The Study of Success Factors and Beneficial Values for School Management in Energy and Environment

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Abstract

The objectives of this research are to investigate the success factors and evaluate the benefits of school management in energy and environment. A focus group discussion with twelve school administrators and teachers of Bansaluangnok School, Chiang Mai, Thailand was conducted to draw conclusions on the success factors in energy and environmental management, and to assess the value in three dimensions i.e., energy and the environment, economic, and social values. The findings revealed that the factors leading to schooling success in energy and environmental management consisted of four components, namely man, money, materials, and management. In terms of energy and environmental value, the school has the potential organic wastes that could be turned into renewable energy. In doing so, the school could produce biogas of 0.97 m^3/day and biomass of 7.90 kg/day which could potentially replace approximately 3.31 kg LPG daily. For economic value, it was found that investing in the school's biomass stove and an anaerobic digester would be worth for investment. According to the economic value analysis, the net present value is 51,097.78 THB (Thai Baht), with a 197% internal rate of return and a payback period of 0.50 years. Finally, supporting energy and environmental projects and activities at school has the social benefit of increasing community awareness and consciousness. As school administrators, teachers, students, parents, and the community participated in school-based activities, they would thus be prepared to move towards environmentally friendly and sustainable development.

Keywords:

Success Factor, Value Assessment, School Management, Energy and Environmental Management, Sustainable Development

1. Introduction

Energy and environmental challenges have risen to become major global concerns, attracting the attention of both technical experts and political leaders. Cooperation at both the national and international levels, from a broad range of governmental organizations and private agencies are required to pursue the goal of tackling these challenges. Additionally, support from public sector is a critical role in mitigating the aforementioned issues [1-3]. In doing so, Thailand has developed the national strategy (2018-2037) and the twelfth national economic and social development plan (2017-2021), focusing on sustainable development in line with a global trend. The developed plans have established strategies for ecologically friendly life development, commencing with the establishment of balanced natural resource management plans. Subsequently, production and consumption based on the protection of natural resources and the environment are promoted. Finally, enhancement of people's knowledge and promotion of adjustments in their behavior to ensure sustainability have been carried out for the benefit of the future generation [4-5].

As a responsible governmental agency, Thailand Ministry of Education prepared the national scheme of education (2017-2036) to update, take lead, and reinforce the national strategy and development plan, based on the current situation in the education sector. The purpose of this scheme is to leverage education as one of the important tools to partially address the national challenges by enhancing the school curricula and educational activities, together with improving the knowledge centers and their medium of instruction. The primary objective is to educate and raise awareness of the students and academic staff about the importance of collaboration in addressing energy and environmental concerns. In addition, behavioral adjustments to conform with this objective is also targeted [6].

Bansaluangnok School, Khi Lek subdistrict, Mae Rim district, Chiang Mai province strongly intends to implement the energy and environmental policies. The school's budget has been allocated annually to develop many projects and activities for raising awareness and improving knowledge on energy and environment among the teaching staff, students, and leaders in the school community. Currently, the attention of the school is focused on the waste-to-energy concept because of the large amount of organic wastes generated by the school. However, the school is lack of information necessary to plan and execute such a project concept. This research, therefore, aimed to determine the critical success factors and the conditions associated with sustainable energy and environmental management in the school. In addition, a feasibility study for waste-to-energy projects was conducted to assist the school administration and an external investor in determining the viability of future investment.

2. Objectives

(1) To investigate the potential and success factors of school management in energy and environment

(2) To evaluate the benefits of school management in energy and environment

3. Methodology

This research was a qualitative and quantitative study of the success factors and beneficial values for school management in energy and environment. The study was focused on one specific school, the Bansaluangnok School, located in Chiang Mai, Thailand. A focus group discussion was conducted with twelve administrators and teachers using a focus group instrument, which was validated by three experts and tested for content validity. There were eleven focus group questions in total, covering: (1) energy and environmental policy of the school, (2) system and process for implementing the energy and environmental policy, (3) projects and activities related to energy and the environment, (4) implementation methods to enable personnel, students, parents and communities to participate in energy and environmental activities, (5) collaboration networks with external organizations or agencies, (6) energy and environmental materials, equipment, teaching materials, and learning resources, (7) type and quantity of wastes generated in the school, (8) waste management and waste utilization methods for each type of waste, (9) success factors in energy and environmental management, (10) benefits of implementing energy and environmental projects and activities at the school, and (11) other suggestions for energy and environmental management.

The content analysis was used to determine the potential and success factors of school management in energy and the environment. Additionally, the qualitative data gathered from a focus group discussion was used to evaluate the benefits of energy and environmental school management in three dimensions as the following approaches:

(1) Energy and environmental benefits: The energy benefit was evaluated by calculating the amount of heat energy that can be generated from the school organic wastes to replace LPG. Organic wastes generated from the school activities were typically classified into two categories: yard wastes (such as leaves and wood scraps) and food wastes (include fruit and vegetable wastes). The energy production from yard waste was determined by multiplying the amount of produced yard waste by the

heating value of biomass. Similarly, the energy generation from food waste was calculated by multiplying the amount of biogas production from food waste by the heating value of methane. Finally, the total amount of energy generated by organic wastes was converted to LPG equivalent. The environmental value was then determined by the content analysis of a focus group discussion.

(2) Economic benefits: The economic benefit was determined through a financial analysis, which included net present value (NPV), internal rate of return (IRR), payback period (PB), and sensitivity analyses. The project lifetime period, and the discount rate for determining the financial analysis were assumed to be 5 years, and 8.5% [7], respectively.

(3) Social benefits: The social value of school management in energy and environment was examined through content analysis of a focus group discussion with administrators and teachers from Bansaluangnok School.

4. Results

4.1. The potential of energy and environmental management in a school

Bansaluangnok School is a public school that serves students from kindergarten to lower secondary level. The school has a total of 178 students and 19 education personnel. The distinguishing feature of the school is the integration of teaching and learning for students to apply their knowledge to real-world challenges by using energy and environmental innovations in agricultural learning management. As a result, the school has received many guaranteed awards. These include the Chiang Mai 2021 Outstanding Awards for a young farmers group, a young farmers group member, and a young farmers group consultant. Additionally, the school has been selected by the Huai Hong Khrai Royal Development Study Centre to be a model learning center for the sufficiency economy philosophy for the Chiang Mai Primary Educational Service Area 2.

The results of a focus group discussion with twelve administrators and teachers concerning the potential of school management in energy and environment revealed that administrators had a broad vision for driving a school toward green school. They developed school policies to improve energy and environmental security. These include turning waste into energy, using renewable energy to reduce use of commercial fossil fuel such as LPG, raising awareness on water management, developing student waste management knowledge, raising awareness on negative impacts of air pollution primarily, PM 2.5, as well as encouraging hands-on experience in farming and organic composting from food waste. According to a professional level teacher no. 4, *"school administrators promote the use of renewable energy through the innovative energy production. They encourage energy efficiency and conservation, PM 2.5 mitigation, and waste management and utilization."*

Bansaluangnok School has allocated a budget for energy and environmental projects and activities. The school also received financial and cooperative support from external organizations, including the Chiang Mai Primary Educational Service Area Office 2, the National Science and Technology Development Agency, Chiang Mai Rajabhat University, Chiang Mai University, the Khi Lek Subdistrict Administrative Organization, and the Chiang Mai Provincial Administrative Organization. The school principal stated that "*the school allocates budgets and organizes collaborative planning meeting to encourage staff members to take roles in carrying out energy and environmental activities by integrating them into the school curriculum.*" The school has established a plan of action, a working group, and a responsible person and implemented energy and environmental projects/activities with the participation of school personnel in order to develop activities and learning processes of the students. The working group consists of teachers and personnel from all subject areas who are in charge of developing learning activities and resources for the benefit of the students. In doing so, teaching and learning activities are organized with the integration of innovation or content in energy and environment into science, social studies, religion, and culture, as well as career and technology studies. As a result, the teaching and learning of all subjects and subject areas are systematically consistent.

Waste is a valuable resource in Bansaluangnok School that needed to be managed effectively in order to reduce environmental pollution. The waste generated from the school can be divided into four categories, including (1) general wastes (plastics and snacks packages), (2) recyclable wastes (papers, cans, glass bottles, plastic bottles/plastic cups), (3) hazardous wastes (light bulbs, face masks), and (4) compostable or organic wastes (branches, timber, dry leaves, food, vegetable, and fruit wastes). On average, the school generated daily around 22.5 kg of general wastes, 7.5 kg of recyclable wastes, 2.5 kg of hazardous wastes, and 17.5 kg of compostable organic wastes. The percentage shares of the various wastes were 45, 15, 5, and 35 percent, respectively. According to the school deputy principal no. 4, "*the majority of waste in the school is general waste because students eat snacks frequently. There are also large amount of food wastes generated from the cafeteria and the student dormitories.*"

The four types of wastes at Bansaluangnok School have been managed in various ways. The wastes are sorted into categories based on the type of material or recyclability. The general and hazardous wastes are collected and disposed by external organizations. Recycled wastes are collected and sorted before being sold to a recycling shop. Solid compostable or organic wastes are managed within the school by organizing hands-on activities between teachers and students to handle these wastes. Students are taught to make organic plant fertilizer to feed the vegetable plot in the school garden. Organic fertilizer is made from organic wastes. The solid organic wastes generated consist of food waste, vegetable and fruit waste, and dry leaves, which daily, amount to an average of 18.9, 4.7, and 6.3 kilograms, respectively, and with percentage shares of 60, 15 and 20 percent, respectively. There are also broken branches, twigs and trunks from trees and other woody plants, generated at an average daily amount of 1.6 kilograms (or equivalent to 5 percent of the total solid organic wastes). These are used by the school as cooking fuel. A senior professional level teacher no. 2 stated that *"the school supports waste segregation by having teachers and students sharing responsibility together. Wastes such as paper boxes and used papers would be sold separately. Compostable waste would be converted into compost fertilizer."*

4.2. The success factors in energy and environmental management

According to the findings of a focus group discussion, it was revealed that Bansaluangnok School has potential and success factors that would contribute to the success in energy and environmental management. The success factors could be classified into four categories, including man, money, materials, and management, as shown in Fig. 1

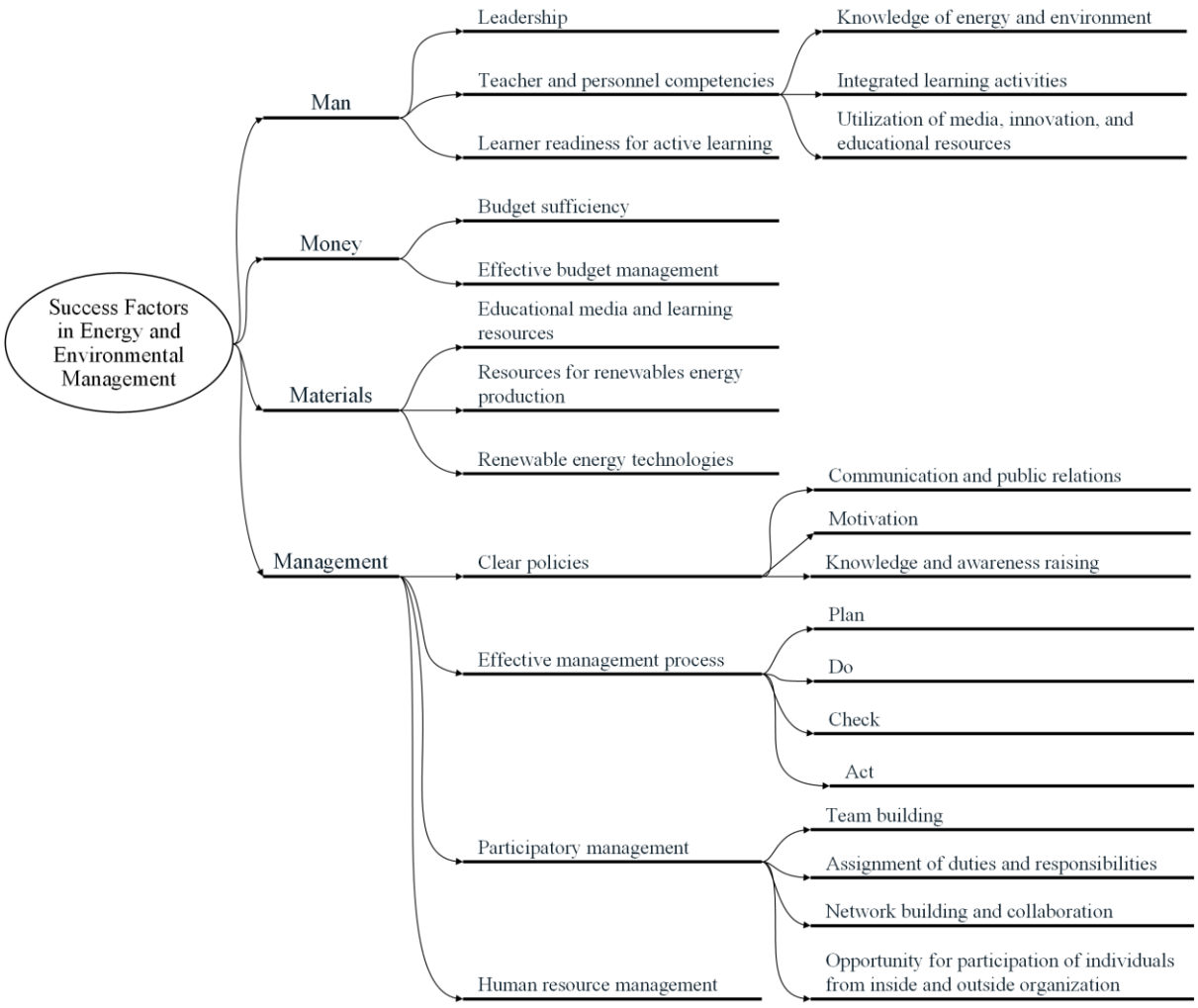

Fig. 1 Success factors in energy and environmental management.

Fig.1 shows the key factors leading to the success of energy and environmental management based on a content analysis of a focus group discussion. The key success factors are described as follows:

(1) Man: Human resources, such as administrators, teachers, staff, and students, are recognized as a key asset for driving organizational success in energy and environment. School administrators must have the leadership skills in order to lead the organization in the proper direction to achieve its goals. They must have the vision and knowledge to initiate new projects or activities while remaining committed to their work and serving as a positive role model for others in the organization. Moreover, teachers and educational personnel must be qualified and capable. The teaching staff must be knowledgeable about energy and environment, capable of integrating learning activities, and be able to apply technology, innovation, and learning resources to facilitate active learners in the teaching and learning processes. The school deputy principal no. 3 stated that "*staff members must be knowledgeable in energy and the environment. They need to share their knowledge and organize activities for students to participate in project implementation.*"

(2) Money: Developing a school into a green school requires a decent and sufficient budget to carry out projects and activities. If there is no budget for implementation, the planned projects and activities would not be accomplished or completed. School administrators are required to have fundamental budget management skills according to the budgeting process or budget cycle. They also need to consider the worthiness of money and other benefits arising from the project implementation

for sustainable development. As confirmed by a senior professional level teacher no. 1,*"budget is required to support the development and management of renewable energy in order to cover various school projects and activities."*

(3) Materials: Learning materials and resources are vital resources for learners to enhance their learning and must therefore be available in the schools. Additionally, the school should have access to a variety of resources, particularly energy conversion technologies, that can be utilized to generate renewable energy. A practitioner level teacher no. 1 confirmed that *"the school can produce renewable energy if we have green technologies, and technological knowledge and skills."*

(4) Management: Efficient management is the key to schooling success of energy and environmental development. Every organization must establish policies that can be put into action. School policies must be explicit, well-communicated, and publicized to the staff members throughout the organization to foster understanding and participation. School administrators must motivate the staff and raise their awareness and knowledge of the advantages of energy and environmental actions. In doing so, management must be systematic and adhere to the principles of participatory management. All organization members, such as school administrators, teachers, personnel, learners, parents, and communities, need to be involved in the process of planning, implementing, evaluating, and improving results. School administrators need to build teamwork and assign responsible personnel based on their skills and expertise. They must also create networks and allow people from both inside and outside the organization to participate actively in the operation in order to bring about changes and suitable development that meet the needs of the society. According to a professional level teacher no. 2, *"staff members must be involved in expressing their opinions on energy and environmental projects and activities. Meetings of staff and education committees are required to encourage all members to participate and work as a team."*

4.3. The benefits of energy and environmental management in the school

According to the findings of a focus group discussion, technology is one of the essential supporting components for the success of the sustainable energy and environmental management in Bansaluangnok School. This school also has potential fuel resources, such as organic wastes (i.e., kitchen waste and yard waste) that can be the feedstock to generate renewable energy. Typically, these wastes are converted biologically to organic fertilizer. In addition, the school administration team has designated human, budget, and management resources for waste-to-energy conversion. Because of the presence of these factors, this study proposed two appropriate waste-to-energy technologies, a 50-liter biomass stove and a 250-liter anaerobic digester (see Figs. 2 and 3) to be considered. However, feasibility studies have to be done to determine the technical and economic viability of the proposed technologies, as well as the social benefits. The results of the feasibility studies are reported in the following section.

4.3.1. Energy benefits

Converting the school's organic wastes to renewable energy can enhance waste management efficiency. This concept can simultaneously treat the organic wastes and mitigate pollution production. The direct benefit of converting resources to renewable energy is thermal energy generated by biomass stove and biogas, which could replace LPG. The amount of produced energy is estimated in the next section.

(1) Biomass energy: Biomass energy can be generated by thermochemically converting the school's yard waste such as leaves and wood scraps using a 50-L biomass stove as presented in Fig.2. The used cylindrical oil tank was used as the combustion chamber of the stove. Additionally, the stove's body was made of iron sheets with the dimension of 0.5 m by 0.5 m by 0.55 m. While the dimension of the stack, located on the top of the stove, is 0.25 m by 0.25 by 0.6 m. According to the energy and environmental resources of Bansaluangnok School, the daily amount of generated leaves and wood scraps (yard waste) were high as 6.3 and 1.6 kg, respectively. Additionally, the total biomass energy produced from the yard waste was 143.26 MJ/d (based on the HHV of spent leaves and wood scraps were 17.76 [8] and 19.92 [9] MJ/kg, respectively. The generated biomass energy could potentially

replace LPG used for cooking of 2.86 kg/d or 571.33 kg/year (assuming the school is operated 200 days/year). Based on the selling price of LPG was 22.27 THB/kg [10], the school's annual expenditure for purchasing LPG might be reduced by 12,721.89 THB.

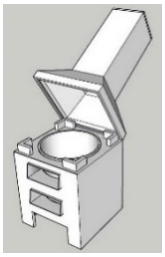

Fig. 2 The 50-L biomass stove for producing biomass energy to replace LPG.

(2) Biogas energy: Biogas is an energy-rich gaseous biofuel produced from biological conversion of organic wastes including but are not limited to food waste and fruit/vegetable waste. The appropriate biogas system for Bansaluangnok School is a household digester as presented in Fig. 3. The digester was constructed using a used cylindric plastic tank with a diameter of 0.58 m, a height of 0.95 m, and an effective volume of 200 L. According to the results from a focus group discussion, the daily generated kitchen waste was 23.63 kg/day which could be potentially converted to 0.97 m^3 of biogas (1 kg of kitchen waste could be converted to 0.041 m^3 of biogas [11]). In addition, the average methane content in the biogas was 60% [12], implying, the daily methane production of 0.58 m^3. The generated biogas could potentially replace LPG of 0.45 kg/day or 89.23 kg/year. When the school's operating period and the LPG market price were assumed to be the same as the above mentioned, the school could annually save up to 1,986.96 THB.

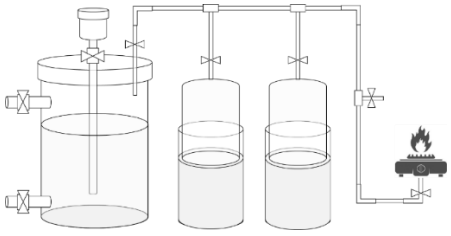

Fig. 3 The 250-L household digester for producing biogas energy to replace LPG.

Organic fertilizer is a significant by-product of anaerobic digestion. It is made from inert material withdrawn from an anaerobic digester. It was reported that 9 grams of dry organic fertilizer could be produced from 1 kg of food waste [13]. Thus, 212.63 grams of dry organic fertilizer might be produced from the school's kitchen waste everyday. This organic fertilizer could effectively serve various school's agricultural activities particularly the cultivation of medicinal herbs. Thus, the school might save around 661.26 THB per year on fertilizer purchases (assuming the selling price of dry organic fertilizer is 15.55 THB/kg) [14].

4.3.2. Environmental benefits

The results obtained from a focus group discussion on the output from converting the school's organic wastes (i.e. kitchen and yard wastes) to biofuels revealed that this waste management procedure could potentially optimize the school's benefit. Additionally, the designed biofuels in this research were biomass and biogas energy, and the environmental outputs are presented as follows:

(1) Thermochemical conversion of the school yard waste to biomass energy or heat using a 50-L biomass stove can mitigate the impact of the improper open burning of yard wastes, such as air pollution,

specifically PM 2.5. In addition, this waste disposal method can effectively limit carbon dioxide emission, the primary greenhouse gas responsible for global warming, by substituting and thus avoiding the use of LPG, a fossil fuel. The school deputy principal no. 4 thus stated that *"turning the dry leaves and branches in the school into renewable energy would reduce energy costs and solve environmental problems. For example, the problem of smoke and particles from open-air burning."*

(2) Biogas production from anaerobic digestion of the school kitchen waste using a 250-L digester could help minimize odor caused by organic matter degradation. In addition, it can help mitigate or avoid water pollution, particularly oxygen depletion in the surrounding streams and rivers. Additionally, an appropriately designed digester might successfully reduce a large number of animal and insect vectors. The professional level teacher no. 1 implied that *"the benefits of converting food waste into biogas include a reduction in the problem of bad odor and flies, which could disturb students and affect their health."*

4.3.3. Economic benefits

The economic value analysis was estimated from the expected benefits of energy and environmental management in the school. These include the biomass and biogas energy production projects to promote sustainable development. The net present value (NPV), internal rate of return (IRR), payback period (PB), and sensitivity analysis were calculated for the project implementation. The projects would be specified for a period of 5 years with a discount rate of 8.5% [7].

Table 1 Total cost summary of the project

Total Project Cost	
The initial cost of the projects	
1. 50-liter biomass stove	4,500 THB
2. 250-liter anaerobic digester	3,000 THB
Maintenance cost	
1. Maintenance cost of biomass stove (Painting cost/Repair cost for general spare parts)	200 THB
2. Maintenance cost of the anaerobic digester (Silicone glue/Rubber hose/General repair parts)	300 THB
Total cost throughout the project duration	10,000 THB

Findings from the cost analysis revealed that the total cost of the projects is equal to 7,500 THB, with a maintenance cost estimating based on the routine maintenance schedule of 500 THB each year. When the discount rate is applied, the total cost of the project throughout the five-year period is 9,470.32 THB (Table 1).

The implementation projects of biomass and biogas energy production from school management in energy and environment delivers direct benefits in cooking gas-saving for the sum total of 14,780.85 THB per year. These revenues include 12,721.89 THB, and 1,986.65 THB from energy production of yard waste, and food waste, respectively. The indirect benefit is an annual savings on biofertilizer expenditures for 661.26 THB. When the discount rate is applied, the total benefits of the project throughout the five-year period is 51,097.78 THB (Table 2).

Table 2 Total benefit summary of the project

Total Project Benefit	
Direct benefit	
1. LPG cost savings from biomass production	12,721.89 THB
2. LPG cost savings from biogas production	1,986.96 THB
Indirect benefit	
1. Organic fertilizers savings	661.26 THB
Total benefit throughout the project duration	76,851 THB

*The price of cooking gas (LPG) in 2021 is equal to 22.27 THB per kilograms [10].
** The price of biofertilizer in 2021 is equal to 15.55 THB/kilograms [14].

According to the economic value analysis of the project, the net present value (NPV) is 51,097.78 THB, with a 197% internal rate of return (IRR) and a payback period (PB) of 0.50 years. Therefore, the project is worth the investment. For the sensitivity analysis, it was revealed that if the LPG selling price is declined by 10% or 20%, the project value is declined slightly. However, the project is still worth the investment with the payback period of 0.56 years and 0.63 years, respectively. Furthermore, if the LPG selling price is increased by 10% and 20%, the profitability of the projects is also increased significantly with the payback period of 0.46 years and 0.42 years, respectively (Table 3).

Table 3 Project value summary

	Base Case Scenario	**LPG Selling Price Scenario**			
		Declined 10%	***Declined 20%***	***Increased 10%***	***Increased 20%***
LPG cost savings from biomass production	12,721.89	11,449.70	10,177.51	13,994.08	15,266.27
LPG cost savings from biogas production	1,986.96	1,788.26	1,589.57	2,185.66	2,384.35
Net present value	51,097.78	45,988.00	40,878.22	56,207.56	61,317.34
Internal rate of return	197%	178%	158%	217%	237%
Payback period	0.50	0.56	0.63	0.46	0.42

4.3.4. Social benefits

The social benefits of energy and environmental management in the school was analyzed through content analysis of a focus group discussion, which could be divided into two categories as follows:

(1) Organizational level: Energy and environmental management in the school, and policy implementation through practices in the projects and activities will contribute to the development of the knowledge of school administrators, teachers, personnel, and students. The projects and activities such as energy-saving, waste management, efficient burning for reduction of PM 2.5, waste to energy projects, renewable energy usage, organic farming, and agricultural water management will help school staff and students to better understand energy and environmental challenges and address the problems in both concrete and abstract ways. According to a professional level teacher no. 3, *"students gain more knowledge and awareness of the environmental problems. They also learn to be energy and environmental leaders."*

(2) Community and social level: The energy and environmental management projects and activities promote community and social development by motivating students to become good global citizens in the future. When students are well educated, they will realize and recognize the value of energy and the

environment, as well as the consequences of destroying natural resources and environment. Additionally, the knowledge that students have gained in the school can be pass on to their parents and surrounding community through organizing joint activities for sustainable development. The school deputy principal no. 1 thus concluded that *"the communities gain knowledge of energy and environment through knowledge transfer and collaborative activities with the school."*

5. Discussion

In order to manage energy and the environment in the school effectively, four administrative factors are required, including man, money, materials, and management. This finding is the same as in a previous study, which indicated that an organization can achieve its goals by having good management factors and principles according to the 4M theory [15].

Human resources are the most important aspect of successful project management. Onyaem [16] also agreed on the importance of human resources as a valuable resource of an organization. Effective administrators oversee operations, team building and delegating responsibilities to knowledgeable and capable individuals. Teamwork would drive the members of the organization towards the same goals, therefore, administrators must emphasis on working as a team. Moreover, Radujković and Sjekavicab [17] stated that the ability of a team, organizational atmosphere, and ability to create an atmosphere will all have an impact on the efficiency of operations. Consequently, the administrators must motivate and enhance the capacity of staff members to optimize their performances.

The budget is the second most important factor that is required for all kinds of operations [16-18]. Administrators need to allocate budget properly using the budget management process and taking into account the value for money and transparency. Attawong and Wongsung [19] proposed a budget management strategy based on the PDCA management process, which is consistent with the findings from this study that school administrators should adhere to the budget cycle process for effective project management. The budget cycle process consists of four steps, which are (1) budget preparation, (2) budget adoption, (3) budget execution, and (4) budget monitoring and evaluation [20].

Materials, equipment, technology, and productive resources are important factors in project management and operation [16]. Food waste, vegetable and fruit waste, dry leaves, as well as branches and timbers, are all potential renewable energy resources at Bansaluangnok School. Food waste and vegetable/fruit waste can be converted into biogas, whilst dry leaves and branches/timbers can be converted into biomass for sustainable energy usage. The technologies required for the conversion of compostable waste into energy include biomass and biogas systems [21-23].

Management is an abstract factor in which school administrators must put emphasis by using effective management process. The most well-known and widely used project management process is the Deming cycle (PDCA), which consists of the planning, doing, checking, and acting steps [24]. The staff of Bansaluangnok School agreed that the PDCA cycle is a useful process for a systematic and high-quality operation. In this regard, staff members at the school should be involved in the operation at all levels. School administrators must provide opportunities for all staff members to participate in the organizational activities in order to increase their motivation, commitment, and ultimately, deliver greater performances. This finding is related to Talib and Hamid [25], which advocates for participatory management. The administrative team must communicate clearly with the employees for them to better comprehend the organizational policies and practices. In addition, administrators must allocate adequate budget, resources, and time for project implementation in order to accomplish the organizational goals.

Energy and environmental management in school provides benefits in three aspects: energy and environment, economic, as well as social benefits. For energy and environmental benefits, turning wastes into energy is a useful approach to properly dispose of organic waste and also obtain clean cooking fuel. Many studies have been undertaken to encourage the energy production and usage of renewable energy in order to increase energy security and reduce environmental pollution [26]. According to Bansaluangnok School's energy and environmental management strategy, converting the school kitchen waste to biogas via an anaerobic digester can produce heat energy for cooking to replace LPG. Additionally, other environmental issues within the school might be reduced, including odors

caused by decomposing organic wastes and breeding grounds for infectious and harmful animals [27]. In addition, using the school yard wastes in a clean and efficient biomass stove instead of open burning generate useful thermal energy for cooking and that also reduces air pollution including fine particulate matter especially PM 2.5. Typically, the high-efficiency biomass stove can significantly reduce PM 2.5 concentration by more than 90% [28-29].

Investing in biomass and biogas systems is an economically worthwhile decision for the school administrators. The investment in these two technologies has a short payback period, as it allows the school to save on expenditures for LPG, particularly since this cooking gas has recently becoming expensive. The results are consistent with the findings of other studies on the economic analysis of clean and efficient biomass stoves and biogas systems. According to other research findings, disposing of compostable waste with waste-to-energy technologies is a cost-effective investment [21-23].

The social benefits of energy and environmental management in Bansaluangnok School include raising public awareness on the importance of being eco-friendly, and pursuing sustainable development. School administrators, teachers, school personnel, students, parents, and communities can all work together on school projects and related activities in energy and environment in order to better understand the importance of environmental conservation and the problems or impacts arising from their actions. In recent years, many researchers are paying attention to the raising of consciousness in energy and environment through educational management, and the implementation of school projects and activities on sustainable development [30]. As people around the world are increasingly concerned with the importance and benefits of environmental education, it is therefore incorporated in the National Scheme of Education under strategy 5: education management to improve environmentally friendly quality of life [6], as well as the sustainable development goals (SDGs) of the United Nations [31].

6. Conclusion

An in-depth understanding of the potentials and influencing factors is the key to the success in developing sustainable energy and environmental management in the school. The critical resources, particularly 4M (i.e. man, money, materials, and management) will assure the success of the organizational management for the project implementation and goal attainment. Moreover, a meticulous project planning and analysis of the overall attained outcomes, including energy and environmental, economic, and social benefits can effectively lead to executive decisions to carry out the projects that will result in the greatest benefits for the organization, and ultimately, surrounding communities.

Energy and environmental issues are among the current global challenges requiring incorporation and integration of various appropriate multi-disciplinary strategies. Presently in the academic sector in Thailand, both public and private schools are already actively concern in energy and environmental issues and are participating in facing the challenges. The work in Bansaluangnok School is one good example. They have developed various projects and activities to increase understanding and awareness of the youth in order to evolve them into good members of society. They have showcased examples of integrating green technologies towards effective conservation and optimum consumption of natural resources. Specifically, the findings in this study indicated that waste-to-energy technologies are worth investing for the schools and other organizations that have the potential to acquire the success factors identified and discussed in this study. The research findings will thus be useful as an informative guideline for individuals or organizations in supporting national energy and environmental goals.

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