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Alternative Financing for Energy Efficiency Saving in Indonesia Under LCCA Analysis

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ABSTRACT*--Under the LCCA system, we present the calculation of the "investment cost" on energy efficiency saving. This paper to set up an initial model in developing the model for Energy Saving Companies in Indonesia in assessing alternative financing for Energy Efficiency Saving in Indonesia. The reviewed for all the energy efficiency saving advantages cover the upfront investment costs are presented. The model is using the Analytic Hierarchy Process (AHP) and life cycle cost (LCC) analysis, with sensitivity analysis, is presented under possible a game-theory process. On some occasion, these alternative financing values are comparing to other similar investment returns as well as the risks.*

Keyword*--LCCA, AHP, Alternative Financing, Energy Efficiency Saving*

I. INTRODUCTION

The choice of an optimal combination of retrofitting investment is a complex process. The investigation of significant factors influencing this choice remains limited. Further research is required on the development of basic models to choose the best ideal optimal combination to maximize energy-retrofitting benefits. This investigation proposes a basic decision-making structure that: (1) ascertains the monetary advantages of retrofit financing as far as life-cycle cost for a specific energy efficiency's lamp during its service life; (2) decides the ideal retrofitting spending that minimizes the total life-cycle cost of the energy efficiency's lamp during its service-life; and (3) chooses the ideal retrofitting technique (using sensitivity analysis) to amplify the retrofit supplier financial advantages during service-life of the energy efficiency lamp based on available investments.

Life cycle cost (LCC) is one sort of procedures to assess the total cost of ownership between totally unrelated other options. LCC can be utilized as a monetary strategy for assessing investment costs that take into consideration all costs arising from owning, operating, keeping up, and discarding the benefit (Fuller & Petersen, 1996). It is the total discounted cost of procuring, working and keeping up of an asset over a fixed period time (Mearig, Coffee, & Morgan, 1999). In other words, LCC is a significant apparatus for positioning the expense of proprietorship between totally unrelated other options. Sensible presumptions can be acquired from evaluating the performance of comparative resources, conducting surveys, getting data from producers, sellers, temporary workers, and using average support and maintenance costs (Robinson, 1996). Under the LCC technique, we present the evaluations

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of the “investment cost” on energy saving compared to other project investments. The benefit of energy efficiency’s saving as they are collecting overtime—associated with electricity generation expenditures. The summarized for all the energy efficiency saving benefits cover the upfront investment costs are presented.

II. LITERATURE REVIEW

Over 70% of the total life cycle of a product took place at the early design stage. Life Cycle Cost (LCC) analysis provides a structure to determine the evaluated complete steady cost of creating, delivering, utilizing, and resigning a specific thing. The capacity of an organization to compete effectively on the competitive market was affected by the expense just as the nature of its items and the capacity to bring items onto the market. It has been perceived that a life cycle engineering approach to deal with the design of products can accomplish these objectives. The intriguing idea was in the service industry. The cost serviceability developed by K. Ishii, C.F. Eubanks, and M. Marks (1993) can be classified as those made under certainty, risk, or uncertainty. A decision under risk is one activity in which each activity may bring about more than one result, contingent on the condition of nature. Each condition of nature (and subsequently out-come) having referred to, or known as a probability. The accomplishment of an LCC investigation including uncertainty and conditions could bring about cost ineffectiveness.

2.1 Life Cycle Cost in Energy Saving

Meanwhile, the period time (useful life) of energy efficiency lamp associated with LCC must be built up and verifiably exact. Moreover, the discounted rate ought to be utilized, since there is inflation. In this manner, when looking at options during a given period, an inflated discounted rate must be utilized. Besides, the discounted rate is presumably going to shift from period to period, and there are many discounted rates. When utilizing the significantly discounted rate in present value (PV) estimations, cost ought to be communicated in steady currency measurement (Mearig et al., 1999). Expenses and devaluation stipends ought to be represented in LCC computations. For the most part, the straight-line technique for devaluation is utilized. The value impact alludes to the differential project undertaking financing type to at any rate one option versus another. For example, the return on investment for ESA financing is lower than ESPC Financing. The net present worth (NPV) is utilized for capital planning where projects with the absolute best NPV exhaust the company's fixed upfront investment (Branson, 1979). NPV is the present value of an investment future cash flow (CF) less than the upfront investment. Under this study, the cash flows are positive (inflows). The highest NPV should be selected.

2.2 Life Cycle Cost in Retrofitting Financing

The emergence of hyper-competition in the energy efficiency market, especially in the LED industry, has forced LED light distributor companies to find solutions to get out of competition and find new business models. One solution is to switch from product-dominant to service-dominant. The Product Service System Concept (PSS) or service-dominant can break traditional barriers between products and services, from selling mere artifacts to providing unique and positive experiences to customers with tailored and results-oriented solutions.

The emergence of the PSS model is accompanied by the emergence of hyper-competition and price wars between fellow sellers and distributors of energy efficiency lamps. Therefore, many LED companies then implemented the PSS business model into their internal operations. Dimanche and Roche 2012, categorize three PSS business models according to empirical research that can be mapped (1) Product-oriented services, (2) User-oriented services, and (3) Services-oriented services results (result-oriented services). In the case of alternative financing, the company converts product-oriented services into results-oriented services and the use of energy efficiency products is provided in the form of lighting services.

The profitability of the result-oriented services PSS model contributes to the company's business competitiveness. Due to the changes to the PSS business model, companies increase their benefit positioning in the competitive market and financial operation (cash flow, sales turnover, margin, and return on Investment) (G.C.J. Ang, T. Baines & H. Lightfoot, 2010). On the other hand, customer loyalty and brand image have also increased where deeper customer-centric relationships have been developed by companies in exploring new sales sources and new connections (GCJ Ang, 2010; Ana Paula B Barquet, Vitor P. Cunha, Maicon G. Oliveira, & Henrique Rozenfeld, 2011;). One of the services as a change in the form of the PSS business model by energy efficiency companies is alternative financing service. There are two alternative types of financing services, including ESA and ESPC, (Nasip & Sudarmaji, 2018[a,b]).

2.2.1 Energy Saving Financing

There are ways to finance the retrofit project, whether traditional or specialized. Traditional financing is usually done by bank loans or capital lease financing. While specialized financing there are three types: "On-Bill Financing Contracts", "PACE Financing Contracts" and "Savings-backed arrangements". There are many types of energy-efficiency financing available today. Retrofit saving back arrangement model has the Energy Saving Performance Contract and the Energy Saving Agreement, they have some features that make them unique. If a customer cannot pay their obligations, the retrofit supplier can reclaim those assets. The second feature is that the ESPC and ESA stated that the customer paid the retrofitting supplier taken from the energy cost saving.

2.2.2 Specialize Financing: ESA & ESPC

The retrofitting financing project scheme can go through a service contract agreement based on the income for the service contract. Performance of ESPC and ESA service contracts has several features and make them unique. The first feature is that what is being installed and owned is new energy efficiency equipment, such as heating systems, air conditioning systems, and lighting systems. If the customer no longer pays for the service contract, the retrofit provider can retrieve the installed equipment. The second feature is that in ESPC performance contracts and ESA service contracts, customers pay only for the amount of energy savings. Negotiating fees for services and negotiating the results of savings contracted by ESPC performance and ESA service contracts will occur very difficult and requires a lot of time. As long as the profit sharing for savings is less than the cost of the utility, the customer will be happy to receive it.

ESA & ESPC Financing are associated as retrofit-financing activities, retrofitting is expressed as the substitute of existing equipment (conventional lamps) with sophisticated ones (LED lamps) to increase energy-saving efficiency and lessen energy costs before the equipment is obsoleted (N. Khan & N. Abas, 2011). Hence, retrofit involves capital investment, where the value of retrofit is determined by the payback period for the new equipment, due to new technology and available financing models. The payback period is determined by the cost investment in new equipment/technology, energy prices and time of operation of the equipment with the decline in prices for new equipment / new technology while energy prices rise, retrofit activities are expected to increase in the future. The LED retrofit project will be carried out for companies whose facilities or facilities operate for 8-16 hours per day (N. Khan & N. Abas, 2011). Energy efficiency can be done by changing conventional lighting into LED lights, where the utility cost savings on LED lights lie in the light-emitting diode technology. Lighting is measured in lumen per watt or the amount of energy needed to produce light. The more lumens, the brighter the light is. In Table.1 below, energy consumption shows that LEDs are 4.5X more efficient than conventional/incandescent lamps, and can last 1.5X longer. The cost of LED lighting consumption and its durability make LED lights have a return period of fewer than six months. The table below is an example of a simple comparison calculation between LED lights and conventional lights.

Based on the engineering-cost calculation, the utility cost savings on LED lights against conventional lights will reduce the payback period either due to an increase in lamp usage hours or by an increase in utility costs (electricity) per watt which is set by the state electricity company (PT. PLN) While a small payback period may be profitable and not at risk of this retrofit project. The percentage of total usage cost of utilities is compared to the cost savings that occur, in increased graphing is confirmation is a factor that causes a decrease in the payback period.

III. METHOD

Ruparathna, Hewage, and Sadiq (2017) used fuzzy logic, which used for energy efficiency and retrofit model. Taha and Daim (2013) used the MCDM to renewable energy sources and suggested the MCDM techniques to use in the fields of renewable energy planning and policy, renewable energy evaluation, project selection, and the environment respectively. Taha and Daim (2013) utilized the MCDM to renewable energy and proposed the MCDM strategies to use in the fields of renewable energy arranging and strategy, renewable energy source assessment, project investment selection, and the environment. To address the undeniable mind-boggling basic decision-making process in energy efficiency saving finance, this paper applied the Analytic Hierarchy Process (AHP) approach, combined with LCCA. The utilization of the AHP system permits the decision-maker to consolidate both subjective and quantitative information into the choice structure model. AHP considered as logical framework for integrating perceptions, decisions, and at that point permits superior comprehension of the issue, its criteria, and possible decision choices.

This research is a case study, semi-structured deep interviews organized with owners and directors who managed retrofit projects. The interview process helps the information obtained, which can only be obtained directly from persons involved. Optional information acquired from industry information and retrofit project archive information is utilized to better understand the lighting industry and energy-saving technology. This initial step enables the authors to have the option to recognize the key components of the survey given, Interviews are directed between January to June 2019, enduring from twenty minutes to an hour. Every respondent was approached to remark on the accompanying points: 1) their meaning of energy-saving or energy efficiency; 2) the idea of energy efficiency innovation (EE) and vitality sparing gear: its starting point; 3) the execution of the energy efficiency strategies, and how it identifies with the general retrofit methodology; 4) key variables for the accomplishment of the retrofit procedure; 5) the role of energy efficiency in a manageable retrofit procedure.

The research uses a systems approach that is carried out in stages, namely (1) observation and literature study to determine the location and scope of research, (2) case studies on companies to obtain empirical data and expert surveys to acquire thinking respondent knowledge in purposive sampling (Cooper and Schindler, 2008). The expert survey phase was carried out through in-depth interviews (IDI) and focused discussion (FGD), as well as filling out questionnaires for AHP analysis. Also, the AHP method is also used (Thomas L. Saaty, 2008) to identify strategic factors that influence the outsourcing system from the perspective of industrial relations. Empirical conditions at the study site are presented in feasibility analysis through financial sensitivity analysis related to split incentives and market conditions as well as their implementation.

IV. ESTIMATION AND RESULTS

The choice of determinants and combinations of retrofitting funding is a very complex process. The LCCA research variable is an important variable that affects the energy efficiency decisions of funding that is as yet restricted. Further research is required on building up a decision-making model to select a retrofitting financing strategy for optimal energy-saving efficiency to maximize the benefits of energy saving. This paper proposes a decision-making structure that: (1) ascertains the financial advantages in terms of the life cycle costs for a particular energy efficiency lamp during its service life; and (2) decide a spending that limits the total life cycle costs of energy efficiency lamps over their lifetime. Life cycle cost (LCC) is a sort of method to assess the total cost of between totally unrelated other options. LCC can be used as an economical method for evaluating investment costs that consider all expenses emerging from owning, working, keeping up, and discarding resources (Fuller and Petersen, 1996). As it were, LCC is a significant instrument for positioning possession costs between fundamentally unrelated other options. Realistic assumptions can be gotten from assessing performance, works of literatures, acquiring data from producers, merchants and temporary workers (Robinson, 1996).

Under the LCC technique, the authors present an assessment of "investment costs" on energy efficiency investments compared to other investments. The benefits of saving energy efficiency are because they accumulate overtime - related to spending energy costs through energy costs and total energy consumption. On several occasions, retrofit financing compares energy efficiency investments with traditional loans or other funding in generating investment returns. This is done in two ways: the first is an annual return on retrofit investment; the second is an examination of risks associated with retrofit investment opportunities provided.

Under LCC Analysis calculation Procedure, the fundamental cost components of this LED retrofit during its service life are the underlying expense of LED lamp investment, upkeep cost, and exceptional fixes cost, activity cost, substitution cost, energy cost, organization cost, tax collection cost, renovation cost, and transfer cost. The interest cost is one of the primary components of any LCC investigation that relies upon the inflation rate. This rate may not be a steady term and may differ over the service life of the project. A loan cost of 2 or 3% above inflation is viewed as a fitting worth. The expected service life of an LED is a maximum of five years. The accompanying cost components are chosen for the LCC condition definition: Upfront Investment Cost (IC), Energy Consumption Cost

(EC) and Maintenance and Replacement Cost (MR. In this way, the change in LCC of a project due to energy retrofits can be determined as: $\mathbf{LCC = IC + PV_{EC} + PV_{MR}}$

To evaluate the practicality of the project, the methodologies, and rules by EPA-Energy Start (United States Environmental Protection Agency, 1998) is used: 1) set up the LCC examination for every alternative agreement, regardless of whether the ESPC and ESA contract is possible or not, 2) figure the IRR for every one of these choices to decide the degree of benefit from every choice, and considering account the rate of return required (hurdle rate), 3) look at the choices and organize choices by utilizing the NPV, and 4) expand energy efficiency with which choice is generally proper? The benefit is normally estimated by the internal rate of return projects past the level of investment required (hurdle rate). Cash flow and financial liquidity of the customer is evaluated first, then the rate of return (payback). The hurdle rate is the acknowledged/dismissed criteria for deciding if an investment passes the profitability assessment. If the IRR is higher than the required rate of return, the project is otherwise profitable investments. Required interest rate is the marginal cost of capital, adjusted for the risk of the project. The higher the cost of capital and risk, the higher the degree of benefit required. Over 20 percent of energy efficiency investments were the necessary required rate of return recommended by EPA Energy Star (the United States Environmental Protection Agency, 1998).

4.1 The Sensitivity Analysis of LCCA

The sensitivity analysis (SA) showed how uncertainty in the outcome of an energy efficiency saving model could be assigned to the operation hours and electricity tariffs into various levels. It may be used to determine the input of the operation hours and electricity tariff variables that contribute the most to energy efficiency. The other Importance input variable affected by an operation hour and electricity tariff variability provide a deeper understanding most effectively. The Scenario analysis: of retrofit's key assumptions, following the sensitivity analysis – the assumptions to estimate the energy-saving split incentive problem which possibility appeared on energy saving potential for both provider and client. Most of these assumptions concerned the risk-adjusted discounted rate of upfront investment and split-saving incentives into various levels of scenario type. This scenario analysis is to investigate the effect of changing the values by changing the key assumptions. The values can be increased or decreased based on reasonable assumptions, and the corresponding changes in energy savings were noted.

The most useful information from the sensitivities scenario analysis is the range of values of discounted payback period (years), IRR and NPV across different sensitivities scenarios, which showed the riskiness of the investment. Under this sensitivities analysis, the information can be useful in determining the inputs variables into a sensitivity analysis that have the most effect on the project value. At the LCC calculates the amount saving energy for a 1pc lamp of LED. Under the scenario of ESA split incentives with ranging discounted rates ranging from 8% to 20%, the higher dominant incentives choice for a provider is lies at a 50%-70% split scheme area. On the contrary, the higher dominant incentives for the client are lies at a 20%-50% split scheme area. The overlapping and possible for having tough negotiation and having a nash-equilibrium for both of them is in a 50% split area. The negotiations for both of the parties will not only be on splitting saving incentive but will also focus on the discounted rate implied.

Meanwhile, under the scenario of ESPC split incentives, the information revealed upon the LCC calculation for values of discounted payback period (years), IRR and NPV with discounted rate ranging from 8% to 20%, the higher dominant incentives for provider are lies at 1year to 1.25 years with full saving energy given to provider and for client at 1.5 years to 2.5years. The negotiation area and possible for having nash-equilibrium is in 1.25 years area. As well the ESA, one of the negotiations issues between both of the parties under ESPC will be focusing on the discounted rate.

4.2 AHP Approach

This paper has proposed the Analytic Hierarchy Process (AHP) model to assess Alternative Financing for Energy Efficiency Saving in Indonesia by looking at decisions dependent on result situation. The split incentives model includes benefits evaluation of the alternatives between Loans, ESA and ESPC are developed. The initial phase in the Analytic Hierarchy Process (AHP) evaluation system was to set up a various leveled structure. The AHP is a piece of the model evaluation process. The AHP is utilized to survey of the criteria subjective markers foundationally. Analytic Hierarchy Process (AHP) is carried out to determine strategies for investment alternatives for Energy Efficiency in Indonesia by using LCC analysis. Analytic Hierarchy Process (AHP) is carried out by compiling a hierarchy based on the objectives of AHP implementation. The hierarchy is structured with 3 levels as follows: Level-1 (Goal) for Choosing an alternative investment, Level-2 (Criteria) for Financing Sources and Level-3 (Sub Criteria) for LCC Analysis. Cluster research results: Retrofitting, placing ESPC with a suspension of 0.6734 in the top position compared with ESA and Traditional Loans with a suspension of 0.2515 and 0.0751. Based on the ESA cluster, placing 'Energy Price' with a suspension of 0.3906 in the top position compared to Energy Consumption, Equipment Service Life with a suspension, Installation & Replacement Cost, Operation, Repair & Maintenance and Residual Value with a suspension respectively 0.1928, 0.1257, 0.0921, 0.1829 and 0.0160. On the other hand, based on the ESPC cluster, placing 'Energy Price' by 0.2869 in the top position compared to Energy Consumption, Equipment Service Life, Installation & Replacement Cost, Operation, Repair & Maintenance and Residual Value with a suspension of 0.2415, 0.0649, 0.1616, 0.1494 and 0.00956. For the results of the Traditional Loans cluster, place 'Energy Price' with the amount of 0.4236 in the top position compared to Energy Consumption, Equipment Service Life, Installation & Replacement Cost, Operation, Repair & Maintenance and Residual Value with a suspension of 0.0898, 0.0553, 0.1271, 0.2729 and 0.0313.

The outcomes of the whole process, based on the interviews and questionnaires, and based on the results of tests conducted on the AHP method with Super Decision software. The Price Energy Price ’criteria were found to determine 3 criteria or factors determining the uncertainty in the LCC analysis in the retrofitting program. The factors determining the uncertainty in the determination or calculation of LCC analysis to decide alternative sources of loans for determining energy efficiency savings targets through a retrofitting program are found in table 4 below. The six determinants of life cycle cost calculation are 1) LCCA 1: Energy Consumption, 2) LCCA 2: Energy Price, 3) LCCA 3: Equity Service Life, 4) LCCA 4: Installation & Replacement Cost, 5) LCCA 5: Operation, Repair & Maintenance and 6) LCCA 6: Residual Value.

Table 1 : Overall result on factors determining the uncertainty

Name	Ideals	Normals	Raw

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Energy Consumption	0.6740	0.2179	0.1089
Energy Price	1.0000	0.3232	0.1616
Equip Service Life	0.2460	0.0795	0.0398
Installation & Replacement	0.4378	0.1415	0.0708
Operating, Repair & Maintenance	0.5170	0.1671	0.0836
Residual Value	0.2189	0.0708	0.0354

V. CONCLUSION

In response to intense competition, company 'X' changed its marketing strategy, by breaking the barriers between product-dominant and service-dominant strategy, the concept of a Product Service System (PSS) acts as a strategic approach that enables the company from selling mere products to deliver a unique and positive experiences to users while traveling with a solution that is customized and results-oriented. Discount or cost-cutting programs are transformed into customer-centered value through the implementation of PSS business models, which aim to increase product and service variability. After the conclusion, it is believed that further investigation into several other contexts needs to be explored. Based on these findings, future research needs to be carried out to examine interactions between various problems, such as the environment, industry, or economy and apply various theories to enhance an in-depth understanding of LED market opportunities and energy efficiency. In concluding this paper, there is always room for improvement to be made.

REFERENCES

1. Ang, G. C. J., Baines, T., & Lighfoot, H. (2010). A Methodology for Adopting Product Service Systems as a Competitive Strategy for Manufacturer. In *CIRP IPS2 Conference* (pp. 489–496).
2. Barquet, A. P. B., Cunha, V. P., Oliveira, M. G., & Rozenfeld, H. (2011). Business Model Elements for Product-Service System. In *3rd CIRP International Conference on Industrial Product Service Systems*. Braunschweig.
3. Besikci, E. B., Kececi, T., Arslan, O., & Turan, O. (2016). An Application of Fuzzy-AHP to Ship Operational Energy Efficiency Measures. *Ocean Engineering*, *121*, 392–402.
4. Branson, W. H. (1979). *Macroeconomic Theory And Policy*.
5. Dimache, A., & Roche, T. (2013). A Decision Methodology to Support Servitisation of Manufacturing. *International Journal of Operations & Production Management*, *33*(11/12), 1435–1457.
6. Fuller, S. K., & Petersen, S. R. (1996). LCCosting Manual for the Federal Energy Management Program. *NIST Handbook 135*.
7. Khan, N., & Abas, N. (2011). Comparative Study of Energy Saving Light Sources. *Renewable and Sustainable Energy Reviews*, *15*, 296–309.
8. Leventis, G., Fadrhonc, E. M., Kramer, C., & Goldman, C. (2016). *Current Practices in Efficiency Financing : An Overview for State and Local Governments*.
9. Mearig, T., Coffee, N., & Morgan, M. (1999). *Life Cycle Cost Analysis Handbook*.

10. Nasip, I., & Sudarmaji, E. (2018a). Government Measures to Promote New Retrofitting Business and Financing Option in Indonesia. *International Journal of Engineering and Technology (IJET)*, *7*(3.25), 531–537.
11. Nasip, I., & Sudarmaji, E. (2018b). Managing Tax Dispute Due to IFRS-16 on the Retrofits Implementation in Indonesia. *International Journal of Engineering and Technology (IJET)*, *7*(3.21), 200–208.
12. Robinson, J. (1996). Plant and equipment acquisition: A life cycle costing case study. *Facilities*, *14*(5/6), 21–25.
13. Ruparathna, R., Hewage, K., & Sadiq, R. (2017). Economic evaluation of building energy retrofits: A fuzzy based approach. *Energy and Buildings*, *139*, 395–406.
14. Saaty, T. L. (2008). Decision Making With The Analytic Hierarchy Process. *International Journal Services Sciences*, *1*(1), 83–98.
15. Taha, R. A., & Daim, T. (2013). Multi-Criteria Applications in Renewable Energy Analysis, a Literature Review. *Green Energy and Technology*, *60*, 17–30.
16. United States Environmental Protection Agency. (1998). Business analysis for energy-efficiency investments. *Energy Star Buildings Manual*, 12.
17. WSGR. (2012). Innovations and Opportunities in Energy Efficiency Finance, (May), 12.