Energy Star rated roof products or its equivalent. It also considers the regular maintenance of such roof covers. B32 is an *optional* sub-attribute. One point is available for project under this assessment. A- <55% of roofed areas covered with non-absorptive material or its equivalent (0 point); B- 55-80% of roofed areas covered with non-absorptive material or its equivalent (0.5 point); and C- >90% of roofed areas covered with non-absorptive material or its equivalent (1 point). Documentary requirement include (i) calculations of the roofed areas (USGBC, 2018a) and (ii) maintenance schedule for the high reflectance surfaces.

**B33 – Exterior walls finishing materials**

It attempts to ensure that the building envelope reduces its solar heat gain using vegetated or planted surfaces and/or the use of high reflectance material with high solar reflectance index (SRI). B33 is a *required* sub-attribute. The higher the percentage of the exterior wall areas covered with the high SRI material, the higher the allocated points using the equation (ii) (IBEC, 2008). A- <25% area of the building envelope is covered by vegetated cover or materials with high SRI (0 point); and B- ≥25% area of the building envelope is covered by

vegetated cover or materials with high SRI (1 point). Documentary evidence include the building plan and elevations.

$$Be_r = \frac{A_{vc} + A_m}{E} \times 100\% - - - eqn\ (ii)$$

Where $Be_r$ = the percentage reduction in solar gain by building envelope

$A_{vc}$ = Area covered by vegetated cover

$A_m$ = Area covered by material with high SRI

$E$ = Exterior area of building envelope

**B34 – Consideration of wind movement and building exterior design**

It encourages and promotes efficiency in building design in such a way as to allow the free flow of prevailing wind within and across the building and project site towards mitigating against the effect of heat islands. B34 is a *required* sub-attribute. One point is attainable by projects under this assessment. The efficiency in the building design is calculated using equation (iii) (IBEC, 2008). A- EBD < 65% (0 point); and B- EBD ≥ 65% (1 point). Documentary evidence include the building plan and the project site plan.

$$EBD = \frac{A_{bw}}{W_{ps} \times H_b} \times 100\% - - - eqn\ (iii)$$

Where $EBD$ = Efficient building design area.

$A_{bw}$ = Area of the building section facing the direction of the prevailing wind

$W_{ps}$ = Width of the project site

$H_b$ = Height of the building

**B35 – Greening and ecological enhancement**

It addresses the restoration and conservation of trees onsite and use of compost or manure for greenery (BCA, 2010). It encourages the project or facility management team to contribute to the enhancement of the local ecology through sponsorships, partnerships, and supports. Supports and partnerships may be in form of fund donations, staff participation (BRE, 2016), and can also involve the protection of wildlife and biodiversity. It also evaluates the proportion of the green areas (greenery) to the total area of the project site (excluding the area of the building).

B35 is an *optional* sub-attribute. One point is attainable by projects assessed with this sub-attribute. Q1- No support, partnerships, or sponsorship for greening and <40% of project site not covered by greenery; Q2- Active support, partnerships, or sponsorship for greening and

ecological enhancement; and Q3- ≥40% of the net project site area covered by greenery. A- Q1 (0 point); B- Q2 *or* Q3 (0.5 point); and C- Q2 *plus* Q3 (1 point). Documentary requirement for this assessment include (i) a copy of the partnering or support arrangements and (ii) a copy of the ecology survey and report.

## 3. ENERGY (C)

It assesses and promote the overall reduction in the operational energy consumption of the building (see Figure 4). The operational energy consumption can be calculated by comparing the actual carbon dioxide ($CO_2$) emission (BRE, 2016). The management of building energy minimizes the economic and environmental harms caused by the emissions of greenhouse gases from energy equipment, appliances, and fittings towards optimizing energy performance (USGBC, 2018a). BRE (2018) pointed out that the independent assessor can use their discretion to gauge the best way to evaluate the building energy performance.

| Indicators | (C) Energy | | |
|---|---|---|---|
| Attributes | Energy Performance | Energy Management | Energy Efficient Systems & Equipment |
| Sub-Attributes | Energy performance targets | Energy operating plan | Interior lighting efficiency and zoning control |
| | Energy modelling & reporting | Energy monitoring and metering | Renewable energy systems |
| | Energy conservation measures | Auditing, commissioning and testing of energy systems | Energy efficient circulation systems (Lifts, moving walkways, and escalators) |
| | Thermal performance of building envelope | Energy management systems | Asset's energy savings |
| | Compliance with local energy standards | Sustainable maintenance | Energy efficient appliances and laundry facilities |
| | | | Energy-efficient HVAC equipment |
| | | | Efficient hot water systems |

***Figure 4: Energy (indicator C)***

### *C1 – Energy performance*

It evaluates strategies deployed to improve the energy efficiency of a building and reduce associated carbon emissions. C1 is composed of five sustainability sub-attributes (C11 to C15) as discussed below. Energy performance are measured based on the source energy and greenhouse gas emissions on a 50-50 scale (USGBC, 2018a).

**C11 – Energy performance targets**

It encourages and development the development of plans and strategies towards setting efficient energy performance targets or baseline. It also involves outlining ways those energy targets can be met or implemented; and considers the reporting on energy consumption to compare it against set targets. Project team should decide on the operational energy performance targets before the completion of the concept design (BRE, 2018). The performance targets might be to reduce $CO_2$ emissions, building energy consumption, heating or cooling energy demands (BRE, 2018). C11 is a *required* sub-attribute. Two points are achievable under this assessment. A- No energy performance targets are set (0 point); B- Energy performance targets are set (1 point); and C- B *plus* ways of implementing or meeting the outlined performance targets (2 points). Documentary evidence include a copy of the energy performance targets and implementation guidelines.

**C12 – Energy modelling and reporting**

It ensures that there is a regular and monthly reporting of the energy consumption of the facility which is evident via verified meter readings or energy utility bills. Such energy consumption record can form a basis to simulate future energy consumption or energy needs of the building. It also reviews and compares the building energy performance with historical data and performance targets. Also, risk assessment might need to be carried out to spot any significant issues with the design and technical specifications that might pose risk to the energy monitoring and performance. Energy monitoring should be carried out during the design and post-construction stages towards predicting the energy consumption figures.

C12 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Energy modelling or simulation is carried out; and Q2- Proper and regular record of energy consumption or verified meter readings or utility bills. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (0.5 point); and C- Q1 *plus* Q2 (1 point). Zero point awarded if the energy consumption reporting is not a 12-month consecutive record. Documentary requirements include (i) a copy of the energy consumption readings/meter readings/utility bills (ii) a report of the energy simulation or modelling.

**C13 – Energy conservation measures**

It helps to highlight the opportunities for building energy savings. It involves the development and implementation of energy consumption measures and assessment of its effect on the energy performance trends (which must be evaluated at least twice a year). It also involve the installation of low or zero-carbon technologies (BRE, 2016). Conservation measures aim at reducing the overall building energy demand using energy-efficient building fabric, use of low-

energy lighting fittings, energy-efficient HVAC systems. It also involves the adoption of building designs which minimizes carbon emissions (BRE, 2018), and glazing which is at least 15% of the floor area, insulated ceilings, etc. (USGBC, 2017). C13 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of two points. A- No energy conservation plan was developed (0 point); B- Provision of an itemized energy conservation plans (1 point); and C- Implementation of ≥70% of the itemized energy conservation plans (2 points). A copy of the building energy conservation measures or plans is a required documentary evidence.

**C14 – Thermal performance of building envelope**

It promotes the design and installation of efficient building envelope that reduces pollutions and adverse environmental effects associated with energy production and consumption (USGBC, 2018d). It helps to reduce the heat gain from the outside through the building envelope which reduces the energy load of the building (e.g. less use of air-conditioning systems) and enhance the performance of the building envelope. Also, to improve the thermal performance of building envelope materials, HKIA (2012) noted that metal oxide which has a low thermal emissivity, can be applied to the glass surface to reduce solar radiation into the building. HKIA (2012) further argued a reflective glass will provide a better insulating performance than a tinted glass.

C14 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of three points. There are two main approaches to measure C14 which are (i) overall heat transfer value (OTTV) (HKIA, 2012) and (ii) envelope thermal transfer value (ETTV) (BCA, 2004). HKIA (2012) and BCA (2004) highlighted some limitations to the use of OTTV in evaluating C14 which include that the OTTV only measure the building envelope but does not consider other interwoven aspect such as the building design and heat gain. Also, it is difficult to measure the parameters of OTTV hence cannot ensure an efficient building design (HKIA, 2012). More so, BCA (2004) argued that the OTTV cannot accurately assessed the solar heat gain through the glazing system. The ETTV standard was later developed to accurately determine C14. In order to conserve energy, BCA (2004) benchmark the maximum threshold of ETTV at 50W/m$^2$ and outlined two ETTV formulas (equation iv and v).

$$ETTV = 12(WWR)U_w + 3.4(WWR)U_f + 211(WWR)(CF)(SC) - - - eqn\ (iv)$$

$$ETTV = \frac{A_1 \times ETTV_1 + A_2 \times ETTV_2 + \ldots + A_n \times ETTV_n}{A_1 + A_2 + \ldots + A_n} - - - eqn\ (v)$$

Where $ETTV = envelope\ thermal\ transfer\ value\ \left(\frac{\mathrm{W}}{m^2}\right)$

$$WWR = window\ to\ wall\ ratio\ (i.e.\ area\ of\ glazing\ \div gross\ area\ of\ exterior\ wall)$$

$$U_w \quad = thermal\ transmittance\ of\ opaque\ wall\ (\frac{W}{m^2k})$$

$$U_f \quad = thermal\ transmittance\ of\ glazing\ (\frac{W}{m^2k})$$

$$CF \quad = correction\ factor\ for\ solar\ heat\ gain\ through\ the\ glazing$$

$$SC \quad = shading\ coefficients\ of\ the\ glazing$$

$$A_1, A_2, \dots A_n \ = the\ gross\ areas\ for\ the\ building\ exterior\ walls\ at\ each\ orientation\ (m^2)$$

More information on the definition, descriptions, measurements and values for $U_w$, $U_f$, $CF$, and $SC$ values exist in the literature (BCA, 1986, 2004, 2015; CIBSE, 2007; HKIA, 2012). Three points are available for this sub-attribute based on a pro-rata allocation of one point per 2W/m$^2$ reduction from the ETTV baseline (50W/m$^2$).

**C15 – Compliance with local energy standards**

It assesses and ensures that the building complies with the local energy standards or requirements. It addresses the benchmarking of the building energy performance against a local or regional standard or threshold and considers whether the building has received a local energy certification. C15 is a *required* sub-attribute. Two points are attainable by projects based on the following rating points. A- No compliance with local energy standards (0 point); B- Building complies or is benchmarked against a local/regional energy standard (1 point); C- B *plus* a local/regional energy certification for the building (2 points). Documentary evidence include (i) a copy of the local energy standard and (ii) a copy of the local energy certification for the building (BRE, 2016).

### *C2 – Energy management*

It promotes and encourages the implementation of energy-efficient strategies in the operation and maintenance of the building. C2 is composed of five sustainability sub-attributes (C21 to C25) as discussed below. It involves the aggregation of relevant energy-related information which can be used for system analysis (USGBC, 2018a), simulations, and trainings.

**C21 – Energy operating plan**

It focuses on the development and implementation of efficient energy operating strategies towards improving energy performance, reduce energy consumption, and increase building occupants' awareness of energy usage. The energy operating strategies and set targets are monitored to ensure it leads to a sustained improvement in energy performance and the operating plan should cover for a period of at least three years (HKGBC, 2016). Also, feedback mechanisms should be included in the plan as well as the training for the energy management

staff. The operating plan should also consider the maintenance of energy equipment, provide details of pre-set operating schedules for HVAC equipment, lighting fittings, etc. C21 is a *required* sub-attribute. Projects under this assessment can gain a maximum of two points. A- No provision of an energy operating plan for the building (0 point); and B- Provision and implementation of the energy operating plan in the building (2 points). A copy of the building energy operating plan is a required documentary requirement.

**C22 – Energy monitoring and metering**

It ensures and promotes the adequate monitoring and benchmarking of the building operational energy overtime which will allow the facility managers to set realistic energy improvement targets; identify, and reduce the energy demands by accurately measuring and monitor the energy consumption. It evaluates the availability of energy meters and its installation, spreadsheet to record the monthly energy consumption or utility bills in kWh. It allows for comparing the energy performance of new and existing building properties (BRE, 2018), and can detect avenues to reduce the building energy consumption and increase energy savings. Also, there should be a proper public display of energy consumption within the building (Mahmoud, 2017).

BRE (2016) recommended separate sub-meters for the different main energy uses (heating, cooling, interior lighting, ventilations, etc.) towards assisting in setting energy targets to achieve efficient operation of the building. However, USGBC (2018a) argued that a single meter with the capacity to aggregate the total energy consumed are acceptable. C22 is an *optional* sub-attribute. Two points are available for allocation according to the following rating points. Q1- Provision of sub-meters for ≥3 main energy uses; Q2- Provision of sub-meters for <3 main energy uses; Q3- Proper monitoring, record, and public display of the building energy consumption over a 12-month period; and Q4- A single 'aggregate' meter for a one-household apartment. A- No metering or energy monitoring (0 point); B- Q2 *or* Q3 (1 point); C- Q2 *plus* Q3 (1.5 points); D- Q1 *plus* Q3 or Q4 *plus* Q3 (2 points). Documentary requirements include (i) a copy of verified meter readings record or energy utility bills and (ii) photographic evidence of installed meters.

**C23 – Auditing, commissioning, and testing of energy systems**

It involves the undertaking of regular energy audit for the building, proper planning in its commissioning in a way to ensure an optimal performance, valuable use of energy resources, and lower operational cost. It addresses the need for the design, specification, installation, and the operation of energy systems to be in accordance with appropriate industry standards and meet the client's energy requirement. It involves the training of the operation and

maintenance staff to carry out the audit, commissioning, and testing (A.C.T) process. It also includes the development of an action plan to tackle errors, faults, and deficiencies identified during the A.C.T process. *Audit*: All faults and findings during the audit process must be documented and reported to the client and facility management team. It involves the development of an energy audit plan. The energy audit plan should include the roles of the audit team, description of the audit process and approach, the deliverables of the audit process, and its proposed schedule (USGBC, 2018b). The auditing should consider the breakdown of energy consumption by each equipment and system, by tenants, fittings among others (Mahmoud, 2017). It should include action plan to achieve C11. It involves performing a cost-benefit analysis of the adopted C13 and updating C21.

*Commissioning*: It involves identifying the energy systems and equipment in the building to be tested and commissioned, and the development of a commissioning plan. The commissioning plan should include the building requirements, responsibilities of the commissioning team, description of the commissioning process and procedure, the deliverables, and the proposed schedule (USGBC, 2018a). *Testing*: It involves the development of a verifiable energy system test and execution procedure. It addresses the identification of problems and faults, testing and performance verification, preventive and corrective action plans (Baechler & Farley, 2011; Canmet Energy, 2008; Mahmoud, 2017). C23 is an *required* sub-attribute. Projects under this assessment can gain a maximum of three points. A- No auditing, commissioning or testing of energy systems (0 point); B- One point each for the completion of the (i) auditing (ii) commissioning, and (iii) testing of the energy systems. Documentary requirements include (i) a copy of the energy audit plan, commissioning plan, and testing plan (ii) a copy of the identified faults and remedies during the A.C.T process.

**C24 – Energy management systems**

It encourages and promotes the use of efficient energy management systems with reliable operating strategies. It includes the development of a preventing maintenance plan for the energy management plan for the energy management systems (EMS). It involves the use of computer-based system to track and monitor the various electrical fittings, systems, equipment, and appliances, and provide record of energy consumptions, energy savings, and performance optimization. The EMS logs the building operation data such as pressure, temperature, air flow rate, cooling load, lighting, water, etc. (HKGBC, 2016). C24 is a *required* sub-attribute. One point is available for this sub-attribute based on the following rating points. A- No provision or installation of energy management system (0 point); and B- Provision, installation, maintenance, and active operation of energy management systems (1 point).

Documentary evidence include (i) Photographic evidence of the installed EMS (ii) technical or manufacturer information, and (iii) A copy of the preventive maintenance plan for the EMS.

**C25 – Sustainable maintenance**

It encourages and promotes the adoption of a proper and sustainable maintenance scheme for the building energy systems and equipment to ensure optimal operation and performance of the energy systems. It includes the development and availability of a maintenance plan and schedule. It includes a maintenance record for all repairs and remedial works carried out on the building energy systems. C25 is a *required* sub-attribute. Two points are attainable by projects based on the following rating points. Q1- Provision and implementation of sustainable maintenance plan; and Q2- Proper record of maintenance works and remedial works. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); and C- Q1 *plus* Q2 (2 points). A copy of the sustainable maintenance plan and schedules is documentary requirement.

### *C3 – Energy efficient systems and equipment*

It promotes the design, specification, and installation of energy-efficient building systems and equipment that support a sustainable management of the operational energy use of the building. C3 is composed of seven sustainability sub-attributes (C31 to C37) as discussed below.

**C31 – Interior lighting efficiency and zoning control**

It minimizes the building energy consumption through the design, specification, and installation of energy efficient lighting fittings and appropriate zoning controls towards reducing $CO_2$ emissions and building operating costs. It includes the adequate maintenance of the lighting fittings and the use of presence sensors to control the lighting and detect human presence. It also the incorporation of time switches for automatic light switch-off of the lightings when no presence is detected after a preset time. The sensors and time switches help to enhance energy savings and addresses the need to maintain of the same quality of space lighting with a more efficient lighting fitting (BCA, 2010, 2015).

C31 is a *required* sub-attribute. Projects under this assessment can gain a maximum of two points with one point each for (i) interior lighting efficiency and (ii) sensors and zoning control. For *interior lighting efficiency*: Q1- Lighting should be of standard design only (custom designs should be avoided) (GSA, 2019); and Q2- Lighting fixture should not exceed the baseline interior illumination levels, see figure 5 (GSA, 2019). Neither Q1 or Q2- 0 point; Q1- 0.5 point; and Q1 *plus* Q2- 1 point. For *sensors and zoning control*: Q3- Presence sensors in lobbies and perimeter areas; and Q4- Adequate zoning and placement of switches in enclosed areas

and rooms. Neither Q3 or Q4- 0 point; Q3- 0.5 point; and Q3 *plus* Q4- 1 point. Points accruable based on summation of Q1 to Q4: A- 0 point; B- 0.5 point; C- 1 point; D- 1.5 point; and E- 2 points. Documentary requirements include (i) photographic evidence of sensors, lighting fittings (ii) technical or manufacturer information, and (iii) building plans showing the location of the lighting fittings, switches, and sensors.

| Area | Nominal Illumination Level in Lumens/Square Meter (lux) |
|---|---|
| **Office Space** | |
| Normal work station space, open or closed offices | 500 |
| Conference Rooms | 300 |
| Training Rooms | 500 |
| Internal Corridors | 200 |
| Auditoria | 150-200 |
| Entrance Lobbies, Atria | 200 |
| Elevator Lobbies, Public Corridors | 200 |
| Ped. Tunnels and Bridges | 200 |
| Stairwells | 200 |
| **Support Spaces** | |
| Toilets | 200 |
| Staff Locker Rooms | 200 |
| Storage Rooms, Janitors' Closets | 200 |
| Electrical Rooms, Generator Rooms | 200 |
| Mechanical Rooms | 200 |
| Communications Rooms | 200 |
| Maintenance Shops | 200 |
| Trash Rooms | 200 |
| **Specialty Areas** | |
| Dining Areas | 150-200 |
| Kitchens | 500 |
| Outleased Space | 500 |
| Physical Fitness Space | 500 |
| Child Care Centers | 500 |
| Structured Parking, General Space | 50 |

***Figure 5: Interior illumination levels (GSA, 2019)***

**C32 – Renewable energy systems**

It encourages the design and installation of self-supply non-polluting energy renewable generation systems in building to reduce GHG emissions and minimize energy usage. Such systems or technologies include the installation of photovoltaic (PV) system according to

industry standards and should include owner's manual for its installation and efficient operation. Other renewable sources include solar energy, wind, geothermal, micro or small scale hydroelectric, biomass etc. It addresses the need to reduce the adverse environmental and economic effect caused by fossil fuel energy. C32 is an *optional* sub-attribute. It evaluates the percentage of energy generated from renewable sources (BCA, 2010, 2015; BRE, 2016; USGBC, 2018b) and a maximum of three points are available based on the percentage of energy generated from renewable sources. A- No renewable energy system installed (0 point); B- <30% of annual energy use in kWh generated from renewable energy source (1 point); C- ≥30-49% of annual energy use in kWh generated from renewable energy source (2 point); D- ≥50% of annual energy use in kWh generated from renewable energy source (3 point). Documentary evidence include (i) photographic evidence of installed renewable energy systems and its meters (ii) A copy of the meter reading for the renewable energy systems.

**C33 – Energy efficient circulation systems**

C33 considers the adherence to relevant standards such as BS EN 1SO 25745 (BRE, 2018) and promotes the design, specification, and installation of energy-efficient circulation systems (escalators, lifts, etc.) within the building and in accordance with industry best practice. The C33 must be appropriate to occupants' demand and usage, enhance safety and comfort of the occupants as well. It should incorporate sleep mode features which increase energy savings (John & Rajappan, 2013; Mahmoud, 2017; NRC, 2009). The circulation systems may include features such as display lighting, peak periods working conditions (such as the switch-off of ventilation fans, displays, lift car lighting etc.). C33 is an *optional* sub-attribute. Two points are achievable under this sub-attribute. Q1- Presence of a passenger or load-sensing device and sleep mode features to enable the circulation system to work in an 'auto start mode'; and Q2- Design and specification of the circulation system according to relevant industry standards. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); and C- Q1 *plus* Q2 (2 points). Documentary evidence include (i) photographic evidence of installed energy-efficient circulation systems (ii) technical or manufacturer information, (iii) building plans showing the location of circulation systems, and (iv) a copy of the relevant industry standards.

**C34 – Asset's energy savings**

It focuses on identifying and evaluating ways of energy savings for the building (through the various energy sources) towards meeting the set energy improvement targets. It involves the us of historical dataset (say, the previous year) and compared with the current year to demonstrate the energy savings made. C34 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- <15% energy savings made (0 point); B- 15-40% energy savings (0.5 point); and C- >40% energy savings (1 point). A copy of the

current year and previous year's energy consumption records is a required documentary evidence.

**C35 – Energy efficient appliance and laundry facilities**

It focuses on the reduction of the total energy demand of the building, prevent unregulated energy consumption, and improve energy performance through the installation of energy-efficient equipment and facilities. BRE (2018) recommended such appliances to be Energy Star certified. Unregulated energy uses include swimming pools, domestic, and commercial scale appliance (fridges, washing machines, ceiling fans, dishwashers, dryers, etc.) (BRE, 2018). C35 is an *optional* sub-attribute. A maximum of two points are available which are allocated as follows. Q1- Identifying and regulating systems with unregulated energy consumption; Q2- ≥60% reduction in the total annual unregulated energy consumption when compared to the previous year; Q3- Appliances and equipment are Energy Star certified. A- Neither Q1, Q2 or Q3 (0 point); B- Q1 (1 point); C- Q2 *or* Q3 (2 points). Documentary evidence include; (i) technical or manufacturer information and (ii) a copy of the calculation based on the unregulated energy uses.

**C36 – Energy-efficient HVAC equipment**

C36 addresses the reduction of GHG emissions of the building through the design and installation of energy-efficient HVAC equipment. It considers the design of efficient controls and component in line with best industry practices to ensure it operate at peak efficiency. It incorporates an operation and maintenance plan and a certified technician must be engaged for the HVAC installation. C36 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Presence of temperature and presence sensors and sleep mode features in HVAC equipment to conserve energy; and Q2- Design and specification of the HVAC equipment in accordance to industry standards. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (0.5 point); and C- Q1 *plus* Q2 (1 point). Documentary requirements are (i) photographic evidence of the installed HVAC equipment (ii) technical or manufacturer information.

**C37 – Efficient hot water systems**

C37 assesses the energy source of the hot water system and the hot water generation type-whether it is a point-of-use or centralized system or a mix of the two. It excludes the system used to heat the house. *Point-of-use system*: is when the hot water is supplied directly from a tap (either for cooking or drinking) (BRE, 2016). *Centralized system*: when hot water is provided centrally e.g. through a boiler. It considers the design and installation of energy-efficient hot water system and a well-insulated piping for the hot water distribution system

(USGBC, 2017). It must have a timer control or water temperature sensors as part of the system to prevent it from working continuously. The water heater or boiler must meet industry standard to prevent heat loss between the hot water source and tap. The hot water piping must be well-insulated. The energy source can be electric, solid fossil fuel, oil, gas (BRE, 2016), solar energy etc. C37 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Energy Star rated hot water system; Q2- Solar water heaters that carries ≥ 65% of the hot water system load; Q3- Solar water heaters that carries ≥35-64% of the hot water system load; and Q4- No rated hot water system installed or solar water heaters carries <35% of the hot water system load. A- Q4 (0 point); B- Q3 (0.5 point); and C- Q1 *or* Q2 (1 point). (i) photographic evidence of the installed hot water system (ii) technical or manufacturer information, and (iii) building plans should the location of the hot water system and piping network.

## 4. WATER (D)

It promotes the sustainable use of water in the building and project site and identifying means to reduce overall water consumption (see Figure 6).

| Indicators | (D) Water | | |
|---|---|---|---|
| Attributes | Water Efficiency | Water Management | Water Efficient Systems & Equipment |
| Sub-Attributes | Water recycling & rain water harvesting | Water conservation plan | Efficient indoor plumbing fixtures & fittings |
| | Water efficient landscaping and irrigation | Water performance monitoring | Leak detection system |
| | Outdoor water use efficiency | Cooling tower water management | Effluent discharge in foul sewer |
| | | Flood and surface management | |

***Figure 6: Water (indicator D)***

### *D1 – Water Efficiency*

It addresses the development and implementation of policies, strategies, and plans to reduce water consumption, diversify the sources of water consumption among others. D1 comprises of three sustainability sub-attributes (D11 to D13) as discussed below.

#### D11 – Water recycling and rainwater harvesting

It promotes and facilitates the sourcing of water from alternative means or reclaimed water such as rain or greywater. The alternative water supplies should be treated before distribution for occupant's use (BRE, 2016); else, it should be used for landscaping or irrigation. It evaluates the percentage of water consumption from alternative sources; and the percentage calculations is based on metered water data. It constitutes harvesting of rainwater to reduce the volume of runoff (USGBC, 2018d) and installation of vegetated roof (USGBC, 2017). According to BRE (2018), greywater are domestic wastewater discharged from showers, laundry, kitchen etc. which are recycled to meet domestic potable water use. D11 is a *required* sub-attribute. Two points are achievable under this sub-attribute. A- No water supplies from alternative means (0 point); B- <65% of total water consumption from alternative means (1 point); and C- ≥65% of total water consumption from alternative means (2 points). Documentary evidence include (i) a copy of the meter reading for main supplies and alternative source supplies and (ii) evidence of treatment of alternative water supplies (if applicable).

**D12 – Water efficient landscaping and irrigation**

It involves the planting of selected plant species and adoption of efficient irrigation techniques to achieve reduced water consumption. It also involve the use of alternative water supplies and smart technologies to schedule the irrigation of the landscape (HKGBC, 2016; USGBC, 2018d) to achieve efficiency in water consumption. It also promotes the implementation of sustainable landscaping practices (USGBC, 2017). D12 is an *optional* sub-attribute. A maximum of three points is achievable by projects based on the following rating points. Q1- <45% reduction in water consumption for landscaping and irrigation; Q2- ≥45% reduction in water consumption for landscaping and irrigation; Q3- Use of smart technologies for smart scheduling for irrigation; and Q4- Installation of irrigation meter to calculate water use. A- Q1 (0 point); B- Q4 *or* Q3 (1 point); C- Q2 *plus* Q4 or Q3 *plus* Q4 (2 points); and D- Q2, Q3 *plus* Q4 (3 points). Documentary requirement for this assessment are (i) photographic evidence of the installed irrigation meters and water distribution system and (ii) a copy of meter reading for the landscaping and irrigation system.

**D13 – Outdoor water use efficiency**

It encourages and promotes the outdoor water consumption by reducing the demand for its use. Outdoor water use includes use of boreholes, rainwater, among others. It includes the use of fixtures and fittings to improve outdoor water use efficiency and water savings and increase the use of alternative water supplies. D13 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No reduction in outdoor water consumption (0 point); B- <45% reduction in outdoor water consumption (0.5 point); and C- ≥45% reduction in outdoor water consumption (1 point). A copy of the meter reading for the outdoor water use or equivalent is a required documentary evidence.

### *D2 – Water Management*

It encourages the management of water use and its monitoring and track them against preset water use targets. D2 consist of four key sustainability sub-attributes (D21 to D24) as discussed below. It evaluates the performance of a water budget analysis before the completion of the design process (USGBC, 2018c) to reduce water consumption and achieve sustainability objectives.

**D21 – Water conservation plan**

It addresses the setting up of water conservation strategies and consumption targets towards reducing the overall water consumption. It should include the incorporation of feedback mechanism to monitor water usage and making such targets and conservation strategies

known to the building's occupants. The conservation plan should embed strategies to maintain water fixtures to minimize leaks. The plan should also facilitate the conservation of natural habitats, water bodies, etc. (USGBC, 2018d) and involves siting the building on a site with no adverse effect on habitat life (water bodies). It should also considers the restoration of water bodies and habitat (USGBC, 2018d). HKGBC (2016) noted that the water conservation plan should be endorsed by top management and according to BCA (2015) involve setting of targets to minimize water consumption. D21 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No conservation plan in place (0 point); B- Provision of a conservation plan but no implementation (0.5 point); and C- Provision and implementation of a conservation plan (1 point). A copy of the conservation plan is a documentary evidence.

**D22 – Water performance monitoring**

D22 focus on the monitoring and benchmarking the water use within the building through the installation of water meters towards reducing the water consumption. Each water meter should be integrated into the building management system for a central monitoring of water use and each assessment should cover a consecutive twelve months period, and there should be a public display of the annual water consumption in cubic meter. Sources of water to be metered includes rainwater, groundwater, municipal water supply, etc. It evaluates the percentage of the annual water targets which were met towards improving the overall water performance and energy savings. Such water performance monitoring can help to identify areas or equipment with high usage of water and examine possible causes (BCA, 2010; BRE, 2018; HKGBC, 2016). D22 is an *optional* sub-attribute. Two points are attainable by projects based on the following rating points. A- No metering or performance monitoring *plus* <30% of water targets met (0 points); B- Water consumption is metered for whole building *plus* 30-45% of water targets met (1 point); C- Metering is undertaken per tenanted space *plus* 46-65% of water targets met (1.5 points); and D- Private water source *or* no water supply to the building *plus* >65% of water targets met (2 points). Documentary requirements for this assessment include (i) photographic evidence of installed water meters (ii) a copy of the building or site plans indication the location of the water meters and (iii) a copy of the water meter readings or water utility bills.

**D23 – Cooling tower water management**

It is concerned with the conservation of water used for cooling towers or condensers especially in data centers, hospitals, and warehouses. A cooling tower water meter should be installed and also considers the installation of water treatment system to achieve at least six cycles of water treatment (HKGBC, 2016). D23 is an *optional* sub-attribute. Projects under this

assessment can gain a maximum of one point and the maximum point is awarded for projects in which cooling tower or treatment system is not available. A-<30% use of recycled water for cooling towers or treatment system (0 point); and B- ≥ 30% use of recycled water for cooling towers or treatment system *or* cooling tower present (1 point). Documentary evidence include (i) photographic evidence of installed water meters, cooling towers and (iii) a copy of the water meter readings or water utility bills for the cooling towers.

**D24 – Flooding and surface water management**

It considers the development and implementation of flood water mitigation measures for buildings located in a locality prone to surface flooding. The assessment must consider the level of the risk of flooding whether zero, low, medium, and high flood risk zones; as well as the flooding sources e.g. tidal (sea), fluvial (rivers), surface or ground water, sewers or a functional flood plain (BRE, 2016, 2018). It aim to protect life and properties and enhance the quality of water used and conserve the natural habitat (USGBC, 2018d). It also helps to reduce the environmental impact of the building footprint (USGBC, 2017) by avoiding the pollution of water courses, onsite flooding, and delay discharge into public drainage or sewers (BRE, 2018). D24 is a *required* sub-attribute. Two points are available for allocation according to the following rating points. A- No assessment for flooding and surface water management undertaken (0 point); B- Flood risk identification carried out but no mitigation measures implemented (1 point); C- Flood risk identification carried out and implementation of recommended mitigation measures (2 points); D- The building or project site is not prone to flooding (2 points). Documentary evidence include (i) a copy of the report of the flood risk assessment and recommended mitigation measures and (ii) photographic evidence of the mitigation measures carried out.

### *D3 – Water efficient systems and equipment*

This sustainability attribute promotes the design, specification, and installation of efficient water system and equipment, which utilizes appropriate technologies to reduce water consumption. D3 consists of three sustainability sub-attributes (D31 to D33) as discussed below. D3 also promotes innovation in the design and manufacture of efficient water equipment (BRE, 2018), and reduce associated energy consumption and cost.

**D31 – Efficient indoor plumbing fixtures and fittings**

This sub-attribute considers the provision of adequate placement of water access points to cater for the building occupants and promotes the specification of water-efficient fixtures and fixtures that enhances water savings. It addresses the need for a proactive maintenance and replacement schedule. The proactive maintenance policy includes either a preventive or

predictive maintenance. More so, water fixtures and fitting should have a Water Sense label or equivalent labels (BCA, 2010; USGBC, 2018c) or other industry standard certifications or meet the baseline water consumption for fixtures as outlined in Figure 7 (USGBC, 2018c).

| *Fixture or fitting* | *Baseline (IP units)* | *Baseline (SI units)* |
|---|---|---|
| Toilet (water closet)* | 1.6 gpf | 6 lpf |
| Urinal* | 1.0 gpf | 3.8 lpf |
| Public lavatory (restroom) faucet | 0.5 gpm at 60 psi** all others except private applications | 1.9 lpm at 415 kPa, all others except private applications |
| Private lavatory faucets | 2.2 gpm at 60 psi | 8.3 lpm at 415 kPa |
| Kitchen faucet (excluding faucets used exclusively for filling operations) | 2.2 gpm at 60 psi | 8.3 lpm at 415 kPa |
| Showerhead* | 2.5 gpm at 80 psi per shower stall | 9.5 lpm at 550 kPa per shower stall |

***Figure 7: Baseline water consumption for fixtures (USGBC, 2018c)***

D31 is a *required* sub-attribute. Projects under this assessment can gain a maximum of three points. Q1- Water fixtures meet the baseline water consumption; Q2- Water fixtures achieve ≥65% reduction in water consumption; Q3- Water fixtures achieve 35-64% reduction in water consumption; Q4- Proactive maintenance policy implemented; Q5- Water fixtures and fittings have Water Sense label or other industry standard certifications. A- Neither Q1, Q2, Q3, Q4, or Q5 (0 point); B- Q3 (0.5 point); C- Q4 (1 point); D- Q1 *or* Q2 (2 points); E- Q1 *plus* Q4 or Q2 *plus* Q4 (2.5 points); F- Q1, Q5 *plus* Q4 or Q2, Q5 *plus* Q4 (3 points). Documentary requirements for this assessment include (i) photographic evidence of the fittings, fixtures, and controls (ii) technical or manufacturer manual and (iii) meter readings or records of water consumption.

**D32 – Leak detection system**

It attempts to reduce the impact of water leaks and provides for the installation of leak detection system or shut-off control system to isolate the source of the leak (BRE, 2016). Such leak detection system can aid in the detection of an unusual flow of water as well as unintended use of water at meters either using sensors or flow-based system. D32 is a *required* sub-attribute. A maximum of two points are attainable from this sub-attribute based on the following rating points. Q1- Provision of a leak detection system; and Q2- Presence of a shut-off control system or automatic shut-off taps. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); C- Q1 *plus* Q2 (2 points). Documentary evidence include (i) photographic evidence of the leak

detection system or water shut-off controls and (ii) technical or manufacturer's manual for the leak detection system.

**D33 – Effluent discharge in foul sewer**

It encourages and promotes efficiency in the discharge of water in foul sewer systems. D33 addresses the design, specification, and installation of water-efficient foul sewer system. It evaluates the percentage reduction in the water used in foul sewer system (HKGBC, 2018; Mahmoud, 2017). D33 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- <20% reduction in discharged water in the foul sewer system (0 point); B- 20-40% reduction in discharged water in the foul sewer system (0.5 point); and C- ≥41% reduction in discharged water in the foul sewer system (1 point). A copy of the dedicated water meter reading for the foul sewer system.

## 5. MATERIAL AND WASTE (E)

The sustainability indicator E promotes the incorporation of sustainable policies in the procurement of materials which has reduced environmental impact, facilitate responsible sourcing, durability, and considers the whole lifecycle approach to such decisions (see Figure 8). It also examines the sustainable ways to efficiently managed waste safely.

| Indicators | (E) Material and Waste | | | |
|---|---|---|---|---|
| Attributes | Sustainable Purchasing Practice | Efficient Use & Selection of Materials | Waste Management Practice | Ease of Conversion of Building Functions |
| Sub-Attributes | Sustainable purchasing plan | Modular and standardised design | Solid waste management policy | Functional adaptation |
| | Ongoing consumables & durable goods | Using non-ozone depleting substances (non-CFC, non-HCFC) | Hazardous waste management | Ease of disassembly (deconstruction) |
| | Facility alterations and additions & reuse | Enhanced refrigerants management | Waste stream audit | Designing for robustness for asset and landscape |
| | Reduced mercury in lamps | | Ongoing consumables & durable goods waste | Building adaptation strategy plans |
| | | | Facility alterations and demolition waste | |
| | | | Collection, storage and disposal of recyclables | |
| | | | Waste equipment installation | |

***Figure 8: Material and Waste (indicator E)***

### *E1 – Sustainable purchasing practice*

It promotes the consideration of sustainable issues such as the impact of the procured materials on the environment, and the health and wellbeing of the occupants. E1 is composed of four sustainability sub-attributes (E11 to E14) as discussed below.

#### E11 – Sustainable purchasing plan

It encourages and demonstrate the consideration of the social and economic impact; other impacts of the materials being procured for the building. Environmental impacts include issues such as biodiversity or toxicity; economic (corruption) and social (slave labor, equality, etc.) throughout the supply chain line (BRE, 2018). It involves the traceability of the procured materials and equipment to the point of production and across the supply chain. It also considers the development of a sustainable procurement plan towards promoting responsible procurement (BRE, 2016). The sustainable purchasing plan must be developed before the

close of the design phase; and consider the provision of performance targets for the procured materials to ensure it meet relevant industry best practices for environmental friendly products (USGBC, 2018a). The procured materials must be assessed to ensure it meets the quality objectives and functional requirements as well as cause minimal environmental harm. BCA (2015) itemized a list of sustainable building system for adoption by designers and project team members. E11 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No provision of a sustainable purchasing plan (0 point); B- Provision of a sustainable purchasing plan but no implementation (0.5 point); and C- Provision and implementation of the sustainable purchasing plan (1 point). Documentary requirement include (i) a copy of the sustainable purchasing plan (ii) a report on the environmental impacts of the procured materials or certification documents from the manufacturers or suppliers and (iii) visual inspection of the procured materials.

**E12 – Ongoing consumables and durable goods**

It encourages the implementation of sustainable principles towards limiting the size and quantity of the consumables procured. Consumables include office papers, cleaning products, electrical equipment, etc. (BCA, 2010). It considers minimizing the adverse effects posed by materials used in the course of the buildings' operations; and focus on the provision and implementation of a sustainable purchasing policy for consumables and durable goods. The procured must meet other criteria such as local sourcing, extended use, and percentage level of recycled content etc. (USGBC, 2018b). USGBC (2018b) recommended that 50-70% of the purchasing should be environmentally friendly. E12 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No provision of sustainable purchasing policy for consumable and durable goods (0 point); B- Provision of sustainable purchasing policy for consumable and durable goods but not implemented (0.5 point); and C- Provision and implementation of the sustainable purchasing policy for consumable and durable goods (1 point). A copy of the sustainable purchasing policy is a required documentary evidence.

**E13 – Facility alterations, additions, and reuse**

It encourages and promotes the use of recycled and reclaimed materials in building construction and alteration works. Also, according to USGBC (2018d), implementing E13 reduces the environmental impacts or adverse effects of extracting and use of virgin materials. E13 is an *optional* sub-attribute. Two points are available for allocation according to the following rating points. A- No recycled material or products used (0 point); B- <40% mass or content of the materials are from recycled materials (1 point); and C- ≥40% mass or content of the materials are from recycled materials (2 points). A copy of the technical or manufacturer's specification of the material is a required documentary evidence.

**E14 – Reduced mercury in lamps**

The sub-attribute focuses on minimizing the level of toxic materials within the facility by purchasing lamps with reduced level of mercury. Such lamps notwithstanding must have a good energy efficiency level as the lamps with no mercury at all. USGBC (2018b) recommended an average of 70picograms of mercury per lumen-hour or less for all mercury lamps in the building. E14 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- >70picograms (on the average scale) per lumen-hour of mercury-containing lamps in the building (0 point); and B- ≤70picograms per lumen-hour of mercury-containing lamps in the building (1 point). Documentary evidence include (i) building plans showing the location of the mercury lamps and (ii) technical or manufacturer's manual for the lamps.

### *E2 – Efficient use and selection of materials*

The sustainability attribute E2 comprises of three sustainability sub-attributes (E21 to E23) as discussed below.

**E21 – Modular and standardized design**

E21 encourages the introduction and implementation of modular and standardized designs and component in the building designs to maximize the procured materials and reduced construction wastes. It also enhances the buildability and reduces material waste. E21 optimizes the quantity of material used and associated environmental cost and simply site operations. E21 is a *required* sub-attribute. A maximum of two points are achievable by projects based on the following rating points. A- No provision for modular design and standardization in the building design (0 point); B- ≤55% of building components incorporate modular and standardized design (1 point); and C- >55% of building components incorporate modular and standardized design (2 point). Documentary evidence include a copy of the building design, specification, and documents that demonstrates the possibilities of the application of modular design and standardization in the building.

**E22 – Using non-ozone depleting substances (non-CFC, non-HCFC)**

The sub-attribute encourages and promotes the use of non-ozone depleting refrigerants in equipment. BRE (2016) highlighted the three main components of refrigerants and their global warming potential (GWP) values. The most preferred refrigerants with a GWP≤1 are ammonia, water, $CO_2$. E22 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- Not specified or use of refrigerants with a GWP>10 (e.g. HFC, CFC, etc.) (0 point); B- Use of refrigerants with a GWP≤10 (e.g. propane) (0.5 point); and C- No

refrigerants used or use of refrigerants with a GWP≤1 (1 point). A copy of the manufacturer's details of the refrigerant makeup and photographic evidence of the refrigerant system are required documentary evidence.

**E23 – Enhanced refrigerants management**

E23 considers the type of system used for the refrigerant cooling system as well as the cooling emitter type (BRE, 2016). There are two main refrigerant cooling system (i) split system and (ii) variable refrigerant flow (VRF) system; with the VRF system reported to work more efficiently and equipped with more indoor units than the split unit (BRE, 2016). E23 is an *optional* sub-attribute. One point is achievable under this sub-attribute. A- No efficient refrigerant system installed (0 point); B- Use of the split system (0.5 point); and C- Use of the VRF system *or* no refrigerants (1 point). A copy of the manufacturer's manual for the cooling system is a documentary requirement.

### *E3 – Waste management practice*

The sustainability attribute E3 comprises of seven sustainability sub-attributes (E31 to E37) as discussed below.

**E31 – Solid waste management policy**

It encourages the development and implementation of waste management policy which should incorporate best practices in waste reduction, reuse of waste materials, recycling, and energy generation from waste. It also considers the proper collection and disposal of waste. E31 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No provision of solid waste management policy (0 point); B- Provision of solid waste management policy but not implemented (0.5 point); and C- Provision and implementation of solid waste management policy (1 point). A copy of the solid waste management policy is a documentary requirement.

**E32 – Hazardous waste management**

E32 focuses on the provision of a storage space to collect and store hazardous waste products (e.g. batteries, lamps, etc.) and maintaining a hazardous waste management policy that addresses the best practices of recycling and disposing such wastes. E32 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No provision of hazardous waste management policy (0 point); B- Provision of hazardous waste management policy but not implemented (0.5 point); and C- Provision and implementation of solid waste management policy *plus* provision of storage cabins for hazardous wastes (1 point). A copy of the hazardous waste management policy is a documentary requirement.

**E33- Waste stream audit**

The sub-attribute considers and evaluates how waste streams are sorted into bins for collection, recycling, and storage as well as the labelling of the waste bins. It involves the setting of waste targets to ensure a better monitoring of waste management and generation. It also promotes the documentation of processes and resources necessary for waste management (BRE, 2016). E33 is an *optional* sub-attribute. Two points are attainable by projects based on the following rating points. A- No waste stream auditing (0 point); B- Sorting of waste into several waste bins and labelling the waste bins (1 point); and C- B *plus* setting of waste targets (2 points). Photographs of segregated waste bins and labelled bins are documentary requirements.

**E34 – Ongoing consumable and durable goods waste**

It focusses on minimizing related cost and environmental damage of consumable and durable goods by encouraging the implementation of waste management best practices. It involves the provision dedicated storage bins for the consumable and durable goods. E34 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Provision of dedicated storage bins for consumable and durable goods waste; Q2- 10-30% reduction in consumable and durable goods waste; and Q3- ≥30% reduction in consumable and durable goods waste. A- Neither Q1 or Q2 (0 points); B- Q1 *or* Q2 (0.5 point); and C- Q1 *plus* Q3 (1 point). Documentary evidence include photographs of the storage bins.

**E35 – Facility alterations and demolition waste**

The sub-attribute considers waste related to demolition, construction, and alteration works towards reducing such waste via recovery, reuse, and recycling methods (USGBC, 2018c). It involves the development and implementation of the facility's demolition and alteration waste management plan, and guidelines towards reducing the overall percentage of the building's waste stream. It also considers the provision of dedicated storage facility for E35 wastes. E35 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Alterations and demolition waste management plan; Q2- 22-45% reduction in E35 wastes; and Q3- ≥46% reduction in E35 wastes. A- Neither Q1, Q2 or Q3 (0 point); B- Provision of 'Q1' but not implemented *plus* 'Q2' (0.5 point); C- Provision and implementation of 'Q1' *plus* 'Q3' (1 point). A copy of the facility alterations and demolition waste plan is a documentary requirement.

**E36 – Collection, storage, and disposal of recyclables**

E36 promotes a hygiene collection, storage, and disposal of waste as well as the recycling and separation of the waste. It encourages the use of separate waste bins for the collection of different waste stream (e.g. paper, cans, plastic, glass, etc.) (BRE, 2016). It aims to minimize waste production and efficient use of waste generated through recycling. E36 is an *optional* sub-attribute. A maximum of two points are attainable from this sub-attribute based on the following rating points. A- No waste bin or no separation of wastes in separate bins (0 point); B- Separation of waste streams in separate well-labeled bins (1 point); and C- B *plus* Proper storage and disposal of generated waste (2 points). Photographs of the labelled waste bins and the central waste collection is a documentary evidence.

**E37 – Waste equipment installation**

It considers the design, specification, and installation of efficient waste equipment in the facility; most especially for commercial, educational or health care facilities. E37 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No waste equipment installed (0 point); and B- Waste equipment installed in the facility (1 point). Photographs of the installed waste equipment is a documentary evidence.

### *E4 – Ease of conversion of building functions*

The sustainability attribute E4 is composed of four sustainability sub-attributes (E41 to E44) as discussed below.

**E41 – Functional adaptation**

It promotes the flexibility of building designs to allow for functional adaptation to meet future demand changes in use and functions. It encourages clients and design team to consider this sub-attribute in the design of buildings. Flexibility involve design features such as ease of repartitioning walls, ease of adjusting placement of plumbing works, and circuits among others. It considers integrating value engineering in the building design. It facilitates the reuse and recycling of materials to increase the life-tie value of the materials and products (BRE, 2018). E41 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No functional adaptivity (0 point); and B- Functional adaptivity (flexibility in building designs) (1 point). Documentary requirements include (i) a copy of the building design and documentation to show functional adaptation was considered by the design team and (ii) photographic evidence of design feature that reflect flexibility.

**E42 – Ease of disassembly (deconstruction)**

E42 encourages and promotes the durability and ease of disassembly of building components and system through implementing sustainable practices in its design, selection of material, and construction. It also helps to reduce the integration of unnecessary framing materials in buildings (BCA, 2010). It helps to minimize the use of excess materials, associated cost, and disruptions that may arise due to future refurbishment. E42 also allows for disassembled at the end of the building use, the use of materials that minimizes frequent maintenance, non-use of welded connections, ease of replacement and repair, and avoidance of toxic treatments and finishing works. E42 is an *optional* sub-attribute. One point is achievable under this sub-attribute. A- No implementation of 'ease of disassembly' plan in the building design (0 point); and B- Provision and implementation of 'ease of disassembly' plan in the building design (1 point). A copy of the 'ease of disassembly' implementation plan and guide is a documentary requirement.

**E43 – Designing for robustness for asset and landscape**

It encourage the inclusion of features in building design and project site plans that protect the building and landscape from potential damage from vehicular or pedestrian traffic and other forms of movement (BRE, 2016). It helps to reduce the level of maintenance and replacement of building components and optimize material use. BRE (2016) pointed out that features such as bollards, wall guards, pathways can be used to protect buildings while features such as pathways or fenced landscaped area can be used to protect the landscapes. E43 is an *optional* sub-attribute. Two points are attainable by projects based on the following rating points. Q1- Protection features for the building; and Q2- Protection features for the landscape areas. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); and C- Q1 *plus* Q2 (2 points). Documentary requirements for this assessment are (i) photographic evidence of the protection features for the building and landscape and (ii) a copy of the building design and documentation that reflect design for robustness.

**E44 – Building adaptation strategy plans**

It examines whether the project team and facility management team has developed a building design adaptation and strategies to promote flexibility in the design and functionality of the facility. It also considers the implementation of the adaptation strategy plans (BRE, 2016). E44 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No provision of a building adaptation strategy guideline (0 point); and B- Provision and implementation building adaptation strategy guidelines (1 point). A copy of the building adaptation strategy plans is a documentary requirement.

## 6. TRANSPORTATION (F)

It assesses the measures, strategies implemented in a building project site and surrounding neighborhoods; to reduce pollution and ease human discomfort arising from transportation (see Figure 9). It considers the transportation trips of the building users and visitors. A regular transport survey should be conducted once a year. Overall, it aims to ensure the use of sustainable transportation solutions.

| Indicators | (F) Transportation | | |
|---|---|---|---|
| Attributes | Alternative Means of Transport | Community Accessibility | Transport Management |
| Sub-Attributes | Pedestrian & cyclist facilities | Public transport accessibility | Car parking capacity |
| | Reduction of conventional commuting trips | Proximity to amenities | Provision of low-emitting & fuel efficient vehicles |
| | Carpooling & vanpooling | | |

***Figure 9: Transportation (indicator F)***

### *F1 – Alternative means of transport*

It takes into consideration efforts to reduce the use of private vehicles and provision of other means of commuting such as cyclist paths, pedestrian walkway, car or vanpooling schemes etc. towards reducing the reliance on use of vehicles. The sustainability attribute F1 is composed of three sustainability sub-attributes (F11 to F13) as discussed below. F1 aims to improve health and wellbeing of users by providing safe and comfortable environments and encourage building occupants to engage in daily physical activities (USGBC, 2018d).

#### F11 – Pedestrian and cyclist facilities

It encourages building occupants to use the pedestrian walkways and bicycles. It factors in the provision of pedestrian and cyclist paths and appropriate facilities; and the pedestrian pathway should link up to other surrounding footpaths. Such facilities should be in proximity of the assessed facility. F11 is a *required* sub-attribute. Two points are attainable by projects based on the following rating points. Q1- Provision of an adequate lighting, appropriate sized, designed, and safe pedestrian walkway or cycle racks; Q2- Provision of an adequate lighting, appropriate sized, designed, and safe pedestrian walkway and cycle racks; Q3- Provision of amenity areas (such as changing and shower facilities) along the pedestrian walkway and

cycle racks accessible to building occupants; and Q4- Proximity to public transport. A- Neither Q1, Q2, Q3, or Q4 (0 point); B- Q3 *or* Q4 (0.5 point); C- Q1 (1 point); D- Q2 (1.5 points); E- Q2, Q3 *plus* Q4 (2 points). Documentary evidence include photographs of the pedestrian walkway and cycle racks as well as the site layout plan showing the location of the pedestrian walkway and cycle racks and nearby public transports.

**F12 – Reduction of conventional commuting trips**

It examines and assess the usage of alternative transportation towards reducing the buildings' occupants use of other conventional travel means. Alternative travel means include carpooling, use of electric vehicles, telecommuting, biking, compressed workweeks (USGBC, 2018b). USGBC (2018b) presents the equation to calculate F12. F12 is an *optional* sub-attribute. A maximum of four points are achievable by projects based on the following rating points (see Table 1). A copy of the survey responses is a required documentary evidence.

$$Percentage\ rate\ of\ reduction\ \ of\ conventional\ transport\ means = \frac{Number\ of users\ using\ alternative\ tranport\ means}{Total\ number\ of\ building\ occupants\ } \times 100$$

**Table 1: Percentage rate of reduction of conventional trips**

| Percentage rate of reduction | Points |
|---|---|
| A- 10 – 30% | 1 |
| B- 31 – 39% | 2 |
| C- 40 – 49% | 3 |
| D- 50 – 69% | 3.5 |
| E- ≥70% | 4 |

**F13 – Carpooling and vanpooling**

It encourages the provision and use of carpooling or vanpooling services among building occupants rather than their private cars. F13 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No carpooling or vanpooling services available (0 point); and B- Provision of carpooling or vanpooling services (1 point). A schedule, timetable, and routes of the carpooling or vanpooling services used by the building occupants are the documentary requirements.

### *F2 – Community accessibility*

It ensures and promotes safe access and ease of movement to nearby amenities and public transport facilities; and encourages the provision of social amenities in the facility that can improves the wellbeing and health of the occupants. The sustainability attribute F2 comprises of two sustainability sub-attributes (F21 to F22) as discussed below.

**F21 – Public transport accessibility**

It evaluates how the available public transport means are accessible to the building occupants. The distance (see Table 2) of the building facility to the nearest public transport point is measured via the safe pedestrian walkaways or cyclist pathways, and not via the crow fly. F21 is a *required* sub-attribute. A maximum of four points are achievable by projects based on the following rating points.

**Table 2: Public transport accessibility**

| Description | Points |
|---|---|
| A- Available public transport means are over 1km away from the building with a 31mins to 1hour service interval at peak hours | 0.5 |
| B- Available public transport means are over 1km away from the building with a 15mins to 30mins service interval at peak hours | 1 |
| C- Available public transport means are within 1km away from the building with a 30mins service interval at peak hours | 1.5 |
| D- Available public transport means are within 500m away from the building with a 30mins service interval at peak hours | 2 |
| E- Dedicated bus or car service at scheduled times of the day | 3 |
| F- Available public transport means are within 1km away from the building with a 15mins service interval at peak hours | 3.5 |
| G- Available public transport means are within 500m away from the building with a 15mins service interval at peak hours | 4 |
| H- None of the public transport means met the above (A-G) criteria | 0 |

Documentary evidence for this assessment include (i) photographs of the public transport means and the safe pedestrian and cyclist pathways (ii) schedules of the public transport service timetables and (iii) annotated map showing the pedestrian walkway and the public transport nodes.

**F22 – Proximity to amenities**

It assesses and evaluates the distance via the safe walking or cycling routes (see Table 3) to the available social amenities like restaurants, automated teller machines (ATM) points,

banks, postal offices, etc. F22 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of three points.

**Table 3: Proximity to amenities**

| Description | Points |
|---|---|
| A- The amenities are over 1km away from the building | 0.5 |
| B- The amenities are within 1km away from the building | 1 |
| C- The amenities (at least two amenities) are within 500m away from the building | 2 |
| D- The amenities (at least three amenities) are within 500m away from the building | 2.5 |
| E- The amenities (at least four amenities) are within 500m away from the building | 3 |
| F- None of the amenities met the above criteria (A-E) | 0 |

Documentary evidence for this assessment include (i) annotated map showing the routes and distances of the building and the amenities (ii) photographs of the identified amenities and (iii) evidence of public display of information of the amenities to the building occupants.

### *F3 - Transport management*

It investigates the means of commuting and the efficiency of the transport means in terms of the fuel usage and $CO_2$ emission as well as the vehicular parking spaces. The sustainability attribute F3 comprises of two sustainability sub-attributes (F31 to F32) as discussed below.

**F31 – Car parking capacity**

It encourages the provision of limited parking facilities within or near the building facility towards minimizing the environmental harm or carbon footprint. The parking facility must be well-lighted and marked; and with access to pedestrian routes closet to the building. It aims to ensure that most of the building occupants avoid the use of private cars; or as a strategy, parking spaces can be sold or lease at a rate higher than the local amount of money spent on public transportation network. F31 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- Unlimited or over-sized car parking capacity (0 point); B- Limited parking facilities meeting the underlisted requirements above (1 point); and C- No car parking facility available (1 point). Photographs of the nearby carparking facilities and layout plans of the facility are required documentary evidence.

**F32 – Provision of low-emitting and fuel-efficient vehicles**

It examines the performance rate of the transportation means available to the building occupants in terms of $CO_2$ emission. It also considers the two-way vehicular movement

coming into and from the facility; and examine the fuel consumption rate of the vehicles (see Table 4). It also encourages the use of electric cars.

**Table 4: Provision of low-emitting and fuel-efficient vehicles**

| Description | Points |
|---|---|
| **(a) Low-emitting vehicles** | |
| A- ≤30% of vehicles are low-emitting | 0 |
| B- 31-60% of vehicles are low-emitting | 0.25 |
| C- >60% of vehicles are low-emitting | 0.5 |
| **(b) Fuel-efficient vehicles** | |
| A- ≤30% of vehicles are fuel-efficient | 0 |
| B- 31-60% of vehicles are fuel-efficient | 0.25 |
| C- >60% of vehicles are fuel-efficient | 0.5 |

The data are collected from the occupants and visitors via a survey on their transportation patterns. F32 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A copy of the survey responses is a documentary requirement.

## 7. INDOOR ENVIRONMENTAL QUALITY (G)

It focuses on building design strategies to improve and enhance the health, wellbeing, and safety of building occupants and visitors (BRE, 2018) and reduce the environmental impacts of building development (see Figure 10).

| Indicators | (G) Indoor Environmental Quality (IEQ) | | | | | |
|---|---|---|---|---|---|---|
| Attributes | Visual Comfort | Indoor Air Quality | Thermal comfort | Acoustic Performance | Hygiene | Building Amenities |
| Sub-Attributes | Daylighting and external views | Minimum IAQ performance | Design and verification | Room acoustics | Plumbing and drainage system & liquid separators | Access for persons with disability |
| | Glare control | Environmental tobaaco smoke control | Controllability of temperature | Noise isolation and control | Chemical leak prevention & storage | Amenity features |
| | Interior lighting distribution | Adequate cross-ventilation | Thermal comfort in AC & non-AC premises | HVAC background noise | Integrated pest management | Efficiency of use |
| | High frequency ballasts | Indoor air quality management | | | Waste disposal facilities de-odorizing system | Low-impact systems and materials |
| | Automatic lighting controls | Control of greenhouse gases (GHS) emission sources | | | Occupancy comfort survey & feedback | |
| | | Reduction of light pollution | | | | |

***Figure 10: Indoor environmental Quality (indicator G)***

### *G1 – Visual comfort*

It considers and promotes the design, specification, and construction of buildings that gives adequate comfort to the building occupants by minimizing sun glares, provide good daylighting, and view-out. The sustainability attribute G1 comprises of five sustainability sub-attributes (G11 to G15) as discussed below.

#### G11 – Daylighting and external views

It encourages the implementation of policies and strategies that promotes inclusive designs in building towards enhancing the well-being of the building occupants; and connect the users to the outdoor environment through the creation of external views and reduction of electrical lighting by using daylights. It also helps to avoid eyestrains affecting the building occupants (BRE, 2016). The daylighting potential of building can be evaluated via simulations (USGBC, 2018c), and BRE (2016) recommends for building spaces to be within seven (7) meters of the external window. USGBC (2018c) outlined the four types of external views. G11 is a *required* sub-attribute. Two points are available for this sub-attribute based on the following rating

points. Q1- Access to external view by the building occupants from at least 60percent of floor area; and Q2- Provision of daylighting to building occupants from at least 40percent of floor area. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); and C- Q1 *plus* Q2 (2 points). Photographs of the building elevations and the building floor plans are the documentary requirements for this assessment.

**G12 – Glare control**

The sub-attribute evaluates the percentage of the building envelope that is glazed. It assesses the building spaces at risk of glare and involved the implementation of appropriate measures through a glare control strategy in the building design (BRE, 2018). G12 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No provision of a glare control strategy in building design (0 point); and B- Provision and implementation of a glare control strategy in building design (1 point). Photographs of the building from all elevations and the building design plans are the documentary evidence.

**G13 – Interior lighting distribution**

It encourages the installation of energy-efficient lamps and control systems. It also ensures the adequacy and maintenance of visual comfort conditions for the building occupants (HKGBC, 2016); and improve the comfort, well-being, and health of the building occupants (USGBC, 2018c). Two types of lighting control system are commonly in use as identified by BRE (2016). These include (i) a special lighting control system which is used to control all lighting fixtures from a central control or switch. It has a preset presence sensor and control to dim lights at different intensity; which is then integrated to the building management system (BRE, 2016), in such a way to enhance the building energy efficiency. (ii) typical lighting control system which make use of a single control in enclosed spaces; and lighting adjustment occurs at each lamp positions e.g. on/off switch (BRE, 2016).

USGBC (2018c) recommended the use of lighting fixtures of less than 2.500cd/$m^3$. G13 is a *required* sub-attribute. A maximum of two points are attainable from this sub-attribute based on the following rating points. Light-emitting diode (LED) type lamps and metal halide-type lamps are given more points compared to a compact fluorescent lamp, tungsten halogens and incandescent lamps (BRE, 2016). A- Use of tungsten halogen or incandescent lamps (0 point); B- Use of LED or metal halide-type lamps + typical lighting control system (≥ 65% of the lamps) (1 point); and C- Use of LED or metal halide-type lamps + special lighting control system (≥ 65% of the lamps) (2 points). Documentary evidence include (i) a copy of the building plans showing areas with the different lighting types and system (ii) technical or manufacturer's specification of the lamps and (iii) photographic evidence of the installed lighting types.

**G14 – High frequency ballasts**

It evaluates the percentage of high frequency ballasts (HFB) use in fluorescent lamps installed in the building. BRE (2016) defined HFB as a device used to limit the current flow through fluorescent tubes to optimize its energy use. G14 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No HFB in fluorescent lamps (0 point); B- <50% of lamps with HFB (0.5 point); and C- ≥50% of lamps with HFB (1 point). Documentary requirement for this assessment include (i) photographic evidence of ballasts used for the fluorescent lamps (ii) a copy of the building design showing areas with fluorescent lamps equipped with HFB and (iii) HFB's technical or manufacturer's specification.

**G15 – Automatic lighting controls**

It encourages the use of presence and daylight sensors to control lighting in buildings. It evaluates the percentage of the building floor area that is controlled by the lighting sensors (BRE, 2016). G15 is an *optional* sub-attribute. A maximum of two points are available which are allocated as follows. A- No automatic lighting controls or sensors installed (0 point); B- <50% of the floor area is controlled by lighting sensors (1 point); and C- ≥50% of the floor area is controlled by lighting sensors (2 points). Documentary evidence are (i) photographic evidence of the sensors and (ii) a copy of the building plans showing where the lighting sensors are installed.

### *G2 – Indoor air quality*

It promotes and encourages the use of materials that enhances the indoor air quality (IAQ), prevent source pollution, and ensure adequate ventilation rate and efficient operation plan for IAQ equipment (IBEC, 2004). The sustainability attribute G2 is composed of six sustainability sub-attributes (G21 to G26) as highlighted below.

**G21 – Minimum IAQ performance**

G21 encourage and promote the comfort, health, and wellbeing of building users through the establishment of a safe minimum standards for IAQ (USGBC, 2018c). The building should meet the minimum industry standards and best practices for ventilation (outdoor air intake) and its monitoring. Relevant IAQ standards include ASHRAE standard 62.1-2016, CEN standards EN 15251-2007, and EN 13779-2007 or any other local equivalent. It also considers the installation of efficient equipment to measure outdoor airflow. G21 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Building designs meet minimum IAQ industry standard; and Q2- Installation of IAQ equipment. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (0.75 point); C- Q1 *plus* Q2 (1 point). A copy of the

applicable IAQ industry standard and photographs of the installed IAQ equipment is a required evidence.

**G22 – Environmental tobacco smoke control**

It focuses on the prevention of smoking by the building occupants and visitors whether within the building or outside. It also minimizes the effect of smoke on the health of the building users and surfaces of the building, and ventilation systems (USGBC, 2018c). It involves the public display of no-smoking signage in the building and its vicinity; and designation of areas which should be at least 7.5meters from the building, as smoking zones (HKGBC, 2016; USGBC, 2018c). Such no-smoking policy should be outlined in the lease agreement. G22 is an *optional* sub-attribute. One point is attainable by projects based on the following rating points. Q1- Provision and implementation of a no-smoking policy; and Q2- Public display of no-smoking signage and designation of smoking zones. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (0.75 point); and C- Q1 *plus* Q2 (1 point). A copy of the no-smoking policy and photographic evidence of the no-smoking signage are the documentary requirements for this assessment.

**G23 – Adequate cross-ventilation**

It encourages and promotes adequate ventilation within the building to reduce the level of pollution, temperature, reduce moisture among others; towards improving the wellbeing of the building occupants. It involves the installation of exhaust systems in bathrooms and kitchen; and mechanical ventilation systems in other areas of the building (USGBC, 2018d). The ventilation system must meet acceptable industry standards or ASHRAE standard 62.2-2010 or other local equivalent. HKGBC (2016) recommended that at least 90percent of the common areas must be well ventilated. Also, BCA (2010) pointed out that proper building layout design is required to facilitate natural ventilation using the prevailing wind; and that ventilation simulation software can be employed to identify the best building layout design. G23 is a *required* sub-attribute. A maximum of one point is available which are allocated as follows. Q1- Installation of efficient exhaust systems and ventilation systems; and Q2- ‘Q1’ must meet industry standards. A- Neither Q1 or Q2 (0 point); B- Q1 (0.75 point); and C- Q1 *plus* Q2 (1 point). A copy of the applicable industry standards and photographs of installed ventilation systems are the documentary requirements.

**G24 – Indoor air quality management**

The sub-attribute considers and promotes the overall well-being, comfort, and productivity of the building occupants by the implementation of an IAQ management plan and strategies for the facility. The IAQ plan must be developed before the occupancy of the building; and it should consider both the mechanical and naturally ventilated spaces as well as a mixed mode

system (USGBC, 2018c). The IAQ management plan should prevent contamination from external sources, increase rate of outdoor ventilation, and the enhance the monitoring of $CO_2$ emission among others. G24 is a *required* sub-attribute. A maximum of two points are available which are allocated as follows. Q1- Provision and implementation of an IAQ management plan; and Q2- IAQ management plan is developed before the building occupancy. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); and C- Q1 *plus* Q2 (2 points). A copy of the IAQ management plan is a documentary evidence.

**G25 – Control of greenhouse gases (GHG) emission sources**

It promotes and encourages the regular monitoring and control of GHG emission within the building to ensure proper wellbeing of the occupants and meet preset design specifications. Emission ($CO_2$) sensors should be installed to detect abnormal emission levels and alert the building occupants and the facility management team towards implementing appropriate measure like opening window or roof vents (BRE, 2016). It also ensures the use of construction materials which are less harmful to the environment and the building occupants (BRE, 2018) or less emissions which must meet the relevant requirements. G25 is an *optional* sub-attribute. Two points are available for allocation according to the following rating points. A- No control of GHG sources (0 point); B- Control and monitoring of GHG sources (1 point); and C- 'B' *plus* the installation of $CO_2$ sensors OR not required in the building (2 points). Documentary evidence include (i) photographic evidence of the $CO_2$ sensors and equipment and (ii) a copy of the monitoring records and procedure.

**G26 – Reduction of light pollution**

It involves the provision and formulation of light pollution policy and control strategy toward reducing associated pollution risks. Such policy, guidelines, or strategy should be in accordance or meet minimum industry best practices. It aims to enhance nighttime visibility and access to the night sky, prevent glaring, and comply with relevant blacklight-uplight-glare (BUG) rating in IES TM-15-11 or relevant local ratings (USGBC, 2018d). Also, it ensures avoidance of upward lighting (BRE, 2018) and mean lamps' lumens must not be greater than 2500 (USGBC, 2018a). It minimizes energy consumption and unnecessary nuisance to the neighborhoods (BRE, 2018). G26 is an *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No light pollution policy implemented (0 point); and B- Provision and implementation of relevant light pollution policy or requirement (1 point). A copy of the light pollution policy or requirement is a documentary evidence for this assessment.

### *G3 – Thermal comfort*

It provides the building occupants with the adequate control over the temperature of the facility. The sustainability attribute G3 consists of three sustainability sub-attributes (G31 to G33) as highlighted below. It also ensures the efficiency in the regulation, control, and maintenance of the building temperature, humidity, cooling, and associated equipment (IBEC, 2004).

**G31 – Design and verification**

It ensures the building meet the minimum requirements and relevant industry best practices for thermal comfort through efficient design and verification. It also improve the comfort, health, wellbeing, and productivity of the building occupants (USGBC, 2018c). It considers the air and radiant temperature, air speed, and humidity in its assessment. Relevant standards such as ASHRAE standard 55-2010, ISO 7730:2005 or other equivalent local standards can be used. G31 is a *required* sub-attribute. A maximum of two points is achievable based on the following rating points. Q1- Design and specification of buildings according to applicable industry standards; and Q2- Verification of the thermal comfort design of the building after occupancy. A- Neither Q1 or Q2 (0 point); B- Q1 (1 point); and C- Q1 *plus* Q2 (2 points). A copy of the applicable industry standard for thermal comfort and an assessment report of the building thermal comfort are the documentary evidence.

**G32 – Controllability of temperature**

It evaluates whether the temperature within the building can be controlled and is in accordance to the design specifications. It promotes an adequate management of temperature within the building at all seasons. G32 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Building temperature can be managed and controlled; and Q2- Implementation of a preset building temperature design specification. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (0.5 point); and C- Q1 *plus* Q2 (1 point). Documentary requirements are (i) a copy of the building temperature design specification for all seasons and (ii) a record of temperatures in the previous years for all seasons.

**G33 – Thermal comfort in AC and non-AC premises**

It promotes and encourages the design and construction of buildings to ensure adequate comfort for building occupants in non-AC spaces through natural ventilation and provision of AC in areas without natural ventilations. G33 is an *optional* sub-attribute. A maximum of two points are available which are allocated as follows. Q1- Adequate well-ventilated non-AC premises to meet relevant requirements; and Q2- Provision of efficient AC equipment in spaces without natural ventilation. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); and

C- Q1 *plus* Q2 (2 points). A copy of the industry standards or requirement for non-AC spaces and manufacturers' manual for the installed AC equipment are the documentary requirements for this sub-attribute.

### *G4 – Acoustic performance*

It provides the building occupants with the best acoustic performance levels in the building according to the optimal functionality of each building spaces (BRE, 2018) and to provide the best level of comfort and enhance the productivity of the building occupants (IBEC, 2004). The sustainability attribute G4 consists of three sustainability sub-attributes (G41 to G43) as highlighted below.

#### G41 – Room acoustics

It encourages the design and specification of the acoustic (reverberation time) of building spaces in accordance with industry best practices. It promotes the regular control and monitoring of the building room acoustics by qualified acoustician (BRE, 2016). Also, all faults and deficiencies must be rectified, and recommendation implemented. All spaces within the building should be assessed. USGBC (2018c) outlined the reverberation type requirements for different room types. G41 is a *required* sub-attribute. One point is attainable by projects based on the following rating points. Q1- Design and specification of building room according to industry standards; and Q2- Verification of room acoustics and rectification of any defects. A- Neither Q1 or Q2 (0 point); B- Q1 (0.75 point); and C- Q1 *plus* Q2 (1 point). Documentary requirements include (i) a copy of the building design showing the acoustics specification of the room types and (ii) a copy of the acoustics verification report.

#### G42 – Noise isolation and control

It encourages the efficient designs of buildings that favors isolation and control of sound in and between adjacent spaces (HKGBC, 2016; USGBC, 2018c) towards promoting the wellbeing, communication, and productivity of building users through efficient acoustic design. USGBC (2018c) argued that the building spaces must meet the minimum composite sound transmission class (STC) ratings for spaces. BRE (2018) recommended a noise impact assessment be carried out in the facility. BCA (2010) also recommended an internal noise level of 55dB (6am to 10pm) and 45dB (10pm to 6am). G42 is an *optional* sub-attribute. A maximum of two points are available which are allocated as follows. Q1- Effective acoustic design of building; Q2- Spaces or rooms must meet minimum requirements or specifications; and Q3- Undertaking a noise impact assessment. A- Neither Q1, Q2 or Q3 (0 point); B- Q1 *or* Q2 *or* Q3 (1 point); C- Q1 *plus* Q2, or Q2 *plus* Q3, or Q1 *plus* Q3 (1.5 points); D- Q1, Q2 *plus* Q3 (2 points). Documentary evidence for this assessment are (i)a copy of the building plans

and its acoustic specifications (ii) a copy of relevant noise level requirement or standards and (iii) a copy of the noise impact assessment report.

**G43 – HVAC background noise**

It ensures and evaluates the HVAC background noise levels is in accordance with industry standards. It involve the installation of a sound measurement equipment or sound level meter (USGBC, 2018c). It is imperative for building designs to align with specified HVAC noise levels to provide maximum comfort for the building occupants. G43 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Installation of a sound level meter; and Q2- Building designs that complies with required HVAC noise levels. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (0.5 point); and C- Q1 *plus* Q2 (1 point). A copy of the building plans and specified HVAC noise level, and photographs of installed sound level meter are the required documentary evidence.

### *G5 – Hygiene*

It aims at providing and promoting a safe, healthy, and wellbeing of the building occupants; as well as provide a safe external site. The sustainability attribute G5 consists of five sustainability sub-attributes (G51 to G55) as highlighted below.

**G51 – Plumbing and drainage system and liquid separators**

It promotes the protection of the natural watercourses from contamination or pollution from run-off from drainage system, kitchen facilities where applicable. It encourages the installation of liquid and grease separators in all drainage and plumbing systems (BRE, 2016). G51 is a *required* sub-attribute. Three points are available for this sub-attribute based on the following rating points. Q1- Liquid separators installed in drainage systems with adequate maintenance; Q2- Liquid separators installed in plumbing fixtures with adequate maintenance; and Q3- Liquid separators is not applicable in the building. A- Neither Q1 or Q2 or Q3 (0 point); B- Q1 *or* Q2 (2 points); and C- Q1 *plus* Q2, or Q3 only (3 points). Documentary evidence are (i) photographic evidence of separators installed and its manufacturers' details (ii) a copy of the building plans showing location of the liquid separators; and (iii) a copy of the maintenance policy for the liquid separators.

**G52 – Chemical leak prevention and storage**

It encourages the development of a policy, strategy, and mitigation measures to prevent chemical or volatile organic compound leaks towards promoting a hygiene environment for the building occupants. It also encourages the adequate containment and storage of hazardous chemicals (BRE, 2016) to reduce the impact of a leak. G52 is an *optional* sub-

attribute. A maximum of two points are attainable from this sub-attribute based on the following rating points. Q1- Provision and implementation of a chemical prevention policy and mitigation measure; Q2- Installation of chemical storage facilities; and Q3- No hazardous chemical stored in the facility. A- Neither Q1 or Q2 or Q3 (0 point); B- Q1 *or* Q2 (1 point); and C- Q1 *plus* Q2, or Q3 only (2 points). Photographic evidence of the chemical storage facility and a copy of the chemical leak prevention policy or strategy and mitigation measures are the documentary requirements.

**G53 – Integrated pest management**

It involves the design, specification, and installation of equipment and system to eradicate or reduce contamination by pests or legionella. It involves regular maintenance and inspection of the installed systems (BRE, 2016) and the development of a pest management policy. The management of pest should be hygiene and have minimal or no environmental impact (HKGBC, 2016). G53 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. Q1- Provision and implementation of a pest management policy; and Q2- Installation of an efficient system to control pests. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (0.5 point); and C- Q1 *plus* Q2 (1 point). Documentary requirement for this assessment include (i) a copy of the pest management policy and (ii) a copy of the pest management records and inspections.

**G54 – Waste disposal facilities de-odorizing system**

It involves the provision of a cleaning policy or strategy (BRE, 2016); and the design and specification of an efficient deodorizing system to minimize the risk to human's health, and to improve overall cleanliness. It also reduces the use of harmful chemicals in cleaning the building. Also, a preset schedule of deodorizing of the facilities should be maintained. G54 is a *required* sub-attribute. A maximum of one point is achievable based on the following rating points. Q1- Installation of efficient deodorizing system; and Q2- Provision and implementation of a cleaning or deodorizing policy. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (0.5 point); and C- Q1 *plus* Q2 (1 point). Documentary evidence are (i) a copy of the cleaning or deodorizing policy or strategy and (ii) a copy of the building deodorizing schedules.

**G55 – Occupancy comfort survey and feedback**

It encourages the setting up of a survey and feedback mechanism to monitor and review the building user satisfaction with the indoor environmental conditions of the building. It also ensures that the feedbacks from the building occupants are addressed; and such surveys should be undertaken twice in a five-year period. BRE (2016) and HKGBC (2016) noted that the survey procedure and targets be made available to the building occupants. G55 is an

*optional* sub-attribute. A maximum of two points are available which are allocated as follows. Q1- Provision and implementation of survey and feedback procedures; Q2- Implementation of feedbacks received from the building occupants; and Q3- Proper conduct of the occupancy survey and feedback. A- Neither Q1, Q2 or Q3 (0 point); B- Q1 *or* Q2 *or* Q3 (1 point); C- Q1 *plus* Q2, or Q3 *plus* Q2, or Q1 *plus* Q3 (1.5 points); and D- Q1, Q2 *plus* Q3 (2 points). Documentary requirements are (i) a copy of the occupancy survey and feedback form (ii) a copy of the survey procedure, targets set and implemented as a result of the feedback received.

### *G6 – Building amenities*

The sustainability attribute G6 consists of four sustainability sub-attributes (G61 to G64) as highlighted below.

#### G61 – Access for persons with disability

It addresses the design and specification of the building and amenities to allow its usability by a wide range of users including those with disability (USGBC, 2018c). It improves the accessibility to open spaces and recreational facilities towards enhancing the health and wellbeing of the building occupants, physical activity, and community networking. Access facilities include elevator or lift, easy-to-grip handles (for doors & windows), motion-detector lighting at entrances, stairs, and closets etc. G61 is a *required* sub-attribute. Three points are available for this sub-attribute based on the following rating points. Q1- Adequate facilities to cater for the disabled; Q2- Ease of accessibility to external open spaces and recreational facilities; and Q3- Efficient maintenance of facilities and access points used by disabled occupants and others, A- Neither Q1, Q2 or Q3 (0 point); B- Q1, Q2 *or* Q3 (1 point); C- Q1 *plus* Q2, or Q3 *plus* Q2, or Q1 *plus* Q3 (2 points); and D- Q1, Q2 *plus* Q3 (3 points). Documentary evidence are (i) a copy of the building plans showing the facilities for the disabled and (ii) a copy of the maintenance schedule for the facilities.

#### G62 – Amenity features

It considers the provision of amenity features both indoor and outdoor for the building occupants. Amenity features provided might include resting spaces or benches, canteens, well-sheltered seating spaces, coffee joints, etc. (BRE, 2016). BRE (2016) noted that the amenity features must be adequate for at least 10percent of the building occupants. Mahmoud (2017) argued that the higher the number of amenity features, the higher the functionality of the facility. G62 is an *optional* sub-attribute. Two points are attainable by projects based on the following rating points. A- No amenity feature provided (0 point); B- One amenity feature provided (1 point); and C- ≥2 amenity features provided (2 points). Documentary requirements

for this assessment are (i) photographic evidence of the amenity features and (ii) a copy of the building plans showing the location of the amenity features.

**G63 – Efficiency of use**

It ensures that all the building spaces and amenities are utilized for their intended purposes and not otherwise. It considers the provision and public display of policy and guidelines to back up the proper use of communal spaces and equipment (BRE, 2016). It aims to extend the lifespan of the building and reduce waste (USGBC, 2018d). G63 is a *required* sub-attribute. A maximum of one point is available which are allocated as follows. A- No efficiency in use of the building spaces (0 point); and B- Proper implementation of the “efficiency of use” policy or guidelines (1 point). A copy of the “efficiency of use” policy is a required evidence.

**G64 – Low-impact systems and materials**

It aims to promote the use of building systems and materials with minimal effect or that reduces its impact on the environment and the wellbeing of the building occupants. The various building components (flooring, insulation, adhesives, wood products, etc.) must meet relevant requirements. For instance, USGBC (2017) noted that wood products must have low formaldehyde emissions. G64 is an *optional* sub-attribute. Two points are available for allocation according to the following rating points. Q1- Use and installation of low-impact building systems; and Q2- Use of low-impact construction materials. A- Neither Q1 or Q2 (0 point); B- Q1 *or* Q2 (1 point); and C- Q1 *plus* Q2 (2 points). A copy of the specification or manufacturers’ details of the installed building components and systems is a required documentary evidence.

## 8. BUILDING MANAGEMENT (H)

Sustainability attribute H consist of four key attributes and fourteen (14) sub-attributes (see Figure 11).

| Indicators | (H) Building Management | | | |
|---|---|---|---|---|
| Attributes | Operation & Maintenance | Security | Risk Management | Green Innovations |
| Sub-Attributes | Condition survey | Security measures | Fire risk assessment | Innovations in techniques |
| | Staffing quality and resources | Intruder alarm system | Fire risk manager | Performance enhancement |
| | Building user manual and information | | Natural hazards assessment | |
| | Operation & maintenance policy | | Emergency strategy | |
| | Operation and maintenance procedures and manuals | | | |
| | Green lease | | | |

***Figure 11: Building Management (indicator H)***

### *H1 – Operation and maintenance*

The sustainability attributes H1 consists of six sustainability sub-attributes (H11 to H16) as highlighted below.

#### H11 – Condition survey

It encourages and promotes the regular conduct of a building condition survey to highlight the current conditions and addresses the faults of the building components, structure, and system for the client or relevant stakeholders; The building condition survey can be either undertaken by the facility management team, an independent third party or an expert (BRE, 2016). The condition survey should be carried out every five years. H11 is a *required* sub-attribute. Three points are available for this sub-attribute based on the following rating points. A- No condition survey was carried out and the building is more than 5years old (0 point); B- Condition survey carried out by facility management team and defects rectified (1 point); C- Condition survey carried out by an independent third party or an expert and defects rectified (2 points); D- 'B' or 'C' certified by relevant authority OR building is less than 5years old and no condition survey is needed (3 points). Documentary evidence are (i) a copy of the recent condition survey and

the defects identified (ii) photographic evidence of the defects rectified and (iii) a certification report from relevant authority.

**H12 – Staffing quality and resources**

It considers the staffing of personnel to cater for the management and operation of the building. It also evaluates the availability of resources and facilities that aids their jobs and ensure the employed staff meets the minimum requirement for their assigned tasks. H12 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No adequate staff and resources for building management (0 point); and B- Adequate staff and resources for building management (1 point). A copy of the personnel records and resources available for the work is a required documentary requirement.

**H13 – Building user manual and information**

It encourages the development and provision of appropriate user manual for building occupants to ease their understanding of the use and efficient operation of the building (BRE, 2016). Such building user manual should be displayed in places accessible to all building occupants. The building user manual should contain details such as security provisions for visitors, shared facilities, safety and emergency information, operational guidelines, environmental strategy, maintenance arrangements and schedules, relevant contact details, and feedback control mechanism among others (BRE, 2016). The displayed information should contain information about the building performance. H13 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No provision of building user manual and information (0 point); B- Provision of building user manual and information (0.5 point); and C- Provision and public display of building user manual and information (1 point). A copy of the building user manual is a required evidence.

**H14 – Operation and maintenance policy**

It encourages the provision and implementation of an O & M policy and its regular review (annual or biannual). It evaluates whether the policy is a reactive or proactive O & M policy (BRE, 2016). The reviewing schedule or process should be preset by the facility management team. H14 is a *required* sub-attribute. A maximum of three points are achievable by projects based on the following rating points. A- No provision of O & M policy (0 point); B- Provision and implementation of a reactive O & M policy (2 points); C- Provision and implementation of a proactive O & M policy (3 points). A copy of the O & M policy is a documentary requirement.

**H15 – Operation and maintenance procedures and manuals**

It involves the provision and implementation of the building O & M manuals. It includes its public display of the O & M manual in noticeboards accessible to building occupants and management staff (BRE, 2016). The O & M manual should detail the maintenance procedure for all installed building services and equipment such as HVAC system, lighting systems, external shading, etc. It ensures the best management practice is adopted in the building and allows for proactive inspections and maintenance. Such operational procedures should not consume much energy. H15 is a *required* sub-attribute. A maximum of three points is achievable based on the following rating points. Q1- Provision of O & M manuals; Q2- Provision and implementation of energy-efficient operational procedures; Q3- Implementation of proactive maintenance procedures; and Q4- Public display of O & M manuals and maintenance records. A- Neither Q1, Q2, Q3, or Q4 (0 point); B- Q2 *plus* Q4, or Q3 *plus* Q4, or Q4 only (1 point); C- Q1 only, or Q2 *plus* Q3 (2 points); D- Q1, Q2, Q3 *plus* Q4 (3 points). Documentary evidence are (i) a copy of the O & M manual and (ii) a copy of the operational and maintenance records.

**H16 – Green lease**

It promotes the provision and implementation of lease agreements that incorporate the practices of green practices by building occupants. Green practices to be implemented by the building occupants includes efficient energy, light, water, waste practices among others (BRE, 2016). The green lease agreements should include sustainable targets for energy efficiency, water, maintenance, etc. Such lease agreement should also contain incentives for the building occupants who implemented it. H16 is an *optional* sub-attribute. Two points are attainable by projects based on the following rating points. A- No green lease agreement (0 point); B- Green lease agreements implemented with qualitative or quantitative targets (1 point); C- Green lease agreements implemented with qualitative and quantitative targets (2 points). A copy of the green lease agreements is a documentary requirement for this assessment.

### *H2 – Security measures*

The sustainability attributes H2 consists of two sustainability sub-attributes (H21 to H22) as highlighted below.

**H21 – Security measures**

It considers the various security measures implemented in the building and the security risks identified. Also, it evaluates whether the security measures are certified by a competent external security organization (BRE, 2016). It entails addressing all detected security risks and

defects in the building. According to BRE (2018), safety and security of building occupants and the environment is vital to a sustainable society. H21 is a *required* sub-attribute. A maximum of two points are available which are allocated as follows. A- No security measures identified or implemented (0 point); B- Proper assessment and implementation of identified security measures (1 point); and C- 'B' *plus* certification by appropriate authority (2 points). Documentary evidence are (i) copy of certification of security measures by a third-party organization and (ii) evidence of rectification of identified security risks.

**H22 – Intruder alarm system**

It examines whether an intruder alarm system is designed according to relevant industry standards or whether the building facility management team employs a security guards and equipped with adequate security equipment. It also involves the monitoring and maintenance of the alarm system (BRE, 2016). H22 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No provision of intruder alarm system or security guards (0 point); B- Provision of intruder alarm system or security guards (0.5 point); and C- 'B' *plus* certification by appropriate authority or adequate monitoring and maintenance of alarm system (1 point). Documentary evidence are (i) photographic evidence of the intruder alarm system and relevant certification documentation and (ii) evidence of employment of security guards (if applicable).

### *H3 – Risk management*

The sustainability attributes H3 consists of four sustainability sub-attributes (H31 to H34) as highlighted below.

**H31 – Fire risk assessment**

It encourages and promotes the conduct of fire risk assessments by the facility management team. It involves the identification of all fire risks to the building and environment, and developing mitigation measures to minimize its effects (BRE, 2016). Such risk assessment should be conducted by a competent expert and the requirements should be well highlighted. H31 is a *required* sub-attribute. Two points are attainable by projects based on the following rating points. A- No fire risk assessments (0 point); B- Conduct of fire risk assessments in the building (1 point); and C- 'B' *plus* developing appropriate mitigation measures (2 points). Documentary requirements for this assessment are (i) a copy of the fire risk assessment requirements and certification of the assessor and (ii) a record of past fire risk assessments conducted.

**H32 – Fire risk manager**

It involves the engagement of a fire risk manager with adequate technical and professional experience to identify and tackle any fire risk hazards and develop appropriate mitigation measures. The fire risk manager manages, monitors, and reviews all procedures related to H31. The fire risk manager should be certified by the fire service department. H32 is required for hospital, educational, commercial buildings, and multi-tenanted facilities. H32 is an *optional* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No fire risk manager was engaged (especially when it is required) (0 point); and B- Engagement of a certified fire risk manager (1 point). An evidence of the fire risk manager certification is a documentary requirement.

**H33 – Natural hazards assessments**

It involves the identification and adequate assessments of the adverse effect of natural hazards related to the facility or project site. Some natural hazards are floods, earthquakes, landslides, wildfires, hurricanes, droughts, etc. (BRE, 2016). Also, such assessment should be detailed and certified by an expert or relevant authority (BRE, 2016). H33 is a *required* sub-attribute. A maximum of two points are available which are allocated as follows. A- No natural hazards assessments (0 point); B- Identification and assessment of the natural hazards and its effects (1 point); and C- 'B' *plus* certification of all identified natural hazards (2 points). Documentary requirements are (i) relevant records of identified natural hazards and (ii) a copy of relevant certification (where necessary).

**H34 – Emergency strategy**

It involves the development and implementation of an emergency strategy or plan to ameliorate the effects of the natural hazards associated with the building; and protect the property, environment, and the users. The emergency plan should cover the identified natural hazards (BRE, 2016) and be certified by an expert or appropriate authority. H34 is a *required* sub-attribute. A maximum of two points are available which are allocated as follows. A- No provision of any emergency strategy (0 point); B- Provision and implementation of emergency strategy to tackle the identified natural hazards (1 point); and C- 'B' *plus* certification of the developed emergency plans (2 points). A copy of the emergency strategy plans is a required documentary evidence.

### *H4 – Green innovations*

The sustainability attributes H4 is composed of two sustainability sub-attributes (H41 to H42) as highlighted below.

**H41 – Innovation in techniques**

It encourages and promotes the implementation and incorporation of innovative techniques, ideas, and exemplary performances in the design, construction, and management of buildings. The innovative strategies must be identifiable and measurable. Such innovative techniques must embed green or sustainable practices (HKGBC, 2016). Also, the green innovative techniques must be cost-effective. H41 is a *required* sub-attribute. A maximum of two points are available which are allocated as follows. A- No innovative techniques implemented (0 point); B- Implementation of green innovative techniques (1 point); and C- 'B' *plus* measurable exemplary performances of embed sustainable practices (2 points). A copy of the itemized innovative techniques implemented in the project is a required documentary evidence.

**H42 – Performance enhancement**

It evaluates whether the green innovative techniques integrated in the building results in the enhancement of the building performance. The identified performance enhancement must be measurable. H42 is a *required* sub-attribute. Projects under this assessment can gain a maximum of one point. A- No performance enhancement (0 point); and B- Performance enhancement as a result of implemented innovative techniques (1 point). Evidence of the performance enhancement in the building is a documentary requirement.

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