International Journal of Engineering & Technology, 7 (4.35) (2018) 442-448

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper



Framework for Green School Model Development in Malaysia

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Abstract

In parallel to global modernization especially in developing country like Malaysia, the urging for energy consumption conservation unwaveringly increases. The initiative of implementing the green building concept and practices is being developed to promote the sustainable development of global society at many levels. Green school model is among the initiatives being explored in this paper. In Malaysia, currently there is no significant studies or guidelines have been developed for green school model development. Thus, the aim of this paper is to review and analyze the requirement for green school model establishment which ultimately will act as a guideline for the implementation of green school model in Malaysia. To achieve this, study on general rules adopted to assess the green school model development by various countries is ventured. In particular, the focus is based on the energy efficiency, water efficiency, thermal comfort, indoor air quality, lighting efficiency, visual health, acoustics, and space utilization. The challenges for the development of green school model in Malaysia is also highlighted. Detailed review on the recent Malaysia's policies and energy development plan is presented. The outcome of this study is a framework for green school model development in Malaysia addressing one of the prime key subject which is the lighting efficiency and its impact towards students' performance.

Keywords: *Green school; Green building guideline; Sustainability; Energy efficiency*

1. Introduction

Rapid industrialization and development of town leads to increase in global warming in which greenhouse gas emission has led to harmful consequences to living organisms in the world. Emission of greenhouse gas increases the energy consumption. International Energy Agency (IEA) forecasted that in 2030, the energy consumption will reach 40 percent higher compared to the energy demand in 2007 [1]. In Malaysia, the electrical energy consumption has increased up to 30 percent in the ten years' period from 2000 to 2010. Increase in energy consumption will lead to increase in the amount of greenhouse gas (GHG) emission, thus causes world climate changes. On the other hand, looking into the Eleventh Malaysia Plan, it is predicted that by 2020, the GHG emission will be reduced by up to 40 percent through the government initiatives towards green growth [2]. Therefore, in parallel to global modernization especially in developing country like Malaysia, the urging for energy consumption unwaveringly increases in order to reduce the GHG emission. Therefore, successful implementation of energy efficiency requires the participation of the building construction sector including in schools.

Thus, the initiative of implementing the green building concept and practices is being developed to promote the sustainable development of global society especially in school level. Schools are educational institution for learner societies including both teachers and students. In Malaysia, our children spend more hours in school, for 9 to 10 months in a year [3]. Therefore, apart from the quality of education, the quality of life of the learner communities must be considered in assessing their achievement. In order to achieve the aim of environmentally more sustainable building, the design of green school model must be adapted in the school construction in Malaysia. Green school construction tends to provide a more productive, comfortable and healthier environment for study and work for the learner societies. It will reduce the consumption of energy resources in the operational phase which are being maintained based on three criteria including environmental, economic and social sustainability. This is attained through important components that formed green school model including the school building envelope, orientation and indoor environmental quality [3].

Taking that into account, since the green school environment contributes students' achievement and outcome, the aim of this paper is to execute a study on the green school model in the scope of Malaysia and develop a framework which will act as a guideline. This paper also focuses on the description and nature of green school model and the benefits of incorporating in academic construction sector. It also presents a general rule adopted by other countries to assess the green school model; in particular, the study is based on the energy efficiency, water efficiency, thermal comfort, indoor air quality, lighting efficiency, visual health, acoustics, and space utilization. In addition, the challenges for the choice of green school model in Malaysia and other countries are also discussed in this study.

This article is organized into 7 sections. In the next section, a review of the green school model is presented. In Section 3, the guidelines to green school model are given. In Section 4, the challenges to green school model are discussed, while in Section 5, current scenario on existing green building initiatives are reviewed. Section 6 discusses on the proposed framework for green school model in Malaysia. Finally, Section 7 presents the conclusions and future works.

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2. Green School Model

The definition of green school is subjective in which it possibly need to be composed within a specific balanced context by integrating the aspects of environmental, social and economic elements. There is no standardized definition for green school in terms of human resolution, building and construction, but, nevertheless, these terms are used popularly [4].

2.1. Definition of Green School

The Centre for Green Schools at the U.S. Green Building Council stated that a green school is defined as a school building or facility that creates a healthy environment that is conducive to learning as well as saving energy, resources and money [5]. In Ireland, green school is referred as Eco-Schools, is an international environmental education program which consist of environmental management system, and award scheme to promote their long term initiative for environment sustainability. On the other hand, Instituto para o Desenvolvimento da Habitacao Ecologica **(**IDHEA) proclaimed that green school is a construction developed based on environmentally more sustainable planning by utilizing efficient use of natural resources, managing waste management efficiently, and rationalize the use available materials for sustainability [6]. Green school building is important for developing environment awareness through the reduction of the impact on the environment caused by construction of building, apart being responsible for environmental sustainability. Fig. 1 shows features that must be considered in order to implement green school model including environmental quality, social performance, economic analysis, energy efficiency, sustainability and regional priority.



Fig. 1: Features of green school model

According to the World Green Building Trends 2016 [7], the percentage of green building projects in 2018 is expected to increase from 18 percent to 37 percent. Fig. 2 demonstrates the increments of green building projects that are anticipated by countries which are still developing green markets. It shows that country such as US and Europe including Germany, Poland and UK have moderate level of progress, while, on contrary, countries such as China, India, Saudi Arabia, Brazil, Mexico, South Africa and Columbia proven to have a rapid progress in the percentage of green building projects. On contrary to that, country such as Malaysia is still grappling in moving towards green growth due to growing population and demand. In Malaysia, the percentages of green building projects are very few and still in developing stages as there are many challenges to implement the concept in construction of building. As a whole, through the results shown in Fig. 2, it is proven that green building concept is already adopted slowly across the countries. It suggested the opportunity for wider implementation of green building concept in future especially in Malaysia. Eventually, this green building concept can be implemented in Malaysia's schools to encourage a better learning environment. Hence, implementation of the green building in school as green school is a promising concept as it will fulfill the construction industry's expectation to become greener in future.

By taking into account of all the aspects of green school model, a meticulous methodology needs to be considered when building green school. In order to reduce the costs in overall life cycle and to bring awareness on environmental education, the system and integrity of green school must be fully scrutinized starting from the planning stage to the design stage. This is to ensure that the students possess a good environment to learn in long term. The designed green school model must able to provide good indoor air ventilation, comfortable temperature range that provide thermal comfort, efficient lighting and low noise pollution. This approach hence, promote better learning environment in accordance to the concept of sustainability development, thus reflects the understanding to meet the needs of the present and future generation.

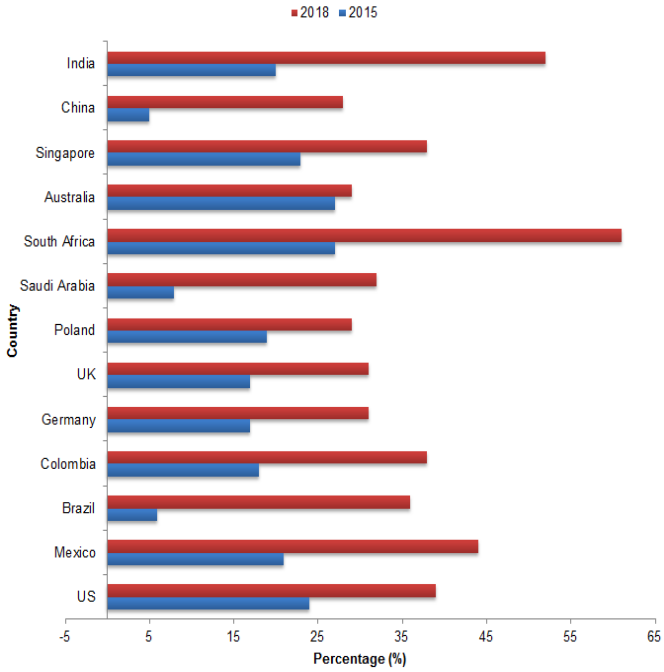


Fig. 2: Percentage of green building projects (2015 and expected 2018)
Source: Dodge Data & Analytics, 2016 [6]

2.2. Advantages of Green School

A good physical environment provides better place to live and it includes all the elements such as lighting, texturing, thermal and so on. Specifically, school learning environment must take consideration on all the elements in environmental design since all the elements affect students feeling and performances [8]. Scientifically, it is proven that student attendance, concentration, academic performances and productivity are affected by the presence of pollutant in air, chemicals and other hygiene factors. Students perform better in comfortable learning environment. According to the University of Surrey, learning environment with good indoor lighting system can improve health, performances and productivity of students up to 20 percent [9]. Generally, the advantages of the green school include financial benefits, environmental benefits and learner communities' benefits including students, teacher and society [10-11]. In an approach for greening America's schools, the green school use approximately 33 percent less energy than conventionally designed schools [10]. This approach proves that green schools are environmentally sustainable besides providing tangible advantages to all the building occupants.

In terms of financial benefits, green school model provide reductions in operations and maintenance cost as well as water saving,

thus enable economic benefits. According to [10], green school offers 20 times more financial benefits compared to conventional school design in which the savings can be used for hiring new teachers and buy new facilities for school benefits. Looking into the environmental benefits, the construction and building orientation of green school are designed to use energy and water efficiently compared to conventionally designed school building. This reduces the overall energy consumption by utilizing the concept of recycling, thus promote environmental sustainability. On the other hand, the strategies and technologies implemented in green school offers improved health condition, academic performances, and faculty retention for the learner communities'. This is due to the condition of green school which comes with improved air ventilation which promote better indoor air quality, efficient temperature range, efficient use of space, and better lighting conditions [10].
Furthermore, the report in [10] stated that green school model design provides many additional benefits including reduced sick days and improved health both for teachers and students, overall reduction in operations and maintenance costs, educational reformation, improved power quality and reliability and promotes positive state competitiveness. Generally, green school model serves as a good platform as a teaching tool by demonstrating to learner communities the practical ways to promote the energy sustainability and to create environmental awareness.

2.3. Characteristics of Green School

From the design perspective of green school model, the system and integrity of green school must be fully scrutinized starting from the planning stage to the design stage in order to reduce the costs in overall life cycle and to bring awareness on environmental education. The Centre of Green School under U.S. Green Building Council has focused the general elements of green school which are dominant to develop and to build the green school model design. The general elements of green school includes conserves energy and natural resources, improves indoor air quality, removes toxic materials from places where children learn and play, employs day lighting strategies and improves classroom acoustics, decreases the burden on municipal water and wastewater treatment, encourages waste management efforts to benefit the local community and region, conserves fresh drinking water and helps manage storm water runoff, encourage recycling, promote habitats protection, and reduced demand on local landfills.
Taking these into account, sustainable development initiatives must be started from the green school model implementation since schools are being the main platform for students to live good environment and potentially a stage for them to outcast their talents. Students' awareness on the environmental sustainability will be greatly enhanced with the knowledge of energy conservation and environmental preservation. Therefore, as a representative of future generation, they will be the asset for promoting sustainable development.

3. Green School Model Guidelines

The Foundation of European Environmental Education (FEEE) in 1994 has proposed the concept of green school which is originated in Ecological School Plan [11]. The aim of this foundation is to implement environmental education into daily school management through classroom education. This can set up a compendious environmental and sustainable management system for school.
Thorough guidelines to achieve the aims of implementing green school model are outlined in the Green School attribute for Health and Learning report by U.S National Academy of Sciences [12]. The guidelines are focused mainly on the aspects of building criteria, the efficient use of land, construction procedure and equipment installation, and the execution of operation and maintenance. In order to achieve a specific goal, there are few engineering techniques being conducted including establishment of school area near public transportation to reduce pollution, construction of school on a green area to reduce the negative environmental impact, installation of improved lighting systems and air ventilation to maximize the use of renewable energy resources, and selection material that are biodegradable [13].
The green school guidelines are different in every country subjected to each authority. However, an essential criterion that is similar in some aspects is agreed by all authority in order to design green school model. These essential criteria can be adopted in Malaysian green school model guidelines by including energy efficiency, thermal comfort, indoor air quality, lighting efficiency, and acoustics by a stage by stage development approach.

3.1. Energy Efficiency

Energy efficiency is defined as consumption of less energy in order to provide equivalent service [13]. It can be achieved through using less electrical energy and use more renewable energy compared to fossil fuels. Factors that are affecting the energy consumption are building design, services design, and user's behavior [14]. For green school model, basic evaluation on energy consumption can be achieved through walkthrough observation, evaluation on utility bill, and monitor seasonal energy resources consumption.

3.2. Thermal Efficiency

Thermal comfort is described as the condition of environment that provides satisfied air temperature [13]. This factor is directly affecting the health and comfort of occupant in an environment. Classroom with the presence of fresh air can reduces the surrounding air temperature, thus improve student's performances including test scores, class activity, and concentration on studies. This is related to scientific fact that low air temperature increases relative humidity level, thus provide cooling air to maintain comfort among the students [14]. Basic evaluation on thermal comfort in the effort to implement green school model are walkthrough observation, spot measurements on environmental parameters that affecting the thermal range and relative humidity and survey on users' satisfaction scale on comfort.

3.3. Indoor Air Quality

Indoor air quality is defined as the quality of air that composed within and surrounds the buildings and structure which are correlating to heath and comfort of building occupants [13]. It reflects to the amount of acceptable air pollutants such as carbon dioxide, volatile organic compounds, pathogens, allergens, viruses, mold, and microbes [13]. Since the presence of occupant in school building increases the amount of carbon dioxide, air moisture, dirt, and dust, a proper air ventilation system that reduces and eliminating the pollutants must be maintained [14]. In the effort of implementing green school model, basic evaluation on indoor air quality is attained through walkthrough observation, continuous long term measurement on the carbon dioxide level in respective classroom, and survey on users' satisfaction scale on air quality.

3.4. Lighting Efficiency

Lighting efficiency is defined as a measure of how well the source of light produces visible lights with less energy consumption [13]. This criterion is very important as lighting is directly affecting the performances of school communities'. For green school model, the design components such as lighting shelves, lighting sizes, placement of lighting systems, fittings and materials of light are necessary to maximize the amount of visible lights without glare and heat gain [14]. It is observed that these criteria emphasized on energy efficiency lighting. Apart from that, proper lighting system will improve the visual health of the school communities, thus increases their overall productivity and performances in school.

Basic evaluations to assist the green school model are walkthrough observation, spot measurement on illuminance for artificial lightings, color rendering of sources, measurement of correlated color temperature of lighting and survey on users' satisfaction scale on visual comfort.

3.5. Acoustics

Acoustic is known as properties of sound, on the other words, it reflects to the qualities of a space or surrounding environment that detect the propagation of sound [13]. According to [15], the sources of background noise are building systems, exterior sound transmission and sound transmission from adjacent spaces. The issues on noise are, it creates distraction in which students lose focus on their studies and unable to understand the lessons. School communities are continuously exposed to the noise distraction which reduces the overall performances especially reading and listening skills. Therefore, in the effort of implementing green school model, basic evaluation on acoustic problem are walkthrough observation, spot measurement in reading and listening skills, measurements on sound insulation level, reverberation time, long term measurement in speech task and intelligence level, and survey on users' satisfaction scale on comfort.

Overall, considering the above-mentioned criteria in the implementation of green school model will promote to the development of sustainability and environment preservation. Table 1 provides list of identified strategies for adopting green building technology and these strategies can be used as reference for the implementation of green school model.

Table 1: Identified strategies for green building technology adoption

No	Identified Strategies for Green Building Technology Adoption	Journal References	
		References	Year
1.	Provide green building construction industry with financial assistance and further market-based incentives	[24], [26], [27]	2009, 2012
2.	Imposed compulsory governmental policies and regulations for certified green building	[24], [25], [26]	2009, 2012
3.	Imposed standardize green rating and guidelines	[27]	2012
4.	Provide new enforcement on the existing green building policies and standards	[28]	2016
5.	Provide affordable loans and subsidy from authority or government	[24], [28]	2009, 2016
6.	Create public environmental awareness on green building (conduct campaign, workshops, seminars, and conferences)	[24], [26]	2009
7.	Advertise or create more publicity through media for example print media, internet, and radio and television programs	[24]	2009
8.	Provide skill works, training and educational programs for green building developers	[24], [26]	2009
9.	Provide a specialized consultancy on cost and benefits of green building	[24], [25], [26], [27]	2009, 2012
10.	Provide a prominent research and development link for the green building developers	[26]	2012

4. Challenges to Green School Model in Malaysia

The implementation of green building in school or educational institution faces many challenges in Malaysia. Among the challenges that have to be faced in the process of adopting the concept of green school model are lack of operation and maintenance costs which high startup capital investment, lack of knowledge on evaluating the sustainability indicators, lack of skills and technical knowledge on green building construction, and miscommunication between communities that are responsible for promoting green school concept [16].

4.1. Lack of Operation and Maintenance Costs

In the process of adopting green school model, no financial support that could run these operation and maintenance processes. Although government is encouraging and promoting green campaign in educational institution, but the funding for the implementation is still underway [16]. Government perception that the return on investment in green school implementation is low thus creates a barrier to adopt the concept in school [17]. Therefore, both government and funding organization must collaborate together to finance projects related to green concept and sustainability concept. With effective plan, the implementation of green building in school will be faster and more significant.

4.2. Lack of Knowledge on Sustainability Education

Generally, there are many criteria and aspect that define the meaning of sustainability. There is no standard and precise meaning of sustainability which can be referred [16]. Therefore, this fact hampers the benchmarking indicators to assist and to evaluate the building's characteristics and performances. Without standardization on sustainability indicator, the construction of green building will create challenges in technical level and innovation among civil construction community [17]. This situation will mark green building as no commercial value thus turn out to be less desirable in terms of profitability and marketability [18]. On account to that, a general similar standard need to be enforced in environmental and sustainability studies in order to prove enforceability of the green school model in civil construction sector.

4.3. Lack of Standard Construction Procedure

One of the main challenges in implementing green school model is scarcity on a standard construction procedure in which there is inadequacy on the technical methodology that establishes the green school model [17]. Standard construction procedure is a platform to promote sustainable building and serves as defense stage to satisfy the consumer. Lacking of skilled and specialized procedure in green construction will hamper the permits for checking the quality of green building [18]. Besides that, this will also create difficulties on execution of proper sustainable techniques and the selection of suitable green materials for building that are being adopted in construction field [19]. Apart from that, environmental training and sustainable education should be provided to accredit employees in civil construction.

4.4. Miscommunication between Green Communities

In order to convey the objectives of information efficiently with clear understanding, a good communication system is needed [17]. Here, in the process of adopting the green school model, one of the main barriers is miscommunication between the green communities. Factors such lack of training, lack of relevant laws and regulation on green building, and lack of scientific research on environmental theme lead to communication breakdown between the members who are involved in the green environment studies and responsible for the decision making [18]. Therefore, top management should be able to perform a good leadership through communication and collaboration, in the process of developing a good tie among the architect, designers, educational top managements and the government. This collaboration effort will lead to successful implementation of green school model by establishment of qualitative and quantitative goals for sustainability management [19].

5. Current Scenario on Existing School Building in Malaysia

The implementation of energy demands in parallel to the development of information technology infrastructure in school building has reflected the priority given by the national planning on the importance of education. In Malaysia, however, control of the energy consumption is insufficient since it is monitored by the school authorities. Therefore, the requirement of energy efficiency building design in schools has begun to draw attention. This attention must consider two factors including the reduction of energy consumption and optimization of students' comfort [20].

According to the All Malaysia Secondary School Energy and Renewable Energy Efficiency Project 2003, the school building energy index (BEI) value has recorded at an average of 19kWh/m^2 per year and the value for school occupant energy index is recorded at average of 115kWh/occupant per year [20]. Looking into the current electricity tariff, the amount spent for the energy consumption in school building is estimated to be RM 5.47 for every square meter of floor area per year and RM 33.12 for every student per year [20]. This energy demands are crucial in Malaysia towards perceiving 40 percent of reduction in GHG emission by 2020 as stated in Eleventh Malaysia Plan, thus countering global climate change.

As discussed in the previous section, the advancement towards green school building in Malaysia is difficult to achieve mainly due to lack of awareness and reluctance in getting involved in green initiatives [21]. However, Malaysia is focusing on the environmental quality issues specifically on the climate change and energy insecurity. This is in parallel to the Malaysia's National Plan and Energy Policies. Four pillars are being focused in order to establish the Malaysia's national green technology policy including the energy, economy, environmental, and social [22]. Table 2 provides several green schemes initiatives that are established by Malaysia in managing GHG emission and energy insecurity issues.

Table 2: Established green scheme initiatives in Malaysia [22]

No	Established Green Scheme Initiatives	Organization	Year
1.	Energy Policy based on: • 1974 Petroleum Development Act, 1975 • 175 National Petroleum Policy • 1980 National Depletion Policy • 1990 Electricity Supply Act • 1993 Gas Supply Acts • 1994 Electricity Regulations • 1997 Gas Supply Regulation • 2001 Energy Commission Act	• MEGTW • KETTHA	Varies
2.	Energy Efficiency in Buildings Guidelines	Ministry of Energy, Telecommunication and Post	1989
3.	MS1525: 2001-Code of Practice Use of Energy Efficiency and Renewable Energy for Non-Residential Buildings	SIRIM	2001 and 2007
4.	Energy Audit Government Buildings	• MEGTW • KETTHA	2001
5.	Malaysia Industrial Energy Audit Guidelines	• MEGTW • KETTHA • MGTC • UNDP-GEF	2003
6.	Design Strategies for Energy Efficiency in New Buildings (Non-Domestic)	• MEGTW • KETTHA • DANIDA • MPWD • JKR	2004
7.	Guidelines for Conducting Energy Audits in Commercial Buildings	• MEGTW • KETTHA • MGTC	2004
8.	Energy Efficiency and Conservation Guidelines for Malaysian Industries	• MEGTW • KETTHA • MGTC • UNDP-GEF	2007
9.	The National Green Technology Policy	• MEGTW • KETTHA	2009
10.	Green Building Index	GBI Sdn Bhd (PAM and ACEM)	2009
11.	The National Energy Efficiency Master Plan Study 2010	• MEGTW • KETTHA	2010
12.	Feed-In Tariff (Renewable Energy Act 2011)	Energy Commission	2011
13.	ASEAN Energy Management Scheme	MGTC	2011
14.	ISO 5001: 2011 Energy Management	ISO	2011
15.	Building Sector Energy Efficiency Project (BSEEP)	• PWD • UNDP • GEF	2011
16.	PWD Green Rating Scheme (JKR Malaysia)	PWD	2012

Besides that, a new Energy Policy in the Tenth Malaysia Plan (2011-2015) is also introduced. This new policy is emphasized on more competitive green market and stage by stage reduction of energy subsidy. Tenth Malaysia Plan includes several new initiatives on Renewable Energy Policy which execute action plan to achieve renewable energy target by 2015. Table 3 shows key focus in energy developments from the Ninth Malaysia Plan to Twelfth Malaysia Plan.

Table 3: Energy development from Ninth Malaysia Plan to Twelfth Malaysia Plan [2]

Malaysia Plan	Key Focus in Energy Developments
Ninth Malaysia Plan (2006-2010)	• Focusing on strengthening initiatives for energy efficiency especially in transport, commercial and industrial sectors, and in government buildings. • Encouraging better utilization of renewable energy through diversify fuel sources. • Recognizing efforts to further reduce the dependency on petroleum provides for more efforts to integrate alternative fuels. • Enhancing the incentives in renewable energy and energy efficiency
Tenth Malaysia Plan (2011-2015)	• Bestowing short term goals vested in National Green Technology Policy • Increasing public awareness and commitment for the adoption and application of green technology through advocacy programs. • Increasing availability and vesting of green technology in terms of products, appliances, equipment and systems in the local market through standards, rating and labeling programs. • Increasing foreign and domestic direct investments (FDIs and DDIs) in green technology manufacturing and services sector. • Increasing foreign and domestic direct investments in green technology. • Expanding of local research institutes and institutions of higher learning to expand research, development and innovation activi-

	ties on green technology towards commercialization through appropriate mechanisms. • Launching new renewable energy act and Feed- in-Tariff mechanism
Eleventh Malaysia Plan (2016-2020)	• Initializing green technology option in procurement of products and services. • Increasing production of local green technology products. • Expanding local market shares in green technology. • Expanding local small medium enterprises and small medium industries on green technology into global market. • Increasing research, development and innovation of green technology by local universities and research institutions. • Expanding green technology applications to most economic sectors
Twelfth Malaysia Plan (2021-2025)	• Instilling of green technology in Malaysian culture. • Adopting green technology to reduce overall resource consumption while sustaining national economic growth • Realizing the reduction in national energy consumption • Improving Malaysia's ranking in green environmental ratings • Launching Malaysia as a major producer of green technology in the global market. • Expanding the international collaborations between local universities and research institutions with green technology industries

The reviews on the Energy Policy and Malaysia Plans concludes that Malaysian government are working seriously towards green and sustainable development. However, there is no specific measure or initiatives that highlights towards the green school development for the schools in Malaysia. Thus, Ministry of Education with the collaboration of non-government association should start to launch and implement green school schemes and policies that emphasis on the green rating criteria discussed in Section 3. In August 2013, International School Kuala Lumpur (ISKL) was awarded as the first recipient of Green Flag Award of the Eco-School Programs. This internationally recognized award reflects to the school best environmental education and management practices on green technology [29]. Therefore, all the related agency must take a lead role in implementing principles of green technology and sustainable development in construction sector especially school building to widen the scope of energy efficiency of building.

6. Proposed Framework for Green School Model in Malaysia

The model, shown in Fig. 3, proposes a sustainability framework for developing a green school model in Malaysia based on one of the criteria discussed in the Section 3 which is the lighting efficiency. Since there is no assessment or analysis conducted towards green school development in Malaysia, thus this study has promoted to tackle the main criteria towards the green school development which is the lighting efficiency. This proposed model may differ from other country since different country came up with different culture, topology and geographical location, government incentive fund and academic regulation. However, the proposed framework is designed in parallel to all the policies, schemes and Malaysia Plan that are related to green technology. The steps discussed in the methodology complied with the green schemes and policies discussed in Section 5.

As mentioned in the introduction section, energy consumption in Malaysia is mainly derived from electrical equipment such lighting systems. Therefore, in this study, lighting systems is chosen as one of the criteria in assessing the green school model as it is ranked as second highest energy consuming equipment used by the Malaysian schools. The framework for green school model focusing on the lighting efficiency is organized into nine steps as discussed below.

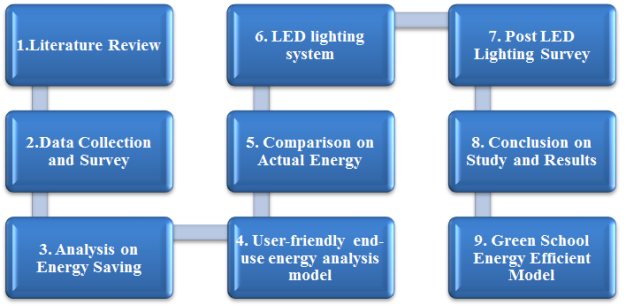


Fig. 3: A framework for developing green school model

Step 1 Literature review

In Step 1, a literature review on current research work performed by other researchers on green energy implementation in buildings especially schools are evaluated. Besides that, a literature review on lighting effects on student performance and evaluation methods are studied. The survey on light emitting diode (LED) lightings technology including lighting fittings and materials are carried out.

Step 2 Data collection and survey

There are two sub-methodologies in Step 2. Firstly, data collection and building characteristics is carried out. In this stage, data collection worksheets and procedures are generated including the formulations on energy consumption, energy intensity and energy savings. Measurement of illuminance level in the classrooms and other buildings using lux meter is carried out. The building area covered for this measurement including classroom, library, ICT room, corridor, staff room, principal office and laboratories. The Lumen method is used for the formulation on the light illuminance level that take into account on factors such as type of light bulb, the quantity and arrangements.

Secondly, survey on students' performance in current lighting system is carried out. This stage will cover the development of appropriate questions and survey forms including attention test, error test and writing test. Later, analysis on the survey data collected and development of an effective analysis for evaluation of students learning performance is carried out.

Step 3 Analysis on the possible energy saving

In Step 3, the pertinent electrical equipment for energy saving is identified. Through the LED lighting system implementation, estimation on the possible energy and cost saving is investigated. The best energy saving practices in operating the electrical equipment is identified subjected to the operation of current air-conditioning system.

Step 4 User-friendly end-use energy analysis model

Step 4 is focused on the development on the Green Energy Audit model by integrating the formulation. This is to compute the optimal energy usage and maximum or worst case energy from the data collections. Besides that, data entry into the working Green Energy Audit on actual energy based on utility bills is carried out.

Step 5 Comparison study on the actual energy

In Step 5, the actual energy used based on the utility bills and energy usage through the energy efficiency implementation and best practices will be carried out.

Step 6 Implementation of LED lighting system

Step 6 covers the installation of LED lighting at appropriate location in schools. This installation is based on the computed Lumen method that determines the required number of lamps and capacity for the best learning environment.

Step 7 Post LED lighting evaluation and survey

Step 7 is one of the crucial factors in the implementation process. Comparison study on the impact of old lighting system and new LED lighting system on the students' learning performance will be conducted. The comparison will be made based on special assessment conducted among the students in order to analyze the impact of LED lighting in school.

Step 8 Conclusions on study and results

Step 8 covers the final findings on the energy efficiency, cost saving and student learning performance. It will cover the outcome and significance of the development of Green School model and its prototype.

Step 9 Green School Energy-Efficient Models

Step 9 will conclude and present a comprehensive and completed prototype on Green School Energy Efficient Model.

7. Conclusion and Future Works

This paper introduces the concept of green building and the benefits of implementing the concept in existing building. The implementation of green building in the scope of green school model is an important step to face various environmental challenges such as depletion of energy resources, environmental issues and change in global climate and weather. This study presents the approach on how to assess the green rating for the school building with a comparison on initiatives carried out from various countries. The detailed review from this study has identified the gaps in the Malaysian government initiatives towards green school development despite the energy development policies and plan. There are many challenges in adopting green school model in Malaysia but a detailed framework and implementation steps can help to work towards a successful and standardized green school guidelines. A framework for green school model in Malaysia is presented. This framework addresses one of the prime key subject for Malaysia's green school model development which is the lighting efficiency and its impact towards students' performance.

Acknowledgement

The authors would like to thank Universiti Tenaga Nasional for its support in funding the project under research grant UNIIG 2017.

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