Examining the Interaction Effect of Cost Information Types and Strategy on the Effectiveness of New Product Development: An Experimental Study

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Abstract

Previous studies on the role of cost information in New Product Development (NPD) producing conflicting results. Motivated by those conflicting results whether cost information is beneficial or detrimental in the design process of new product, an experiment approach is adopted to examine the interactive effect of cost information types and strategy on the effectiveness of new product development.

The results of this study show that cost effectiveness of new product design is enhanced when designers are facilitated with specific cost information rather than relative cost information, with greater magnitude in low cost strategy orientation. Additionally, we find a trade off in low cost strategy orientation, namely as designers are provided with more precise cost information, their focus on product feature decreases.

Keywords

Cost Information
New Product Development
Strategy
Cost Information Type

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Introduction

Given a highly competitive environment, companies must manage costs properly, especially at the new product development (NPD) stage, if they want to survive. This is because for some companies, product cost is mostly predetermined during the design process (Davila and Wouters 2004; Cooper and Chew 1996; Raffish 1991). More specifically, Hertenstein and Platt (1998, p. 50) note, 'between 75 percent and 90 percent of a product's costs are predetermined when the product design is finished.' Similarly, Tornberg et al. (2002, p. 75) stress that 'the most effective way to control costs is to design them out of the products.'

Extant literature in NPD (e.g. Booker et al., 2007; Davila and Wouters 2004; Davila 2000; Hertenstein and Platt 2000; Nixon 1998) have recognized the important role of cost information in NPD stage. However, there is no consensus on how cost information affects product design process. For example, Booker et al. (2007) observe that cost information is beneficial for product designers and allows them to design products more effectively. On the other hand, cost information may cause designers to neglect product features and more to focus on cost. This may result in product that does not meet customer needs.

Conflicting views of cost information role in NPD has not been fully resolved. As a consequence, there have been growing calls for management accounting scholars to address the role of cost information in product innovation more thoroughly. At least there are two issues should be explored by more thorough studies. First, there is a need to explore further the role of different type of information in supporting product development teams (Zahay 2011; Frishammar 2005, 2007); and second, there is also a need to address the role of strategy (Kleinscmidt 2010; Citrin 2007) because of its possible congruence with cost information in NPD.

Zahay (2011) notes that research in NPD should address whether different form of information affect NPD effectiveness differently. Understanding the diversity of forms of information that must be incorporated into the project and across projects over time may help support the needs of product

development teams. Additionally, Frishammar (2005, 2007) notice that despite the general agreed-upon importance of acquiring, sharing, and using information in NPD, knowledge about what kind of information needed is lacking.

Booker et al. (2007) have investigated the effect of two different kinds of cost information, specific and relative, on product cost effectiveness. They expect there is a trade off between cost effectiveness and product features for incremental product design facilitated by more precise cost information. However, their results did not support their expectation. Pointing out at their results, there is a need to examine the effect of various kinds of information on product development process since a better knowledge about the effect of different kinds of information in NPD will give a clearer explanation on cost information role in NPD.

Citrin's (2007) study demonstrates the importance of congruence between strategy and information in the context of NPD. Contingent role of strategy in the success of NPD also revealed by Kleinschmidt (2010) and Parry (2009). Drawing on strategy link and its related information-processing requirement in early work by Galbraith (1973) which has been corroborated by succeeding works, such as Kleinschmidt (2010), Parry (2009) and Citrin (2007), it can be inferred that the effect of information used by NPD designers on NPD performance possibly depends on specific strategy orientation in NPD process.

Management accounting literature has referred to this notion, including the ones proposed by Davila (2000) and Booker (2007). However, Davila (2000) study on the relation between cost information and strategy together with its positive effect upon performance has not taken into account cost information type difference. On the other hand, Booker et al.'s (2007) study, although has explored the effect of different type of information, has not included the contingent role of strategy since they adopt only time-to-market strategy setting. Focusing on time-to-market strategy setting solely is not enough to explore complete picture of how different organization maintains its competitive advantage by adopting different strategy, as a response to current atmosphere of fast-changing environments.

Highlighting De Toni and Tonchia (2003), strategy adoption of each organizations will be unique based on competitor characteristics, customer expectations, and the internal resources available, means that there will be strategy orientation other than fast mover to market. Therefore, a more complete consideration on strategy is needed to explore current organization environment. Booker et al. (2007) also had acknowledged the importance to examine different NPD strategies: "Future research might build upon this study by examining the role of cost information when different NPD strategies, such as low-cost or customer-focus, or different performance measures are employed" (p. 37).

The discussion on different type of cost information effect and contingent role of strategy concerning cost information's importance in NPD has led to two basic questions. First, how will different strategy orientation influence specific kind of cost information's effect on new product design? Second, given specific strategy orientation, is there trade off between NPD outcomes as a result of different types of cost information? This current study intends to address those questions by examining the interactive effect of different strategies (time to market, low cost, and customer focus) and different type of cost information (specific and relative) on two product development outcomes (cost effectiveness and product features). The reason of why an interactive effect should be exposed is based on argument that interaction will provide useful information which can be used when setting priorities among different type of cost information and can help to attain higher NPD performance by adopting an optimum combination of selected variables. This argument has also been pointed out by Filippini (2004) who suggests analysis of interactions within the NPD fields for further study.

Exploring cost information type and strategy interactively is important in order to gain a complete understanding of how the effect of cost information type on product development performance may change under different strategies. This understanding will be beneficial, particularly for practitioners, in determining proper cost information should be provided in new product development process in order to obtain an optimum performance.

Moreover, previous studies show whether the effect of cost information on NPD outcomes will be different due to different strategy orientation is still unclear. Therefore, this study is expectedly will give a clearer explanation and thorough understanding which can contribute to the body of literature and NPD practices.

Literature Review and Hypothesis Development

Cost Information Role in NPD

Cost information plays an important role in NPD. The ability to develop new products efficiently has become an important consideration in the current atmosphere of fast-changing organization environments and this will be facilitated by cost information. This is supported initially by Nixon (1998), who examines the role of target costing, when cost is a critical design parameter. The longitudinal view of the specific product development project examined in Nixon case (1998) highlights a fusion of management accounting and design techniques as well as the role of accounting as an integrating vernacular that links all project team participants. The importance of cost information, though, is not only in target costing context. Davila (2000) links cost information with strategy and gives evidence on the intensive use of cost information as low cost product strategy's importance increases, and a positive effect upon performance in new product development. Additionally, study by Booker et al. (2007) which examines the effect of cost information precision in new product development indicates specific cost information will increase designer's cost focus and will lead to cost effective design.

Cost information can be detrimental instead of beneficial, since it may focus designer attention toward cost considerations and away from other objectives, such as product features, resulting in product that does not meet customer needs. Previous studies confirmed this detrimental view of cost information comes from quality management framework by Anderson and Sedatole (1998), high technology and time-driven context by Davila and Wouters (2004) and product development metrics balance modelling by Langerak (2010). Detrimental view of cost information conceives there will be trade-off among NPD objectives comes from better cost information possessed by designers – whilst cost effectiveness increases, product features may decreases.

New product development literature has recognized this issue. Frishammar (2005, 2007) notices that despite the general agreed-upon importance of acquiring, sharing, and using information in NPD, knowledge about what kind of information needed is lacking. Zahay (2010) stresses that future research into the forms in which information is used would be very interesting, whether the information was numbers, words, physical artifacts, videos of action, etc. A more thorough study expectedly will give clearer explanation of how the role cost information plays in NPD.

In management accounting field, the information produced by managerial accounting system can serve important roles in an organization: to provide some of the necessary information for planning and decision making, and this referred to as the decision-facilitating role (Sprinkle and Williamson 2007). This lead to notion that better information will lead to better decision (Sprinkle 2003). Cost information is no exception in serving that role in NPD. Concerning type of information in NPD setting, Booker et al. (2007) has examined the role of two information, i.e. relative and specific. Product designers possess cost information regarding products and product features that can vary from relative to specific (Gupta and King 1997; Cooper and Kaplan 1987). Relative cost information provides designers with only the rank ordering of costs for options in a given category (i.e., option 1 costs more than option 2). In contrast, specific cost information provides designers with exact dollar amounts for the cost of options in a given category (i.e., option 1 costs $20 and option 2 costs $10). With specific cost information, designers know with a high degree of certainty the magnitude of the difference in costs across options and the resulting total product cost for a combination of options for any one point in time. These specific and relative differentiation of cost information, is relevant to what Zahay (2010) propose as the different form of information should be further explored in research.

Contingent Role of Strategy Type

In addition to the discussion regarding type of cost information which should be further analyzed, another important issue is the contingent role of strategy in NPD. Citrin (2007) demonstrates that firms focusing on specific types of information-use innovate successfully only when that information use is congruent with an appropriate strategic orientation. Contingent role of strategy in the success of NPD also revealed by Kleinschmidt (2010) and Parry (2009). Drawing on strategy link and its related information-processing requirement in early work by Galbraith (1973) which has been corroborated by succeeding works, most recently by Kleinschmidt (2010), Parry (2009) and Citrin (2007), it can be inferred that the effect of information used by NPD designer on NPD performance possibly depends on specific strategy orientation in NPD process.

Further line of reasoning following this argument fall on the contingency theory. Commonly, contingency theory studies postulate that organizational outcomes are the consequences of a fit or match between two or more contingent factors – we can refer to some initial works in management literature such as from Burns and Stalker (1961), Lawrence and Lorch (1967), and Galbraith (1973). Management accounting research has also adopted the concept of this theory. Hayes (1977) examines the appropriateness of management accounting in order to measure the effectiveness of different departments in large organizations and found that contingency factors or contingencies were the major predictors of effectiveness for production departments. Hayes (1977) also advocates the use of contingency theory in studies of organizational assessment and subunit evaluation.

More recent management accounting research has referred to this notion (Govindarajan and Gupta, 1985; Merchant, 1985; Chenhall, 2003; Cadez and Guilding, 2008), specifically, the ones examine the role of cost information i.e. Davila (2000) and Booker et al. (2007). Yet, this limited results still inadequately support body of literature since Davila's (2000) study on the relation between cost information and strategy together with its positive effect upon performance has not taken into account cost information type difference. Likewise, Booker et al.'s (2007) study, though has explored an effect of different type of information has not included the contingent role of strategy since they adopt only time-to-market strategy setting. By only time-to-market strategy implemented, Booker et al.'s study does not capture the role of different cost information precision in a complete strategy comparison. Aside from time to market circumstance, low cost strategy setting may force designers to minimize costs at the expense of reducing product features whereas customer focused strategy setting may lead to product feature's prioritization by ignoring cost minimization. By focusing on multiple performance, but not addressing different strategy setting, significant trigger of designer's behaviour could merely be the compensation linked to particular performance measure, i.e. time to market as adopted by Booker et al's study. The faster a product completed and launched to market, the higher the compensation will be for designer. This attracted condition in experiment may eliminate the effect on designer's behavior expected to come out from cost information manipulation, in the form of specific information or relative information.

Low-Cost and Customer-Focus Strategy and Type of Information

Exploring cost information type and strategy interactively is important in order to gain a complete understanding of how the effect of cost information type on product development performance may change under different strategies. The typology of product strategies selected for the research is based on Miller and Roth (1994) who identify price, time-to-market, and customer focus as different product strategies, referred to as caretaker, marketer, and innovator, respectively. These examples are consistent with findings from other strategic group research that demonstrates that a broad range of strategies is available to competitors within an industry (for example Porter 1980; Suwardi and Ratnatunga, 2014). The similarity to Miles and Snow's (1978) taxonomy is apparent, though yields fewer categories. Clearly, Miles and Snow's "prospectors," "differentiators" and "defenders," are similar to the innovators, marketers, and caretakers here.

Notably, the caretakers, who are competing first on price, or referred to as low cost strategy orientation, tend to place relatively

lower emphasis on metrics other than cost (Miller and Roth, 1994). New product design with low cost strategy orientation focuses on cost minimization achievement. Design option and other matters which should be decided by the designer will mainly rely on how much cost can be decreased. Different from this, customer-focus strategy orientation will lead designer to emphasize on customer's satisfaction on the product, including on maintaining product features, product quality, etc. Focus on how to design new product to meet customer satisfaction is greater than focus on how to minimize product cost, though to some extent cost minimization is still has to be achieved.

Booker et al. (2007) argue that designers given relative cost information compared against designers given specific cost information are less likely to pursue cost minimization as a strategic focus because the cost information possesses uncertainty with respect to the magnitude of the cost differences between various design options and is expressed in words requiring more cognitive effort to process than numerically expressed cost information.

With respect to product cost, studies such as Iselin (1990) suggest that uncertainty affects decision quality, with greater certainty resulting in better decision quality. This reasoning suggests that specific cost information, which allows designers to be more certain of the cost of various product designs, should result in the designer choosing lower cost options. Specifically, the reduction in uncertainty allows designers to more clearly understand the cost-benefit tradeoffs involved in different product designs, thereby leading to more cost-effective design choices. Therefore, compared to relative cost information, specific cost information is expected to result in more cost-effective designs. The following hypothesis will be tested:

Ha1: Cost-effectiveness of new product design is higher when designer is facilitated with specific cost information rather than relative cost information, and the cost-effectiveness difference is greater for the design with low-cost strategy orientation than the design with customer-focus strategy orientation.

Time-To-Market Strategy and Type of Information

Due to its focus on speed and reduced NPD's length of time (to be the first mover in market), new product with time to market strategy orientation (a marketer) is less influenced by detail/better cost information. This strategy choice place significantly more emphasis on shorten total product cycle times. Concerning on the plan to embark upon manufacturing programs that reduce their manufacturing lead-times (Miller and Roth, 1994). Facilitated with specific or relative cost information expectedly has little effect on increased cost effectiveness, because designer will mainly focus on how to shorten product development time, regardless the cost.

Based on these arguments, we hypothesize as follows:

Ha2: Cost-effectiveness of new product design with time-to-market strategy orientation is no different whether designer is facilitated with specific cost information or relative cost information.

Figure 1: Experimental Design

		Cost Information Type	
		Specific	Relative
Strategy	Low-cost	Cell 1	Cell 4
	Time-to-market	Cell 2	Cell 5
	Customer-focus	Cell 3	Cell 6

Cost Effectiveness and Product Features Trade Off

Specific cost information is expected to provide a cost minimization framework for designers as a way of thinking about design options. However, this increased focus on cost minimization is expected to lead designers to use their limited cognitive resources to determine low-cost alternatives, rather than to develop products with increased features that might be more expensive but also more valuable to customers. Thus, compared to relative cost information, specific cost information is expected to reduce the extent to which designers incorporate product features into their design.

Under customer focus strategy orientation there is a relatively greater number of design options that yield greater design flexibility and opportunities to significantly change the products' features. The flexibility with respect to product features allows designers to create product designs that incorporate targeted cost reductions with less reduction in product features, as compared to the relatively less flexible design environment (low cost strategy). Thus, we expect that the provision of specific cost information decreases the level of features to a greater extent for low-cost strategy oriented products than for customer-focused oriented products. We predict the following interactive effect of cost information type and NPD strategy on product features:

Ha3: Features of new product design with low-cost strategy orientation is decreased when designer is facilitated with specific cost information than with relative cost information.

Research Method

Experimental Design

In accordance with the objective of this study, experiment method is employed, with a 3x2 between subject designs. Since interaction between variables becomes the main point in this study, experiment using factorial design is suitable because where interaction between two or more variables simultaneously makes a difference; this design will reveals this difference. It permits the testing of several hypotheses simultaneously, rather than having to conduct a series of single experiment to answer several questions. Basic statistical technique used to test the hypotheses is analysis of variance.

Figure 1 shows 6 (six) experimental conditions (cell 1 up to 6) formed by 2 (two) levels of cost information types and 3 (three) levels of strategy examined in this study. As between-subjects design is chosen (Schepanski et al., 1992, Harsha and Knapp, 1990), different set of participants is appearing in every treatment condition.

Participants

This study uses 93 engineering and business students as participants. All participants are in their 4th to 5th semesters and all are below 25 years old. The use of students as subjects lies on argument that students as proxy of real product designers in the industry can be a valid methodological choice, provided researchers give careful consideration to align task's complexity with appropriate level of the students (Elliot et al. 2007). The task for participants in this study is appropriate since we use a simplified product form and simplified design process using building-blocks construction.

Task and Procedures

To prevent from the effects of other systematic but unwanted variables that might influence the experimental outcomes, randomization is applied to assign subjects to each experimental groups randomly and also to make sure a random assignment of treatment or control conditions. Similar to prior research (Booker et al., 2007; Young et. al., 1993; Young, 1985), an experimental setting using building-blocks construction is adopted in this study. Participants in the experiment are instructed to design new product on specific context and task. Each participant is assigned randomly to one of experimental condition which can be one of two cost information levels(specific or relative) and one of three strategy settings (time to market, low cost or customer focus). Participants then informed that they are assumed to be a designer of a new product (doll-house) in toys division of a hypothetical company, to be constructed out of various building blocks like the one produced by

LEGO® brand.[1] Their main objective is a cost-effective design at a given cost information and particular strategy. All participants obtain one set of blocks, guidance book and data about product specification in the worksheet for designing the new product. Before they start the session, one questionnaire describing their demographic data and one to measure their creativity has to be filled in. Additionally, a short training session was conducted.

Variables and Measurements

Independent Variables

The strategy orientation within which new product is designed is manipulated by varying future orientation to be achieved by designer: for low cost strategy, designers should reach the lowest cost possible for them; for time-to-market strategy, designers should reach the fastest move to market; and for customer focus strategy, designers should reach the highest quality represented in product's feature. In the experiment execution, monetary awards are given to three best designers for each strategy condition (lowest cost per unit achievers, fastest move to market achievers, and highest quality achievers).

The level of cost information precision is manipulated by varying the presence or absence of specific costs in Indonesian Rupiahs (IDR) for alternative design options. Participants with specific cost information are given the exact cost in IDR of each choice of blocks needed to design the product, i.e. six blocks with different colour from orange block which costs IDR 6.500 to purple block which costs IDR 1,500. Those with relative cost information are given only the relationship between the costs of each option, i.e. orange block as the most costly followed by yellow block which costs more than green, green block which costs more than pink, and continues up to purple block as the least costly.

In the training session, the relationships between the cost of different design options are explained in detail such that participants in the relative cost condition could infer the general cost ordering of options (see appendix for example of detail worksheet given to participants).

Dependent Variables

The dependent variables in this study are product cost and product features. Product cost is determined by the designer's product design choices. As such, product cost is measured as the sum of the individual design choice costs. Design choices vary across the colour of the blocks.

Features of design also vary based on designer's choices and in this study is measured as the sum of intensity reflected by each colour of the block. Intensity, sometimes called "saturation", describes a colour's strength or weakness – and is used as measure of product's feature in this study based on the result of interview with two design experts, since doll-house as new product which is designed in the experiment is mainly characterized by its colour and proportion. To control for differences in product intensity, cost is divided by intensity. Product cost per unit of intensity controls for intensity variation and provides a measure of the product's cost effectiveness. Lower product cost translates into higher cost effectiveness.

Control Variables

Due to possibility of some characteristics of participants which may affect the results, participant's level of creativity and years of experience in design is measured, to ascertain that none of these variables is significantly different across experimental conditions. This is based on previous research evidence which shows that creativity is essential in design process (Couger, 1990) and that working experience will increase skill which may affect performance (Cloyd, 1997; Libby, 1995). Among 93 participants, there is no significant difference in creativity level across experimental conditions.

However, there is difference of design experience (in year) between engineering and business students as presented in table 2. Table 1 provides overview of the descriptive statistics of main variables used in the analysis.

[1] To reduce the level of complexity for intended participants, new product's form which should be designed is restricted to the doll-house's *facade* (the exterior side of a building, usually the front) – in the task, participant does not necessarily construct a complete form of a doll-house.

Table 1: Overview of the Main Variables

Variables	N	Mean	Standard Deviation	Min	Max
Strategy					
Low Cost	31				
Time to Market	33				
Customer Focus	29				
Cost Information Types					
Specific	47				
Relative	46				
Cost Effectiveness		8.1664	0.2054	7.56	8.55
Feature		5.5904	0.82791	3.87	6.59
Control Variables					
Creativity		2.6651	0.76726	1.00	4.33
Experience		1.3226	1.66427	0.00	7.00

Table 2: Mean Comparison

Participants	*N*	*Creativity*		*Experience*	
		Mean	Standard Deviation	Mean	Standard Deviation
Engineering Students	45	2.6742	0.83545	2.7333	1.35931
Business Students	48	2.6565	0.70621	0.0000	0.0000
Difference		*Sig.* 0.9120		*Sig.* 0.0000	

Results and Discussion

Preliminary Analysis

Prior to hypotheses testing, we analyse whether there is any significant difference revealed by group of participants and test whether experiment's treatment given to participants are successful. The result shows, as presented in table 2, that there exist a significant difference in experience between engineering and business students, but not in creativity level.

Engineering students have some design experience with average length of 2.73 years whereas business students do not have that design experience. Further, from mean difference comparison, table 3 shows that across experimental conditions, creativity level difference is not significant with all p's $\geq$ 0.821. For controlling possible effect of this two variables and the interaction between them (since creativity may correlate with work experience as suggested by Bryant et al., 2011), we include creativity, experience, and interaction between creativity and experience as covariates in the additional analysis section.

Table 3: Comparison Between Experimental Groups

Panel A *Mean Comparison*

Group	N	*Creativity*		*Experience*	
		Mean	Standard Deviation	Mean	Standard Deviation
1	17	2.4282	0.87788	1.5882	2.10086
2	16	2.5031	0.65398	1.0625	1.10868
3	14	2.7457	0.77429	1.0714	1.12416
4	14	2.7593	0.85119	1.2500	1.38328
5	17	2.7618	0.54190	1.6765	2.35147
6	15	2.8333	0.89958	1.2000	1.47358

Panel B *Creativity - Mean Difference Across Groups*

		Mean Difference (*I*) - (*J*)					
Group (*J*)	**Group (*I*)**	1	2	3	4	5	6
1			0.07489	0.31748	0.33105	0.33353	0.40510
		sig.	*1.000*	*0.934*	*0.922*	*0.902*	*0.821*
2				0.24259	0.25616	0.25864	0.33021
			sig.	*0.980*	*0.975*	*0.968*	*0.922*
3					0.01357	0.01605	0.08762
				sig.	*1.000*	*1.000*	*1.000*
4						0.00248	0.07405
					sig.	*1.000*	*1.000*
5							0.07157
						sig.	*1.000*

In order to assure experimental treatment (manipulation) has been understood by subjects correctly and sufficiently, manipulation check is performed by giving some questions verifying whether 1) subjects correctly understand they are designing with low cost strategy orientation, time-to-market orientation, or customer-focus orientation; 2) subjects correctly understand they are given specific or relative cost information; 3) subjects correctly understand that differences in design choices will result in different product cost and different features. Responses to all questions indicate that participants in all conditions understand equally whether they are designing with low cost strategy orientation, time-to-market orientation, or customer-focus orientation, whether they are given specific or relative cost information, and whether differences in design choices will result in different product cost and different features. Therefore, the manipulations are successful.

Descriptive statistics for each cell is presented in table 4. It shows means of cost effectiveness resulting from particular treatment, standard deviations and number of observations in each cell.

Table 4: Descriptive Statistics*

		Cost Type: Specific	Cost Type: Relative	Row Means
Strategy	Low-cost	7.9152 (0.15932) [17]	8.1314 (0.12097) [14]	8.0233 (0.140145)
	Time-to-market	8.1716 (0.14395) [16]	8.2937 (0.22311) [17]	8.2327 (0.18353)
	Customer-focus	8.2234 (0.10508) [14]	8.2808 (0.17449) [15]	8.2521 (0.139785)
	Column Means	8.1034 (0.1361)	8.2353 (0.1729)	

*Cells contain mean, (standard deviation), and [number of observations].

Test of Hypotheses

Hypothesis 1 predicts that, cost-effectiveness of new product design is higher when designer is facilitated with specific cost information rather than relative cost information, and the cost-effectiveness difference is greater for the design with low-cost strategy orientation than the design with customer-focus strategy orientation. ANOVA results (table 5 panel B) indicate significant main effect of cost information type ($F = 18.861$, $p = 0.000$). However, the interaction between strategy and cost information type is not significant. Note that though the interaction is not significant ($p = 0.167$), data on mean difference as presented in table 4 shows higher cost effectiveness resulting from specific cost information type for each strategy (7.9152 versus 8.1314 for low cost strategy, 8.1716 versus 8.2937 for time to market strategy and 8.2234 versus 8.2808 for customer focus strategy), and a greater difference of that cost effectiveness for low cost strategy (0.21621) compared to customer focus strategy (0.05733) as presented in the chart (figure 2 panel A). Therefore, H1 is supported.

Hypothesis 2 predicts that, cost-effectiveness of new product design with time-to-market strategy orientation is no different whether designer is facilitated with specific cost information or relative cost information. Figure 2 panel B indicates a difference of cost effectiveness between the design with specific cost information and relative cost information in time-to-market strategy with greater magnitude than that in customer focus strategy (0.12212 versus 0.05733) which is inconsistent with H2.

Hypothesis 3 predicts that, features of new product design with low-cost strategy orientation is decreased when designer is facilitated with specific cost information than with relative cost information. In this research, features of new product represented in intensity of color from blocks used to construct the product. ANOVA result for intensity (table 5 panel B) shows that the effect of strategy, type and the interaction between strategy and type on intensity are not significant. Consistent with H3, figure 2 panel B shows a decreased intensity when designer is facilitated with specific cost information (5.3540) than with relative cost information in low cost strategy (5.3965), but the decrease is not occurred both in time to market and customer focus strategy. Therefore, H3 is supported.

Table 5: ANOVA Results

Unit Cost				Intensity			
	MS	***F*-Stat**	***p*-value**		**MS**	***F*-Stat**	***p*-value**
Factors				*Factors*			
Strategy	0.493	18.861	0.000	Strategy	1.213	1.751	0.180
Cost Type	0.402	15.374	0.000	Cost Type	0.133	0.191	0.663
Strategy*Type	0.048	1.829	0.167	Strategy*Type	0.101	0.146	0.865
$R^2 = 0.414$ $N = 93$				$R^2 = 0.044$ $N = 93$			

Figure 2: Chart of Mean By Mean Comparison

Panel A: Unit Cost

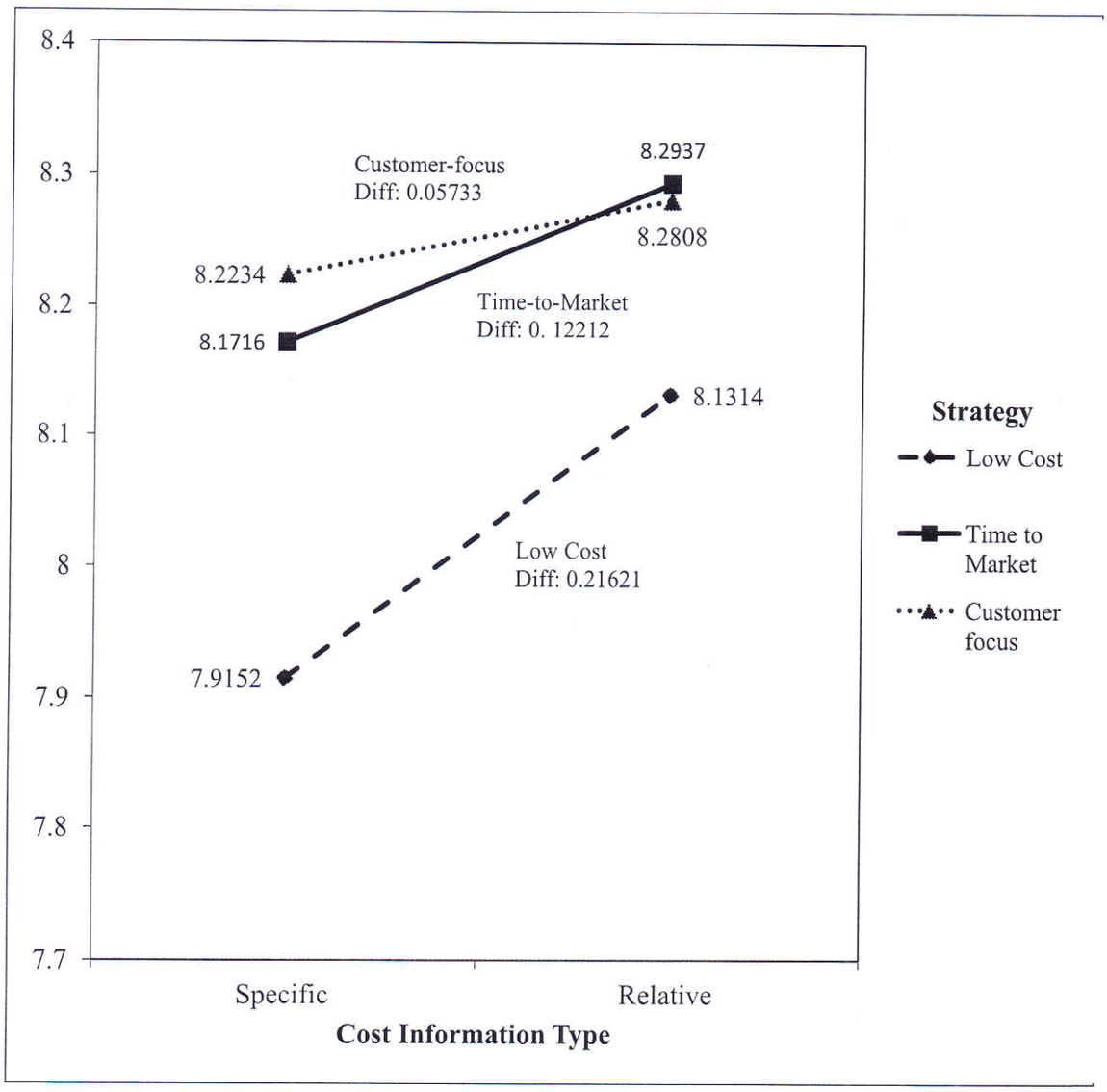
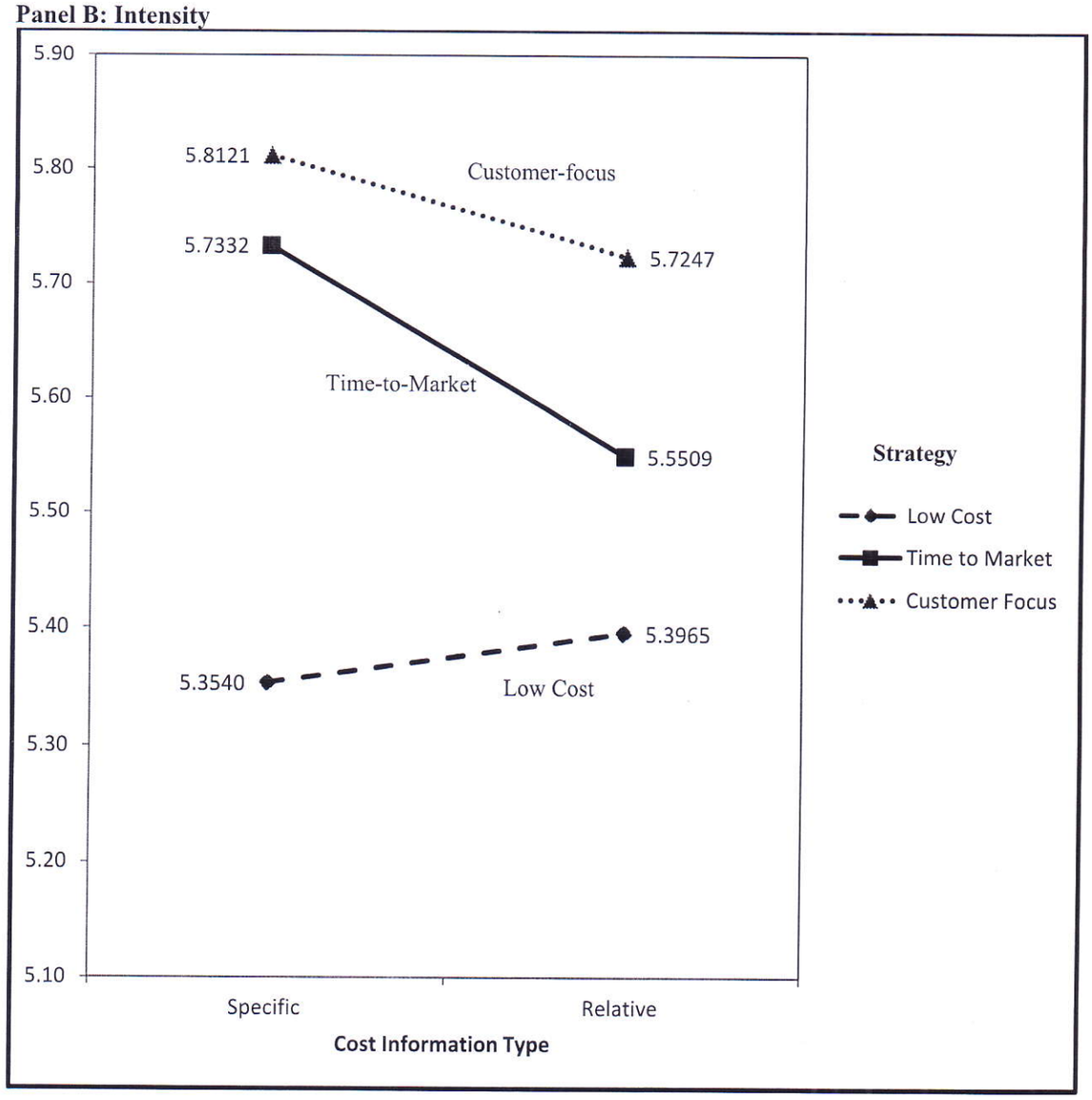


Figure 2: Chart of Mean By Mean Comparison (Continued)

Panel B: Intensity



Additional Analysis

Preliminary analysis shows a difference in experience between engineering and business students; controlling for possible effect of experience and creativity on cost effectiveness, we include those variables as covariates. Table 6 shows the result, and we can see that there is no significant difference in this analysis compared to previous main analysis result.

Further, inconsistent result of H2 test presented in previous section lead to argument that in time to market strategy, designer orientation is on speed, means that they focus mainly on becoming the first mover. We assess each group's time spent to complete the design process in the experiment, and the result support this argument since in time to market strategy group (group 2 and 5), mean of completion time reach the highest (fastest) level. Table 7 shows overall mean comparison of completion time. Meanwhile, strategy also has significant effects on completion time as shown in Table 8.

Table 6: ANOVA Results – Controlling for Creativity and Experience

	Controlling for Cand E			Controlling for C, E, and C X E		
	MS	***F*-Stat**	***p*-value**	**MS**	***F*-Stat**	***p*-value**
Factors						
Strategy	0.502	19.967	0.000	0.507	20.017	0.000
Cost Type	0.363	14.447	0.000	0.371	14.67	0.000
Strategy*Type	0.055	2.181	0.119	0.055	2.168	0.121
Covariates						
Creativity (C)	0.004	0.145	0.704	0.001	0.034	0.853
Experience (E)	0.131	5.225	0.025	0.000	0.003	0.956
C X E						
	$R^2 = 0.449$ $N = 93$			$R^2 = 0.452$ $N = 93$		

Table 7: Group's Mean of Completion Time

Group	**N**	***Completion Time (in minutes)***			
		Mean	Standard Deviation	Min	Max
1	17	76.0588	16.24989	50	120
2	16	59.6250	12.10441	40	80
3	14	74.2857	15.30927	60	120
4	14	69.3571	8.15812	57	85
5	17	56.5882	11.23087	30	75
6	15	69.2000	12.95707	50	90

Table 8: ANOVA Results – Completion Time

Completion Time			
	MS	***F*-Stat**	***p*-value**
Factors			
Strategy	2127.843	12.591	0.000
Cost Type	563.952	3.337	0.071
Strategy*Type	26.892	0.159	0.853
	$R^2 = 0.254$ $N = 93$		

Implications for Practice

This study has important practical implications. Since it is confirmed that cost effectiveness of new product design is enhanced when designers are facilitated with specific cost information rather than relative cost information with greater magnitude in low cost strategy orientation, this result should be considered by both management accountants and new product development managers. Given that specific cost information is not always available to the designer of new product as appeared in previous literature (Siddens, 2001; Ellsworth, 1998), management should determine whether specific type of cost information must be provided for designer at particular strategy orientation. As this study suggests, to achieve optimum performance in NPD, it is important to adjust the type of cost information to the strategy orientation adopted in the process design together with a cost benefit analysis of presenting more or less precise information to the designers. Managers in this field will be better served and get benefit from this.

Moreover, the existence of trade off in low cost strategy orientation demonstrates the importance to consider the way to prevent from decreasing product's quality. As more precise cost information for designer leads to decreased features of new product being designed, simply assigning precise information without giving attention to maintain quality at low cost strategy will bring about product which fails to meet quality requirement. The confirmation of such trade off, different from previous research result (Booker et al., 2007), highlights the contingent role of strategy in the effect of cost information types on NPD performance.

Conclusions, Limitations, and Suggestions for Future Research

This study experimentally investigates how different strategy orientation influence specific kind of cost information's effect on new product design. The results from this study advances our understanding of cost information role in new product development process in several ways. First, it is found that different cost information types – i.e. its precision variation – influence cost effectiveness of new product's design differently. Designers in low cost strategy orientation, achieve more cost effective design result when facilitated with specific cost information type compared to those facilitated with relative cost information type, where the difference of cost effectiveness is greater than in customer focus orientation. It is also found that there is trade off between product feature and cost effectiveness as cost information becomes more precise. However, we do not find the interactive effect of cost information types and NPD strategy on new product design's cost effectiveness. Furthermore, the magnitude of cost effectiveness difference is greater in time to market strategy than that in customer focus strategy, which may occur due to speed orientation of the designer - thus in time to market strategy, it may be implied that relative cost information affects more on the decrease of cost-effectiveness if compared to customer focus strategy.

Second, from theoretical point of view, detrimental-beneficial conflicting view of cost information in new product development context will be narrowed. Therefore, recognition of cost information importance can be corroborated as well. This study has given a clearer explanation which contributes both to the management accounting and NPD literature.

Potential limitations of this study may come from number of participants and the possibility of participant's preference or colour-sensitive effect on the design, which may influence the findings since product's colour and design has a great proportion in this study. Future research should explore more on this difference, to gain a more complete view.

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