

The Implementation Of Eco Office Concept Based On User Behaviour In Office Building

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Abstract: The countless office building in urban area contributes to the significant degradation of environmental quality. Various green acts has been carried out to preserve the earth by implementing various energy consumption efficiency effort. The research intends to reveal the Eco-office concept in office building. The research employs descriptive quantitative approach. The sample in the research is office-building employee. The research uses questionnaire as the instrument. The instrument is tested for the degree of validity and reliability to comply for the requirements of research data procurement. Analysis of research data using score percentage analysis. Of the five indicators, namely, electricity savings, water savings and conservation, office waste management, greening, and other efforts. The conclusion of the study was that the accumulation of eco office application scores was 59%, which showed that the application of the eco office concept in the building was quite implemented. The distribution of these levels is in accordance with the implementation indicators, namely electricity saving (53%), water saving and conserving (56%), office waste management (65%), greening (66%), and other efforts (54%). The suggestions of the research results are the reduction of the use of lights by utilizing solar energy, the use of energy-saving lamps; use of water-saving taps and utilization of wastewater recycling; provision of separated trash bins between organic and inorganic waste; the addition of greening in the building; socialization of eco office application to the employees.

Keywords: eco office, energy efficiency, conservation, behavior, building

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I. Introduction

The current environmental damage has become a global problem [24]. The emergence of the energy crisis in the 20th century caused an increase for the need of energy in various fields [6]. There is almost no aspect that do not need energy in their operation [20] [17]. This include energy usage in buildings for lighting, heating and air conditioning, and various electronic devices [20].

The contributions to the increasing number of offices caused a significant decline in environmental quality. Every day the office spends paper, water, electricity and creates domestic waste that pollutes the environment [12]. This situation indicates the need for the efforts to control environmental impacts, so that the risk of damaging the environment can be minimized [5]. The efforts to anticipate global warming are also carried out by the industrial/office sector [10]. The efforts to prevent and reduce pollution caused by office activities can be done by implementing environmental management from ISO 14000 in office environments through eco-office or green office programs [14]. The implementation of the Eco-office is in line with the Minister of Environment Regulation No. 16 of 2009 concerning the Office of Environmental Care (Eco-Office). The cultured environment office is a reflection of the office's policy that applies the Environmental Management System (SML) [11]. Eco-office is one of the effective efforts to implement an environmental management system (SML) in an effort to create a clean and comfortable office work environment and an effort to save the environment that involves all individual activities as well as increasing the effectiveness and efficiency of the use of natural resources and energy [16-17]

The concept of Eco-office is an effort to save energy that can be applied to buildings, in order to minimize the environmental impacts. This concept includes the aspects of maintenance, saving the use of natural resources, maintaining good quality in the building environment and paying attention to the health of its inhabitants who all must adhere to the rules of sustainability [1]. Through an efficient movement of both electrical and mechanical equipment along with ongoing administrative maintenance that can minimize the usage of consumed energy [3].

The application of the Eco-office concept based on employee behavior in the building is based on the desire to know the extent of the application of Eco-offie that has been applied to the building, hence creating

environmentally friendly building and provide comfort for users of building services. There are five aspects of an office that can be considered to have an Eco-office concept, i.e. consideration of human health and well-being, a high level of comfort, a design that follows changes, the use of the latest technology, and training in human resources [8]. In addition to the selection of building materials, which also plays an important role for the more sustainable buildings, for example if the building is made of the proper wood, it can reduce almost 50% of CO₂ emissions [25].

Related to these problems, a formulation of the problem in this study was made, that is to say; how to implement the eco office concept based on employee behavior studies in the office building environment and knowing the parameters that contribute the most to the implementation of the eco office concept. This study objectives is to identify and to describe the form of employee behavior in the application of the eco office concept, and find out the parameters that contribute the most to the implementation of the eco office concept in building. Hence, it is expected that the eco office program can create an office atmosphere that is environmentally friendlier so that it can be used as a reference in step Eco-office implementation program in the future as one of the efforts to save the environment [7,12].

II. Material And Methods

This study uses a quantitative descriptive approach. The sample in this study were office building employees. The instrument used in this study was a questionnaire. The instrument is tested for the level of validity and reliability to meet the requirements for research data collection instrument. The analysis of the research data is using score percentage analysis. Five indicators of the application of the eco office concept that have been tested are, electricity savings, water saving and conservation, office waste management, greening, and other efforts.

2.1 Time and Research Location

The study was conducted in October -December 2017 in an office building located on Slamet Riyadi Street Surakarta City, Central Java Province.

2.2 Population and Sample

Population is the total subject of research. Population is also defined as a group of subjects to be recognized for the generalization of research results [2]. The observed population in the study were the office-building employees. The research samples are some individuals who are considered to have and reflect the state of the population or as representatives of the population under the observation. The sampling process in the study is by simple random sampling.

2.3 Method of Collecting Data

In the study, to obtain the data being studied, the following data collection techniques are employed:

A. Observation Method

Observational research was carried out by observing and recording directly on the object of research, that is; by observing activities or the process of applying the eco office that had been carried out in the office building.

B. Interviewing Method

The research uses interviewing method to get the data of general description of how far is the implementation of eco-office in accordance to the building user behavior.

C. Documentation Metode

The documentation method is used to retrieve the data obtained from documents usually in the form of a list of labels, graphs, records contained in the research location so that the data obtained is accurate. The documentation method used to obtain data of the general description of the object of research related to the extent to which the eco office process is applied to both buildings and infrastructure/facilities that support the eco office concept.

D. Questionnaire Method

The questionnaire method is a series or list of questions arranged systematically and then sent to be filled in by respondents⁴. Questionnaire method was used to obtain data on independent variables (building employee behavior) and dependent variables such as electricity saving behavior, water saving and conservation, waste management, greening, and other efforts that support eco-office behavior. The type of questionnaire used is a closed questionnaire. Based on the shape, it is using a rating-scale type, (a multilevel scale), which is a statement that shows levels. Likert model scale was used in this study to measure attitudes. The attitude scale is designed to reveal the pros and cons, positive and negative, agree and disagree with a social object. The attitude scale contains attitude statements, namely a statement about an object of attitude, an attitude statement consisting of two types, namely a statement that is favorable (supporting or favoring the object of attitude) and a statement that is not favorable (not supporting the object of attitude).)².

2.4 Validity and Reliability

The calculation of Validity test is to measure the level of instrument validity by using the Pearson Bivariate formula (Product Moment Correlation) [23]. To find out whether the instrument is valid or not is completed by consulting the correlation coefficient (r) at the 5% significance level or 95% confidence level. If $r > r_{table}$, the instrument can be declared valid, subsequently the instrument can be declared as eligible for data retrieval. Reliability is used on an instrument in order to be used as a data collection tool. The formula used to measure the level of reliability in this study is to use the Alpha Cronbach coefficient formula [23].

2.5 Data Analysis

The data analysis technique used in this study is the percentage descriptive technique used to find out the description or the state of the application of the eco office concept on the office building, as for the steps taken as follows:

- A. Descriptive table percentage distribution of respondent questionnaire answers designing
- B. The determination of the respondent's answer score is carried out by giving a number for each choice of activity that has been determined as the followings:
 1. Option SST score 5 = Well done
 2. Option ST score 4 = Done
 3. Option CT score 3 = Sufficiently done
 4. Option KT score 2 = Inadequately done
 5. Option TT score 1 = Failed
- C. Calculation of all respondents' scores for each of question from the respondent
- D. Calculation of percentage of scores in formulas:

$$\text{Score Percentage (\%)} = \frac{n}{N} \times 100\%$$

Legends:

n = The total of score of respondent's answer

N = The total score of ideal answer

- E. The collection of calculation results.

The following is the classification of reliability for the study of the application of the eco office concept to office building employees. Here is the percentage interval classification

Table 1. Percentage interval classification

Percentage Interval	Criteria	Code
81% <Score ≤ 100%	Well done	SST
61% <Score ≤ 80%	Done	ST
41% <Score ≤ 60%	Sufficiently done	CT
21% <Score ≤ 40%	Inadequately done	KT
0% <Score ≤ 20%	Failed	TT

Table 2. Interpretation of correlation coefficients

	Score	Criteria
	0,800 – 1,000	Well done
r_{11}	0,600 – 0,799	Done
	0,400 – 0,599	Sufficiently done
	0,200 – 0,399	Inadequately done
	0,000 – 0,199	Failed

Sources :Riduwan, 2003[22]

III. Results and Discussions

The implementation of the concept of Eco-office based on user behavior in the office building environment was observed in 5 aspects, namely:

3.1 Electricity Saving Aspect

The observations on the aspects of electricity savings in office buildings are carried out on the usage of lights, in this case lighting in buildings, the usage of air conditioning, and the usage of computers and socialization of electricity savings based on employee behavior. In general, the usage of electrical equipment in buildings has a pattern of being turned on in the morning and turned off during the afternoon when office hours are finished. Based on the following research, the results of the behavior of implementing the Eco-office concept on aspects of electricity savings are listed in Table 3.

Table 3.The application to the aspect of electricity savings

No.	Efforts to Implement the Eco Office Concept	Score (%)	Criteria of Implementation
a.	The building has reduced the use of lights and utilizes sunlight through the window	43	Sufficiently done
b.	The building has reduced the use of air conditioning by simply placing the air conditioner in a certain room	57	Sufficiently done
c.	The building has increased ventilation in office space for air circulation and saves AC usage	42	Sufficiently done
d.	Already turn off the room lights at rest and lunch and go home from work	58	Sufficiently done
e.	Already turn off the computer during lunch break and go home from work	63	Done
f.	The building already uses energy-saving lamps	51	Sufficiently done
g.	The building has used sufficient lighting necessarily	67	Done
h.	In the building there are stickers / posters in strategic locations that encourage electricity savings	48	Sufficiently done
Average		53	Sufficiently done

Based on the calculation with the percentage score, on the aspect of electricity savings, an average score of 53% that shows the Criteria Sufficiently done is obtained. With regard to saving electricity, it is necessary to make several efforts such as setting the stand-by mode on each computer, turning off electricity in the room at rest, besides considering the room insulation system because of the inefficiency of AC usage caused by the room insulation system. In this office building in general, it has not utilized natural energy such as the sun or the wind and has not been equipped with windows to save on the use of lights and air conditioning. After knowing the level of employee awareness in terms of energy savings, program socialization and the importance of energy savings can be executed. This process is an important step to take considering that the energy saving action is not only the responsibility of the institution's leadership, but also the responsibility of all employees as building users. The communication and socialization of energy saving programs aims to change the behavior of employees from energy-efficient (wasteful) behavior to be more efficient in operating equipment that uses energy (electricity), such as lights, air conditioners, and other electrical equipment.

In ESDM Regulation Number 13 of 2012, supporting equipment means the inclusion of computers and printers [19]. There are several checklists that can be used as a reference in preparing energy saving programs and activities at the office for some of the supporting equipment. There are several ways to save energy for computers and monitors to ensure all computers and monitors use power saving mode, namely standby and sleep after 10 minutes and hibernate after 15 minutes, turn off the monitor when left for more than 15 minutes [13]. While to prevent energy consumption when turning on the printer can be done by printing several documents at once, by printing 2-3 documents every time you turn on the printer, it can prevent the energy being wasted. Subsequently, using a timer when the printer is used together, to prevent the machine from being turned on after working hours. Using an inkjet printer that is more energy efficient than a laser printer.

3.2 Water Saving and Conservation Aspects

Observations of water conservation and conservation efforts are the efforts made to save water usage, the usage of innovative wastewater management technologies such as rainwater utilization [9]. The rapid growth in the number of industries and offices now results in the need and continued use of water every year. The government also issued Presidential Instruction No. 13 of 2011 in an effort to reduce water consumption in government buildings and offices. The presidential instruction was issued to provide role models from the government apparatus to the community and efforts to change wasteful behavior and away from the principle of efficiency in the use of energy and water. Based on the following research, the results of the behavior of the implementation of the Eco-office concept on the aspects of saving and water conservation are listed in Table 4. The average score was 56% which showed the Sufficiently Criteria

Table 4.The Implementation on the Aspects of Water Saving and Conservation

No.	Efforts to Implement the Eco Office Concept	Score (%)	Criteria of Implementation
a.	Inside this building there is a recommendation to use water as needed.	51	Sufficiently done
b.	This building has used a water-saving sink in every bathroom	57	Sufficiently done
c.	Do not use automatic automatic rinsing closet	58	Sufficiently done
d.	In this building there are stickers/posters in strategic locations that encourage water saving activities	56	Sufficiently done
e.	Do not let the faucet open when washing your hands (when not in use)	70	Done
f.	Already use laundry water and abluion for watering plants	46	Sufficiently done
Average		56	Sufficiently done

The observation of the source of clean water in the buildings is that the building is using PAM (Water Supply Company), while for additional sources of clean water such as processing of recycling units, as well as utilization of rainwater does not yet exist. The usage of water-saving faucets is also not yet available, most of the taps in the toilet and the sink still use a manual faucet so that the use of water cannot be controlled properly. Most building toilets use toilets with dual flush systems. Generally this flush system uses a ratio of 3: 6 liters, which uses a small button 3 liters of water and a large button releases 6 liters of water. The implementation of recommendations from observations of savings and conservation in buildings needs to be made efforts to save water, including: The use of water-saving taps needs to be done to provide high performance while reducing the amount of water needed. The use of sensor faucets is reviewed most effectively to save water which is more than 70% compared to the use of manual taps. Need to also develop waste water recycling technology. Water savings can be done by recycle. Applicable uses include abluion water for washing cars, watering the garden using filter technology, replacing toilets and plumbing systems [9].

3.3 Aspects of Office Waste Management

The observation on aspects of office waste management is the implementation of the presence of trash cans both inside and outside the building, the availability of sorted trash cans is for the purpose of the waste may be recycled according to the criteria, and the cleanliness of the building environment. Based on the results of the study listed in Table 5, it is obtained that an average score of 65% based on interval score shows the criteria of done. The following is the behavior of implementing the eco office concept based on the results of research that has been carried out:

Table 5.The Application of Aspects of Office Waste Management

No.	Efforts to Implement the Eco Office Concept	Score (%)	Criteria of Implementation
a.	The building has prepared a trash bin	83	Well Done
b.	Trash bin inside the building	83	Well Done
c.	There is a prohibition not to bring food or drinks in an office building room	37	Inadequately done
d.	Already separate dry waste and wet waste	43	Sufficiently done
e.	Disposing of garbage in the provided trash can	77	Done
f.	The building is clean and there is no garbage scattered	73	Done
g.	Manage office waste to be sent to a waste bank or social institution that manages waste	60	Done
Average		65	Done

The observations on the aspects of office waste management in buildings includes not having disaggregated waste bins between organic waste and inorganic waste and wet and dry waste. All garbage is still put together in one disposal container. Overall behavioral analysis of employees shows the criteria that have been implemented, including the behavior of throwing garbage in the places that have been provided, but integrated waste management has not been implemented. So that the reuse or recycling of garbage has not been done in the building. It is noticeable that paper waste is the type of waste that is produced most of the remaining office building activities every day. The 3R concept (reduce, reuse, and recycle) can be used as a way of looking at waste or in this case office waste can be seen as a valuable resource so that the selection and use must be done

wisely. Activities to reduce paper use can be in the form of avoiding wasteful use of paper, using paper as needed [15].

3.4 Greening Aspects

The aspect of greening observed was the availability of parks for greening both inside and outside the building. Based on the results of the application of the greening aspects attached to Table 6, the average score was 66%. The implementation of the eco office concept on the building based on the score interval shows the criteria done.

Table 6. Application of Greening Aspects

No.	Efforts to Implement the Eco Office Concept	Score (%)	Criteria of Implementation
a.	This building has a garden	74	Done
b.	There are many parks around this building	71	Done
c.	This building has greened the room with the addition of ornamental plant pots	57	Sufficiently done
d.	This building has been preserving plants as a means of good air exchange	63	Done
Average		66	Done

The behavior of applying the eco office concept to the greening aspect may concludes that it is showing the Sufficiently done criteria. It can be seen from the greening that surrounds the building area, there are small parks around the parking lot, although a little but the availability of green open spaces in the building environment can overcome decrease in the impact of deteriorating environmental quality.



Picture 1. Greening on the side of the building

In the green area on the side of the building, a small garden has a different mound/level of land and has a vegetation structure in the form of grass with plants that function as shade, windbreak, and plants that function as aesthetics that can be enjoyed through the sidewalk. However, some plants are poorly maintained even though they function as aesthetics on the side of the building. If the park is better maintained and optimizes the arrangement of vegetation, this park can function to support ecological functions. In the area there is also a stand (tree) which serves as a producer of O₂ to suppress CO₂ levels in the air so as to create comfort for building employees and create healthy air and function as shade as seen in figure 1. The existence of reforestation can create an environmentally sound environment.

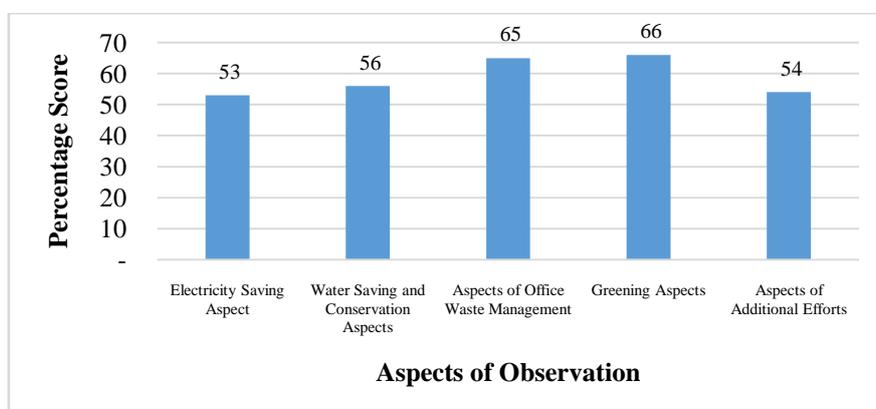
3.5 Aspects of Additional Efforts

Observations on the aspects of additional efforts were aimed at several other efforts undertaken to be able to support the study of the application of the eco office concept in addition to the 4 criteria mentioned earlier. Some of the efforts referred among others are socialization on the eco office principle, the paperless principle, several special appeals that support the concept of eco office (appealing to use enough water, appealing not to smoke, appealing to dispose of garbage in its place), as well as several behavioral efforts that can contribute to support emission reductions to CO₂ such as public vehicle use by employees. The following is the behavior of implementing the eco office concept on other aspects of effort based on the results of research that has carried out:

Table 7.Application of Aspects of Additional Efforts

No.	Efforts to Implement the Eco Office Concept	Score (%)	Criteria of Implementation
a.	In this building there is an appeal not to smoke in public spaces such as work space	51	Sufficiently done
b.	In this building there is a special room for smokers	50	Sufficiently done
c.	Use double side paper (used paper) to make report concepts	57	Sufficiently done
d.	Prioritizing the paperless principle, by utilizing e-mail facilities as data transmission media	70	Done
e.	This building has conducted eco office socialization for employees	57	Sufficiently done
f.	Prefer to use public transportation than private vehicles to go to the office building, in order to reduce CO2 emissions	39	Inadequately done
Average		54	Sufficiently done

Based on the analysis of the calculation of scores from the application to other aspects of effort listed in Table 7, an average score of 54% was obtained. The implementation of the eco office concept based on the score interval shows the Sufficiently done criteria. Overall the implementation of the Eco office principle based on building user behavior for each aspect observed is shown in the following graph.



Picture 2.Implementation of the Principle of Eco office in Every Aspect

Based on the graph above, it can be seen that the aspect of greening is the aspect that mostly contributes to the concept of Eco office in office buildings, which is 66%.

IV. Conclusions

The implementation of the concept of Eco office was tested in 5 aspects, namely the aspects of electricity saving, aspects of saving and water conservation, aspects of office waste management, greening aspects and other aspects of effort obtained by the distribution of levels as follows: electricity savings (53%), savings and water conservation (56%), office waste management (65%), reforestation (66%), and other efforts (54%). The results of the implementation of the concept of the Eco office converged at a score of 58.8% which showed that the application of the concept of the Eco office in the building was Sufficiently done..

The suggestions from the results of this study are:

- 1) With regard to electricity savings, it is necessary to make several efforts such as reducing the use of lights by utilizing energy from sunlight, setting the stand-by mode on each computer, using energy-saving lamps, and optimizing the use of windows both as lighting and as air circulation to reduce AC usage.
- 2) The use of water-saving taps and water-saving toilet and sink as well as the use of recycled waste water in order to clean the water use efficiency. Installation of a rainwater reservoir system is needed so that it can recycle water to water the plants or flush the toilet. Sanitation equipment that is used is the equipment that is able to save water, such as flush toilets use water sparingly. Water savings can be done by recycling. The applicable useage include ablution water for washing cars, watering the garden using filter technology, replacing toilets and plumbing systems.

- 3) Providing disaggregated bins between organic and inorganic waste and the use of recycled waste paper waste.
- 4) Add more of the greening in the building.
- 5) Conduct socialization of eco office application to the building employees and provide a number of posters or appeals attached to walls in certain corners that explain how to save electricity and water.

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