

Eco-Friendly Product Development: The Joint Effect of Cost Information and Performance-Prove Orientation

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Abstract. This study aims to examine the effect of cost information, management control system and performance-prove orientation on eco-friendly design in new product development. This study is conducted using a laboratory experiment with 117 students as participants since causal relationship between variables will be the main consideration. Result of hypothesis test reveals significant main effect of cost information and a joint effect of cost information and performance-prove orientation on eco-friendly design. This result provides implication on new product development management which emphasize specific cost information to support decision on eco-friendly materials together with the effort to develop designer's performance-prove orientation. Previous research had observed the effect of cost information on NPD performance with consistent result. However, the effect of individual characteristic during the process needs to be further explored. Current study emphasize the role of performance-prove orientation and showed significant interaction effect with cost information in the context of designing eco-friendly product.

Keywords: Eco-friendly design, New product development, Cost information, Management control system, Performance-prove orientation

1 Introduction

The development of new product becomes an aspect of the company's sustainability [1], especially in the era of globalization that demands innovation, creativity, and environmental consideration [2]. The company needs to manage costs effectively in New Product Development (NPD) to survive in the competition [3]. Acknowledges in the context of climate change issues, the main focus of NPD currently is on the development of products that are not only innovative but also environmentally friendly, providing opportunities for the company to differentiate its products from competitors, create superior products, and provide additional benefits to consumers. Product performance improvement involves enhancing design, appearance, and functionality in line with the company's goals.

Several companies in Indonesia have adopted environmentally friendly designs in their product development. They use sustainable raw materials, reduce waste, improve energy

efficiency, implement minimalist designs, choose recycled materials, reduce hazardous substances, and provide understanding to consumers. These efforts aim to minimize the negative impact on the environment throughout the product life cycle [4]. Eco-friendly design is defined as intelligent design to meet present needs for use by future generations. Environmentally friendly principles are integrated into the product development process, including the use of eco-friendly raw materials, waste reduction, energy efficiency, and product life cycle improvement [5][6][7]. The implementation of eco-friendly design can help reduce negative environmental impacts and enhance the sustainability of new product development.

Cost information is one of the factors that influences the development of new products because it involves relevant cost information in decision-making related to new product development [8]. Considerations for various types of costs, including development, production, marketing, distribution, and customer service costs, are crucial. Cost information serves as a guide to evaluate whether the investment in new product development will yield positive results and align with the company's strategic goals. In the context of environmentally friendly design, companies also need to consider associated costs such as alternative raw materials, environmentally friendly production equipment, and changes in production process costs [9].

Research by [10] indicates that the type of cost information influences product costs in new product development, while [11] found that specific versus relative cost information can impact the design of both incremental and innovative products. In the context of eco-design, management needs to consider cost aspects to support environmentally friendly product designs to remain affordable [12]. [13] states that specific cost information provides advantages in cost savings in production. In conclusion, cost information is essential in new product development, and specific cost information can be a crucial factor in achieving the goals of new product development.

Factors influencing companies' decisions in utilizing environmentally friendly designs for new product development (NPD) also include management control systems (MCS). MCS plays a key role in overseeing and directing decisions in new product development, providing a structured framework for information management, performance measurement, and business process management [14][15]. Research by [16] indicates that the use of MCS can be directed towards a diagnostic approach, which assesses outcomes and evaluates goal achievement, as well as an interactive approach that supports the exploration of opportunities, changes, and organizational activities. Therefore, the use of diagnostic and interactive MCS can motivate organizations to achieve goals, including in the context of environmentally friendly new product development.

Goal Orientation is a psychological concept that encompasses the reasons or motivations behind an individual's engagement in an activity. The two main types of goal orientation are mastery and performance, with performance further divided into performance-prove orientation and performance-avoid orientation [17]. Performance-prove orientation involves the desire to demonstrate skills and receive positive evaluations, while performance-avoid orientation involves the desire to avoid situations that could harm skills and lead to negative evaluations [18]. Goal orientation can also be linked to environmentally friendly design, considering the impact on the environment. Therefore, goal orientation can be aligned with efforts to create a positive goal orientation that also has a beneficial impact on the environment.

This research employs Contingency Theory, which is an approach that recognizes that there is no one-size-fits-all management approach. In this context, Contingency Theory is used to understand that the influence of cost information and Management Control Systems (MCS) on decisions regarding the development of eco-friendly designed New Product Development (NPD) can vary depending on the situation or challenges faced by the company. This study will test the impact of cost information and MCS together with designer's goal orientation on eco-friendly design in new product development through an experimental method. This method is chosen to measure the causal relationship between dependent and independent variables. Experimental participants are students, considered as designer who can provide practical task for companies.

This research is conducted due to the increasingly fierce competition among companies and global discussions focusing on environmental issues caused by climate change. As a result, environmental impact has become a primary concern, and companies are required to develop not only innovative but also environmentally friendly products, and taking cost into consideration. Therefore, cost information and management control systems as well as designer's orientation are considered crucial in creating new products with eco-friendly designs.

2 Literature review and Hypothesis

2.1 The effect of cost information on eco-friendly design

Contingency theory, as articulated by [19], enriches the understanding of management theory by emphasizing the role of the environment in managerial decision-making. In today's highly competitive business environment, the presence of cost information is crucial in the development of environmentally friendly products, aligning with contingency theory that assists companies in managing costs according to the situations they face. Research by [11] indicates that, compared to relative cost information, specific cost information significantly enhances cost-effectiveness in designing environmentally friendly products. This underscores that specific types of cost information can enhance cost management focus, resulting in more cost-efficient designs.

Cost information also plays a crucial role in the development of environmentally friendly new product innovations, as highlighted by [20]. Several studies indicate that cost information aids in decision-making related to the development of new product innovations, optimizing productivity, cost efficiency, and opening up new market opportunities through product innovation [21][22]. Cost information is considered a critical foundation in decision-making related to environmentally friendly design [23]. Companies can make better decisions in the development of environmentally friendly new product innovations, helping identify opportunities, measure efficiency, and calculate costs associated with environmentally friendly designs by considering relevant cost information.

H_1 : Cost Information has the effect on Eco-Friendly Design in New Product Development.

2.2 The effect of management control systems on eco-friendly design

According to contingency theory, the design of management control systems within an organization is influenced by environmental factors and company characteristics [24]. The management control system, which includes diagnostic control systems and interactive control

systems, as well as their interaction known as a levers of control system (Simons, 1955) [25], plays a broad role. This system utilizes accounting information to provide guidance in the decision-making process for the development of environmentally friendly new products.

Management control systems can have a significant impact on the design of environmentally friendly products in the decision-making process for the development of innovative new products. Through the implementation of management control systems that emphasize environmental concern, companies can ensure that the product development process takes into account the environmental impact of the products [26]. This approach can result in more sustainable and environmentally friendly products, meeting customer needs while minimizing negative impacts on the environment. Additionally, management control systems assist companies in identifying areas where they can enhance environmental performance and reduce environmental impact by monitoring and measuring their environmental footprint.

H₂ : Management Control Systems has the effect on Eco-Friendly Design in New Product Development.

2.3 The effect of performance-prove orientation on eco-friendly design

Contingency theory is a theory that emphasizes the effectiveness of leadership depending on how well the leadership style fits a specific situation. One famous contingency theory is the theory by [27], which introduces the concepts of leader-member orientation and task structure as part of the leadership situation. Meanwhile, performance-prove orientation is one leadership style defined as a leader's orientation inclined towards proving capabilities and focusing on achieving results. Goal orientation plays a crucial role in assisting designers in understanding client preferences and ensuring that design outcomes meet the expected targets. This approach also serves as a guide for designers to identify and prioritize essential design elements, thus ensuring the effectiveness and efficiency of the design in achieving organizational goals [28].

According to [29], performance-prove is positively associated with Type II style. Goal orientation reflects an individual's motivation to achieve performance evaluations. Its underlying motivation is skill development or the demonstration of those skills, although generally considered a form of approach motivation, goal orientation has been conceptualized and measured in two different dimensions, utilizing the approach and avoidance aspects of the concept. These dimensions are the motivation to achieve positive performance assessments (Performance-prove orientation) and the motivation to avoid negative performance assessments (Performance-avoid orientation) [17].

Sustainable design aims to optimize performance, minimize negative impacts on the environment, and implement principles such as the use of environmentally friendly products [6]. Therefore, it can be concluded that performance-prove orientation can have a positive influence on environmentally friendly design by promoting the use of sustainable practices and materials.

H₃ : Performance-Prove Orientation has the effect on Eco-Friendly Design in New Product Development.

3 Methodology

This research adopts an experimental method to examine the influence of cost information, management control systems, and performance-prove orientation on eco-friendly design in the development of new products. The experimental design to be employed is a 2x2x2x2 between-subjects design.

Table 1. Experimental matrix 2 x 2 x 2 between subject

	Management control system			
	Diagnostic		Interactive	
	Cost: Specific	Cost: Relative	Cost: Specific	Cost: Relative
Performance-prove: high	Cell 1	Cell 2	Cell 3	Cell 4
Performance-prove: low	Cell 5	Cell 6	Cell 7	Cell 8

Based on the above experimental matrix, participants will be given 8 different treatments as follows:

Cell 1: Participants with high Performance-Prove orientation with diagnostic management control systems and specific cost information.

Cell 2: Participants with high Performance-Prove orientation with diagnostic management control systems and relative cost information.

Cell 3: Participants with high Performance-Prove orientation with interactive management control systems and specific cost information

Cell 4: Participants with high Performance-Prove orientation with interactive management control systems and relative cost information.

Cell 5: Participants with low Performance-Prove orientation with diagnostic management control systems and specific cost information

Cell 6: Participants with low Performance-Prove orientation with diagnostic management control systems and relative cost information

Cell 7: Participants with low Performance-Prove orientation with interactive management control systems and specific cost information

Cell 8: Participants with low Performance-Prove orientation with interactive management control systems and relative cost information.

4 Experimental Task

Experimental participants are instructed to design a new product in a specific context. Each participant is randomly assigned to one of the experimental conditions, which can be one of two levels of Cost Information (specific or relative) and two types of Management Control Systems (interactive or diagnostic). Participants are then informed that they are considered designers of a new product (a dollhouse). All participants will receive a set of blocks, a

manual, and data on product specifications on the worksheet provided for designing the new product. Before participants work on the case, a brief training session is conducted, and they have to fill out a questionnaire explaining their data information to measure their performance-prove goal orientation. After the experiment is completed, participants are given a manipulation check consisting of 5 questions to assess their understanding of the conducted experiment.

5 Findings and Discussion

5.1 Descriptive statistic

Table 2. Descriptive statistic

Cost information			Mean	Std. deviation	N
Specific	Diagnostic	High PERFPROVE	4.6571	1.32716	35
		Low PERFPROVE	5.5000	1.87083	6
	Interactive	High PERFPROVE	4.6875	.79320	16
		Low PERFPROVE	4.6000	1.14018	5
Relative	Diagnostic	High PERFPROVE	4.6571	1.65328	16
		Low PERFPROVE	3.5000	.70711	2
	Interactive	High PERFPROVE	4.7500	1.19137	16
		Low PERFPROVE	4.0000	1.58114	5
Total			4.6923	1.30292	117

Descriptive statistic for variables tested in the hypothesis can be seen from the table above. To observe the mean of eco-friendly design, standard deviation, and the number of participants in each experimental group, the experimental results data are presented in Table 1.2. The distribution of participants in each experimental group ranges from 2 to 35 participants.

6 Hypothesis Test

To test proposed hypothesis, an Analysis of Variance is performed with an addition of including 2 (two) variables as covariates, experience and participant's GPA, since there may be an effect from participant's experience in design as well as their academic capability which may affect result of eco-friendly design in the experiment. Therefore, Analysis of Covariance (ANCOVA) is performed with the following result:

Table 3. ANCOVA result

	Covariate: Experience, GPA			
	MS	<i>F-Stat</i>	<i>p-value</i>	
Factors				
Cost information	5.842	3.504	0.064	*
Management control system	0.033	0.020	0.888	
Performance-prove	0.828	0.496	0.483	

Cost information * performance prove	5.779	3.466	0.066	*
Covariates				
Experience	2.076	1.245	0.267	
GPA	0.337	0.202	0.654	
	R ² = 0.064 N = 117			

The ANCOVA test indicates that overall, treatment (manipulation) of Cost Information, together with Performance-Prove Orientation provided in the experiment resulted in differences in the mean of Eco-Friendly Design between groups. With the statistically significant influence of the interaction variable between Cost Information and Performance-Prove, the interpretation of the main effects of Cost Information and Performance-Prove Orientation individually becomes less relevant. This is because there is evidence of the strength of the interaction variable, indicating interdependence between the effects of Cost Information and the effects of Performance-Prove [30].

6 Conclusion

This study aims to test the effect of cost information, management control system, and designer's performance-prove orientation on new product eco-friendly design. Based on experimental result from this study, it is found that decision regarding material choice to construct an eco-friendly product during new product development process will vary depending on contingent factors, namely cost information and designer's goal orientation in performance-prove type. Analysis of covariance performed in analyzing the data from laboratory experiment in this study reveals a significant interaction effect between cost information and performance-prove orientation variables. Meaning, effect of cost precision level used in product design will depend on level of performance-prove orientation of the designer. This is in line with contingency theory which explains that there is no one-size-fits-all factors affecting performance.

This study's result implies that in performing new product development especially when there is environment consideration such as in designing eco-friendly design, the way the underlying data will be presented and the composition of the team becomes main consideration for management to achieve optimum result. Further, in depth analysis will be needed to explore more the effect of such factors in the product design, which may be executed in future research. Extension of the study result may be performed as well from different research approach and methods.

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