

Customer acceptance evaluation of design for material value conservation using structural equation modelling: A case study of plastic packaging

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Abstract

Design for material value conservation in this case study was a trial implementation of design principles of plastic bag in order to minimize its value degradation and maximize its salvage value in the end of life, and therefore increase its acceptance by plastic recyclers. A Structural Equation Modelling (SEM) with Lisrel 8.8 software used as tool of analysis in evaluating customer acceptance of the two types of design paradigm, current and material value conservation based design. The results indicated that customer accepted both type of packaging. With final standard factor loadings, the proposed design indicated slightly better correlation coefficients: 0.46 for Ease of Information Delivery and 0.74 for Informational Content variables, better than current design with 0.44 and 0.73 coefficients. Wide spread implementation of design for material value conservation will save virgin plastic consumption for plastic packaging production, reduce plastic waste generation as well as support material resource conservation in a better condition of environment. Social and economic benefit will also be obtained as multiplier effect of material value conservation. Copyright © 2018 VBRI Press.

Keywords: Plastic packaging, design for material value conservation, plastic recycling, customer acceptance, structural equation modelling.

Introduction

Product packaging is the science, art and technology of protecting products for the purposes of containment, protection, transportation, storage and information display [1]. In the context of information display purpose, current design of plastic packaging tend to excessive coloring and printing with various color and printing ink which covered its most part of packaging surface. This trend of design reduces its value and price significantly when collected as raw material in plastic recycling business because of low quality of its recycled products [2,3]. Plastic packaging and its user acceptance assessed as central concern in this study. Customers of packaged rice were selected as respondents for two important consideration. First, they are need appropriate packaging that support its function and informational display [1]. Second, plastic packaging with intensive of usage and its value conservation as a new paradigm need customer acceptance [2]. Rice packaging with plastic material selected in this research because of this type of packaging reflect general usage of flexible plastic packaging.

The proposed design for material value conservation conserved plastic material from excessive color pigment and printed surface that down grade material quality

[4,5,6,7] on two-kilograms-rice plastic bag packaging. Informational display medium replaced by a thin layer and easy removed printed paper or plastic label [8,9] on a part of plastic bag surface to prevent ink contamination and its value degradation [2]. Implementation of design for disassembly in the new paradigm support material value conservation in terms of processing time and cost reduction [8,9]. It was as opposite with the existing design paradigm, design that more focused for functionality, especially for information display with excessive color and ink.

This study aimed to reveal customer acceptance of design for material value conservation (MVC Design) of flexible plastic packaging. With good customer acceptance and its implementation, plastic packaging industry can help reducing plastic waste that contaminated the ocean [10].

Methodology

Sample and Research Instrument

Within intensive surveys, a number of 420 rice customers in five town, Jakarta, Bogor, Depok, Tangerang and Bekasi, had responded to a set of questionnaire with well

tested before. The data obtained by questionnaire represents buyer perception with scores within Likert scale of 1 to 5. All of 84 questionnaires collected were considered as valid and used in data processing.

Measurement model

Measurement model is a specification of the measurement that shows how constructs are operationalized by sets of measured items. Confirmatory Factor Analysis (CFA) is used to test the reliability of a measurement model. CFA allows the researcher to tell the SEM program which variable belongs to which factor before the analysis. CFA allows the researcher to specify the actual relationship between the items and factors as well as linkages between them. Construct validity is the extent to which a set of measured items actually represents theoretical latent construct; those items are designed to measure. The reliability of variables' value scale was examined by specifying a model in CFA using Lisrel 8.8 software. Reliability of an instrument can also be calculated by the use of SEM technique to measure goodness of fit and assess a model's goodness of fit.

Structural model

The next step after assessing the eligibility of scale for measuring different variables in the research is to test the hypothesized relationships in a structural model. Some variables affect to informational purpose [1] analyzed in this study. Two variables affected to dependent variables identified as informational content on packaging and ease of information delivery. The two independent variables were proposed as causal factor of informational purpose on flexible plastic packaging.

Many description varies among packaging purpose. This research suggest informational purpose as key variable in customer acceptance, because some other variables designed same as the current design of packaging [1]. Important aspect in this study was the use of color and ink on plastic packaging that have significant impact to plastic waste value after its end life as packaging. Customers responds to current design and to design for material value conservation analyzed to reveal the different acceptance between them. Fig. 1 represented current design of plastic packaging, mostly with low value of plastic waste caused by excessive color and ink contaminants on both side of surface. Fig. 2 represented rare current design with high value of plastic waste as a comparison. Fig. 3 represented one of five alternatives that represented design for material value conservation with thin plastic layer only on one side of the plastic packaging surface, therefore 100% of main plastic material had high value at the end of life as rice packaging.

Data Collection and Analysis

The research subjects were rice buyers who have responded to a set of questionnaire according to a preliminary model of relationship. Packaging for two kilograms of rice used as instrument in this research. The

buyers were asked to explain their opinion according to instrument statements by chosen the list on questionnaires. First, about informational content on the packaging and ease of information delivery as independent variables. The second, customer opinion about informational purpose of observed packaging as dependent variable. Latent variables with each number of manifest variables represented in Table 1.

Table 1. Latent and Manifest Variables.

No	Latent Variable	Manifest Variable
1	Ease of Information Delivery	KMDHN
2	Informational Content	MTAN1, MTAN2, MTAN3, MTAN4, MTAN5
3	Informational Purpose on Packaging	KGIN1, KGIN2, KGIN3



Fig. 1. Current Design Example of Plastic Packaging with Low Salvage Value.



Fig. 2. Current Design Example of Plastic Packaging with High Salvage Value.



Fig. 3. Design for MVC Example of Plastic Packaging with High Salvage Value.

The relationship model variable was a new relationship between variable that have not been introduced before. With 420 buyers' respond of all type of packaging design represented 5 Likert scale, after reliability and validity test procedures completed, and then within appropriate skewness and kurtosis, a computer program prepared for SEM. Serial steps of model specification, model identification, model estimation, goodness fit tests, and then re-specification of structural models were conducted in this study.

Results and discussion

Relationship between variables

Structural equation according to SEM with 420 samples indicated that goodness fit of two independent variables support its effect to one dependent variable, both for current design of packaging and material value conservation design. Therefore Ease of Information Delivery (KMDHN) and Informational Content (MTAN) strongly considered significant cause of Informational Purpose on Packaging (KGIN). Evaluation of the structural equation represented in Fig. 4 and Fig. 5 and Table 2 and Table 3 concluded that the equation with two independent variables and one dependent variable was well accepted according to the good results of goodness fit and correlation coefficient.

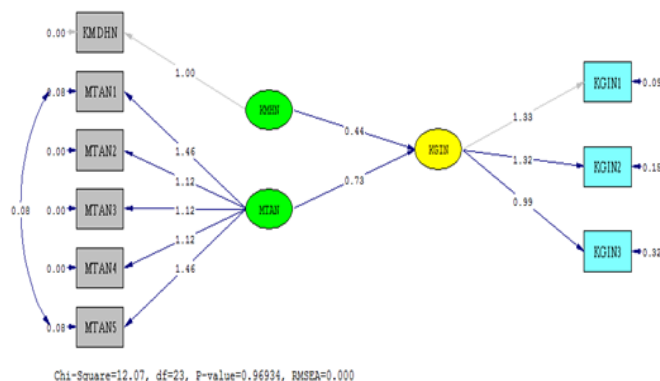


Fig. 4. Path Coefficient between Three Latent Variables on Current Design.

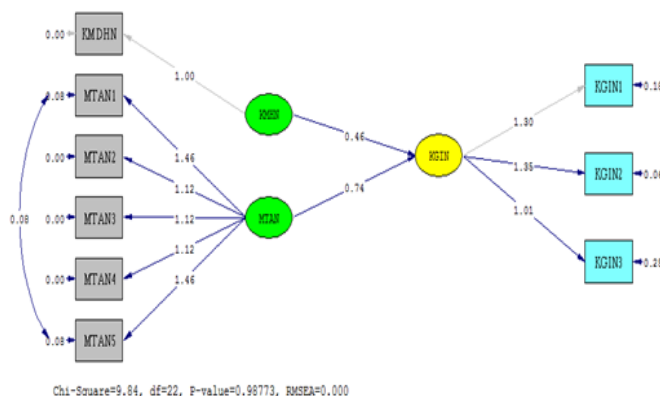


Fig. 5. Path Coefficient between Three Latent Variables on MVC Design.

Table 2. Goodness of Fit of Packaging with Current Design.

No	Goodness of Fit	Acceptance Criteria	Model Estimation	Note
1	Chi-Square	$p > 0.05$	0.96	Good
2	RMSEA	≤ 0.08	0	Good
3	NCP	Lower value	0	Good
4	NFI	$NFI \geq 0.9$	0.99	Good
5	NNFI	$NNFI \geq 0.9$	1.01	Good
6	CFI	$CFI \geq 0.9$	1	Good
7	IFI	$IFI \geq 0.9$	1.01	Good
8	RFI	$RFI \geq 0.9$	0.99	Good
9	CN	>200	273.63	Good
10	RMR	≤ 0.05	0.037	Good
11	GFI	$GFI \geq 0.9$	0.97	Good
12	AGFI	$AGFI \geq 0.9$	0.94	Good

Table 3. Goodness of Fit of Packaging with MVC Design.

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7	IFI	$IFI \geq 0.9$	1.01	Good
8	RFI	$RFI \geq 0.9$	0.99	Good
9	CN	>200	359.76	Good
10	RMR	≤ 0.05	0.037	Good
11	GFI	$GFI \geq 0.9$	0.98	Good
12	AGFI	$AGFI \geq 0.9$	0.96	Good

Current design versus MVC design

The next analysis focused on the different of relationship among variables observed and tested between packaging with current design and MVC design. Structural equation according to SEM indicated that both type of design accepted by customers. Their goodness of fit result indicated good fits for every measurement of testing. According to the equation, customers responds to MVC Design was slightly better than Current Design as seen on Table 4. The result may be supported by more transparent area on packaging with MVC Design [5,6,7], while on the Current Design, used of excessive color and printing ink covered on most of packaging surface. This type of packaging had worst visibility than packaging with MVC Design and made rice buyers unable to see condition of the content of packaging and down grade material value [3].

Table 4. Relationship between variables.

No	Relationship	Correlation Coefficient	
		Current Design	MVC Design
1	Ease of Information Delivery to Informational Purpose on Packaging	0.44	0.46
2	Informational Content to Informational Purpose on Packaging	0.73	0.74

Informational Purpose (KGIN) depend on Ease of Information Delivery (KMDHN) and Informational Content on Packaging. Ease of Information Delivery depend on size of printed information and its contrast. While Informational Content depend on appropriate and useful information printed on packaging surface, including: appropriateness information about rice producer (MTAN1), rice identity (MTAN2), rice nutrition content (MTAN3), safety in consuming the rice (MTAN4) and information about producers license as well as rice quality certificate. Those information support the need of customers while they reading and then making a decision to buy a certain rice.

Consequently, rice manufacturer that focused its strategy on informational purpose only would reduce plastic waste value because of excessive use of color and printing ink [5,6,7] and slightly reduce the purpose of packaging according to customer experience. They also wasting expensive material for coloring and printing with no significant purpose. Otherwise, smarter manufacturers will take important advantage in their customer satisfaction in informational delivery and ease in deciding of a rice purchase. A good design, appropriate information and effective rice information delivery to buyers [1] will support customer satisfaction. With MVC design, plastic waste value will be better conserved and contribute more valuable recycled raw material for many type of plastic industry and reduce virgin plastic material consumption. More widespread of Design for MVC of plastic packaging will reduce abundant unmanaged plastic waste, because of high value of the waste will be accepted by plastic recycling industry [2] and no more waste problem like before [11].

Conclusion

Design for MVC in plastic packaging industry not only accepted by customer but also promotes many opportunity in cost saving and cost reduction and protect the quality of environment [11]. This finding suggest a new perspective in plastic packaging design that worth both for purchasers, manufacturers as well customers, with good prospect for virgin material saving and environmental protection. Introducing design for MVC and its practices may be a strategic decision of encouraging the new design paradigm benefit that supported by customers. Design for material value conservation in mechanical recycling context also proposed a paradigm, a new design principle between sets of design category called “design for X” [12,13] and design for sustainability [14].

The new design paradigm not only need appropriate regulation and law enforcement, but also overall stakeholders support in the plastic industry supply chain. Plastic packaging users and purchasers, plastic packaging producers, households, waste collectors and traders, plastic recyclers, plastic industry as users of recycled plastic have interrelated role in material value conservation. Therefore strategic role of stakeholders are needed in order to conserve the value of plastic waste through implementation of the new paradigm. Identification of influenced stakeholders and their strategic role should be analyzed and interpreted appropriately. Previous research by Gabriel and Anindityo [15] using with brain-writing method and interpretive process methods proposed list of stakeholder and their role. At last, widespread implementation of MVC will make environment [4,11] and community better than before [4].

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