

Enhancement of Estidama Pearl Rating of a Retail Store and Energy Centre Using Sustainable Solutions

Sneha Sanjay

ABSTRACT--- *The main concept of environmentally sustainable buildings is its design that offers minimal environmental impact with maximum human comfort. This paper presents a more green and sustainable retail store and energy centre of an arena by changing its Estidama Pearl Rating from 2 to Estidama Pearl Rating 3 in its design stage, thereby increasing its points from the already existing 75 points to 85 points. The points are achieved by modifying and improving the design, materials, efficiency, facilities and thermal comfort under credit sections of the Estidama Pearl Rating System such as Integrated Development Process, Livable Outdoors and Stewarding Materials of the structure. Furthermore, the cost analysis for each credit point is also provided.*

Index Terms: Pearl Rating, Sustainable Building, Material, Cost

I. INTRODUCTION

Rick Fedrizzi once said, "Green Buildings are a hallmark in economic sound business decisions, thoughtful environmental decisions and smart human impact decisions". 'Sustainability/ Sustainable development' is one of the most discussed and talked about everyday challenge yet very few understand and act on it. It has been estimated that the daily operation of buildings accounts for up to 40% of the total energy usage worldwide. Buildings and construction together account for 36% of global final energy use and 39% of energy-related carbon dioxide (CO₂) emissions. "Green Building" is now a global revolution and as a part of its initiatives around the world is the launch of a series of green building rating systems, standards, guidelines, and certifications, one of which is 'Estidama Pearl Building Rating System' which is specifically tailored to middle eastern regions. 'Estidama' means 'Sustainability' in Arabic and this green building concept is based on a life cycle perspective during a building's design, construction, and operation, so that its negative impact on the natural environment and human health reduced.

II. ESTIDAMA PEARL BUILDING RATING SYSTEM

The current pressing demand for sustainable infrastructure is on the rise as it is no longer a personal choice but an urgent need that we preserve our finite resources and look for wider and greener options.

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Table 1. Pearl Building Rating Levels

Requirement	Pearl Rating Achieved
All mandatory credits	1 Pearl
All mandatory credits + 60 credit points	2 Pearl
All mandatory credits + 85 credit points	3 Pearl
All mandatory credits + 115 credit points	4 Pearl
All mandatory credits + 140 credit points	5 Pearl

The Pearl Rating System provides design guidance and detailed requirements for rating a project's potential performance in relation to the four pillars of Estidama - Environmental, Social, Cultural and Economic. Integrated Development Process, Natural System, Livable Buildings, Precious Water, Resourceful Energy, Stewarding Materials, Innovating Practice are the seven credit sections that Pearl Building Rating system (PBRS) focuses on.

Table 2. Maximum credit points available for each section

Credit Section	Maximum Credit Points
IDP - Integrated Development Process	13
NS - Natural Systems	12
LB - Livable Buildings	37*
PW - Precious Water	43*
RE - Resourceful Energy	44
SM - Stewarding Materials	28
IP - Innovating Practice	3
TOTAL	177*

III. METHODOLOGY

This paper's scope of work is the Retail Store and Energy Centre of the main Arena project. The two larger retail buildings are steel framed, with steel columns in the perimeter supporting steel roof trusses and beams. The roof structure of these buildings is of composite metal deck construction, with shear studs connecting the metal deck to the supporting steel structure. The Energy Centre is a single storey structure located to the west of the Arena building and contains primary centralized MEP plant and equipment. A mezzanine level is included at level +9.500 NADD. The building includes a basement over the majority of its footprint which extends approximately 4.5metres below existing ground level.



ENHANCEMENT OF ESTIDAMA PEARL RATING OF A RETAIL STORE AND ENERGY CENTRE USING SUSTAINABLE SOLUTIONS

The buildings were awarded a Pearl Rating of 2- a common rating achieved by all retail and commercial buildings in Abu Dhabi - after scoring a total of 75 points in the Estidama Design Rating Assessment. This paper aims to take the buildings' sustainability a level higher by proposing a plan and design to change its Pearl Rating from 2 to 3 by achieving additional credit points of '10' to get the total of 85 points.

The PBRS was taken as the baseline for creating the objectives. The solution and outcome for each credit point were assessed based on the list design credit requirements given under each point. The following are the credit sections and credits which are targeted to be achieved to successfully fulfil the additional '10' required points:

- **IDP: Integrated Development Process**
 - IDP-2: Guest Worker Accommodation
- **LB: Livable Buildings**
 - LBo-1: Improved Outdoor Thermal Comfort
 - Lbo-4: Active Urban Environments
 - Lbo-7: Bicycle Facilities
 - Lbo-9: Travel Plan
- **SM: Stewarding Materials**
 - SM-2: Design for Materials Reduction
 - SM-8: Material Reuse
 - SM-11: Rapidly Renewable Materials

The originally designed Retail store and Energy Center i.e: Pearl Rating 2 is first modelled in Revit 2017 with its structural and architectural components by linking the 2D plan in AutoCAD 2017. The BIM Model is shown in Fig.1.

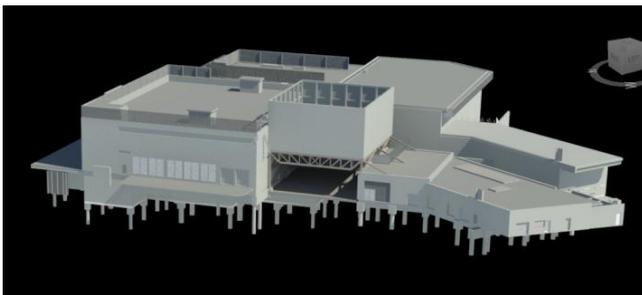


Fig. I. BIM Modelling of the Retail Store and Energy Centre

Note: The targeted credit points are selected based on whether they are not attempted by the client or attempted and not accepted after the Estidama Design Rating Assessment.

IV. IDP- INTERGRATED DEVELOPMENT PROCESS

As per PBRS- This credit encourages construction activities that value workers welfare, quality and sound environmental management.

IDP-2: Guest Worker Accommodation

Intent: To promote fair labour practices in building construction.

Total Credit Points: 2

Already Achieved credit points: 0 (Reason: Not Attempted)

Targeted credit points 2

Newly Achieved credit points: 2

Calculations and Methodology: This credit requires all the laws and regulations of Abu Dhabi Cabinet Decision No. (13) of 2009 to be met or exceeded. The manual set up by the main contractor for the labour camps, the existing plan, design, facilities, health and safety, Utility and emergency systems of existing labour camp for the Arena Project are cross checked with the Abu Dhabi Cabinet Decision No. (13) of 2009 and seems to fulfil all the requirements.

V. LIVABLE OUTDOORS

This credit focuses on those elements that influences the quality of human life and are in the direct and deliberate control of the design and development team.

1 LBo-1: Improved Outdoor Thermal Comfort

Intent: To improve outdoor thermal comfort during transition months and further reduce thermal discomfort during summer months in public spaces and walkways.

Total Credit Points: 1

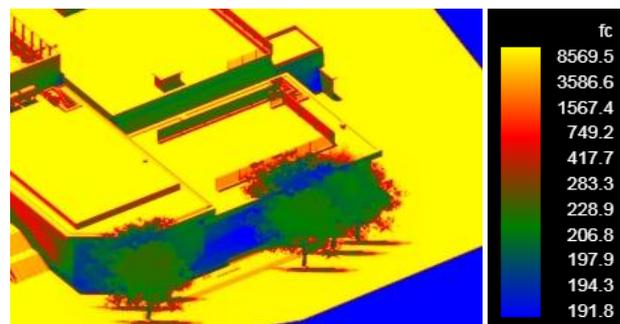
Already Achieved credit points: 0 (Reason: Not Attempted)

Targeted credit points 1

Newly Achieved credit points: 1

Methodology and Calculations: Primary pedestrian corridors as defined in the Abu Dhabi Urban Streen design Manual with 1m frontage zone which is provided adjacent to the building line for door openings, pedestrian movement, 2m throughway that is kept in the same level and material as that of the frontage zone, 0.7m of furnishing zone with street furniture, trees and transit stops and a 2m cycle track with an edge of 0.5m.

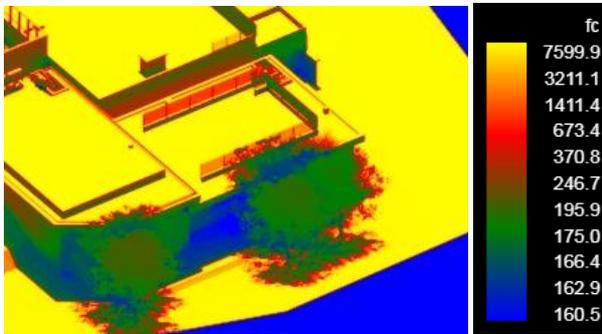
The SRI is a composite measure of a material's reflectance and emittance. It is calculated as set out in ASTM E 1980.1. Shading primarily with shading trees of varying height (7-18.5m) such as Lombardy Poplar(12.2m), Red Oak(18.2m) and Red Ash(7.6m). SRI values range from 29 to 37(SRI value of 29 being minimum requirement). These natural canopies which must be in place at the time of occupancy.



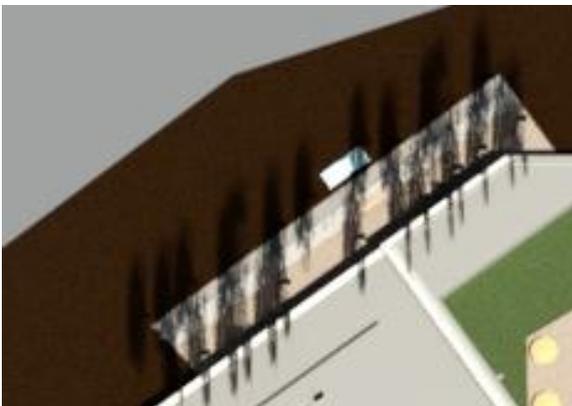
(a)



(b)



(c)



(d)

Fig. 2 (a) Illuminance Analysis (b) Solar Shading in Revit 2017 in cloud on March 21,2019(Equinox)
(c) Illuminance Analysis (d) Solar Shading in Revit 2017 in cloud on June 21,2019(Summer Solstice)

Some additional benefits include increasing cooling energy savings and reduced heat island effect. Shaded surfaces, for example, may be 20–45°F (11–25°C) cooler than the peak temperatures of unshaded materials. The above illuminance analysis shows that providing trees attenuates light up to 85-96%. A wooden canopy with metal frame is provided for the bicycle racks.

Cost Analysis: Oak trees come in the range of Dhs3600 to Dhs5700 with elm trees ranging from Dhs580 to Dhs1200. The cost of tree installation and labour costs is therefore much less than the cost of installation of steel framed wooden canopies which ranges from Dhs30,000- Dhs100,000 for primary pedestrian walkways.

LBo-4: Active Urban Environment

Intent: To encourage active lifestyles by providing building occupants and users with recreational public open spaces.

Total Credit Points: 1

Already Achieved credit points: 0 (Reason: Not Attempted)

Targeted credit points 1

Newly Achieved credit points: 1

Calculation and Methodology: None mentioned in PBRS

Since the project is of an arena, it satisfies the condition of ‘sports field areas’ which is also provided with accessible shower and changing room facilities.

LBo-7: Bicycle Facilities

Intent: To minimize greenhouse gas emissions, improve connectivity and encourage bicycle use (particularly during the cooler winter months).

Total Credit Points: 2

Already Achieved credit points: 0 (Reason: Not Accepted)

Targeted credit points 2

Newly Achieved credit points: 2



Fig.4 Bicycle Facilities with wooden canopy shading.

Calculations and Methodology:

1 credit: The bicycle facilities were not accepted in the previous design rating due to inadequate bicycle racks.

Each bicycle rack allows both the wheel and the frame of the cycle to be locked safely and each space is provided with dimensions of 2 x 0.75m. The number of bicycle racks and spaces is provided as per the requirement of a minimum of 1 space per 500m² of GFA, which amounts up to a total of 6 spaces for the retail store (short term and long-term commuter parking) and 4 spaces for the energy centre (long term commuter parking, provided less than 30m from the entrance of the retail store. A minimum space of 15m² is to be provided.

1 credit: Another credit is awarded on providing a maximum of one shower per gender for every 5000m². The total GFA of the retail store and the energy centre is 5215.54m². Since the project is an arena the shower and



ENHANCEMENT OF ESTIDAMA PEARL RATING OF A RETAIL STORE AND ENERGY CENTRE USING SUSTAINABLE SOLUTIONS

changing facilities provided for arena can be utilised by the cycle users.

Cost Analysis: Bicycle rack costs can range from approximately Dhs180 to Dhs10,800, depending on design and materials used. On an average the cost is approximately Dhs1980. Bicycle lockers costs range from Dhs3840 to Dhs8040, and bicycle stations are approximately Dhs750,000.

LBo-9: Travel Plan

Intent: To reduce single occupancy vehicle use by managing the demand for travel and by maximizing the availability of alternatives to travel by car.

Total Credit Points: 1

Already Achieved credit points: 0 (Reason: Not Accepted)

Targeted credit points 1

Newly Achieved credit points: 1

Calculations and Methodology: Out of the 1900 parking spaces provided for the project, 5% can be allotted for green vehicles (95 spaces) and electric vehicle supply equipment (EVSE) in 2% of all the parking spaces used by the project (38 spaces) with level 2 charging capacity (208-240 volts) or greater. Car park management systems such as providing discounted rate of a minimum of 20% for the green vehicle parking spaces can encourage citizens to go for greener options. Offering staff, the option to work from home or other flexible working options whenever possible, getting company pool cars so that staff can have access to vehicles, providing electronic barriers with number plate recognition to car parks to control who comes in, are a few pointers that can be included in a Travel Plan. Bicycle facilities, public transport, shuttles etc offer cheaper options to citizens with an added advantage to enjoy the scenic beauty of the surrounding landscape elements provided in the vicinity thus improving air quality, reducing noise pollution, dirt and fumes.

Cost Analysis: The average cost of operating an electric vehicle is Dhs1455 as compared to gasoline powered vehicle which is Dhs3351. Maintenance costs for conventional vehicles increase with age such as changing engine oil, coolant, transmission fluid etc, however in the case of electric powered vehicles the largest possible cost is the change of battery pack which again is covered if the vehicle is under warranty.

VI. STEWARDING MATERIALS & RESULTS

SM-2: Design for Material Reduction

Intent: To reduce the overall amount of material used in the development of buildings.

Total Credit Points: 2

Already Achieved credit points: 0 (Reason: Not Accepted)

Targeted credit points 2

Newly Achieved credit points: 2

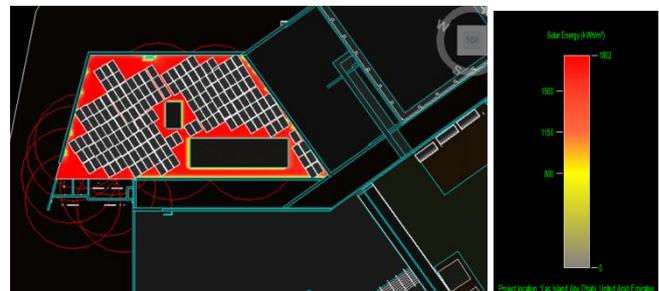
Calculations and Methodology:

Providing building with integrated photovoltaics on 12% of the building envelop (478m²), replacing traditional building materials for powering the retail store would offer the traditional advantage of uses such as unlimited energy

and lower electricity bills. Vegetated or green roofs for (52% of the building envelop) are thin living layers of vegetation installed on conventional roofing system. They are provided with layers of substrate, waterproofing membrane, roof barrier, filter fabric and growing media.

Cost Analysis:

Though the initial cost of solar panels is high (Dhs75,000 per panel for 5kw system). Cost of vegetative roofing is about Dhs 3000 per sqft per year but as compared to conventional roofing they provide a 30% savings in terms of cool building strategies and heat island effects.



(a)



(b)

Fig.5 (a) Solar Energy Analysis on the PV panels (b) Results- PV Energy Production, energy savings and payback period of PV panels installed on an area of 478m²

SM-8: Material Reuse

Intent: To promote the selection of previously used or salvaged materials to reduce demand on natural resources and reduce waste

Total Credit Points: 1

Already Achieved credit points: 0 (Reason: Not Accepted)

Targeted credit points 1

Newly Achieved credit points: 1

Calculations and Methodology: Reuse of plastic (polypropylene pellets with 2% SBF) in asphalt or plasphalt pavements is a viable alternative to conventional pavement not only provides better physical and chemical performance but also is a more sustainable option of disposing off such non-bio-degradable wastes. Salvaged materials such as structural members and flooring add significant character to



design. Frequently, salvaged wood products are sourced from old-growth timbers; these offer close grain finish and are extremely hard wearing.

Cost Analysis: Although plasphalt costs 10% more than the conventional asphalt pavement, it lasts 25% longer and diverts 27% of wastes from landfill. The average minimum

cost of reclaimed wood flooring is Dhs 24.54 per square foot. The average maximum cost of reclaimed wood flooring is Dhs 31.29 per square foot.

SM-11: Rapidly Renewable Materials

Intent: To increase the use of fast-growing materials as an alternative to slow growing materials and finite resources.

Total Credit Points: 1

Already Achieved credit points: 0 (Reason: Not Accepted)

Targeted credit points 1

Newly Achieved credit points: 1

Calculations and Methodology: Linoleum, a natural floor covering made of 98% of mineral based raw material and 80% renewable: materials like Linseed oil, natural resins, wood and cork powder and jute can be used for the floor finishes. Naturally occurring material that 'breathes' such as wool maintains the acoustic and thermal insulation for the lifespan of the structure. Its high integrity eliminates the need for glue and other bonding agents. Rockwool is used in thermal and acoustic insulation in walls. There is a minimum of 75% industrial waste in stone wool insulation, often as high as 90% and has an R-value as high as 4.0-6.0 per inch

Cost Analysis: Linoleum and Wool Insulations costs as low as Dhs12 and Dhs25 per square meter respectively.

VII. CONCLUSIONS:

The above-mentioned improvements in the design of the structural and architectural aspects of the Retail store and Energy Center by providing sustainable solutions in its design stage ensures that the building once constructed does not stop its commitment to sustainability and energy efficiency. The intent and credit requirements as per the PBRS and its subsequent points are successfully met. When cost analysis is performed the costs under each section for may be higher for some credit sections, but its benefits cannot be compensated by any conventional means. The community of 'green buildings' are once again awakening our planet and aiding in replenishing finite resources one step at a time without compromising the basic human comforts and requirements and the possibility of more sustainable solution remains endless.

VIII. ACKNOWLEDGMENTS

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AUTHORS PROFILE



A Final year student at Karunya Institute of Technology & Sciences, Coimbatore, India, Sneha Sanjay is also currently working as a Trainee at the Tendering & Engineering Department of BAM Higgs & Hills, Dubai, UAE. She won the 'Best Paper Award' for her research paper

'Enhancement of Estidama Pearl Rating for a Retail Store and Energy Center Using



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Sustainable Solutions’ for presenting at Tech Insight 2019-2nd International Conference on Research Advances in Engineering, technology, science and management. She was the Secretary for the Indian Geotechnical Society, Student Chapter of Coimbatore and her involvement in coordinating its various events in the department is highly appreciated. She was also the Head, Human Resources & Alumni for IAESTE, India for the year 2017-18.



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