The Effect of Sustainable Design Strategies on Resource Consumption – Home Laundry Activities in Indonesia

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Abstract

Resource consumption in household activities partially represents the consumption pattern in a society. It encompasses the usage of water, electric energy, oil, gas and others, where the amount of the consumed resource also shows the impact to the environment. Meanwhile, most of the household activities involves appliances such as washing machine, air conditioner, and cooking appliances, sustainable design is considered as one of the solutions to the mentioned environmental problems. The notion is supported by previous studies which show that applying modification strategies on the product design and its installment may reduce the consumption of the resource. However, the effect may differ depends on the local characteristics of a society. Based on this concept, this research investigates the effect of the implementation of certain design strategies on home laundry activities in Indonesia, by conducting an experiment with participants doing their laundry in a studio. The consumption of water and electric energy is measured while the behavior is observed through video recordings and interview session. By analyzing the results, several options for improving the level of sustainability through sustainable design will be discovered. The findings shall be beneficial for the industries to innovate future sustainable products to be marketed in Indonesia.

Keywords:

Sustainable design, resource consumption, household appliance

1 INTRODUCTION

Resource limitation has become a crucial topic, because of the rapid growth of the global population. The growth is followed by the increasing demands of resources, encompassing water, fossil fuel, natural gas, etc. These resources are used extensively in daily activities of the growing society, which further create wastes, emission, and scarcity. Moreover, poor management of the resources has led to more severe consequences in the present and future, where it frequently happens in developing countries including in Indonesia. For an example, in many big cities in Indonesia, clean water availability is a serious problem that has to be solved in order to maintain the quality of the societies' life [1]. Water in Indonesian households is used for drinking, laundry, bathing and other washing actvities, where the main source is from the ground water wells owned by the families. Household water waste is then streamed through the sewage system, which usually empty to the river. In most of the cities, these water waste is not treated properly so that rivers are polluted and the clean water stock is hardly replenished but relying on the rainfall. When the dry season comes, drought makes the condition even worst to some parts of Indonesian cities, and families have to suppress down their washing activities.

Besides the management and facilities lacking, the poor consumption pattern of resources also come from the society's behavior. Low awareness of environmental issues and cultural habits may form unnecessary activities which leads to more wastes [2]. And since most of these activities are using household appliances, this is where the design engineering field can take its part to improve the sustainability, in this case, to reduce the resources consumption in household activities. Prior researches show that even simple design interventions can decrease the environmental impact and improve the sustainability level [3], [4]. For a developing country like Indonesia, a simple and effective design strategy is needed to be accepted among the consumers.

Based on the above exposure, this research, presents several design intervention strategies and apply them in a workshop, involving twelve participants. The laundry activities are performed by the participants and observed using devices and interview. Further, the strategy with the best saving result shall be taken as a priority in developing the next scenario in addressing a more responsible consumption pattern in Indonesia. In summary, the purpose of this study is to investigate the effect of applying design strategies to the resources consumption level in laundry activities.

2 RELATED WORKS

2.1 Sustainable Design in Indonesia

Resource consumption control through product design is a part of sustainable design concept, which has been formulated by numerous researches [5], [6]. However, the

effect of the concept implementation in different places may vary. Thus studies should be conducted based on local values and condition [7], [8].

In Indonesia, the concept development is still in an early stage. There are challenges to overcome related to technical and non-technical issues, including response from the consumers [9]. In this case, dealing with human behavior is a complicated topic, where design strategies have to be applied in various circumstances to obtain the best responses.

2.2 Design Intervention Strategies

Sustainable design on a household activity encompasses the design of the appliances, the environment and the response of the consumer. To reduce the resource consumption, one may apply several strategies involving technology and stimulating the consumer's awareness to the resources consumption. A prior study [3] has proposed strategies related to this, and mentioned that arising the consumer's awareness might be increased by displaying the amount of resources consumed directly to the consumers while using the product. Once the consumer spent a large volume of resources while he or she could see that on the display, the concept aims for the consumer's guilty feeling. This condition hopefully leads to a more frugal action in the next occasion using the same product, thus it addresses to sustainable behavior [10]. This strategy is called as 'the awareness' strategy.

Meanwhile, household utilities manufacturers have come recently with resources less-consuming products. The technology used inherently inside the products cover sensors usage, inverter system and alarms to warn excessive exploitation of resources. These products target middle to high income class market in developing countries, due to their relatively expensive prices. In the case of laundry, front-loading washing machine represents this type of product. The machine secures the water utilization in low level based on the manufacturers' claim, but its users are limited in a narrow number in Indonesia, around 3% from all washing machine used in this country [11]. However, the existence of these products is obviously a step forward in achieving higher sustainability in laundry activities. Further it is called as 'the technology strategy'.

This study employs both of above strategies and compares their effectiveness in decreasing the amount of water and electricity used during the laundry activities. Findings shall be analyzed and further utilized for developing better strategies based on local condition.

3 METHOD

The usage of water and electricity during the laundry activity also heavily depends on the users' behavior. Thus in this study we use experimental research at studio which is designed like a laundry spot in Indonesian households, involving respondents from different backgrounds. Laundry spots in Indonesian houses may located in the kitchen, near the traditional water well or in the bathroom. Although in rural areas, we may find many people still doing laundry right on the river. Furthermore, most of people from middle and low income society use hands or twin-tube washing machine, or mix of both (Figure 1).

Figure 1. Washing by hands and a twin tube washing machine

Replicating to these condition, all washing facilities are provided in the studio to accommodate the respondents' usual behavior, to be compared with the process using strategies as mentioned in prior section. Subsequently, 12 respondents were recruited to perform the laundry activities. The profile is presented in Table 1.

Table 1: Respondents' Profile

Respondents' Profile		Freq
Gender	Male	4
	Female	8
Education level	Elementary School	0
	Junior High School	3
	Senior High School	4
	College	5
Age	18 – 25	2
	26 – 40	4
	Above 40	6

Each respondent shall perform 3 times laundry activities, which comprise type 1, type 2, and type 3 activity. Each type is described in Table 2. The weight of clothes to be washed is set to be equal in all activities, that is 3,5 kg. This weight is equivalent to the estimated amount of clothes used by a family consisting three members (2 adults and 1 child) in one full day or 24 hours. The activities consume water and electricity that is measured by devices and recorded to a data log system. Activity type 1 represents the participant's habit in daily life, while type 2 and 3 simulate the implementation of the mentioned design strategies.

These activities are managed to be accomplished in less than 6 hours by each participant. Activity type 1 is set as the first activity, while laundry activities type 2 and 3 are enrolled alternately for every participant to avoid sequential bias of the process (Figure 2). All activities are done in a

studio, which is a room that has been designed like a real laundry spot in a house.

Table 2: The Experiment Activities

Laundry Activity	Description
Type 1 (A1)	BAU (business as usual). Participant washes the clothes using the method as he / she uses to perform in daily life
Type 2 (A2)	The awareness strategy. Participant washes the clothes using the method as he / she uses to perform in daily life, while seeing the resource consumption through monitor
Type 3 (A3)	The technology strategy. Participant washes the clothes using low-watt front loading washing machine as the representation of high-tech utility in reducing resources consumption

Participants enter the studio one by one and perform the activities alone, without being accompanied by the researchers. The condition is favorable to give more privacy to the participants, and to let them do the laundry as usual.

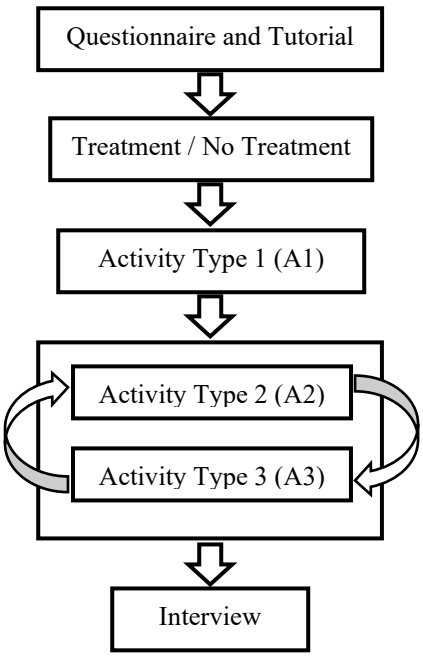

Figure 2. The Experiment Flow

Experiment for each participant is begun with a tutorial session, followed by the participant filling a questionnaire to reveal the participant's backgrounds and understanding on the process and environmental issues. In the next step, the participants are divided into two groups, those who receive 'treatment' and the others do not. The terminology 'treatment' here refers to brief lecture and discussion between the researcher team and the participant about environmental problems, especially in the case of laundry at home.

We want to observe how this initial talk may evoke the awareness of the participants. Prior studies showed how consumers in Indonesia frequently need reminders to initiate their concern about environmental issues [2], [12]. Subsequently the three process are enrolled, and the experiment is ended with interview to obtain the participant's perception during the activities (Figure 2).

While participants do the laundry activity, the water and electricity consumption rate is measured and recorded using a data log system. CCTV is placed to validate whether the participants do not perform unnecessary actions related to the resources exploitation. The layout of the studio to support the experiment is depicted in Figure 3.

Activity type 1 and 2 can be done in facility 1 (F1) and facility 2 (F2), while activity type 3 should be done in facility 3 (F3). Small LCD monitor is placed near F1 and F2 to display the amount of resource used in activity type 2, while it is turned off when a participant doing activity type 1.

The recorded data is subsequently analyzed to understand the effect of the design strategies to the resource consumption. Moreover, results from interview session are even more important to reveal reasons and perception from each participant related to their behavior.

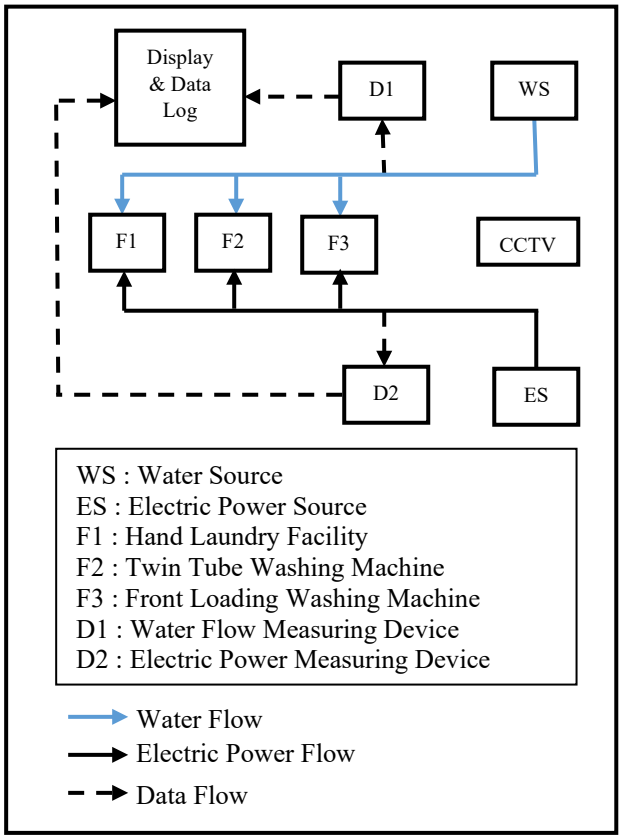

Figure 3. The Experiment Layout

4 RESULTS AND DISCUSSIONS

4.1 Overview

The experiment has been conducted at August 2021 in Bandar Lampung city, Indonesia. Twelve participants were involved with profile as described in the previous section and the resource usage data is presented in the following Table 3. Participants who use to wash with hands are marked with 'h', while those who do their laundry by twin tube machine or mix between hands and machine are marked with 't' and 'm' respectively.

Table 3: The Results

Participants	Treatment	Mode in A1	Water Usage (liter)			Electricity Usage (kWh)		
			A1	A2	A3	A1	A2	A3
1	none	t	142	153	40	0,17	0,17	0,07
2	none	t	68	68	19	0,12	0,12	0,03
3	none	h	94	100	34	0	0	0,07
4	none	t	40	20	35	0,04	0,03	0,05
5	none	m	113	100	35	0,05	0,05	0,06
6	none	h	41	40	19	0	0	0,03
7	yes	m	169	119	40	0.06	0,05	0,07
8	yes	h	100	37	38	0	0	0,06
9	yes	h	49	21	20	0	0	0,03
10	yes	t	168	156	40	0,19	0,18	0,07
11	yes	h	351	132	40	0	0	0,08
12	yes	t	102	76	39	0,16	0,15	0,07

h = participant has BAU using hands only
t = participant has BAU using twin tube washing machine
m = participant has BAU using mix of hands and twin tube washing machine

4.2 Water Consumption

It is found that the participants have responded in a wide range of result variation to the experiment. Three respondents seemed to have habit using less than 50 liters in doing laundry, while three others oppositely used more than 150 liters in their first activity (BAU). One of them extremely used 351 liters during the process. The rest just spent between the numbers. One term related to this has appeared from the interview session, that is 'cleanliness perception'. Participant's perception about clean clothes has determined the behavior in doing laundry. Our data shows that participants with higher education background seem to have higher standard of hygiene than those with lower education. However, the data is considered as not sufficient to jump into a conclusion, thus the discussion about this is saved for the next research.

After revealing the spending habit, we find that 9 from 12 respondents willingly reduced their water consumption while interacting with activity type 2, while other 3 did not. Notably, the last 3 respondents were not given 'treatment' before the activities, therefore there is no regret for the large consumption. Even they stated their surprise about the volume of water, the interview result indicates ignorance to the environmental issues. On the other hand, all participants with 'treatment' have reduced the water usage at the activity type 2, and intensely discussed about how to maintain the pattern to less water consumption in their next daily activities. Some of them have succeeded in saving a large volume of water in activity type 2 in comparison to type 1, including the participant who has spent 351 liters water previously. Moreover, these 9 participants also expressed their interest to have a measuring device at their home, so they can control the water consumption by their own in the future. In this point, the awareness strategy has its opportunity to be developed further in aiming better sustainability level in household activities.

Distinctively, activity type 3 shows more constant water usage due to the control system of the machine. Slightly different amount of water in each participant result is determined by the working mode chosen by the participants in every activity. Overall, this technology strategy has worked impressively in reducing the usage of water. Moreover, the performance of the machine does not depend on the users' perception. Unfortunately, the machine's water saving ability is not recognized widely in Indonesia, while the machine's price is assumed as expensive among the citizen. Meanwhile economical consideration is important in Indonesian market, subsidizing policy from the authorities is assumed as a solution to implement this strategy widely, despite the manufacturers should socialize the benefit to consumers more aggressively. Regardless the price aspect, we argue that an extensive usage of this machine would significantly decline the clean water provision problem in high-density cities in Indonesia.

4.3 Electric Energy Consumption

The amount of electric energy used is defined by the machine's motor specification, the work load and its usage duration. Moreover, the work load and duration depend on the users' behavior, so the energy consumption will also be determined by habit and perception of the consumers.

Based on the interview, we find that energy consumption is a crucial consideration for the participants in deciding the washing method. Even though the electricity price in Indonesia is categorized as low in comparison to other countries in South East Asia, most of participants assume the electricity cost is a heavy burden to the family. As the result, some of them still prefer to wash by hands, or mix between hands and a machine to save electricity. While washing by hands does not require the electricity, according to the measurement activity type 3 signifies the fairest result

compared to the twin tube machine performance. The data is surprising for the participants, because they thought a machine with more complexity should require bigger energy. Subsequently, after knowing the data and multiplying it with the electricity price, most of participants agree that using washing machine does not cost them much. Nevertheless, all of them stated that currently they cannot afford the front-loading washing machine, due to the price.

4.4 Consumers' Awareness Movement

Based on the findings above, participants can be classified into four groups of awareness, as seen in Figure 4, divided by 2 axes : not knowing – knowing, and ignorance – concern. The A group is those who do not know or know only a little about environmental issues, thus they do not concern about the issues. In this study, most of our participants are here at the beginning of the experiment. Moreover, all the participants expressed their surprise realizing the amount of water they have used.at the first process. Next, the B group is those who are actually concern about the environment, however, they do not realize that they have contributed to its damage. They have the biggest potential to be converted as eco-consumers, as long as they obtain the right information and education. On the opposite quadrant, the C group represents the people who already have the knowledge, but still do not show any concern in their activities. This group is hardly persuade to shift their consumption pattern, thus the technology strategy suit to this group. Meanwhile, as the ideal group of consumer is D, where the people here have sufficient information in what they do related to the environment, and they take actions to address better sustainability in their daily life. They choose the best process to less the impact to the environment, based on their financial ability and to use the resource wisely.

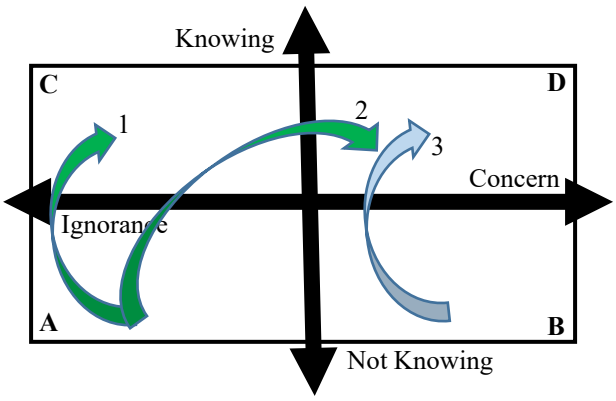

Figure 4. Map of Consumers' Awareness Movement

The awareness strategy has an opportunity to promote consumers from A and B groups to the D group, symbolized with 2 and 3 arrow movement (Figure 4). And it surely is able to promote the A people to become C, but it will require other methods to convert C into D. The conversion efforts should be achieved through education and substantiation programs, which are beyond our discussion in this paper. And as a limitation to this analysis, the map in Figure 4 has not been able to measure the promotion of awareness quantitatively, but it will be an interesting topic to discuss in next studies.

5 CONCLUSION

Design intervention strategies have been implemented in laundry processes in order to reduce the water and electric consumption, in a studio scale. We identify two strategies which are 'the awareness strategy' and 'the technology strategy', which are further compared to the usual habit of the participants in washing clothes.

The experiment shows that design strategies has strong relation to the amount of resource exploited in a household laundry process. Furthermore, design strategies can lead users to a higher level of awareness, or even can impose a more sustainable consumption pattern without the users' notice. In the end, the participants obtain new and surprising facts related to the washing process and environmental issues, such as the volume of water they have exploited daily and missed perception about energy consumed by each washing machine.

In this paper, we recommend further research to increase the users' awareness through more advanced design, and future studies in economic field to support the technology strategy implementation in high-density cities in Indonesia.

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