

Extending the Responsibility of Plastic Packaging Purchaser and Producer Companies and Willingness to Conserve the Material Value

Fathia Nisa and Djoko Sihono Gabriel

Department of Industrial Engineering, Universitas Indonesia, Depok, West Java, Indonesia

Email: {fathia.nisa, gabriel}@ui.ac.id

Abstract—Plastics are widely used as the primary material in the production process for packaging products, both flexible and rigid packaging. In 2017, around 900 plastic packaging industries produced plastic packaging with a total of 4.68 million tons in Indonesia. Based on field observations, most plastic packaging products in the market do not follow the design criteria for material value conservation. In addition, the Indonesian legal framework regarding EPR that regulates producers' responsibility in reducing plastic waste already exists but has not been implemented, and there is no obligation to conserve the material values. This research aims to compile a description of the extended producer responsibility and explore the plastic packaging purchaser and producer companies' willingness to realize the material value conservation. Direct observation of 537 plastic packaging samples was carried out to obtain the distribution of samples for the plastic packaging residual value category. In addition, extended responsibility items for the two groups of companies were identified through literature review. From the survey results, the average RWI score of 3.88 indicates that overall, plastic packaging purchaser companies are somewhat willing to conserve the material values, and plastic packaging producers are somewhat willing to conserve the material value with the average RWI of 3.95.

Index Terms—extended producer responsibility, material value conservation, plastic packaging, plastic waste residual value

I. INTRODUCTION

Plastic is a material that is easily found in daily life. Almost all aspects of daily life involve plastics, such as transportation, telecommunications, clothing, footwear, and packaging materials. It is because plastic is an inexpensive, lightweight, strong, durable, corrosion-resistant material with high thermal and electrical insulation properties [1]. In Indonesia, plastic is widely used as the main ingredient in the production process for packaging products, both flexible and rigid packaging. In 2017, around 900 plastic packaging industries produced flexible and rigid packaging with a total production of 4.68 million tons. It is accompanied by the demand for

national plastic products, which has increased by 5 percent in the last five years [2].

Plastic packaging and other packaging products were first designed for their primary functions: containment, protection, and preservation followed by identification and information functions [3]. The various functions of plastic packaging develop various packaging forms and features, and the intensive use of color pigments and colorful printing inks, painting, and coatings reduce the material properties required by secondary plastic recycling [4], and then reduce the quality of plastic waste and thereby reducing its acceptance by plastic recyclers [5]. With the lower quality of plastic waste as raw material and a lower selling price for recycled pellets, the recycling business will not be competitive enough, resulting in more plastic waste that is not managed correctly and causes serious environmental problems [6].

The direct observation of plastic packaged products circulating in the market was carried out by Tyani & Gabriel [7]. The observation was carried out at Carrefour Lebak Bulus, South Jakarta and the identification was carried out based on the residual value category of the material [5]. These observations reveal that many packaging designs still fall into the packaging design category with low residual values. The packaging design with a low residual value is a design with a concentrated color pigment and printed ink on more scattered parts of the sheet and is not easily separated.

A paradigm is proposed by Gabriel [5] as a strategic option to increase the acceptance of plastic waste, namely Material Value Conservation (MVC). The MVC implements various approaches, product, and process design principles, processes or treatment of materials, and other efforts to minimize value depreciation and maximize residual value to increase the life cycle and overall value. According to the MVC paradigm, every material should not be considered marginal material but a valuable resource whose value must be preserved. In order to realize MVC, plastic packaging purchaser and producer companies with their roles must follow the appropriate regulations and law enforcement because this group of activities is the driving force in the initiation of the implementation of MVC [8].

Extended Producer Responsibility (EPR) is the principle of environmental protection policies to reduce

the environmental impact of the product life cycle by extending the manufacturer's responsibility for the product life cycle with the final recall and disposal of the product after-sale [9]. In Indonesia, the legal framework for an EPR system already exists. However, the implementation has not been carried out. The MVC paradigm is in line with the Waste Management Law Number 18/2008, which views waste as a usable resource. Therefore, plastic packaged product stakeholders, such as plastic packaging purchaser and producer companies, can consider applying the MVC design principles to encourage increased availability of high quality recycled plastic waste. Thus, a more sustainable environment and society can be realized in the future [10].

From these backgrounds, this research states that most plastic packaging products marketed in stores do not follow the design criteria for MVC, and the EPR regulation to support MVC in plastic packaging purchaser and producer companies has not existed. Therefore, the purpose of this research is to compile a description of the extending of the responsibility of plastic packaging purchaser and producer company to realize MVC and to assess the willingness of plastic packaging purchaser and producer company to conserve the material value in order to obtain the key to follow-up in disseminating the MVC paradigm through the application of product redesign.

Research on the willingness to conserve the material value is still limited. Research conducted by Oyewole [11] examines the willingness to invest in green features, one of its features is material use and conservation. Several other studies concerning the conservation of material value can be adopted from the willingness to recycle. Previous applications include energy conservation and environmental protection [12]–[14], waste recovery behavior [15]–[17], and choice of mode of travel [18]–[20]. They are applied to analyze each recycling behaviour's willingness, but which indicator is more influential has received mixed findings [21], [22].

II. MATERIAL VALUE CONSERVATION

Material Value Conservation (MVC) paradigm is an implementation of various approach, product and process design principles, process or treatment of materials, and other efforts in order to minimize its value degradation and maximize its residual value, and therefore increase its life cycle and the overall value [5]. According to this paradigm, every material should not be considered as marginal material but as a resource whose value must be preserved. Verification of the existence of MVC was initially carried out by observation through plastic packaging products with a phenomenological approach.

Conservation of material values in plastic packaging is focused on the value of material quality as raw material for plastic recycling. The higher the plastic material's quality value, the higher its potential to be recycled into high-quality plastic pellets. It is because plastic packaging waste with a high-quality value has a high selling price to be used as a high-quality raw material for plastic pellets [5].

The paradigm of MVC in plastic packaging does not aim to limit or prohibit plastics as raw material for packaging but rather to direct its use wisely to reduce the value of plastic materials as little as possible. The application of MVC in plastic packaging will encourage the development of plastic recycling businesses. As a result, more and more plastic packaging waste will be absorbed as raw material and processed into quality, high-value, high-value plastic pellets.

An important aspect of this study is the use of color and ink in plastic packaging, which significantly impacts the value of plastic waste after its shelf life as packaging [23]. Previous research [24] has shown that the categories of plastic packaging waste, as shown in Table I.

TABLE I. PLASTIC PACKAGING WASTE CATEGORY

Category	Description	Residual Value
1	<ul style="list-style-type: none"> No printing ink and color pigment on the high and medium quality of packaging Easy to remove plastic or paper labels, which used for branding and product information 	High
2	<ul style="list-style-type: none"> Light or transparent color pigment on the high and medium of plastic packaging Use of limited printing ink 	Medium
3	<ul style="list-style-type: none"> The deep color pigment used on the high and medium of plastic packaging Printing ink on more and spread part of the sheet, not an easily separated label 	Low
4	<ul style="list-style-type: none"> Multi-layer material on the high and medium of plastic pellets Degradable agents, low value of plastic pellets, dark or black color pigment used Toxic or other dangerous materials used 	No Residual Value

III. METHODOLOGY

A. Identification of Current Producer Responsibility

Producer responsibilities are identified in two company categories: plastic packaging purchaser and plastic packaging producer companies. The two companies have different responsibilities. The identification of the two categories of companies' responsibilities can be made by reviewing Indonesia's laws and regulations. The identification of the current producer responsibility for plastic packaging purchaser company is based on Government Regulation Number 81 of 2012 Articles 12 to 14 and Minister of Forestry and Environment Regulation Number 75 of 2019 Articles 6 and 7. The identification of the current responsibility for the plastic packaging producer company is based on Law Number 18 Year 2012 Articles 82 and 83 and Minister of Industry Regulation Number 24 Year 2010 Article 4.

B. Identification of Current Residual Value of Materials

The next step is to identify the distribution of packaging samples in the store according to the category of residual value. This step aims to determine the impact of current responsibilities that have not adopted the MVC paradigm. The sample used was 537 plastic packaged products from a convenience store in a sub-district in South Tangerang City, Banten. The packaging products are grouped into two types of plastic packaging: flexible

plastic packaging and rigid plastic packaging. After identifying the type of plastic packaging, the next step is to identify the product residual value category. After classifying the product samples into each category of residual value of plastic packaging, then calculating the percentage of each category of residual value of the entire sample. Identification of product residual value categories based on plastic packaging waste category as shown in Table I.

C. Identification of Companies' Willingness to Conserve the Material Value.

The survey, which was conducted with a questionnaire, was addressed to two groups of respondents: plastic packaging purchaser and plastic packaging producer companies' representatives. The Likert scale was adopted to measure respondents' perspectives on the various problems discussed in the questionnaire. There is a 5-point Likert scale used which indicates the level of willingness from very unwilling to very willing. The questionnaire was distributed to plastic packaging purchaser and producer companies through an online questionnaire. Questionnaire items were obtained from the design criteria for plastic packaging that conserve the material value [7], [24]. The list of plastic packaging companies is obtained from the directory of industrial companies on the official page of the Ministry of Industry of the Republic of Indonesia, and companies are randomly selected from the database. The next step is calculating the Total Weight Value (TMV).

TWV is the sum of the number of responses for each variable and the weight value attached to each rating [11]. RWI thus ranges between the values 1 to 5. Therefore, the TMV calculation formula can be seen in Eq. (1).

$$TMV = \sum_{i=1}^5 P_i V_i \quad (1)$$

TWV is the total weight value, P_i is the number of respondents who rated an attribute i , and V_i is the weight assigned to each attribute i .

The next step is calculating the Relative Willingness Index (RWI). RWI for each variable is obtained by dividing the sum of the weighted values (TWV) by the respondents' total number. RWI is obtained by dividing the TWV by the respondents' sum for each of the five attribute ranks. The RWI calculation formula can be seen in Eq. (2).

$$RWI = \frac{TMV}{\sum_{i=1}^5 P_i} \quad (2)$$

RWI is the relative willingness index and P_i is the number of respondents who rated attribute i .

The gap assessment of the ideal willingness to conserve the material value can be seen from the average RWI distribution. The closer RWI to five, the higher the assumed relative willingness. An analysis of the causes of the companies' reluctance to conserve the material value can be obtained from the survey results and a gap assessment of the willingness to conserve the material value. Furthermore, a cause-and-effect diagram can be made or commonly called a fishbone diagram which can identify several possible causes of problems that occur.

IV. RESULT AND DISCUSSION

A. Current Producer Responsibility

Regulations regarding the Extended Producer Responsibility policy in Indonesia are based on Government Regulation Number 81 of 2012 and Minister of Environment and Forestry Regulation Number 75 of 2019. These laws regulate the responsibility of producers to implement the 3Rs, namely reduce, reuse and recycle. These recent regulations promote producer responsibility for the waste of their products and encourage them to be involved in the activities carried out to reduce the impact of the wastes, using recyclable production raw materials, encourage producers' active role in efforts to reduce waste through a road map for reducing waste by producers. The target of reducing waste is 30 percent in 2025. Efforts to reduce this waste can be made using raw materials that can be reused or recycled, creating a take-back mechanism, and providing storage facilities

Meanwhile, plastic packaging producer companies' responsibility is based on Law Number 18 of 2012 Articles 82 and 83 and Minister of Industry Regulation Number 24 of 2010 Article 4. These laws regulate food packaging standards, in which producers must use food packaging materials that do not endanger human health and distribute products in a manner that can prevent damage or pollution. Submission of information on types of plastic raw materials and the inclusion of logos and recycling codes, in which producers must convey correct information regarding types of plastic raw materials for food packaging and include a logo and recycling code on each food packaging.

B. Current Residual Value of Plastic Packaging

Companies that do not adhere to the material conservation paradigm's current responsibility result in many plastic packaging having a very low residual value category. 537 samples of products using plastic packaging were identified based on the residual value category. The identification results are shown in Table II and Table III.

TABLE II. CURRENT RESIDUAL VALUE OF FLEXIBLE AND RIGID PLASTIC PACKAGING

Category	Residual Value	Flexible Plastic Packaging		Rigid Plastic Packaging	
		Total (pcs)	Percentage (%)	Total (pcs)	Percentage (%)
1	High	19	5.14	77	46.11
2	Medium	20	5.41	40	23.95
3	Low	324	87.57	36	21.56
4	No residual value	7	1.89	14	8.38
	Total	370	100	167	100

Source: Direct observation on February 2021

TABLE III. CURRENT RESIDUAL VALUE OF PLASTIC PACKAGING

Category	Residual Value	Total (pcs)	Percentage (%)
1	High	96	17.88

Category	Residual Value	Total (pcs)	Percentage (%)
2	Medium	60	11.17
3	Low	360	67.04
4	No residual value	21	3.91
	Total	537	100

Source: Direct observation on February 2021

The samples were divided into two categories of plastic packaging, flexible and rigid plastic packaging, with 370 and 167 samples, respectively. Items observed at the convenience store included mineral water, soft drinks, liquid milk, snacks, biscuits, instant noodles, rice, kitchen supplies, tissue, baby and child needs, cosmetics, body wash, shampoo and conditioner, household necessities, office stationery, and so on. It can be concluded that with the current responsibility of producers, 67.04 percent of plastic packaging products on the market categorized as low residual values, 17.88 percent categorized as high residual values, 11.17 percent categorized as medium residual values, and 3.91 percent categorized as no residual values.

C. Extended Producer Responsibility to Conserve the Material Value

To realize the MVC, plastic packaging purchaser and producer companies must follow the appropriate regulations and law enforcement because these activities are the driving force for implementing MVC. Extended producer responsibilities to conserve the material value are formulated based on design criterias for flexible [24] and rigid [7] plastic packaging.

Based on the identification results, extended responsibilities for plastic packaging purchaser to support the MVC are summarized as follow:

1. Purchasing and ordering plastic packaging whose design comply the design criteria for material value conservation;
2. Requesting plastic packaging producers to use plastic materials with high recycled value;
3. Avoiding requests for adding color pigments to plastic materials;
4. Avoid plastic packaging designs with ink printing on the surface of the plastic material;
5. Optimally use paper labels on the packaging surface to display colors, symbols, pictures, letters, graphics, and so on as a substitute for:
 - a. the need for the coloring referred to number 3, and
 - b. the need for the printing referred to number 4; also
6. If the use of paper labels cannot fulfill particular needs, then the thin plastic labels can be used on a limited basis, as referred to in number 5.

The extended producer responsibilities for the second producer category, plastic packaging producer, are summarized as follow:

1. Using recyclable plastic material with high recycled value;
2. Receiving and producing the procurement of plastic packaging designed to comply the conservation of material value;

3. Labeling with colors, symbols and/or signs, and barcode to identify materials according to the name, type and/or category of plastic material;
4. In the case of plastic packaging requiring adhesives, the type of adhesive is chosen, making it easy to remove and does not become a contaminant in the plastic recycling process; and
5. Suggesting to the customer to redesign the plastic packaging that is not in line with the design criteria of material value conservation.

D. Companies' Willingness to Conserve the Material Value

The survey was conducted on 30 company representatives in the Greater Jakarta Area, Indonesia representing each company. The survey results show that 23 (77 percent) companies are plastic packaging purchasers and 7 (23 percent) companies are plastic packaging producers. 2 (7 percent) companies were between 1 and 5 years old; 5 (17 percent) companies were between 6 to 10 years old; while 23 (77 percent) companies were over 10 years old. The majority of companies of 14 (47 percent) have more than 600 workers. The findings also reveal that the majority (79 percent) of the companies are located in Jakarta, Indonesia.

The level of willingness of companies using plastic packaging to conserve the material value was identified through a survey. The Relative Willingness Index (RWI) obtained for each feature for companies using plastic packaging is presented in Table IV. The average RWI (\overline{RWI}) of plastic packaging purchasers to conserve the material value is 3.88. The \overline{RWI} value shows that the plastic packaging purchaser companies are somewhat willing to conserve the material value. The results show that the "Minimize the type and number of fasteners and connectors on plastic packaging" feature has the highest RWI of 4.22, while "Avoid printing ink on the surface of the plastic material to protect the value of the material" has the lowest RWI of 3.61.

TABLE IV. THE LEVEL OF WILLINGNESS OF PLASTIC PACKAGING PURCHASER COMPANIES TO CONSERVE THE MATERIAL VALUE

No.	Feature	RWI	RWI- \overline{RWI}	Rank
1	Minimize the type and number of fasteners and connectors on plastic packaging	4.22	0.34	1
2	Use a packaging design with a packaging structure that is easy to empty	4.17	0.30	2
3	Minimize the number of components and parts of plastic packaging	4.04	0.17	3
4	Purchase and order plastic packaging whose design complies with the design criteria for material value conservation	3.96	0.08	4
5	Requesting plastic packaging manufacturers to use plastic materials that have a high selling value from recycled products	3.96	0.08	5
6	Limited use of thin plastic labels intended to replace the need for coloring (addition of color pigments)	3.83	-0.05	6

No.	Feature	RWI	RWI-RWI	Rank
7	Limited use of thin plastic labels intended as a substitute for printing needs (ink printing)	3.83	-0.05	7
8	Optimal use of paper labels on plastic packaging surfaces as a substitute for printing needs (ink printing)	3.74	-0.14	8
9	Avoiding requests for adding color pigments to plastic materials to protect material values	3.65	-0.23	9
10	Optimal use of paper labels on plastic packaging surfaces as a substitute for coloring (addition of color pigments)	3.65	-0.23	10
11	Avoid printing ink on the surface of the plastic material to protect the value of the material	3.61	-0.27	11
	\overline{RWI}	3.88		

RWI obtained for each feature of plastic packaging producers is presented in Table V. Thus, the \overline{RWI} of plastic packaging producers for features related to MVC is 3.95. This \overline{RWI} value indicates that the company is somewhat willing to conserve the material value. The results showed that the feature "Minimize the type and number of fasteners and connectors on plastic packaging" has the highest RWI weight of 4.14. Meanwhile, the feature "Receive and produce procurement of plastic packaging designed to comply with MVC" has the lowest RWI of 3.71.

TABLE V. THE LEVEL OF WILLINGNESS OF PLASTIC PACKAGING PRODUCER COMPANIES TO CONSERVE THE MATERIAL VALUE

No.	Feature	RWI	RWI-RWI	Rank
1	Choose the type of adhesive that is easily removed so that it does not become a contaminant in the plastic recycling process	4.14	0.19	1
2	Minimize the use of adhesives for ease and savings in sorting costs in the plastic recycling process	4.14	0.19	2
3	Minimize the number of polymer types used for sorting costs in the plastic recycling process	4.00	0.05	3
4	Use recyclable plastic materials with high recycled selling value	3.86	-0.10	4
5	Label plastic packaging with color, symbol and/or sign, and barcode for identification of materials according to the name, type and/or category of plastic material	3.86	-0.10	5
6	Receive and produce procurement of plastic packaging designed to comply with material value conservation	3.71	-0.24	6
	\overline{RWI}	3.95		

The survey results found that several features to realize the MVC still have values below the RWI average. It shows that the company is not yet fully willing to conserve the material value. The companies' reluctance to conserve the material value was obtained from the results of a questionnaire with open-ended questions. Some of the reasons these companies have not conserved material values or are reluctant to conserve the material value are summarized in the fishbone diagram in Fig. 1.

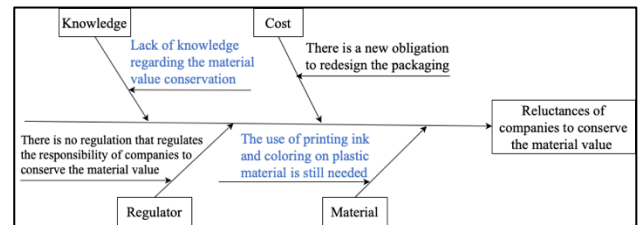


Figure 1. Fishbone diagram of the causes of companies' reluctance to conserve the material value.

V. SUMMARY

Based on the research that has been carried out, several conclusions can be drawn. First, based on the identification of producer responsibility, there is currently no responsibility to conserve the material values. The identification results of 537 plastic packaging product samples from convenience store showed that the majority of plastic packaging products with a percentage of 67.04 percent of all items were categorized as packaging products with a low residual value, 17.88 percent were categorized as high residual values 11.17 percent were categorized as medium residual value, and 3.91 percent were categorized as no residual value. Eleven extended responsibility points for realizing MVC consisting of 6 extended responsibility points for plastic packaging purchaser companies and five additional extended responsibility points for plastic packaging producer companies have been formulated based on literature review. Assessment of companies' willingness to conserve the material value shows that the RWI were 3.88 and 3.95, indicating that the two types of companies were somewhat willing to conserve the material values. The reasons why companies are reluctant to conserve the material value are due to a lack of knowledge about MVC, the use of printing inks and coloring on plastic materials is still needed, there is a new obligation to redesign the packaging, and no regulations are governing the companies' responsibility to conserve the material values.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Djoko Sihono Gabriel had contributed to determining research topics regarding material value conservation and analyzing the overall results. Fathia Nisa had contributed to analyzing the data and writing the paper. All authors had approved the final version.

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Fathia Nisa is a post-graduate student in the Industrial Engineering Department of Universitas Indonesia. She holds a Bachelor's Degree in Industrial Engineering from Universitas Islam Indonesia. She is currently completing her final project to conduct a research about material value conservation.



Djoko Sihono Gabriel is a Professor in the Industrial Engineering Department of Universitas Indonesia. He earned Master of Engineering and Doctorate in Universitas Indonesia. He is the first person to introduce "Material Value Conservation" knowledge with plastic packaging as the first evidence of the new paradigm phenomenon. His research interest area includes Industrial Engineering, Manufacturing Systems, Material Value Conservation, and Sustainable Manufacturing.