

The Effectiveness of Building Maintenance Management Towards Environmental Sustainability

Masalinda Binti Mansor^{1*}, Muhammad Hakeem Bin Ruzaini² and Rosidi Bin Muhamad Nor¹

¹Politeknik Mukah, 96400 Mukah, Sarawak.

²Politeknik Sultan Salahuddin Abdul Aziz Shah, 40150 Shah Alam, Selangor.

ABSTRACT

Environmental Sustainability is one of the important factors should be considered in making a building function efficiently and effectively in Facilities Management. Environmental sustainability such as energy efficiency, water efficiency, indoor air quality, material and resource, and innovation are factors contributing to sustainable building environment. Therefore, Penang General Hospital should meet some of the features in sustainability aspect such as advanced sub metering, renewable energy, refrigerant and many more to achieve sustainability. The scope of the research is to develop new rating tools. In this study, Ambulatory Care Centre (ACC) located in Penang General Hospital been selected. The building evaluated with a new measurement variable, specifically for maintenance. It is difficult to implement a sustainable building requirement, cause by issues of building age. Secondly, is an issue of cost implementation. This study uses a mixed approach. The instruments used, interviews and observation. Interviews were carry out with the top management and engineers. Based on the evaluation conducted, Ambulatory Care Centre is not categorize as a sustainable building. An improvement needed to achieve a sustainable building status. Malaysia Health Ministry need to comply with the green policy requirement in order to achieve a sustainable building status for Penang General Hospital.

INTRODUCTION

The number of health facilities throughout the country has grown dramatically, from seven public clinics in 1957, to more than 1,000 (1167) in 1970 and again by more than 1,000 (2264) in 1980 [1]. The meaning of sustainability, may provide a variety of understandings and perspectives, depending on the context it is used. Healthcare buildings has to be designed for hygienic control; control infection; of adequate space and capacity for the function; ease of circulation; adequate ventilation; safe and comfortable environment; and having supportive healing environment among its design attributes [2]. The maintenance management of healthcare facilities is a multifaceted field of facilities management due mainly to the complexity of the building designs and service systems and shortage of maintenance budget [3]. Green building concept, in broader terms, involves a building, which is designed, built, operated, maintained or reused with objectives to protect occupant health, improve employee productivity, use wisely natural resources and reduce the environmental impact [4]. In order to provide an effective building maintenance management towards environmental sustainability, new user friendly has to be developed.

Problem Statement

*Corresponding Author: masalinda@pmu.edu.my

Maintenance must not only focus in increasing the building performance but should also consider the implications of maintenance or the lack of it on sustainable development [5]. There is a fundamental need to consider sustainable development in maintenance, because the processes and procedures involves in maintenance management have great impact on social, economic and environmental issues. Sustainable building provides energy saving, water saving, healthier indoor environments, better connectivity to a social facilities and amenities while embracing resource cycling initiatives. The need for maintenance management in buildings will only intensify as the value of the building and the associated engineering services must be preserved and sustained for the building to be meaningful to its users throughout its life span.

The lack of maintenance on hospital buildings will mean that the buildings cannot add value to hospital's corporate objectives and users /clients expected functions and roles [6]. Buildings may fail due to a number of reasons, such as faulty design, faulty construction, faulty maintenance, faulty materials and faulty use [7]. The evitable process of decay can be control and the physical life of building can be extend as long as proper maintenance is impose on them.

Objectives

The primary purpose of this investigation is to conduct an evaluation on the effectiveness of building maintenance management towards environmental sustainability. To reach the objectives and answer the research question, objectives created: -

1. To investigate available instrument for building maintenance management criteria towards environmental sustainability.
2. To introduce measurement variable for building maintenance management criteria towards environmental sustainability
3. To propose measurement tools towards for building maintenance management towards environmental sustainability

Scope of Works

The scope of this research is in Ambulatory Care Centre, Penang General Hospital. The reason for this selection cause by the building age and conditions. This is the newest and latest building, which has enough data to be evaluate for building sustainability.

LITERATURE REVIEW

Malaysia is a developed country, with the ambitious target of joining the ranks of the developed countries by the year 2020; it has made sustainable development one of its primary objectives. To realize this goal, the Malaysian government has undertaken numerous initiatives in various sectors to encourage energy efficient practices across the country. Buildings considered one of the largest consumers of energy. In the developing countries, huge number of new buildings constructed yearly. One of the major barriers for better building energy efficiency is the lack of aiding tools during the primary design stage [8]. In order to incentivize energy-efficient construction and promote sustainable development, it has developed a suite of related policies [9], including the Development of Malaysian standard MS: 1525 [10], Government Initiatives in Energy Efficiency in Malaysia [11], Green Building Index [12], and the Energy Audit and Retrofit in selected government buildings [13]. Sustainable building evaluation systems have led to the emergence of a new environmental building design paradigm [14]. Conceptual framework will briefly explain the form of study, the direction of the study, the study format and the stages or phases in the study. It is found on any existing or self-formed theories based on previous studies. This conceptual framework will guide the study to be implement. Figure 1, is a

conceptual framework for rating tools towards the effectiveness of building maintenance management towards environmental sustainability.

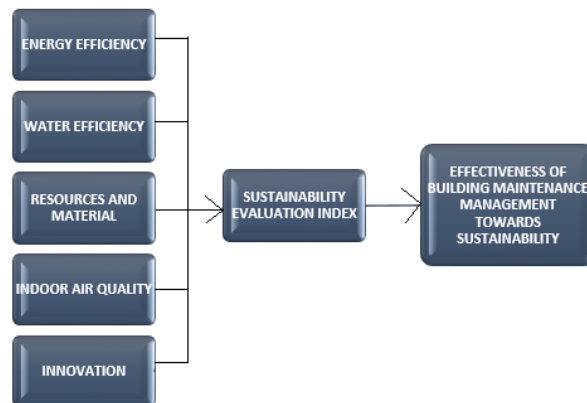


Figure 1. Conceptual framework.

Green Building Index

The Green Building Index (GBI) is Malaysia's industry recognized green rating tool for buildings to promote sustainability in the built environment and raise awareness among Developers, Architects, Engineers, Planners, Designers, Contractors and the Public about environmental issues and our responsibility to the future generations. The GBI rating tool provides an opportunity for developers and building owners to design and construct green, sustainable buildings that can provide energy savings, water savings, a healthier indoor environment, and the adoption of recycling and greenery for their projects and reduce our impact on the environment [12].

Green Mark

The Building and Construction Authority (BCA) is an agency under the Ministry of National Development, championing the development of an excellent built environment for Singapore. The BCA Green Mark Scheme was launch in January 2005 as an initiative to drive Singapore's construction industry towards more environment-friendly buildings. It is intend to promote sustainability in the built environment and raise environmental awareness among developers, designers and builders when they start project conceptualization and design, as well as during construction [14]

LEED (Leadership in Energy and Environment Design)

The first Leadership in Energy and Environmental Design Pilot Project Program, referred to as LEED® Version 1.0. The US Green Building Council (USGB) launched it in USA in 1998. A non-governmental organization includes representatives from industry, academia, and government. The LEED® Version 4.0 released in 2016 and now is currently in use. The LEED® Green Building Rating Systems are voluntary and intended to evaluate the environmental performance of the whole building over its life cycle [15].

Energy Efficiency

Energy efficiency measures meant to reduce the amount of energy consumed while maintaining or improving the quality of services provided in the building [16].

Water Efficiency

Water efficiency means responsible use of freshwater. Water efficiency means reducing usage of water and minimizing wastewater. Water efficiency implies using improved technologies and practices that deliver equal or better service with reduced water consumption. For example, the use of low flow faucet could be more effective than conventional faucets. Responsible use of water is using the water cautiously and conserving for our grandchildren [17].

Indoor Air Quality

Indoor air quality describes how inside air can affect a person's health, comfort, and ability to work. It can include but not limited to temperature, humidity, mold, bacteria, poor ventilation, or exposure to other chemicals [18].

Resources and Materials

Adopting green building materials is an excellent approach to meet this target. Selection of construction materials, which have minimum environmental burdens, is useful in the sustainable development of a country. Therefore, building related contribution to environmental issues is large and therefore essential. Selecting environmentally preferable building products is an excellent method to boost a buildings environmental performance [19].

Innovation

Accordingly eco-innovation is defined as "the creation or implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organizational structures and institutional arrangements which - with or without intent - lead to environmental improvements compared to relevant alternatives". Building on these two definitions, it is conclude that eco-innovation is "a new concept of great importance to business and policy makers. It is about innovations with lower environmental impact than relevant alternatives. The innovations may be technological or non-technological (organizational, institutional or marketing- based).

METHODOLOGY

To obtain the objectives of this study, two method has been carry out, which is an interview and observation. The observation conducted by using rating tools developed and certified by field expert and a semi-structured interview used for this research.

RESULTS AND DISCUSSIONS

The study conducted at Ambulatory Care Centre (ACC) building, in Penang General Hospital (HPP). This location chosen because it is one of the new constructed buildings in Penang General Hospital. ACC building has an appropriate data of rooms and facilities currently available. This research is focusing on the tool development for facilities management audit and observation for sustainability in ACC building.

First Objective

This section is use to analyse data to achieve the first objective of this research, which is the first objective of this research is to investigate available instrument for building maintenance management criteria towards environmental sustainability. The first objective is achieve by the

literature review in this research, which is categorize into three instruments that is Green Building Index, Green Mark and LEED (Leadership in Energy and Environment Design). The three tools selected because it is relate to the research such as types of building, types of index, and types of purpose.

Second Objective

The second objective of the study is to introduce measurement variable for building maintenance management criteria towards environmental sustainability. To achieve the second objective in this study, three tools were choose in introducing the measurement variable for building maintenance management criteria towards environmental sustainability, which is Green Building Index, Green Mark and LEEDS. From these three tools, an index was create by analysing the established index like LEEDs, Green Building Index and Green Mark by comparing their similarities.

From that index, a competent person would endorse the measurement variable stating that it can be used in evaluate the building in Penang General Hospital. From the index, a framework was constructed consist of five categories for the measurement variable that is Energy Efficiency, Water Efficiency, Indoor Air Quality, Resource and Materials and Innovations from the similarities that have been analysed. Each category given separate marks that indicate the level of sustainability for the building ACC.

Once evaluated, the marks will determine the level of maintenance towards sustainability for selected location. 11 rooms evaluated for the new measurement variable which in level 1 - 2 Department, level 2 – 3 department, level 3 – 3 department and level 4 – 3 department. Figure 2 below is the chart showing the relationship of index between Green Building Index, Green Mark and LEEDS.

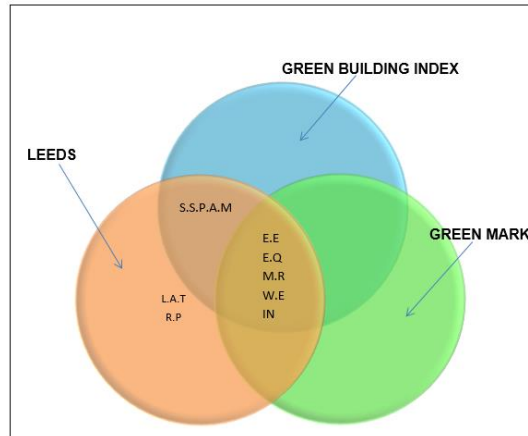


Figure 2. Venn diagram for the mapping between GBI, Green Mark and LEEDS.

Table 1 Venn diagram Legend

Abbreviation	Full Sentences
L.A.T	Location and Transportation
R.P	Regional Property
E.E	Energy Efficiency
E.Q	Indoor Environmental Quality
M.R	Material and Resources
W.E	Water Efficiency
IN	Innovation
S.S.P.A.M	Sustainable Site Planning and Management

Third Objective

The third objective of this research is to propose a measurement tools for building maintenance management towards environmental sustainability. The methods used in achieving the third objective have been discuss in the first and second data of the collection. Every data collected will contribute to the effectiveness of the building maintenance management towards environmental sustainability in Penang General Hospital will be identified in determine the level of environmental sustainability. Semi-structured interview conducted with five departments, in order to get detail information for achieving the third objective (Table 2).

Table 2 Location evaluated with the new measurement variable

No	Level 1	Level 2	Level 3	Level 4
1	Clinical Research Center	Operating Theatre	Administration and Supervisor	Library
2	Combined Room	Obstetric ward and Maternity Hall	Medical Record Office	Information Counter
3		Endoscopy Day Care	Office officials and units	Critical Skills Training Centre
TOTAL			11 ROOMS	

Energy Efficiency (Lighting Zoning)

The total of 10 points allocated for Energy Efficiency. These point consisting of Lighting Zoning (3 marks), Advanced Energy Metering (2 marks) and Renewable Energy (5 marks). Based on the observation of the lighting zoning, one mark obtained. Cause by all enclosed space have individual switched and easily access by building occupants. The concession lost 2 marks due to unavailable auto sensor specifically for lighting, and unavailable motion sensor for lighting installed in the building ACC.

Energy efficiency (Advanced energy metering)

In advanced energy, metering, full mark given due to energy metering installation in high-energy load and tenancy areas such as operating theatre and chillers. Other than that, one mark obtain through linking all energy sub-meters to any automated system, which is located in the energy manager room.

Energy efficiency (Renewable energy)

In renewable energy, no marks obtain cause by unavailable solar energy. Based on the interview with the concession facility manager, the proposal for renewable energy in Central Service Block has been submit, they are waiting for the budget approval.

Indoor Air Quality (Treatment of Recirculating Conditioned Air)

No marks obtain UVGI (Ultra-Violet Geothermal Irrigation) installation. Based on the interview with En. Khalil Bin Ibrahim, said that the UVGI treatment is being discussed on the implementation with the head of the board and Head Quarters of concession on the effects of UVGI installed in AHU's

Indoor air quality (Carbon dioxide monitoring and control)

No marks obtain from Carbon Dioxide Monitoring and Control, based on the interview with the person in-charge, they only use portable carbon dioxide sensor to inspect infected room.

Indoor air quality (IAQ before / during occupancy)

In IAQ before / during occupancy, 1 mark obtain in the area such as Operating Theater room, Clinical Research Center, Medical Record room, Satellite Pharmacy room and Administration room. IAQ testing and assessment report conducted annually.

Materials and Resources (Refrigerants)

For refrigerants, the concession company uses R22 for their air-conditioner which is higher than 100 because the global warming potential for R22 is 180. Therefore, no marks given to concession.

Materials and resources (Waste management)

In Waste Management, Penang General Hospital could not obtain any marks, due to unimplemented of any green initiatives to the management and the occupants in Penang General Hospital.

Water Efficiency (Water Usage and Leak Detection)

Water usage and leak detection that was given two marks. The concession company does have their own private meters to monitor the water usage for their tenants. Unfortunately, the private meter unable to link to building management system. If there is any leak, it cannot be detect by the system, they have to shut down the entire building system to carry out the repair activities.

Water efficiency (Water efficiency fittings)

Fittings only available in clinical research centre. One mark obtains for their showerhead efficiency. Basin taps, toilets are not up to the standards. The concession company does not install any urinal in the building ACC therefore fail to obtain any marks.

Table 3 Result of the evaluation in building ACC using new measurement variable

LEVEL / FLOOR	LOCATION	MARKS
1	Clinical Research Center	5/25
1	Combined Room	6/25
2	Operating Theater	5/25
2	Obstetric Ward And Pregnancy Hall	5/25
2	Endoscopy Day Care	5/25
3	Administration And Supervisor	4/25
3	Medical Records Office	5/25
3	Office And Unit Office	4/25
4	Library	4/25
4	Information Counter	5/25
4	Critical Skills Training Center	5/25

25 X 11 = 275

To Obtain 100 Marks = 100/275 = 0.363

Sustainability Of Acc Building = 5 + 6 + 5 + 5 + 5 + 4 + 5 + 4 + 4 + 5 + 5 = 53 / 275

= 53 X 0.363 = 19.239

Table 4 Ratings of the new measurement variable

POINTS	GBI RATINGS	INTERFERENCE
86-100	Platinum	Global Excellence
76-85	Gold	National Excellence
66-75	Silver	Excellent Practice
60-65	Certified	Certified

CONCLUSION

All data collected and processed using the new measurement variable. As conclusion, based on the results of the study analysed through observation and semi-structural interviews, it is found that the new measuring tools are easy to use and suitable for the maintenance management towards environmental sustainability.

Limitation and Recommendation

The result of this study only for selected building in Penang General Hospital. The rating given does not shows the overall condition of buildings in Penang General Hospital. It is suggests that concessions and clients need to make more frequent programs and training related to the awareness of the importance of a building sustainability Penang General Hospital. Additionally, this study can be used as a guidance for concessions and clients to improve the organisation maintenance management towards building sustainability policies.

REFERENCES

- D. Ahmad, Enhancing Sustainability in Healthcare Delivery—A Challenge to the New Malaysia, *Malays J Med Sci.* Jan–Feb 26(1): 1–4 (2019)
- N. M. Nawawi, A. R. Sopian, N. H. Abdul Majid, S. Aripin *Hospital Designs in Tropical Malaysia - Towards A Green Agenda*, The Uia/Phg 2013 Annual Healthcare Forum + Gupha Meeting at Iidex Canada, Toronto, Canada, 24-28th (2013)
- O. Amankwah, C. W. Wai, A. H. Mohammed and M. Baba, A Review of Sustainable Maintenance Management of Public Healthcare Facilities in Developing Countries: The Case of Ghana. *International Journal of Real Estate Studies*, Volume 11 Number 2
- S. Islam, M. A. Al Awadh and R. A. Khan. Recent trends in the Green Building Concept. *International Journal of Advanced and Innovative Research (2278-7844) / # 189 / Volume 5 Issue 1(2016)*
- Z. A. Ismail & N. Kasim, Maintenance Management Practices for Building
- O. Mydin, M. Azree. Significance of Building Maintenance Management On Life Span of Buildings. *Robotica and Management.* 22.40-44 (2017)
- A. Olanrewaju, W.W. Fang, S.Y. Tan Hospital Building Maintenance Management Model. *International Journal of Engineering & Technology*, 7 747-753 (2018)
- M.S. Awad, A. Al-Mofleh. Energy 10 Performance on Building Energy Efficiency in Jordan. *Journal of Emerging Trends in Computing and Information Science.* VOL. 3, NO. 2, February 2012. ISSN 2079-8407 (2012)
- U. A. Umar, M. F. Khamidi and H. Tukur *Sustainable Building Material for Green Building Constructions, Conservation and Refurbishing.* Management in Construction Research Association (MiCRA) Postgraduate Conference (2012)

- Malaysian Standards: (MS) 1525: 2019 – Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings – Code of Practice (Third Revision) (2019)
- Ministry of Energy, Green Technology and Water Malaysia. *Government Initiatives in Energy Efficiency in Malaysia*. Ee Challenge 2014 Award Ceremony and Seminar on Epc Implementation in Government Buildings (2014)
- Saleh M. Algburi, A.A. F Baharudin, B.T.H.T., Review of Green Building Index in Malaysia; Existing Work and Challenges. *International Journal of Applied Engineering Research* 11 (5), 3160-3167 (2016)
- S. Pandey, *Impact of Green Building Rating System on The Sustainability and Efficacy of Green Buildings Case analysis of Green Building Index, Malaysia*. MIT-UTM Malaysia Sustainable Cities Program, 2014–2015 (2015)
- BCA Green Mark *Technical Guide and Requirements*. BCA Green Mark for Non-Residential Buildings. (2017)
- A. Ahankoob, S.R. Morshedi, E. Kiyanoosh, G. Rada Comprehensive Comparison between LEED and BCA Green Mark as Green Building Assessment Tools. *The International Journal of Engineering and Science (IJES)* Volume 2 Issue 7 Pages 31-38 (2013)
- T. P. R. Syed Hussain, H. Ismail and M. K. Md Noh, *Kesedaran Mengenai Penjimatan Tenaga Elektrik dan Kelestarian Alam Sekitar* Prosiding Perkem VIII, Jilid 2 (2013) 977 – 990 (2013)
- K. N. Sheth. Water Efficient Technologies for Green Buildings. *International Journal of Engineering Innovation and Scientific Research*. Vol.1(3)-P.P. 5-10 ISSN:2395-6372 (2017)
- Department of Occupational a Safety and Health Indoor *Air Quality*. Chemical Management. www.dosh.gov.my/index.php/chemical-management-v/indoor-air-quality (2017)
- Pulselli, R.M., E. Simoncini and S. Bastianoni. Energy analysis of building manufacturing, maintenance and use: Em-building indices to evaluate housing sustainability. *Energy and Buildings*, 39(5): 620-628. (2007)

