

VALUE ENGINEERING FOR VALUE CREATION IN THE AUTOMOTIVE INDUSTRY

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ABSTRACT

This paper intends to explore the adoption of Value Engineering (VE) as a value creation tool within Malaysian automotive organizations. VE relates to a systematic and multi-disciplinary team approach adopted by organizations which analyze the functional requirements of new and existing products, projects or services. The aim is to achieve the essential function at the lowest overall cost while maintaining customers' optimum value assurance. Dual research methods comprising of case study and survey were adopted in this study. The survey findings were able to confirm and extend the case study findings. The findings indicate that VE is a common and routine activity within the automotive industry. Further, the stage model adopted in this study provides the understanding of VE innovation by confirming that the identified stages do exist and by indicating the contingencies, it determines whether the stages of adoption happen in a predictable order.

Introduction

In the present condition of globalization and trade liberalization, organizations are facing rapid advances in technology and scarcity of resources, thus they are expected to be innovative in order to be effective, grow and survive (Damanpour and Wischnevsky, 2006). Lindgreen and Wynstra, (2005) suggested that innovation and

product development are the core activities in the value creation process. For creating value, organizations need to be competitive and hence, it is essential that organizations continuously managed their costs and maintain better quality products that meet customers' changing needs and desires. If these are not achieved, organizations will not be able to survive nor sustain their position in the competitive market. Therefore, industries must increasingly display competitive characteristics which should stimulate the use of cost reduction and prevention techniques such as Value Engineering (VE) (Reuter, 1983) the focus of this study.

VE relates to a systematic and multi-disciplinary team approach adopted by organizations to solve problems in terms of value of product or service from the consumer's point of view (SJVE, 1981). As such, VE is considered to be an innovative tool that enables firms to sustain their business performance. This is because, VE aims to achieve the essential business functions at the lowest overall cost while maintaining customers' optimum value assurance. Despite being viewed as a management accounting tool by accounting researchers, VE is commonly applied for cost optimization in the engineering and technical field such as the automotive industry. Along this line of discussion, Lindgreen and Wynstra (2005) noted that there is a lack of research that examined corporate adoption of value tools like VE in their product development. Hence, there is a need to explore the role of VE, particularly within the Malaysian automotive organizations

This paper therefore, examines the extent of VE adoption within Malaysian automotive components manufacturing organizations. Both case study and survey methods are adopted to achieve the research design triangulation that enables findings in the study to be validly both in depth and breadth dimensions. The remaining of this paper presents the previous research on value creation, VE and diffusion of innovation studies. The dual research methods of case study and survey are explained in the following sections. The case study (dominant method) on an automotive manufacturing organization is conducted in phase one of the study. This is followed by a survey on the automotive industry in phase two of the study which complements the case study findings. The final section concludes the paper.

Literature Review

This section provides a review of the literature on value creation, Value Engineering (VE) and theory of diffusion of innovation.

Value Creation

Value creation can be developed through new products and services (Miller and Floricel, 2004) and this can be achieved by meeting customers' specific requirements, as they consider value as something worth paying for (Jancsurak, 1998; Maskell and Baggaley, 2001). Miller and Floricel (2004, p.26) have defined value creation as:

“The creative invention of new products and services to delight consumers by discovering new market spaces and thus increasing the utility that they draw from them”.

Value creation begins with the customer and hence manufacturers must be focused on customer needs and desires for products, and services, besides other value-added offerings (Maskell and Baggaley, 2001). It is essential that organizations anticipate and innovate to create new value to meet the customers' changing needs and desires. This is achieved through innovative products, services and processes. It is vital for organizations to understand the current and future value needed by existing and potential customers. Only organizations that provide a high level of value to their customers will prosper and survive.

Value Engineering (VE)

VE was first conducted by Lawrence Miles in 1947 at General Electric Company, USA. VE reflects breaking down an object into smaller parts. The aim is to detect and solve problem pertaining to the product value. The main use of VE is to identify and eliminate unnecessary cost, but it is also found to be effective in enhancing the performance of a product. The application of VE has increased from not just focusing on manufacturing products but to other sectors such as services, projects and administrative procedures. VE is also a methodological approach which seeks to design cost out of new products (Bescherer, 2007). VE evaluates new development

designs, which focus on other development possibilities that will enhance the value of the development. The Society of Japanese Value Engineering (SJVE) (1981, p.3) defines VE as:

“A systematic approach to analysing functional requirements of products or services for the purposes of achieving the essential functions at the lowest total cost.”

According to Gheorghe and Liviu (2011), the notion of function is the backbone in a VE exercise. Function reflects the natural or characteristic action that the product or process performs. Jergeas et al. (1999, p. 25) describe function in relation to what is to be achieved and ideally use a verb and noun such as “transport water” to clearly indicate the desired result. This description of a function provides VE team members with a variety of scope of thinking, which enables the creativity of the product or project to be enhanced (Fong, 1999).

A large body of literature exists on the practice of VE in the United States of America (USA) (Mansour, 1991; Rabino, 2001), Canada (Jergeas et. al, 1999), United Kingdom (UK) (Rwelamila and Savile, 1994), Iran (Mahdavi et. al., 2012), Hong Kong (Fong, 1998), Brazil (Ibusuki and Kaminski, 2007) and Japan (Yoshikawa et al., 1995). These studies examined VE in various industries which included manufacturing and construction. However, limited VE studies have been conducted in Malaysia and this was limited to only the construction industry. In addition, many researchers and practitioners of VE focused on the hard system, which included cost reductions through life-cycle costing, FAST diagrams and weight evaluation (Jaapar, 2006). A similar pattern also occurred in the local scene (Che Mat, 2002). In essence, VE was mostly examined from the operational and technical perspectives, and its application at the project level in the Malaysian construction industry. Given the limited studies in VE, it was not surprising to note that the application of VE in Malaysia was still at the infancy stage (Cheah and Ting, 2005; Jaapar, 2006). A review of the literature also revealed there were no empirical studies conducted on VE in the Malaysian automotive industry.

Diffusion of Innovation

Innovation is perceived as an important research area because innovations are expected to aid organizations to successfully adapt to and continue to exist in volatile business environments (Emsley, 2005). Innovation is defined by Rogers (2003, p.12) as:

“...an idea, practiced or objects that is perceived as new by an individual or other unit of adoption.”

As long as an idea, practiced or objects is perceived by an individual, group of individuals or an organization as new regardless of the lapse of time since its initial application or discovery, the term innovation can be used. This indicates that innovation may also have existed previously in a different form or in another area. In addition, the newness can be related to knowledge, persuasion or decision to adopt (Rogers, 2003). VE fits well with innovation characteristics and thus, can be viewed as an innovative technology. Further, VE provides a new way and improvement to an activity and this concurs with the studies of Zaltman et al. (1973) and Rogers (2003). VE is also viewed as innovative since it develops alternatives through the evaluation of creative ideas (Sperling, 2001).

The diffusion of an innovation reflects its spread of population of potential adopters over time. According to Frederickson et al. (2004), some would view the term diffusion as change whilst those who prefer a particular diffusion, call it reform or innovation. Rogers (2003, p. 11) defined diffusion as:

“The process by which an innovation is communicated through certain channels over time among members of a social system”.

The purpose of a diffusion of innovation research is to provide explanation or prediction of the rates and patterns of its adoption over time and/or space (Wolfe, 1994). Studies have examined the diffusion of innovation(s) in an organization (e.g. Attewell, 1992; Anthony, 2003; Ibrahim et al., 2007) and across organizations (e.g. Christian and Bjornenak, 2005; Yang et al., 2007). The adoption rates of innovation have been studied within a country (e.g., Bjornenak, 1997; Malmi, 1999) and across different countries (e.g.

Firth, 1996; Conde and Ruiz, 2001). Several of these studies also included analysis on the early and late adopters along with the diffusion of innovation plotted over time.

A review of the literature showed that diffusion studies on innovation have covered a wide area that included accounting, management, administration, technology and education. This suggests that it has a great multidisciplinary characteristic (Bjornenak, 1997). The diffusion of innovation studies is extensive which has encompassed on the manner innovation diffuses at the aggregate level through diversity of population of adopters, the determinants of innovativeness of organizations, and the processes of the implementation of innovation (Malmi, 1999). Additionally, many diffusion researchers have examined single (e.g., Cohen et al., 2005; Ibrahim et al., 2007) or several organizational innovations (e.g., Firth, 1996; Lapsley and Wright, 2004). Research on organizational innovation adoption generally focused on what made an organization more incline to change while other organizations were slower to change, as well as how environmental factors influenced an organization's decision to innovate.

Studies have shown that an innovation can be implemented in varying degrees. The varying degrees or extent of VE adoption was explained using the organizational adoption stage model by Cooper and Zmud (1990). The model consists of the following six stages:

1. Initiation - an organization searches for an innovation based on internal needs and external competitive threats.
2. Adoption – the organization makes decisions to invest resources to facilitate change.
3. Adaptation – Unforeseen needs are identified in the process of changing.
4. Acceptance – Employees are persuaded to commit to use the new technology.
5. Routinisation – Innovation application is encouraged as a normal activity.

6. Infusion – The innovation is applied in a comprehensive and integrated manner which enhances organization's effectiveness.

According to Gallivan (2001), the crucial variable in organizational adoption is that it is not innovation use or user adoption per se that is of concern as the outcome of interest, but rather the extent to which the organization uses the innovation and its effects on processes, structures and cultures within the organization. Therefore, it is important to highlight the extent of organization adoption of innovation processes rather than whether or not the organization adopts the innovation. Consistent with the above, this study examines the extent of VE adoption within the automotive organizations.

Case Study Design

Case study which forms the dominant method is used to explore the extent of VE adoption within the automotive case organization. The method chosen is based on the intentions of the study, which are to specify the information type to be collected in advance of the study and to allow issues to emerge from the investigations. Part of the preliminary investigation on the automotive component manufacturing industry included initial discussion with experts from the automotive industry, attending meetings conducted by the national automotive association and analysing related secondary sources. The preliminary investigations have enabled information on the general practice of the VE within the automotive industry and eased the identification of the case company. A Malaysian automotive component manufacturing organization was the subject of this case study. The status of the case organization as a leading manufacturer, being in the maturity stage of VE practice, its willingness to participate in the case study and the proximity of the firm's location were factors that contributed to the selection of the case firm.

Company Background

This Malaysian automotive component manufacturing company was established in 1989 with a paid-up capital of RM2.5 million. The case company's nature of business is to manufacture and supply automotive fluid transfer systems, engine metal parts and components and transmission

systems. Through its subsidiary company, the case company provides services which include engineering consulting and design and manufacturing and installing jigs and fixtures. The case company has two plants (Plant A and Plant B) located in Malaysia. Plant A manufactures stamping and tubing products, which include engine parts, tubing and break system. On the other hand, Plant B manufactures modular products such as fluid lines and fuel filler neck. The case company's products are marketed to the national and foreign automotive manufacturers and assemblers in Malaysia.

Multiple Sources of Evidence

The aim of a multiple source of evidence is to corroborate evidence from one source with the evidence from other sources. This suggests the triangulation of data with the intention of corroborating the same theme or phenomena. Thus, the construct validity of the findings can be enhanced through the multiple sources of evidence adopted in this study, (Hoque and Hopper, 1994). Furthermore, its main advantage is to develop converging lines of inquiry (Brewerton and Millward, 2003) which will lead to accurate and convincing case study findings. The varieties of sources included semi-structured interviews, documentation, observations and external information of VE practices in the case organization.

Semi-structured Interviews

Semi-structured interviews were the primary source of qualitative data (Innes and Mitchell, 1990) for the case study. The semi-structured interviews were conducted face to face on the field site with relevant personnel from different functions and hierarchical levels. This was to secure a variety of perspectives (Perera, 2005). The informant included the Managing Director, plant manager, personnel of the quality, production, engineering, logistic, research and development, accounts and human resource departments. Table 1 provides the information on the semi-structured interviews conducted at the case organization.

Table 1: Information on Semi-Structured Interviews

Case Study	No. of interviews	Interview range (Hour)	Total interviewed hours	Average interviewed hours	Longest interviewed hours
Phase 1	19	1 - 2.56	26	1.38	2. 56

A total of approximately 26 interview hours were conducted on the 19 personnel. 83% of the informants were males and approximately 72% of them had tertiary education. Majority of them had an engineering background and half of them had been with the case organization for more than ten years. On average, an interview took approximately 1 hour and 38 minutes; however the longest interview of almost three hours was conducted with one of the R&D (Research and Development department) personnel. More time was required as he was fully and directly involved in all the company’s VE activities.

Documentation Review

The aim of examining the organizational documents was to provide an understanding of the VE practice, which included its application and results. The document review provided information on the organization charts, financial reports, organizations structure, performances and an understanding of its history and language which facilitated the focus of the interviews. Documents were also gathered on information relating to technical form of VE, its implementation, operation processes and results of its application. These documents and other pertinent written materials were collected and analyzed, along with other sources of evidences to enhance the construct validity of the findings (Yin, 2003). In order to compare findings from the semi-structured interviews and documentary review with the actual behaviour, the researcher carried out non-participatory observations of several relevant meetings and plant tours.

Observations

Direct observations were possible by making several field visits to the case organization. This involved observations of several plant tours, formal and informal meetings, sidewalk activities throughout the organization and its two plants. The plant tour was to observe the entire process flow

of the products manufactured by the case company from its initial to final stage. This observation provided a fuller understanding of the production process. Several opportunities for direct observation were also made during the 'morning market highlights' and VE meetings with its major customer. Copies of the minutes taken at all the meetings were reviewed and analysed.

External Information

Scrutiny of the external information, which included its professional magazine, company website and a brief documentary of the case organisation, was obtained. The external information collected enabled a better understanding of the case organisation's involvement in various activities within its social system and the views from external parties. The findings of the documentary evidence, observations and external information further validated the evidence through interviews.

A qualitative analysis software program, NVivo was used to manage, code, analyze, and model the data. The textual data were coded using tree nodes that were organised in a hierarchical structure. Emerging themes were also identified and coded as free nodes. NVivo was used to 'pull down' from the data key patterns and themes and search for interrelationships.

Survey Design

The literature review and case study findings aided in the development of the questionnaire used in the survey. The objective of the survey was to complement or enrich the case study findings. The not well answered issues addressed by the case organization were filled-up through the survey method. The survey has provided diversity in the VE population and practices. Sulaiman (2005) pointed out that management accounting research should consider the triangulation method, as it was not appropriate to be over reliant on one particular method. There were strength and weaknesses in both the case study and survey methods and as such both methods complemented one another.

Questionnaire Design

To explore the research objectives, a survey instrument was developed to collect the specific information about the characteristics of the organization, its product diversity, competition level, knowledge and application of the technique and companies effectiveness. As suggested by Brewerton and Millward (2003), the questionnaire had to be customized according to the level and specific characteristics of the target population. The questionnaire also included regular skip patterns. The respondents could skip questions and sections within the survey instrument, which were not related to them. Even though the survey was mainly quantitative in nature, there was avenue for several qualitative responses in the questionnaire. This took the form of open-ended question requesting for their perception on whom and why the champion for VE was chosen.

Sample Selection and Target Respondents

Table 2 presents the information of the sample selected from the automotive industry.

Table 2: Sample Size of the Survey

Category	Total population	Number selected (Sample size)	% of total population	Response rate
Survey (Automotive industry)	133	133	100	32% (42)

A substantial amount of time and effort is required to conduct the in-depth case study (Hopmann, 2002). Hence, the time, effort and cost considerations associated with the collection of both the qualitative and quantitative data had delimited the sample of the participant organizations for the survey to the population of the National Automotive Vendors Association (NAVA). The NAVA represents the national car manufacturer’s fraternity, which was launched in 1992. As to the national car manufacturer, the vendors are their partners in business. The members are among the main suppliers and manufacturers of automotive parts and components in the country. The latest NAVA Directory provides the members list (133 registered members) and, it contains vendors’ addresses and background information. The choice of

suitable respondents was in tandem with the findings from the case study and relevant literature reviews. The respondents in the survey included the R&D managers and personnel from the procurement, production, quality control, logistic, engineering, and accounts and finance departments.

Response Rate

After several follow-ups, eventually 43 responses were received with one incomplete questionnaire which was subsequently excluded from the analysis. As shown in Table 2, the survey generated 42 completed questionnaires with a response rate of 31.6% (42/133).

Case Findings

The extent to which the automotive case company has adopted VE is explained in terms of its stage of adoption, areas of application and tools used.

Stage of VE Adoption

The automotive case company regularly conducts VE exercises internally as well as with the customer. The 'VE In-house' is a routine cost reduction exercise for material and supplier change as well as product improvement and process enhancement. The PMC (Purchasing Material Control) department conducts VE on procurement activities for the material change supplier on an annual basis. The R&D division together with the other departments conducts VE for product and process enhancement on a regular basis. In addition, 'VE with customer' is an annual cost reduction exercise requested by the customer. Although the customers request the case company to use VE for cost reduction, the personnel particularly in the R&D division undertake to conduct VE on their own initiative as well as part of their daily activities. According to the R&D manager:

“Most of the time, it is based on our own initiative or department’s initiative. Sometimes it is based on their knowledge and experience. They refer to customers’ internal process. That’s how they got the idea to improve the process or reduce cost. Our contract here is to reduce cost, improve our production and productivity using VE.”

The remaining interviews and reviewed documents evidences suggested that employees perceived VE as a routine activity. Moreover, the application of VE was also emphasized in the mission and quality objectives. There seemed to be a culture of always trying to reduce costs and the need to continuously enhance business process using VE within the case company. Furthermore, consistent with Rogers' (2003) report the case company has adopted VE since its incorporation and the employees accepted it as a regular activity. Therefore, based on the analysis the current application of VE within the case company has reached the fifth or routinization stage of Cooper and Zmud's (1990) stage of innovation adoption model. Figure 1 summarizes the case company's current status in terms of VE innovation extent of adoption.

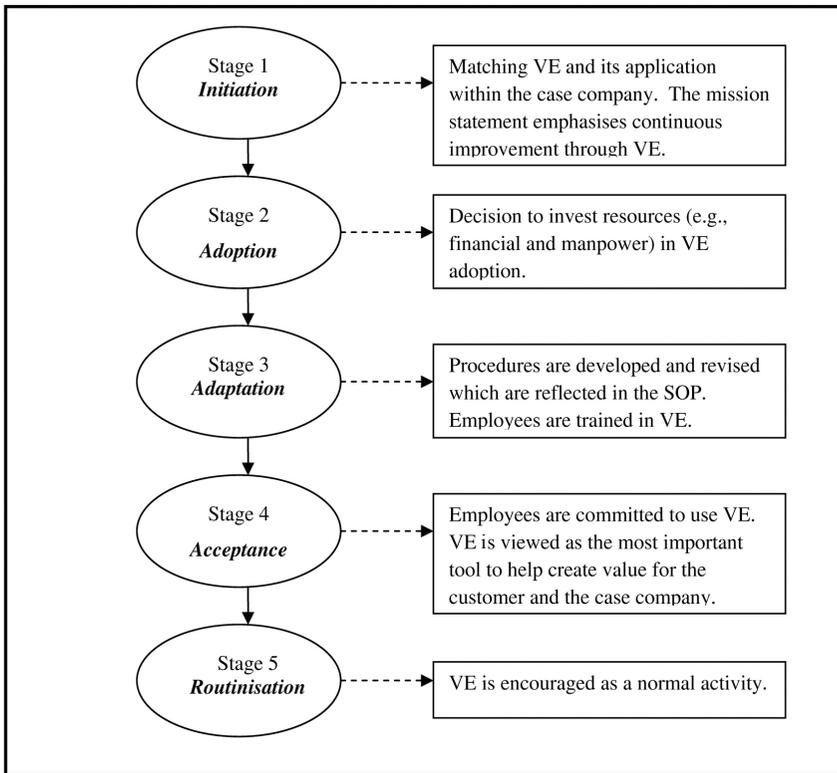


Figure 1: Summary of Stages of VE Adoption

Stage of VE Application

Multiple evidences gathered showed that VE exercises used to enhance products and processes within the case company were mostly conducted on existing products that were mass produced. This was because the design had already been finalized and suppliers of components were required to strictly follow the part design provided by the customer. However, to date, the case company had conducted one VE exercise at the late design stage of an upcoming model at the request of the customer. The aim of the VE exercise was to achieve fuel consumption saving through cost and weight reduction in body parts. Nevertheless, Customer 2 emphasizes that:

“Normally, VE exercise is conducted during the design stage of project development since it is the best time to study what is best for the product and process, given customer requirements for a product.”

Furthermore, according to researchers (e.g., Tani et al., 1994; Yoshikawa et al., 1995), optimum benefits from VE exercises are achieved when it is applied at the design stage. Nonetheless, it could be concluded that VE was used at the design, as well as at the manufacturing stage within the case company.

Areas of VE Application

The extent of VE application within the case company focused on the procurement activities, product enhancement and process improvement. The purposes of VE exercises were to reduce cost as well as improve quality of products, which subsequently added value to the customer. VE conducted on procurement activities enabled the purchase of existing or alternative materials at competitive prices. Product enhancement was achieved through reducing defects on completed parts. Process improvement was achieved by eliminating non-value added process such as the reworking process. Customer 2 supported this point:

“Areas for VE activities include process improvement, product enhancement and/or cost reduction.”

Tools Used

The analysis showed that various tools or concepts are adopted to enhance the application of VE for product improvement. Table 3 provides examples of the tools used by the case company to enhance VE application.

Table 3: Examples of VE Tools/Techniques or Concepts Used

VE tools/ techniques or concepts	Aims
The concept of 'cost' Pareto's analysis	Emphasis on the most profitable customers
Issues related to VE in corporate context	Corporate strategy adopted was customer driven. From the economics perspective, the focused was on creating and adding values for the customers through cost reduction and providing competitive price.
Creative thinking technique	Brainstorming applied in gathering ideas.
The concept of 'Value'	All levels of management had adopted the attitudes based on value.
VE as an indirect tool	It enhanced communication, and promoted culture of cross-discipline coordination and teamwork.
Function analysis	Focused on customer requirements and achieving their satisfaction of needs.

Other methods and tools used in VE study also included Advanced Product Quality Planning (APQP), Failure Mode and Effect Analysis (FMEA), Quality Circles, Quality Function Deployment (QFD), Kaizen, Ishikawa diagram, Five Why and target setting. Thus, consistent with the empirical studies in the VE literature (e.g., Prasad, 1998; Chin et. al., 2005) the VE study within the case company involved the integration of many different tools, concepts and methods which emphasised on product improvement and process enhancement in creating value for the customer.

Survey Findings

Survey findings on the adopters of VE and the extent of VE adoption within the automotive industry are presented in this section. Table 4 presents the frequency of non-adopters and adopters of VE.

Table 4: Does your Organization Practice or Use VE?

	Frequency	Percentage (%)
No	5	12.0
Yes	37	88.0
Total	42	100

Overall, 42 responses were received from the survey. The result indicated that 88% of the organizations practiced VE in the automotive industry.

Organization Characteristics and Structure

The characteristics and structure of the adopters of VE encompass its year of establishment, main business activity, industry level and size. Table 5 shows the descriptive results of VE adopters.

Table 5: Organizations' Characteristics and Structure

Number of years incorporated		
	Frequency	Percentage (%)
< 5 years	-	-
5 to 10 years	3	8.1
11 to 15 years	9	24.3
16 to 20 years	12	32.5
> 20 years	13	35.1
Total	37	100
Main business of organization		
Metal	14	37.8
Plastic	7	18.9
Rubber	3	8.1
Electrical	3	8.1
Other	10	27.0
Total	37	100
Industry level		
Tier 1	20	54.1
Combination of Tier 1 and 2	17	45.9
Total	37	100
Number of employees		
< 50	4	10.8
51 – 100	5	13.5
101 – 200	7	18.9
201 – 300	4	10.8
301 – 400	6	16.2
401 – 500	5	13.5
501 – 1000	5	13.5
> 1000	1	2.7
Total	37	100

The result showed that just over a third of the automotive (35.1%) organizations had been incorporated for more than 20 years and this revealed well-established organizations (Sulaiman, 2003). The nature of

the main business activity was distributed over five categories, which were based on the latest NAVA directory. 37.8% of automotive organizations manufacture metal products, while 27% manufactured glass, carpet and rubber floor. Over half of the respondents (54.1%) belonged to Tier 1. Tier 1 organizations supplied parts and components directly to the Original Equipment Manufacturers (OEM). They were the supplier organizations situated closely to the automotive industry supply chain. The size of both the automotive organizations was represented by the number of employees and annual sales turnover. In addition, there was a considerable spread in the size of the automotive organizations. This suggested that VE was adopted irrespective of the size of the organizations.

Extent of VE Adoption

The extent of the VE adoption covers areas of its application and tools used in VE. This will be discussed in the subsequent sections.

Areas of VE Application

Table 6 shows the summary of the results of the descriptive analysis on areas of VE application¹ in the automotive industry. The areas of VE applications in the automotive organizations are classified into five categories namely production process, purchasing of raw materials, purchasing of parts/components, products, and projects

Table 6: Summary of Descriptive Results on Areas of VE Application

Areas of application	N	SD	Mean	Median
1. Production process	35	0.871	3.71	4.00
2. Product	31	0.674	3.64	4.00
3. Purchasing of raw materials	36	1.164	3.53	4.00
4. Purchasing of parts/components	36	1.034	3.52	3.50
5. Project	31	0.850	3.50	4.00

SD: Standard Deviation

¹ Respondents are required to determine the level of application for the identified area based on a five Likert scale which ranges from 'never' (1) to 'always' (5). An option 'not applicable' is also given which represents the area of application not related to the respective organizations.

The highest means were seen in the production process (3.71), followed by the product (3.64) and purchasing of raw materials (3.53). These results indicated that the application of VE was mostly used within the manufacturing processes. It was obvious that VE was used as a tool to reduce production cost and manufacturing cycle. In addition, the application of VE could also be extended to other activities, which included product development, purchasing of raw materials, purchasing of parts/components, and project development. This finding suggested that VE was not used in every single product or project and procurement activities.

VE Tools

The VE methodology was underpinned by a variety of key concepts, tools and techniques such as the job plan and Functional Analysis System Technique (FAST). The extent of the VE adoption could be examined by relating to the number of tools, techniques or concepts of VE used by adopters. The higher number of tools, techniques or concepts used by an organization could imply the innovativeness and extensiveness of adoption within an organization. Table 7 tabulates the descriptive results of the VE tools/techniques or concepts adopted by organizations within the automotive industry.

Table 7: Descriptive Results on VE Tools/Techniques or Concepts Adopted

VE tools/techniques or concepts ¹	Number of responses	Percentage (%)
1. The concept of 'cost' (e.g. Pareto's 80-20 rule; life cycle costing)	19	45.2
2. Issues related to VE in corporate context (e.g. target costing, strategy and economics viewpoint)	14	33.3
3. Creative thinking techniques	10	23.8
4. Job plan	8	19.0
5. The concept of 'Value'	8	19.0
6. Functional analysis	7	16.7
7. VE workshop	6	14.3
8. Enhancing scope of VE by adopting successes from related areas such as IT, robotics etc.	3	7.1
9. VE as an indirect tool to serve other purposes (e.g. enhance communication; promote culture of cross-discipline coordination)	3	7.1
10. None	2	4.8
11. Other	2	4.8
12. FAST diagram	1	2.4
13. Value Management Change Proposal (VMCP)	1	2.4
Total valid responses	37	

Table 7 shows that 45.2% of the organizations used 'cost' concept such as Pareto's 80-20 rule and Life-Cycle Costing (LCC) in their VE exercises. Observations made under Pareto analysis showed that a very small proportion of items (e.g. 20% customers) normally accounted for the majority of the value (e.g. 80% profits). Special attention can be directed towards enhancing the relationships with the most profitable customers in ensuring the organizations' valued customers. The link between Pareto analysis and VE lies in the emphasis on customers' value creation. While through LCC, the management will be able to understand the cost consequences of developing and manufacturing a product and identifying areas whereby the cost reduction effort is considered as most effective. The LCC in VE evaluates the alternatives generated during VE exercise

(Fisher, 1999) which enables an opportunity to determine the most cost effective and highest quality alternatives for expenditure while ensuring cost minimization throughout the life cycle period.

Approximately a third (33.3%) of the responses applied VE in the corporate context by using target costing (TC) or strategy and economics viewpoint. TC aided in reducing cost at both the planning and design, and production stages of the life cycle of a product or project. The objective of the technique was to achieve the target cost specified for the product at the required functionality, quality level and other customer requirements. The VE was used as a means of reducing cost as well as achieving the target cost (Kato, 1993). TC and VE by way of functional analysis were effective cost management systems and the two were linked through the assignment of target cost to individual product functions (Tanaka et al., 1993).

Summary of Findings

This study has provided an explanation of the extent of the adoption of VE in Malaysia particularly within the automotive industry. The case study findings revealed that the extent of VE adoption can be associated with the breadth and depth to which the case company used VE. The arrears of VE application and the number of various tools used suggested the breadth of the VE exercises. The stage of adoption was related to the depth of use of VE within the automotive case company. In addition, VE adoption within the case company was in the routinisation stage which indicated that the VE exercise was a normal and routine activity. In a sense, it was a regular practice for product and project development within the automotive case organization. The case company conducted VE exercises on all areas namely procurement of materials, enhancement of product's/project's function and quality, and improvement in production processes. VE was applied not only for the manufacturing processes but also for the planning and design of products within the case company. The case company used a variety of VE tools/techniques, as well as other related tools to enhance the product and project values. In the second phase of the study, the survey findings indicated that most of the organizations that adopted VE were mature organizations, involved in manufacturing metal components and of different sizes. The extent of VE adoption was reflected in the widespread areas of VE application and the various tools used in VE in the automotive industry.

It can be concluded that VE was applied in a wide range of areas in the automotive industry. However, VE was mostly applied in the manufacturing processes within this industry to reduce production costs and shorten the manufacturing cycle. Similar with the findings found in the case study, VE exercises in the automotive industry was also carried out for other activities, including product development, purchasing of raw materials, purchasing of parts/components, and project development. Thus, the survey findings have provided support for and extent the case study findings.

Nevertheless, VE application by automotive organizations was aimed at cost reduction without compromising quality, reliability and customer requirements. This provided support for findings found in the literature (Mansour, 1991; Hartley, 2000; Davies, 2004). Automotive organizations apply varieties of tools or concepts which are used either in combination with VE to enhance customers value and organizations profit or/and as an indirect tool to achieve other objectives. In general, the results also indicated the innovativeness of the organizations/industries as reflected by the number of tools used in VE. Overall, these results suggested that VE application was not just limited to the early stages of the product or project development but organizations did apply it at the latter stages.

Conclusions

Several conclusions can be made from the research findings. First, the research findings added to the growing body of literature on VE and theory of diffusion of Innovation. Second, research has been lacking in examining the corporate adoption of value appraisal tools such as VE in terms of product development. The study of VE would normally be a part of a broader study of the application of other tools such as Target Costing and Life Cycle Costing, suggesting that little consideration was given by researchers to investigate and explain VE in its entirety. Third, the description of the current VE practices in Malaysian organisations was a significant contribution of this research. VE was discovered to be a common and routine activity within the automotive industry. The findings further advanced the research on the general practice of VE in Malaysia, explicitly within the automotive industry. Fourth, this study was also able to confirm and identify the predictable adoption stages of VE. The stage model of

Cooper and Zmud (1990) adopted in this study contributed to the literature on the understanding of VE innovation by confirming that the identified stages did exist and by indicating the contingencies, which determined whether the stages of adoption happened in a predictable order. Fifth, the findings from this study showed that the integration of VE with several other tools in VE exercises enabled value creation for customers in terms of cost, time and quality through product/project enhancement and process improvement. This study has further contributed to the limited literature on how organizations adopted and implemented innovations from both the theoretical and practical perspectives. Therefore, the answers to 'why' VE was adopted by some organizations and not by others could aid Malaysian VE propagators in the wider diffusion of the innovation. Finally, the case study findings on the adoption of VE within the automotive components manufacturing case company were able to meet Scapens' (2006) challenge for the future. This is achieved by applying the theoretical informed understanding through using in depth case study in providing insights, which were relevant and useful for practitioners besides enriching the knowledge of reality (Afonso et al., 2006). Hence, indeed the dual method used also ensured that a holistic approach was undertaken to contribute to the theoretical, analytical, contextual and statistical generalizations.

The limitations in conducting a case study included among others the problems of generalization, time constraints and personal perceptions of the informants. There were also some limitations associated with the survey research in the present study, such as low response rate, and non-response biasness. Despite the common limitations observed in the present study, clearly, the findings explained above have extended and expanded the current literature. Therefore, it is hoped that this study will help to provide some answers, as well as become a foundation for future investigations.

A worthy area for future research would be in relation to looking at how various categorizations of management accounting innovations, including VE, may aid in teasing out the factors that significantly facilitate or impede their adoption in various industries. Further research could replicate the exploratory survey on a broader perspective involving other industries to substantiate the present findings and covering different types of management innovations are also merited. In addition, collaboration between academicians and practitioners using an interventionist type of

research would also enable a superior understanding of the application of VE. Interventionist research enables the interaction of both parties to search for solutions to the problems of real organizations (Lukka, 2006). This type of research aims to narrow the gap between practice and academic theory. In this instance, the researcher becomes more closely involved with problem solving or change processes through his involvement in the VE study conducted in a real organization, as well as getting the opportunity to develop and contribute to academic theory. Hence, while the present study has made several significant contributions to the rapidly growing body of literature on VE and, diffusion and adoption of an organizational innovation, many challenges, and opportunities for future researchers remain.

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