Identifying Constraints Of Sustainable Product Development In Indonesia

Achmad Yahya Teguh Panuju, Ahmad Suudi, Gusri Akhyar Ibrahim

Abstract: The production and consumption of sustainable products is assumed as one of the solutions to achieve higher sustainability level in a society. Not only rises the human's quality of life by fulfilling needs, but it also preserves the environment to ensure the availability of resources for the next generations. However, due to some constraints, the level of sustainability in nowadays products is still in an early stage, mainly in many developing countries. On the other side, identifying the local constraints is considered to be essential for aiming sustainability level improvements in certain countries. This paper reveals the constraints of sustainable product development in Indonesia, as a preliminary study to build strategic plans in addressing better sustainability in Indonesian competitive manufacturing business environment. The research is conducted using literature review, a group discussion and interview sessions with experienced industrial design practitioners in Indonesia, and subsequently the data is analyzed qualitatively. As the result, four themes of constraints are identified encompassing consumer issues, human labor issues, policy issues and supporting factors issues. The results are further discussed in their relation to the sustainability aspects, and how the condition can be addressed to make improvements in the future. However, the implementation of these results to the product design process is out of the scope of this paper. The discussion is acclaimed to be beneficial for the product manufacturers, researchers and the government, where the improvement would only be effective with total commitment from these stakeholders.

Index Terms: design constraints, green product, local oriented design, sustainable product development.

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1 INTRODUCTION

IN achieving the goal of global sustainability, countries around the world face different challenges and conditions. Overall, there are obvious disparities between developed and developing countries in the level of sustainability achievement, mostly in dealing with the environmental and prosperity problems [1]. In contrast to progresses in developed countries, developing countries have significant gap to chase in attaining the United Nation's Sustainable Development Goals (SDGs). Therefore, well organized actions should be developed seriously based on proper recognition of local characteristics in these countries [2]. As one of strategies to do so, the production and consumption of sustainable products concept is proposed around the last two decades [3] [4]. Briefly, the main concept is about considering environment, social, and economic dimension in designing, producing and using the product. Meanwhile, experts are finding risks in the production and consumption of many existing products, dominantly in environmental aspect [5][6][7]. So that the formulation of further sustainable product concept is considered to become more crucial at the present. There should be a change toward using new products with higher sustainability level than prior ones. In the perspective of design engineering, it should be begun in designing phase, where the designers should plan the products to comply the sustainability requirements in all product's phases: material extraction, manufacturing, usage and end of life [8]. However, according to local condition as previously mentioned, there are only a few discussions about planning sustainable products based on local characteristics. In different countries, we may find various challenges and problems in persuading the society to get used to sustainable products in daily life. Therefore, to conduct a successful sustainable product development, designers should recognize constraints in each targeted country [9]. This research aims to identify constraints in designing sustainable products in Indonesia as a developing country, based on empirical

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experience from industrial design practitioners. Indeed, there must be distinctions whether the product is designed and manufactured in the targeted country or not. Nevertheless, we focus on the product development processes which are conducted by manufacturing companies Indonesia, for the Indonesian market as well.

2 RELATED WORKS

2.1 Sustainable Product Design Concept

The sustainability concept constitutes three dimensions which are environment, social and economic [10]. Therefore, the aim of sustainable product development should encompass the whole dimensions. Furthermore, these dimensions should be considered in the frame of life cycle perspective which consists material extraction, manufacturing, usage and end of life phase. According to this framework, experts have formulated goals in product design process, as references for the designers to achieve higher product sustainability level.

While social and economic aspects have been widely used in designing products for decades, environmental aspects are relatively new to the process. Challenges are found in how to integrate the environmental considerations to the existing design methods. In order to overcome the challenges, discussions related to this topic have been conducted from various perspectives. However, a comprehensive implementation of these methods in industries is still hardly met [11]. Therefore, an ideal role model for a sustainable product development cannot be recognized yet. There are problems and challenges on the way, which further are described as constraints in this discussion. Constraints are described as the limiting factors to the achievement of product sustainability aspects. They cannot be solved at the present due to reasons, but they become projects for next improvements. By using this definition, it can be concluded that sustainable products can be designed only inside these constraints (Fig. 1). It can be easily understood that constraints in different countries may differ due to the disparities in many aspects including geographical, financial, political and cultural condition [12]. However, there are several constraints faced globally in all countries such as the newest

technology innovation, the amount of resources around the world, and so on. Thus we divide constraints in this discussion into local and global constraints.
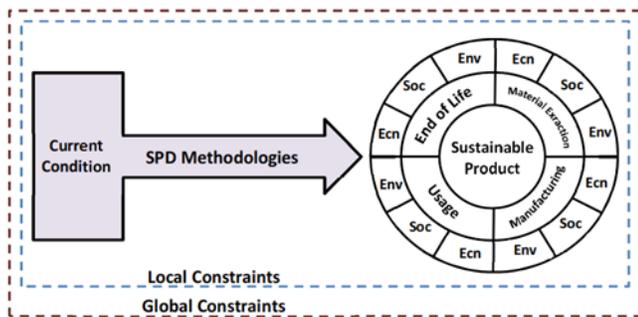

Fig. 1 *SPD Methodologies in Achieving Product Sustainability*

TABLE 1
PRODUCT'S SUSTAINABILITY / DESIGN CONCEPTS IN PRODUCT'S LIFE CYCLE PHASES

Phases	Environment	Social	Economic
Material Extraction	Eco-extraction process; waste treatment	Ethical responsibility; societal impact; comply to policies	Low Cost of Extraction Process
Manufactu-ring	Eco-manufactu-ring process; waste treatment; eco-packaging	Ethical responsibility; societal impact; comply to policies	Low Cost of Manufactu-ring; low cost of distribution
Usage	Energy and natural sources saving; using renewable energy; Low level of emission	Safety; comfort; low noise level; high reliability; ethical responsibility; societal impact	Reasonable sales price; low cost of operational; low cost of maintenance;
End of Life	High reusability; non-toxic waste; high recyclability	Ethical responsibility; societal impact	High after-use economical value; low cost of recycling; low cost of remanufactu-ring

By looking at Fig. 1, one may understand that the criteria of sustainable product consist many aspects which must be implemented in the product's design concepts. A constraint may exist for a specific design concept or more. It means that to identify the constraints, firstly it should be defined which design concepts are significant to the discussion. While the sustainability design concepts for different products may have discrepancies, several similar concepts from several previous researches are presented here for an illustration (Table 1). These concepts are withdrawn and modified from previous researches with various products as the objects [13][14][15][16].

2.2 Sustainable Product Constraints in Indonesia
Indonesia as a developing country has a big population which makes it a great market for various products, from inside and outside of the country. Domestic manufacturing is done by the SME (small and medium enterprises) and big manufacturing companies. Among these companies, many of them carry local brands, while the others bring international brands to be manufactured locally. This condition makes Indonesia's

production and consumption pattern has a big potential in affecting global sustainability, which consequently bring the sustainable product design concept is crucial to be implemented in this country. Nevertheless, the concept has not been widely accepted due to the discussed constraints, mainly related to the environmental aspects. The growth of products with 'green label' is slow, even though the consumers' green awareness is increasing gradually [17]. Constraints in one country are classified as global and local, as described previously. This research focus on local constraints, so that the result can be applied for specific design concept of a product. We classify sustainable product manufacturers into two, which are big manufacturing companies and SME. In this section, constraints encountered by these companies are studied through literature review. While literatures about Indonesian big manufacturing companies are hardly found in trusted scientific articles, information related to Indonesian SME are more sufficiently provided. Generally, most SME are limited to financial barriers, low human resources skill and lack of technology innovation to implement sustainable design and manufacturing concept into their businesses [18][19]. The focus of the SME is how to upscale their businesses, while additional environmental issues are still considered as burdens. The condition is happening on millions of SME in all Indonesian regions. Therefore, although the government has arranged supporting programs for the SME by giving incentives, events and trainings, they are assumed not enough due to the huge number of SME in Indonesia [20]. To develop sustainable products, manufacturers have options whether by inventing new product or by adding modifications to the existing products. Responding to this, SME start trying to improve toward sustainability with innovations in new products and processes. However, not all innovation initiatives affect positively to the sustainability due to internal reluctance to change, and weak relationship between SME and scholars [21]. Local innovations with patents are expensive to buy, while SME only have small access to consult the scholars. Furthermore, weakness in innovation process makes SME's product competitiveness low [22]. Whereas the competitiveness is needed for further improvement, SME face a circular problem which lead these companies hardly grow among stiff rivalry, especially in achieving product sustainability. With these limitations, SME hardly enter the competition in manufacturing products with high-end technology such as vehicles and electronic appliances [20]. On the other hand, most of SME in Indonesia are growing in agricultural, fashion (fabric-based) and furniture products (mostly using woods as the materials). Based on the characteristics, these products are classified as having relatively low impact to the environment, although several impacts are crucial to notice in the material extraction and manufacturing phase. As examples, some of the characteristics are not using internal energy in-use, not being chemically transformed in-use, high reusability and high recyclability [23]. However, some of these constraints are not only encountered by SME. Big manufacturing companies also seem to have difficulties to introduce new sustainable products to the market. Numerous scientific articles have been presented by Indonesian scholars in the related topic, nevertheless most of the papers discuss only the marketing aspect of the problem [24][25]. We assume that these discussions are not properly sufficient to achieve the sustainable production and consumption pattern in Indonesia,

unless the product design area is also discussed to contribute to the topic.

3 METHODS

As discussed before, the condition in SME is very limited to describe sustainable product development process in Indonesia. For instance, from the perspective of environment dimension, most of high-emission and energy demanding products such as vehicles and electronic appliances are manufactured by big companies, not by SME. Therefore, this research focuses on recognizing constraints in sustainable product development in big companies. And since literatures from the trusted publishers in this area are very difficult to find, thus we explore primary data from the industrial design practitioners, who have sufficient experience and expertise in developing sustainable products in Indonesia. Further, these practitioners are mentioned as the respondents. As a minimum requirement, we assume that having 10 year experiences in product development or product engineering division is a mandatory. Moreover, the respondents are chosen from industries with high environmentally impact products, such as vehicles and electronic appliances industries. Revealing constraints from a complicated process like product development requires a perceptual equalization and a wide opportunity to share notions between the respondents and the researchers. Thus we divide the interactions with the respondents into several stages which include an introduction, a perceptual equalization and an interview session for each respondent (Fig. 2).
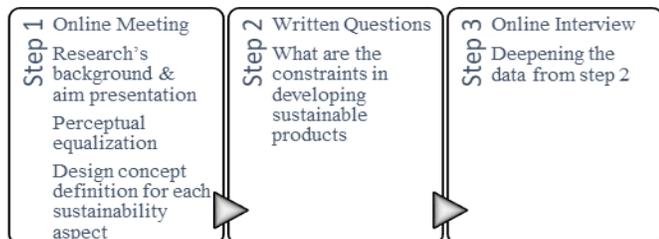

Fig. 2 Methodology Steps

Introduction is required in recognizing the expertise of the respondents by investigating their project experiences and understanding about sustainability. This stage was conducted through online messaging applications. Moreover, all respondents should confirm that their companies have set the goal of sustainability in a certain level for each company. All of the companies should have obtained at least the ISO 14001 certification, while social and economic aspects are common target in reaching the market in Indonesia. Thus the respondents can confirm their experience in achieving the sustainability goals on products. Subsequently, researchers presented the aim of the research and preliminary studies related to the research using an online perceptual equalization session meeting. In this session, an evaluation is made by a short oral question and answer session in the end of the presentation, so that we assume that we have obtain similar perception about the definition of sustainable product development and its goals. Included in this session, several design concepts for each sustainability aspect are defined based on product sustainability criteria in Table 1, where further discussion is limited to the defined concepts. This is to ensure the focus of the discussion and to choose which

concepts are significant to the product development. Following this stage, several questions were sent to the respondent in advance to shape early understanding about the interview. And finally, an interview session was scheduled for each respondent using phone call. Interviewing is assumed as the best method to obtain clear responses by exploring respondents' opinion based on their empirical experience. To synthesize the data, the thematic analysis method is used. As the result, a table of themes is extracted and further analyzed qualitatively. The method to analyze the data is thematic analysis method [26]. This method is considered as simple and effective in finding important themes in a raw data from discussion, essay or interview [27]. These themes are extracted through a long reviewing process of the data. Subsequently the themes are furthered discussed by the researcher team and compared to other findings from previous studies.

4 RESULTS AND DISCUSSIONS

4.1 Data Extraction Results

In order to reveal the constraints in developing sustainable products in Indonesia, the best sources to obtain the data are the industrial design practitioners, who have sufficient experience and expertise during a certain time developing products for Indonesian market. In this research, four design engineers with high expertise are recruited as the main sources of the data. The respondents' profile is described in Table 2, while detail identities are confidential based on the agreement with the respondents.

TABLE 2
RESPONDENTS' PROFILE

No	Experience	Current Position	Products	Education Background
1	17 years	Product Engineering Manager	Automotive	Bachelor in Mechanical Engineering
2	15 years	Mechanical Design Manager	Electronic Appliances	Bachelor and Master in Mechanical Engineering
3	10 years	R&D Senior Engineer	Electronic Appliances	Bachelor in Mechanical Engineering
4	15 years	Plant Manager	Automotive	Bachelor in Mechanical Engineering

Two respondents are senior engineers in automotive manufacturing companies, while others are senior engineers in electronic appliances (washing machine, TV, kitchen appliances and other utilities) manufacturing companies. All of these companies have big market share and are among top performers for manufacturing companies in Indonesia. Based on the investigation, the respondents have fulfilled the requirements as experts in product development field, with fair knowledge about sustainable product concept and implementations. Further, a discussion session using online meeting application was conducted in July 2020. As a consideration, offline meeting was highly avoided due to corona virus pandemic during this period. This meeting is required to obtain similar perception between the respondents

and the researchers, so that bias can be reduced in subsequent discussion. The three dimensions of product sustainability were presented with examples from previous researches to the respondents, while they confirmed the implementation projects of the aspects in the companies. After that, the meeting formulated design concepts that are considered as significant concepts in developing sustainability in products, as can be seen in Table 4. According to these design concepts, researchers defined questions to be discussed in the interview session. The questions were sent to the respondents before the real interview, as a guidance to shape an early understanding about the upcoming interview. Based on the agreement with the respondent, a schedule was set and the interview session was conducted using phone call for each respondent. Each respondent's session took time for about 30-60 minutes, depended on the discussion. Subsequently, the interviewer asked the questions as sent before, and the discussion could grow based on the respondent's explanation. Main data were about the constraints and examples of each constraint that the respondent had experienced in his professional career as an industrial designer. The interviews are noted and analyzed using thematic analysis method. Constraints are recognized by synthesizing all of the data, while similar constraints are signed with the same codes. By the end of synthesizing process, codes are withdrawn and presented in Table 3.

TABLE 3
DATA EXTRACTION FROM THE INTERVIEW

Codes	Themes	Themes Number
Consumers have less preference on the concept	Consumer Issues	1
Consumers have certain behavior that is contra-productive to the concept		
Incapability of the human labor	Human Labor Issues	2
Lack of supporting policies	Policy Issues	3
Inconsistency in running the policies		
Lack of End of Life Facilities	Supporting Factor Issues	4
Lack of Supporting Industries		

The respondents have explained their experiences in dealing with constraints while developing products for Indonesian market, and its relation to sustainability aspects. There are 9 codes extracted from the interview, and further these codes are classified into 5 themes as illustrated in Table 3. The themes are consumer, technology provision, human labor, policy and supporting factor issues. Additionally, the respondents also have declared some global constraints which are beyond the discussion of this paper. Meanwhile, further description related to the constraint themes are discussed in the next sub section.

TABLE 4
RESPONDENTS' RESPONSES TO each THEMES

Sustainability Aspects	Design Concepts	Constraints for each Theme			
		1	2	3	4
Environmental Aspect	Using recyclable material			3	3
	Using non-toxic material			3	2
	Using energy saver technology	3	1	2	2
	Using renewable energy	3	1	2	3
Social Aspect	Safety	1			
	Low Noise Level	1			
Economic Aspect	Reasonable Sales Price				1
	Low operational cost				2
	Low maintenance cost	1			
	Low recycling/ remanufacturing cost	3			

The correlation between the described themes and each sustainability aspects can be explored in Table 4. Each product sustainability aspect is connected to each theme of constraints, where the numbers in the columns reflect how many respondents support the correlation. It should be noticed that the following table is not meant to conduct a quantitative analysis on the data, whereas it can be beneficial for mapping condition between the themes and the sustainability aspects.

4.2 Discussions
Overall, it can be seen from Table 4, each theme is connected with the design concepts. For instance, consumers' preferences and behavior influent the manufacturers on all aspects. Moreover, three of the respondents agree that this is the reason why they seldom or even do not use energy saver and renewable technology on their products. Inspite of this, policy and supporting factors issues are contributing to many constraints, as seen on Table 4.

4.2.1 Social Aspect with Less Constraints
Among the sustainability aspects, social aspects are considered to having less problems in the implementation. Only a few problems are declared by the respondents, which means they mostly assume that manufacturers have succeeded in fulfilling social aspects such as safety, social ethic and comforts in their products. One possible reason is because the aspects have been the designers' main considerations during periods. Product designers have got used to deal with these aspects for a long time. Since decades, safety, social ethic and comfort have been main factors to make the products chosen by Indonesian consumers. This complies to prior study which found that Indonesian consumers' main consideration in choosing vehicles is the social dimension aspects [24] However, there are still some constraints limiting the achievement of required sustainability. For instance, respondent 5 assume that some Indonesian consumers still see safety features as unneeded. This is a dangerous mind, where it leads to severity of accidents in Indonesia [28]. For this group of drivers, attaching more safety features into a product generally increases price, and this does not comply to the marketing requirement. In vehicles cases, the provision of newest technology and supporting facilities in Indonesia is also limited, so even if the manufacturers put the safety technology into the product, providing facilities for maintenance can be very costly [29]. Putting safety on the top of mind of the consumers requires serious education programs, while the vehicle safety features follow the consumers' preference. Consumer issues are the main discussions on social aspect improvement, while suggestions have been made by other researchers [30][31]. From the perspective of product development field, the technology to support social sustainability has been sufficiently provided. However, the implementation of the technology still waits for the consumers' readiness to willingly buy the technology.

4.2.2 Challenges for The Environmental Aspect

Overall, the environmental aspects have more constraints to discuss, since eco-product is a relatively new issue in Indonesia. Our respondents have confirmed that they face various problems in achieving environmentally friendly products. Sometimes, eco design concept conflicts to other requirements, such as to the functional and cost-efficiency requirements. Respondent 1 said: "Environment requirements sometimes do not match to functional requirements. For instance, there are components with toxic material that do not have any substituting material yet. So that we still have to use it after all." Nevertheless, this statement indicates a global constraint, because the unavailability of substituting material also happens in other countries [32]. From the perspective of the manufacturers, efforts to achieve environmental sustainability more means additional cost, so that sometimes they only work according to minimum requirements. In comparison to the condition in several developed countries, where product's eco characteristic can be exploited as a strength for winning in certain market segments [33][34], Indonesian consumers green purchase level is still in an early stage [24]. Respondent 2 said: "We try to create environmentally conscious features in our products based on the targeted country's compliances. To do more than that, we must have a clear business goal, whether the additional effort shall result in profit or not." Respondent 4 said: "We doubt Indonesian consumers shall welcome the use of renewable energy technology in our products, while the cost to implement the concept is obviously huge." Obviously, cost is a great consideration in implementing green decision in the product development. Therefore, the ability of a developing country like Indonesia to provide materials, human resources and technologies related to the product in a competitive price, has become a crucial constraint in this topic. The scope of one country's ability, as mentioned here, is including the formulation of policies, interesting tax incentives, building supporting facilities and so on [35]. So the manufacturers can reach out for the resources in relatively lower cost. Another role of the government is by providing policies which supports the concepts. As mentioned before, manufacturers comply to policies requirements, thus an environmentally supporting policy is a starting point for improvements in this topic [25]. Most of our respondents confirm this notion. Respondent 3 said: "We always design products based on policies in the targeted country." On the other hand, economic aspects still have several constraints presented by the respondents. Products' economic value is essential for Indonesian consumers [24], while new competitors with lower price products are sprung up every year. It has implied manufacturers to always find new ways to keep their position in the market. Our respondents have stated several constraints in creating products with better economic value for the consumers. Respondent 5 said: "Products' price and other economic benefits like lower operational cost, are always having great impact on Indonesian consumers' purchase decision. Lately, we found a lot cheaper product with lower quality than ours, and it has affected our market quite significant." Respondent 5 and 4 support the idea that the government also has roles to develop a healthy product price rivalry in Indonesia. For an example, minimum requirements for products' safety and environmental compliances should be clarified. So that products with worst quality cannot enter the market, while discipline executions of the policies also should

be noticed. Further, the respondents consider these items are constraints in developing sustainable product in this country. Reasonable sales price does not always mean the reduction a product's quality. Sometimes cheaper price can be gained by applying a new technology to the manufacturing process. However, as an optimist closing statement in this section, researches have shown that sustainable products in Indonesia shall have brighter future in a few next years. Youngsters in this country tend to have more awareness to environmental issues and are potential to purchase green products if they can afford them [36][37][38]. Moreover, the government's attention to the issues also grows during the last years. It is positive signs for the manufacturers to prepare products with higher level of sustainability, especially in the environmental aspect in the future.

4.2.3 The Economic Aspect

The last aspect to be discussed here is the economic aspect. One might think that the sustainable economic aspects are important for the developing countries, so that the manufacturers should put the aspects into their products in the first place. However, the respondents stated that they still meet difficulties to achieve several parts of the concepts in their product designs. For many international brand cases, products to be delivered to developing countries have different specifications to those which are marketed to developed countries. This is to adapt to the purchasing ability in developing countries, which is lower than in developed countries. But in some cases, the manufacturing cost for producing these products is higher in developing countries. Based on the respondents, it may be caused by the lack of supporting manufacturing industries in the country, resulting some components should be imported from abroad. The condition surely gives impact to the final price of the products. The same cause has made a condition where the manufacturers cannot put the latest technology into the products, such as energy saving technology, which results a slightly higher operating cost for the consumers. Another challenge is the consumer preference on the ability of the products to be recycled or remanufactured. The consumers' acceptance to recycled or remanufactured products is generally low [39], and so in Indonesia, according to most of the respondents. At previous years in 80s and 90s, Indonesian consumers tended to repair their broken household products in repairing workshops. Nevertheless, the number of these workshops is gradually inclining by the change of consumer's preference. Thus, industries are not motivated to provide additional design features related to this concept on their products. However, generally the products with good economic aspects still have good positions among Indonesian market.

5 CONCLUSIONS

Creating products which comply sustainable design concepts is one of the efforts to address a better sustainability level in Indonesia. However, based on the findings in this research, the effort is not only the responsible for the manufacturers, but also a responsible for other stakeholders constituting the government, scholars, and the society itself. The research has identified four themes of constraints in developing sustainable products encompassing consumer, human labor, policy and supporting factors issues. These constraints affect the manufacturer's motivation to develop products with higher sustainability. Thus, the development of sustainable product

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still grows relatively slow in comparison to the condition in most developed countries. Using further analysis, it is found that each theme is connected with at least one aspect of sustainability. Furthermore, the environmental aspect has most constraints in the industrial implementation due its relatively new introduction to the business. On the other side, the other two aspects have less constraints to encounter but they still get a few challenges mostly related to consumer issues. Overall, sustainable products have a good opportunity in the future to be dominant in the market. Continuous improvement in all aspects is a mandatory, but the synergy of all stakeholders shall be arranged seriously to overcome the challenges. Further studies are required in defining each stakeholder's roles, from interdisciplinary fields. Especially in design engineering, solutions should be brought within the product to influence a more responsible production and consumption pattern.

ACKNOWLEDGMENT

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