Exploratory Research on Green Information Technology Knowledge

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Abstract. In this study we focused on the extent of green IT knowledge and the effort to minimize energy use and electronic waste (e-waste). It was conducted by distributing questionnaires to students of the Faculty of Engineering and Informatics, Universitas PGRI Semarang. By using random sampling technique, we considered 91 students as the total sample size. It consists of 20 participants from informatics study program, 7 participants from architecture study program, 4 participants from electrical engineering study program, 20 participants from civil engineering study program and 33 participants from mechanical engineering study program. The results show that our participants are 16-25 years old. They have been using laptop/PC for about 5-10 years and 3-5 hours per day. In average, they owned only one laptop/PC. In a day, they print more than 50 sheets using one-sided mode. It implies that our students actually understand enough the essential of green IT. Nevertheless, efforts to minimize e-waste must be increased.

1. Introduction
Along with the development of technology, electronic waste (or the so called e-waste) rises worldwide problem. It is because the content of more than 1000 large categories of hazardous and hazardous substances (B3), such as heavy metals (mercury, lead, chromium, cadmium, arsenic, silver, cobalt, palladium, copper, etc.) [1]. Actually, there are many things that the government can do to create environmentally friendly environments, such as paperless policies, virtualization, changing conference calls, changing computers with laptops, blank screensaver options, hibernating and replacing lights if you don't need server space and so on. However, up to now the government does not provide clear regulations and socialization on how to safely use the electronic device or on how to wisely dispose the electronic waste. Green information technology or the so-called green IT is all about research and practice in the design, production, and use of computers, software, hardware, and computer systems. Effective communication without negative impacts on the environment. Green IT also participates in the use of IT in support, guidance and environmental awareness [2]. This method might be a solution of the above mentioned problem. Production and use of IT equipment consume a lot of energy, and this contributes about 2% of total carbon emissions in the world [3].

In this work, we investigate the awareness and green IT knowledge among our students in the Faculty of Engineering and Informatics, Universitas PGRI Semarang, Central Java, Indonesia. In this case, the term of Faculty of Engineering and Informatics, Universitas PGRI Semarang, Central Java, Indonesia will be abbreviated as FTI UPGRIS for simplicity. In the first step, Green IT behavior is being
investigated to minimize e-waste. The above problems are in line with the strategic issue of UPGRIS Research Master Plan. The research topics in the Information Technology and Communication Sector, especially the development of green technology. The purpose of this study was to find out the extent of green IT knowledge and the effort to reduce e-waste amongst our students in FTI, UPGRIS. The advantages of this study are to improve green IT knowledge and contribute in the implementation of policy making especially in the information technology infrastructure sector. In addition, it also can be used as reference in the formulation of green IT and science studies related to green IT.

Many studies in this field has been reported to our knowledge. Among them, a paper entitled Impact of Green Computing Behavior on Efforts to Minimize E-Waste was reported by S. J. Prasetiono et al. in 2016 describes the behavior of green computing for students [1]. T. B. Chiyangwa in 2014 published their paper entitled Belief and Actual Behavior in Green Information Technology within a South African Tertiary Institution. It evaluates the actual beliefs and behaviors of IT users regarding green IT in South Africa by conducting surveys. A hypothesis model based on the Theory of Planned Behavior (TPB) was used to evaluate the main factors that contribute to Green IT awareness in empirical studies [4]. Another paper on Green computing entitled "Future of Computers" has been reported by J. M. Prakas in 2014. It described how the concept of green computing is applied to computers in industry, the relationship between the application of green computing and the system used. Finally, he obtained a key which was used to identify the most relevant and influential factor on the application of green computing. He successfully used several approaches to support system performance [5]. Murugesan et al. through his research also explained that there are 4 approaches to carry out Green IT project, such as green use, green manufacturing, green design, and green disposal of IT system. This approach can be used to analyze the impact of IT usage.

2. Methods
The method employed in this work is a scientific method used to obtain data with specific purposes and uses [6]. Firstly, we define the number of samples require in this exploratory study. Table 1 shows the number of students and the number of samples used in this work. There are students from the year of 2015, 2016, and 2017 of each study program in FTI, UPGRIS such as Informatics, Architecture, Electrical Engineering, Civil Engineering, Mechanical Engineering, and Food Technology.

| Study program       | Year 2015 | Year 2016 | Year 2017 | Number of student | Number of sample |
|---------------------|-----------|-----------|-----------|-------------------|------------------|
| Informatics         | 56        | 86        | 71        | 213               | 20               |
| Architecture        | 29        | 25        | 20        | 74                | 7                |
| Electrical Engineering | 20        | 13        | 14        | 47                | 4                |
| Civil Engineering   | 69        | 77        | 68        | 214               | 20               |
| Mechanical Engineering | 123       | 115       | 126       | 364               | 33               |
| Food Technology     | 28        | 24        | 27        | 79                | 7                |
| **TOTAL**           | **325**   | **340**   | **326**   | **991**           | **91**           |

By using Slovin method [7], we obtained the number of samples as shown on the left column of Table 1. They were calculated by eq. (1).
where \( n \), \( N \), and \( e \) are the number of samples, the population size and the error limit, respectively. Then according to eq. (1), the total samples is

\[
n = \frac{N}{1 + N \cdot e^2}
\]

Secondly, we prepared the multiple choice questionnaire. In total, there are 36 questions which include participant’s age, the length of time to use a laptop in total and in a day, the number of laptops owned, the number of pages printed per day, the type of paper used for printing, and the opinion regarding to the green IT. There are 3 types of answers for each question which scored 1-3. Score 1 indicates the lack of green IT knowledge and e-waste effort. Higher score 2 or 3 indicates the better understanding.

Before distributing them to the students, we tested the validity and reliability of the questions. The validity test was carried out to find out whether the questions are logic and reasonable. The questions are valid if follows the following relations.

\[
\text{valid} \quad r_{\text{count}} > r_{\text{table}} = \text{valid} \quad (3)
\]

\[
\text{invalid} \quad r_{\text{count}} < r_{\text{table}} = \text{invalid} \quad (4)
\]

where \( r_{\text{table}} = N = \text{number of sampling} = 91 \), and \( r_{\text{table}} \) is the significance level at 5% = 0.204. We obtained \( r_{\text{count}} \) for those 36 questions are in the range of 0.232 – 0.624. Therefore, all questions are logic.

On the other hand, the reliable test was carried out to find out whether the questions are consistent. It was calculated using Cronbach's Alpha approach [7]. The questions are reliable if follows the following relations.

\[
\text{consistent} \quad \text{Alpha} > r_{\text{table}} = \text{consistent} \quad (5)
\]

\[
\text{not consistent} \quad \text{Alpha} < r_{\text{table}} = \text{not consistent} \quad (6)
\]

where \( r_{\text{table}} \) is at the significance level at 5% = 0.204. Since the Cronbach's Alpha was 0.937, the questions in our questionnaire are consistent.

3. Results and discussion
Based on the distributed questionnaires, we summarized the results as shown in Table 2. It shows that most of our participants are 16-25 years old. They have been using laptop/PC for about 5-10 years and 3-5 hours per day. In average, our students owned only one laptop/PC. They print more than 50 sheets per day using one-sided mode.
Table 2. The scores of each question in the questionnaire obtained from students in the Faculty of Engineering and Informatics, Universitas PGRI Semarang (FTI UPGRIS).

| No. | Variable                                                                 | Score 1 | Score 2 | Score 3 | Total score |
|-----|--------------------------------------------------------------------------|---------|---------|---------|-------------|
| 1   | Age                                                                      | 25.3    | 50.5    | 24.2    | 100         |
| 2   | The length of time to use a laptop (year)                               | 11      | 76.9    | 12.1    | 100         |
| 3   | The length of time to use a laptop in a day (hour)                       | 35.2    | 29.7    | 35.2    | 100         |
| 4   | The number of laptops / PCs owned                                        | 15.4    | 72.5    | 12.1    | 100         |
| 5   | The Number of pages printed per day                                     | 61.5    | 38.5    | 0       | 100         |
| 6   | The type of paper used for printing                                      | 0       | 16.5    | 83.5    | 100         |
| 7   | Switch the laptop / PC to low power consumption mode at any time         | 24.2    | 75.8    | 0       | 100         |
| 8   | Green IT to deals with how to use a laptop / PC and technology           | 86.8    | 13.2    | 0       | 100         |
| 9   | Be aware of the risks to the environment due to global warming, paper print | 76.9    | 23.1    | 0       | 100         |
| 10  | With the average usage, laptops use less energy than desktop pcs        | 26.4    | 9.9     | 63.7    | 100         |
| 11  | Using a screensaver to save energy when the computer is idle             | 16.5    | 75.8    | 7.7     | 100         |
| 12  | The use of a computer processor with high specifications will improve its performance and also increase the power demands required | 16.5    | 74.7    | 8.8     | 100         |
| 13  | Constantly shutting down and restarting your computer will consume more energy than allowing it to run | 22      | 57.1    | 20.9    | 100         |
| 14  | It is better to use the IT equipment (ex. Computer, cellphone, LCD, printer) as long as possible so as not to become electronic waste. | 83.5    | 16.5    | 0       | 100         |
| 15  | Refilling printer ink is more environmentally friendly than replacing the printer cartridge | 56      | 44      | 0       | 100         |
| 16  | The spread of learning services and online education is a way to reduce paper print | 94.5    | 5.5     | 0       | 100         |
| 17  | The screen saver makes your computer monitor last longer                 | 34.1    | 62.6    | 3.3     | 100         |
| 18  | Know that electronic waste contains toxic and dangerous substances       | 34.1    | 58.2    | 7.7     | 100         |
| 19  | Do not throw electronic waste into any place                             | 89      | 9.9     | 1.1     | 100         |
| 20  | Secure electronic waste from the reach of small children                 | 86.8    | 13.2    | 0       | 100         |
| 21  | Do not mix electronic waste with household waste                        | 34.1    | 58.2    | 7.7     | 100         |
| 22  | Do not keep electronic waste for too long, causing chemical processes with surrounding water or air | 29.7    | 62.6    | 7.7     | 100         |
| No. | Variable                                                                 | Score | Total score |
|-----|--------------------------------------------------------------------------|-------|-------------|
|     |                                                                          | 1     | 2           | 3           |              |
| 23  | Know that there are certain components that can be recycled to electronic waste | 78    | 16.5        | 5.5         | 100          |
| 24  | Prefer to sell damaged PC / laptop components rather than throw them away because knowing electronic waste is very difficult to decompose | 34.1  | 60.4        | 5.5         | 100          |
| 25  | Prefer to repair your PC / laptop components when you are in trouble compared to directly buying a new PC / laptop | 28.6  | 63.7        | 7.7         | 100          |
| 26  | Prefer to sell a damaged PC / laptop even though the price is very cheap rather than being electronic waste | 23.1  | 70.3        | 6.6         | 100          |
| 27  | Do not throw away the laptop power supply (adapter) carelessly           | 78    | 22          | 0           | 100          |
| 28  | Know that electronic waste can damage the environment                    | 95.6  | 4.4         | 0           | 100          |
| 29  | Know that electronic waste recycling will benefit the environment        | 97.8  | 2.2         | 0           | 100          |
| 30  | Do not throw away the laptop battery that has been worn carelessly       | 96.7  | 3.3         | 0           | 100          |
| 31  | Agree if the government provides a special place / section to accommodate electronic waste | 92.3  | 7.7         | 0           | 100          |
| 32  | Choose a laptop that has a long battery life                             | 90.1  | 9.9         | 0           | 100          |
| 33  | Know the latest laptop technology has energy efficiency that is more efficient than older laptops | 82.4  | 16.5        | 1.1         | 100          |
| 34  | The laptop you are using now is your first laptop                        | 63.7  | 33          | 3.3         | 100          |
| 35  | Only have one laptop                                                     | 72.5  | 24.2        | 3.3         | 100          |
| 36  | Remove the laptop power supply from the socket when it is full          | 62.6  | 37.4        | 0           | 100          |

**Figure 1.** The opinion regarding to Green IT knowledge and the effort to minimize e-waste amongst students in the Faculty of Engineering and Informatics, Universitas PGRI Semarang (FTI UPGRIS).
Figure 1 shows the opinion regarding to Green IT knowledge and the effort to minimize e-waste amongst students in FTI, UPGRIS. In the case of the participant’s opinion regarding to the green IT knowledge, they are 40% strongly agree, 44% agree and 16% disagree. On the other hand, the participant’s opinion regarding to the effort to minimize e-waste, they are 67% strongly agree, 30% agree and 3% disagree.

4. Conclusion
We have successfully performed an exploratory study on green IT knowledge and efforts to minimize e-waste of our students in the Faculty of Engineering and Informatics, Universitas PGRI Semarang, Central Java, Indonesia. The results show that our students understand enough about the importance of the green IT and minimize the e-waste. This research is a good start which implies that our students have high awareness to keep clean our environment. Nevertheless, efforts to minimize e-waste are still not optimal. Therefore, our plan to do the next research on how to categorize and how to re-use the electronic e-waste is clear.

5. References
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