THE IMPLEMENTATION OF FUNCTIONAL ANALYSIS USING VALUE ANALYSIS VALUE ENGINEERING (VAVE) APPROACH DURING NEW PRODUCT DEVELOPMENT (NPD) PHASE

BY

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ABSTRACT

To remain competitive in global marketplace, automotive manufacturing organizations need to improve their development process. One of the methods is by producing high-quality products that can meet customer desires and at the same time trying to increase the operating income requirements for the organizations. This is important to ensure the product can be properly developed with the right specification, quality, cost and time. Current intense worldwide competition in the global marketplace force these industries to generate better demanding environments which make them to think more than twice before applying their development guideline. This thesis attempts to develop a systematic approach that is able to measure and enhance the product value by either improving the product performance or decreasing the product cost through focusing on one of the tools used in Value Analysis Value Engineering (VAVE) methodology; Functional Analysis and its implementation during New Product Development (NPD) phase. A case study on product part problems from one of the automotive organisations in Malaysia is analysed, within several selected performance criteria's. Few concepts and designs within the scope model of this study are developed. The 2-Dimensional and 3-Dimensional simulation models are designed, tested and implemented using CATIA V6 simulation package to generate various development scenarios. The discrete simulation events are used to find the difference among the different concepts and designs. Then the performance measures of various development phases are used to produce and at the end introduce the alternative through the prototyping designs. The decision matrices are also developed in this thesis. The development of these matrices involved generation of several important tables. These matrices are capable of analysing the performance score of particular designs and showing the potential improvement. Furthermore, the application of these matrices also enable user to proceed with the cost evaluation before finally resolve the problems. The framework produce in this thesis is generated enough and may be used for further study either to test various development phases or extending its application to other problems.

خلاصة البحث

تحتاج منظمات تصنيع السيارات إلى تحسين عملية تطويرها لتبقى منافسة في السوق العالمية. إحدى الطرق لتحقيق ذلك هي بصنع منتجات عالية الجودة تلبي رغبات الزبون، وتحاول في الوقت نفسه زيادة متطلبات الدخل التشغيلي للمنظمات. إنّ هذا مهم لضمان إمكانية تطوير المنتج كما ينبغي في المواصفات، الجودة، التكلفة والوقت. تؤدي المنافسة القوية الحالية في السوق العالمية إلى إجبار هذه الصناعات على تهيئة بيئات أكثر تطلباً ما يجعلها تفكر أكثر قبل تطبيق مبادئها التوجيهية الإنمائية. تهدف هذه الأطروحة إلى تطوير طريقة منهجية قادرة على قياس وتحسين قيمة المنتج إما بتطوير أداء المنتج أو خفض تكلفة المنتج من خلال التركيز على إحدى الأدوات المستخدمة في طريقة الهندسة القيمية التحليلية (VAVE)، التحليل الوظيفي وتطبيقها خلال مرحلة تطوير المنتج الجديد (NPD). تم تحليل دراسة حالة عن مشاكل قطعة منتج من إحدى منظمات السيارات في ماليزيا ضمن عدة معايير مختارة للأداء. طُوّر عدد قليل من المفاهيم والتصاميم ضمن نطاق نموذج هذه الدراسة. تم تصميم، اختبار وتطبيق نماذج المحاكاة ثنائية الأبعاد وثلاثية الأبعاد باستخدام حزمة المحاكاة CATIA V6 لتكوين سيناريوهات تطوير مختلفة. أُستخدم محاكاة الأحداث المنفصلة لإيجاد الفرق في المفاهيم والتصاميم المختلفة. بعد ذلك، أُستخدم مقاييس الأداء لمختلف مراحل التطوير لإنتاج وتقديم البديل في النهاية من خلال تصاميم النماذج الأولية. كما تم تطوير مصفوفات القرار في هذه الأطروحة. تضمّن تطوير هذه المصفوفات تكوين عدة جداول مهمة. هذه المصفوفات قادرة على تحليل درجة أداء تصاميم معينة وإظهار التحسّن المحتمل. علاوة على ذلك، تُمكّن تطبيق هذه المصفوفات أيضاً المستخدم من المضي قدماً في تقييم التكلفة قبل حل المشاكل في النهاية. تم تكوين إطار العمل في هذه الأطروحة إلى حد مقبول ويمكن استخدامه لمزيد من الدراسة إما لاختبار مراحل التطوير المختلفة أو توسيع تطبيقه على مشاكل أخرى.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science (Manufacturing Engineering).

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DECLARATION

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DFMA	Design For Manufacturing and Assembly
FAST	Function Analysis Systems Technique
MTBF	Mean Time Before Failure
NPD	New Product Development
PDS	Product Design Specification
VA	Value Analysis
VASAC	Value Analysis Study Activity Chart
VE	Value Engineering
VM	Value Management

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Increasing competitiveness worldwide has forced automotive manufacturing organizations to seek to produce high-quality products that can meet customer desires and at the same time try to increase the operating income requirements for the organization. In order to reach this goals, today's automotive manufacturing organizations are required to develop their own set of processes to be used as a product development guideline for any new models and for the enhancement of the existing models. However, current intense worldwide competition in the global market place force these industries to generate better demanding environments which make them to think more than twice before applying their development guideline. Despite the advantages of ensuring the product to be properly developed with the right specification, quality, cost and time, organizations that cannot provide high value products and services to their customers will cease to exist (Gerhardt, 2011).

A NPD phase is a stage-gate product development process used by many companies in order to encourage rapid product development and to cull out the least promising projects before large sums of money are committed (Dieter & Schmidt, 2008). Other than that, NPD encompass the complete engineering design process; conceptual design, embodiment design, detail design, planning for manufacturer, planning for distribution, planning for use and planning for retirement. The characteristics of NPD can be explained through figure 1.1 and figure 1.2.

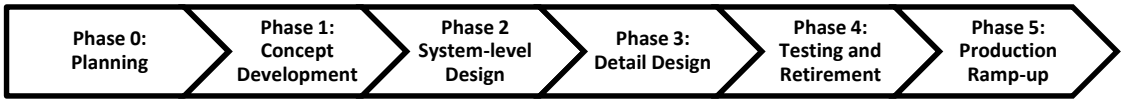


Figure 1.1 The product development process in stage-gate format (Dieter &Schmidt, 2008).

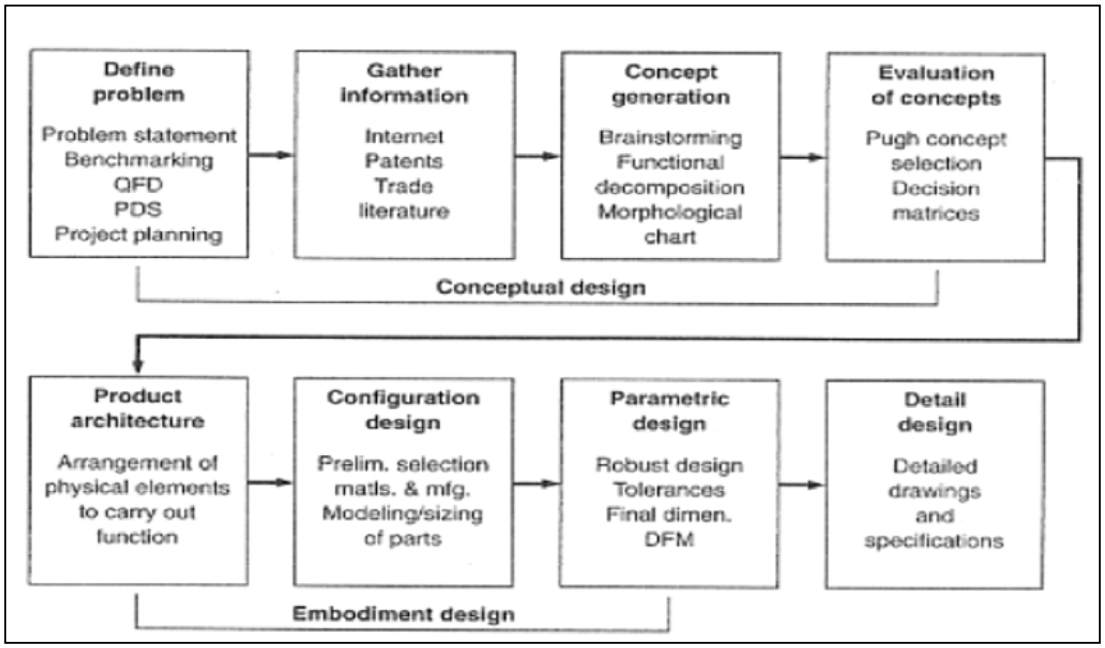


Figure 1.2 Discrete steps in engineering design process from problem definition to detail design. The chief tools or techniques applicable in each step are given (Dieter & Schmidt, 2008).

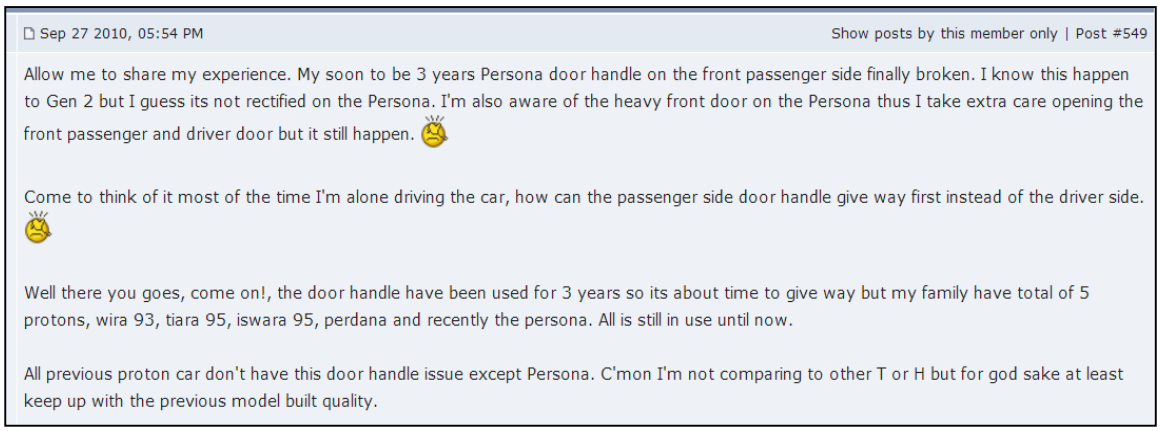
1.2 STATEMENT OF THE PROBLEM

In order to grab trust from the customers, most of the car manufacturers have offered the different set of features for the different type or model of cars in the different market segments that they have targeted. However, it is a challenge for those manufacturers to provide a win-win situation within the customers, manufacturers and suppliers. The manufactures may require more expertise, time and cost in order to fulfill customer requirements while at the same time search for the maximum profit.

On the other hand, the customers may search for a higher value of products and services where they can also have their desired appearance and features.

For example, PROTON has come out with a new pattern of the outer door handle for it recent models; Gen2, Persona, Saga BLM and Satria Neo to replace the previous one on Waja. However, lots of complaints received from the customers regarding the poor quality. Figure 1.3 shows part of the experience shared by one of the Persona user.

For that, PROTON has proposed vehicle cost reduction study via the application of VAVE methodology. This is to ensure total cost can be reduced or at least maintained while developing higher value of products or services as per requested from the customers and at the same time trying to maximize the profit for both the manufacturers and suppliers. The bottleneck of this study is based on one of the tools use in VAVE; Functional Analysis.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Allow me to share my experience. My soon to be 3 years Persona door handle on the front passenger side finally broken. I know this happen to Gen 2 but I guess its not rectified on the Persona. I'm also aware of the heavy front door on the Persona thus I take extra care opening the front passenger and driver door but it still happen.

Come to think of it most of the time I'm alone driving the car, how can the passenger side door handle give way first instead of the driver side.

Well there you goes, come on!, the door handle have been used for 3 years so its about time to give way but my family have total of 5 protons, wira 93, tiara 95, iswara 95, perdana and recently the persona. All is still in use until now.

All previous proton car don't have this door handle issue except Persona. C'mon I'm not comparing to other T or H but for god sake at least keep up with the previous model built quality.

Figure 1.3 Experience shared by one of the Persona user ("PROTON Problems Official Thread", 2010).

1.3 RESEARCH OBJECTIVES

This research is started by solving the current issues arise among the demanded vehicles. It is expected that, by solving those issues through increasing the value of the

vehicles can develop more trust from the customers. Previous survey shows common problems faced by the customers were power window faulty, high fuel consumption, gear not engaging properly, dashboard rattles/vibrates and door handles faulty ("PROTON cars", 2000). Figure 1.4 summarized those problems according to their percentage of occurrences.

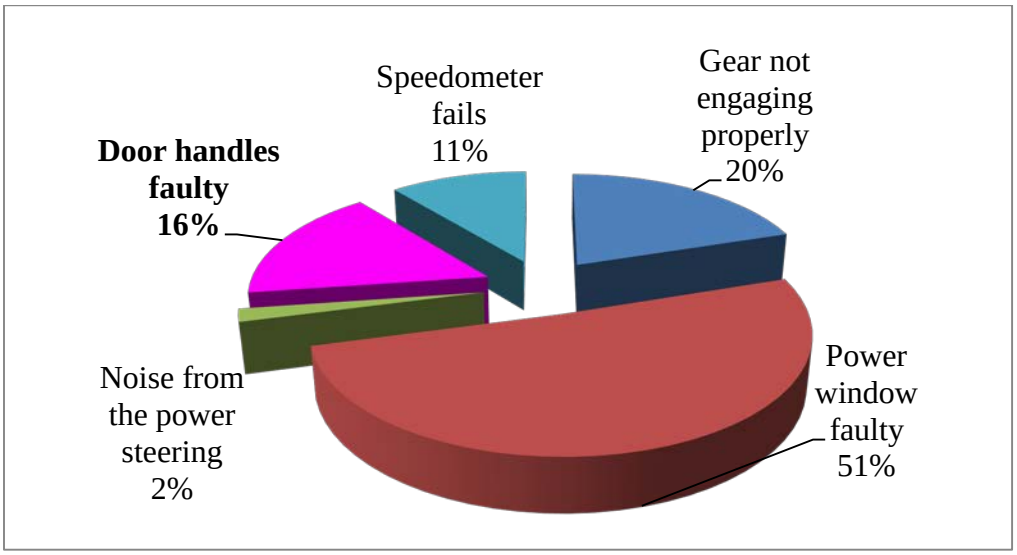

Figure 1.4 PROTON Problems ("PROTON cars", 2000).

Below are the objectives of this research study:

1. To evaluate Voice of the Customer (VOC) on the various vehicle model designs and performances.
2. To determine how VAVE can be implemented during NPD phase for enhancing the value of vehicles.
3. To identify the effectiveness of VAVE through the development of part redesign for vehicle within vehicle cost reduction framework.
4. To propose the value of an improved model based on VAVE methodology.
5. To validate the model against the existing data and information.

1.4 RESEARCH QUESTIONS

1. How are the various vehicle model designs and performances on the eyes of the customers?
2. How vehicles value can be enhanced?
3. What is the effectiveness of implementing VAVE through the development of part redesign for vehicle within vehicle cost reduction framework?
4. How to determine the value of an improved model?
5. How to prove that the selected model is improved from the previous one?

1.5 SIGNIFICANCE OF THE STUDY

This study is going to enhance the current design of vehicle part through its functions in order to meet the customer requirements of having higher value vehicle, while at the same time trying to reduce the total vehicle cost and maximizing the profit for the manufacturers and suppliers without scarifying the quality, salability and maintainability (Rich, 2000).

1.6 LIMITATIONS OF THE STUDY

This study is concerning on one of the tools used in VAVE methodology; Functional Analysis and its implementation during the NPD phase of redesigning the outer door handle for vehicle. Outer door handle was chosen as it is among the common problems encountered by the customers (Rich, 2000) and it is the first part to be reached with which represent the first impression of the customers towards the vehicle before they can access their car. Moreover, the four-door family sedan car, B Segment; Proton Saga is chosen as it is among the popular car models that has higher potential to be improved base from the current market demand analysis.

The other constraints of this study are:

1. This study focused on redesigning the outer door handle based on the basic functions found through the Functional Analysis without going deep into the mechanical analysis.
2. The design process is started from the conceptual design until the detail design.
3. The design process is not covered the material selection analysis in detail.
4. The design process is not concerned on the ergonomic study and the Mean Time Before Failure (MTBF) analysis.

1.7 CHAPTER SUMMARY

This chapter has presented and discussed the background of the study. It explained why proper product development process is vital to create better demanding environment. Definitions of concepts were included several sources. Additionally, the statement of the problem was discussed, as this study set to discover the opportunity for total vehicle cost reduction through the application of VAVE methodology. This chapter also presented the research objectives and questions. The significance of the study followed; highlight how this study fills the gap in research literature within vehicle cost reduction framework during NPD phases. Finally, the limitations of the study were mentioned.

CHAPTER TWO

LITERATURE REVIEW

2.1 ENGINEERING DESIGN PROCESS

Discrete steps in engineering design process from conceptual design to detail design are described as follows:

1. Conceptual design – is the process by which the design is initiated, carried to the point of creating a number of possible solutions, and narrowed down to a single best concept. It is sometimes called the feasibility study. Activities that are considered under the conceptual design are identification of customer needs, problem definition, gathering information, conceptualization, concept selection, refinement of the Product Design Specification (PDS) and design review.

2. Embodiment design – is where the structured development of the design concept occurs. It is the place where flesh is placed on the skeleton of the design concept. An embodiment of all the main functions that must be performed by the product must be undertaken. This design phase sometimes called preliminary design. It concern with three major tasks; product architecture, configuration design and parametric design.

3. Detail design – is the phase where the design is brought to the stage of a complete engineering description of a tested and producible product. Missing information is added on the arrangement, forms, dimensions, tolerances, surface properties, materials and manufacturing processes of each part (Dieter & Schmidt, 2008).

2.2 TARGET COSTING

2.2.1 DEFINITION

"Target costing is a proactive cost control system. The target cost is calculated by deducting the target profit from a predetermined selling price based on customer's views. Functional analysis, value analysis and value engineering are used to change production methods and/or reduce expected costs so the target is met". Target costing aimed at reducing the life-cycle costs of new products, while ensuring quality, reliability, and other consumer requirements by examining all possible ideas for cost reduction at the product planning, research and development and prototyping phases of production. But it is not just a cost reduction technique; it is part of a comprehensive strategic profit management system (Whittle, 2011). Figure 2.1 shows the standard life cycle costing diagram while figure 2.2 shows detail calculation technique of the target costing.

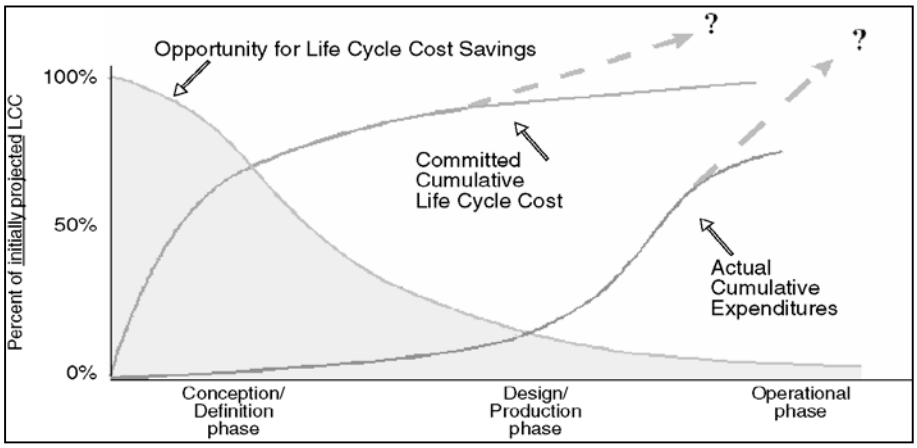

Figure 2.1 Life cycle costing (Dieter & Schmidt, 2008).

2.2.2 TARGET COSTING PROCESS

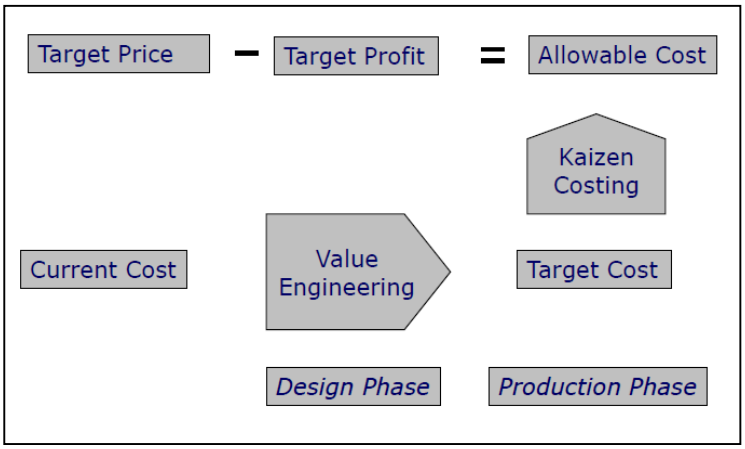

Figure 2.2 Target costing calculation ("Enhancing Supply Chain Competitiveness through Cost Excellence", 2014).

2.2.3 KEY OF COSTS

Below are the key costs of a product (Rich, 2000):

1. Cost of the parts purchased
2. Cost of direct labor
3. Cost of factory overheads
4. Cost of manufacture
5. Cost of assembly
6. Cost of poor quality
7. Cost of warranty

2.3 VALUE MANAGEMENT

2.3.1 DEFINITION

Value = function/cost. Greater value can be achieved by increasing performance and holding cost the same or decreasing cost and holding performance the same (Dekker, 2003). Value can be classified into four aspects (Whittle, 2011):

1. Cost Value – is the cost of manufacturing and selling an item.
2. Exchange Value – is the price a customer is prepared to pay for the product, or service.
3. Use Value – is the purpose the product fulfills.
4. Esteem Value – is the prestige a customer attaches to the product.

Value Management (VM) is the methodology used at the conceptual stage of a product or process to optimize cost. As the name implies, this is principally a management tool which provides logic to decision making, whether it be at an operational or strategic level (Johnson, 2013).

2.3.2 JOB PLAN

Job plan is the technique that used to govern the value studies; VM, VA and VE. The structured job plan technique is very helpful in providing assessment and evaluation for a product and procedures values. The job plan involves three main phases; pre-workshop, workshop and post workshop as shown in figure 2.3. While pre-workshop phase assign to prepare for the foundation of the studies and post workshop responsible for the follow up action plan, the workshop phase involve six other sub-phases; information gathering phase, function and analysis phase, creative phase, evaluation phase, development phase and presentation phase (Dekker, 2003).

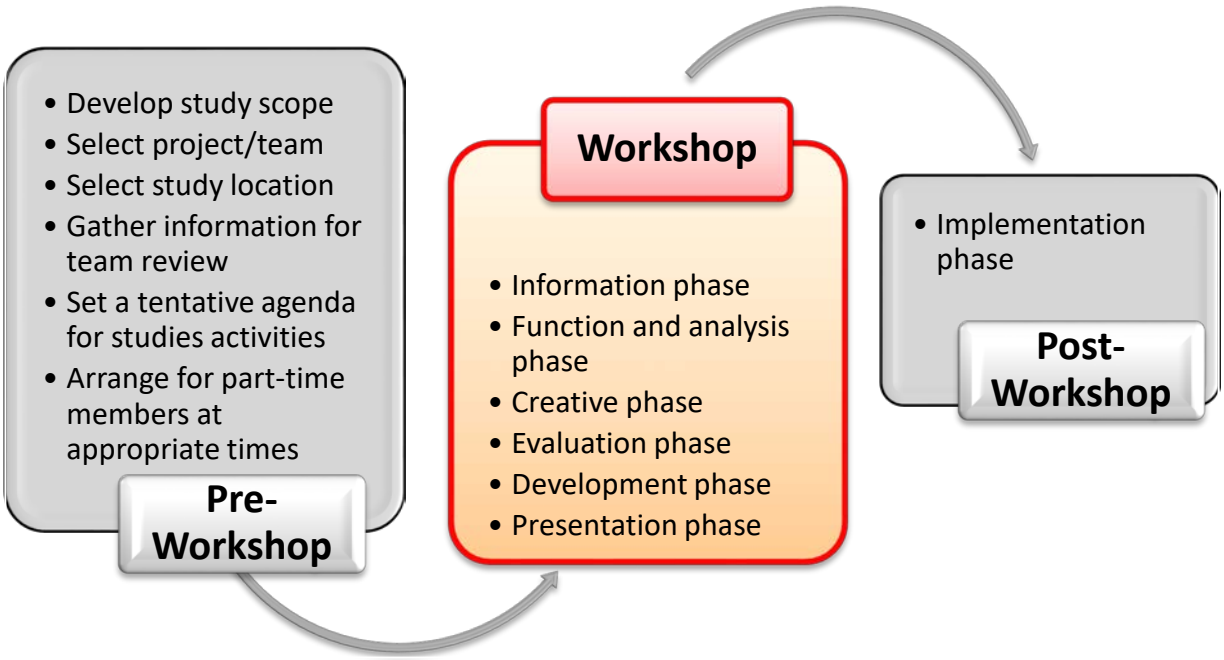

Figure 2.3 Job plan of value studies (Dekker, 2003).

2.4 VALUE ANALYSIS AND VALUE ENGINEERING

2.4.1 DEFINITION

CIMA Official Terminology: VA is "systematic inter-disciplinary examination of factors affecting the cost of a product or service, in order to devise means of achieving the specified purpose most economically at the required standard of quality and reliability" while VE is "Redesign of an activity, product or service so that value to the customer is enhanced while costs are reduced (or at least increased by less than the resulting price increase)"(Whittle, 2011). In other words, VE is the application of VA to new products. Figure 2.4 shows the main stages of VAVE methodology principle.