

Technology and Operations Strategy

The Critical Quality Attributes of the New Product Development Model

Lyn Shen (twdream8@gmail.com)

Graduate Institute of Business Administration

College of Management National Taiwan University

1. Introduction

In the global market, enterprises are facing fierce competition, rapid changes in technology, as well as shorten the life cycle of the product, as the result, the new product development (NPD) has become an important issue for enterprises.

In the development of new products, enterprises should consider various factors, including technology, competitors, customers, costs, resources and other factors. (Thomas,1993) Each company is committed to the development of successful products, but there are still many examples of failures. No one deliberately designed a bad product, most of the designers believe that they do their best to design the ideal product which should be welcomed by the market, but ultimately failed. Many designers think that one of the reasons for the failure is that the final product has a huge gap with the original ideal design.

From the ideal design to the products, there are many procedures, there are numerous reasons will lead to the gap. There are some processes that help to reduce the gap between design and finished products, but others are the opposite. In this paper, we will try to construct a design to the product model, find out the factors between the process, and study the influence of the factors on the design to the product is positive, negative or neutral. This paper has the following objectives:

- Construct the new product development model and find out the influencing factors.
- Analysis of the influencing factors in phase stage are positive factors, negative factors (gaps) or neutral factors.
- After analyzing the attributes of influencing factors, we can consider how to increase the positive factors and reduce the negative factors, in order to increase the success probability of the products.

2. Literature Review

Review and integration of the important research of NPD in order to construct the NPD four processes of this research: concept development, screening and business analysis, prototype development and testing, and product commercialization. Then discuss the factors that may be covered in the four stage (see Figure 2).

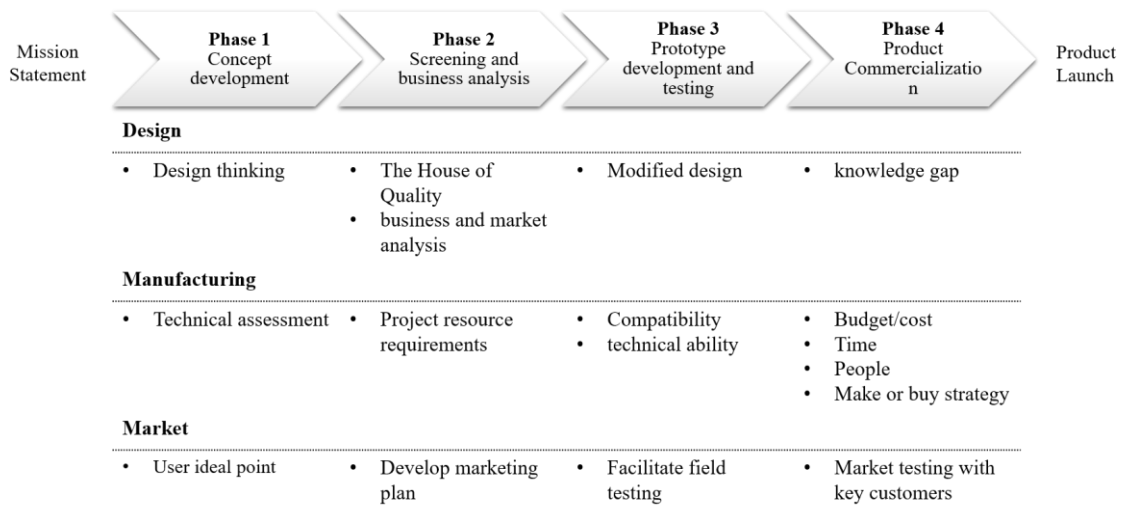


Figure 2: The new product development model and factors in this study

2.1 The new product development process

The new product development process is divided into many stages, there is an evaluation mechanism to determine whether the new product should continue or terminate at each phase. There are numerous NPD studies, Cooper (1986) divided NPD into thirteen phases, and Song (1988) merged it into six phases. Ulrich et al. (1995) considered the gate-stage into five phases. The following is the summary:

Author	NPD process
Cooper and Kleinschmidt (1986)	<ol style="list-style-type: none"> 1. Initial screening 2. Preliminary market assessment 3. Preliminary technical assessment 4. Detailed market study/market research 5. Business/financial analysis 6. Product development 7. In-house product testing 8. Customer tests of product 9. Test market/trial sell 10. Trial production 11. Pre-commercialization business analysis 12. Production start-up 13. Market launch
Song (1988)	<ol style="list-style-type: none"> 1. Strategic planning 2. Idea development and screening 3. Business and market opportunity analysis

	4. Technical development
	5. Product testing
	6. Product commercialization
Kuczmariski (1992)	1. Category screening
	2. Idea generation
	3. Concept development
	4. Business analysis
	5. Screening
	6. Prototype development
	7. Plant scale-up
	8. Market testing
	9. Commercialization
	10. Post-launch checkup
Ulrich et al. (1995)	1. Concept Development
	2. System-level design
	3. Detail design
	4. Testing and refinement
	5. Production ramp-up

Table 1: The NPD literature review

Based on the above summary, we found that the various theories have some point of views in common, this study further integration into four phases: concept development, screening and business analysis, prototype development and testing, product commercialization. (see table 2)

<i>Literature review</i> <i>This study</i>	Cooper and Kleinschmidt (1986)	Song (1988)	Kuczmariski (1992)	Ulrich et al. (1995)
Concept development	1.Initial screening 2.Preliminary market assessment 3.Preliminary technical assessment	1.Strategic planning 2.Idea development and screening	1.Category screening 2.Idea generation 3.Concept development	1.Concept development
Screening and business	4.Detailed market	3.Business and market	4.Business analysis	2.System-level design

<i>analysis</i>	study/market research 5.Business/financial analysis	opportunity analysis	5.Screening	3.Detail design
<i>Prototype development and testing</i>	6.Product development 7.In-house product testing 8.Customer tests of product 9.Test market/trial sell 10.Trial production 11.Pre-commercialization business analysis	4.Technical development 5.Product testing	6.Prototype development 7.Plant scale-up 8.Market testing	4.Testing and refinement
<i>Product commercialization</i>	12.Production start-up 13.Market launch	6.Product commercialization	9.Commercialization 10.Post-launch checkup	5.Production ramp-up

Table 2: The literature review of new product development model

2.2 Concept Development

All design ideas from the thoughts of the designers, Cooper and Kleinschmidt (1986) showed that designers do the initial screening, preliminary market assessment, preliminary technical assessment. Song (1988) argued that it includes strategic planning, idea development and screening. Kuczarski (1992) pointed out that it combines category screening, idea generation and concept development. Ulrich et al. (1995) thought it is the phase of concept development.

Tim Brown (2008) argued that thinking like a designer can transform the way you develop products, services, processes and even strategy, as well as design thinking includes observation, brainstorming, scenarios, prototyping strategy and storytelling. Stickdorn and Schneider (2011) showed the tools and methods like stakeholder maps, expectation maps, personas, business model canvas and storytelling to evaluate decisions during the early stage.

In a marketing context, the ideal point model (Joel Huber, 1976) provides an appealing geometric metaphor which can be used for defining new products, repositioning old products, and determining "benefit" segments who desire similar attributes in a product. Based on the above discussion, this study suggests that design thinking, user ideal point, and technical assessment should be included in concept development phase.

2.3 Screening and business analysis

After concept development, the designers are then screened, in this phase, Cooper and Kleinschmidt (1986) thought it requested detailed market study/market research, Business/financial analysis. And Song (1988) argued that it includes business and market opportunity analysis. Kuczmarski (1992) pointed out that it combines business analysis and screening. Ulrich et al. (1995) thought it is the phase of system-level design and detail design

Hauser and Clausing (1988) argued that House of Quality(HOQ) which is one of the matrices of an iterative process called Quality Function Deployment (QFD), in order to construct the basis of meeting the customer's needs with the combination of the customer needs and technical requirements. Temponi et al. (1999) developed a heuristic inference scheme to reason about the implicit relationships between requirements. (see Figure3) Bottani and Rizzi (2006) pointed that there are eight steps comprise HOQ operations:

1. Defining customer requirements
2. Formulating relative importance of CRs
3. Comparing competitors
4. Establishing DPs
5. Creating the relationship matrix between CRs and DPs
6. Creating a correlation among DPs
7. Calculating the absolute importance of DPs
8. Prioritizing DPs by absolute importance.

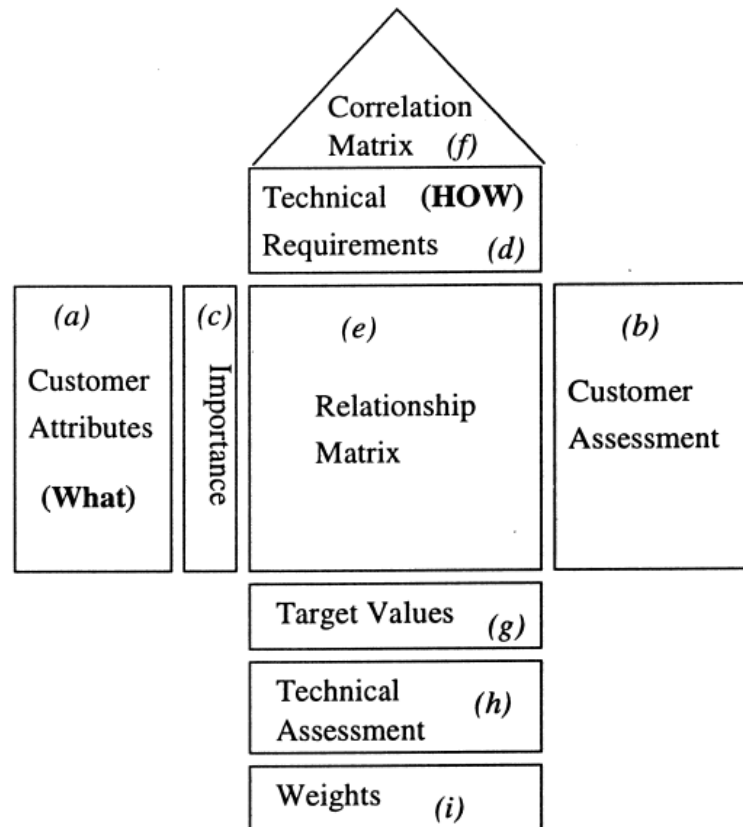


Figure 3: House of quality matrix (Temponi et al. 1999)

Based on the above discussion, this study suggests that the house of quality, business and market analysis, and screening should be included in screening and business analysis phase.

2.4 Prototype development and testing

When the Designer completes screening and business analysis, then the idea is implemented as a product prototype. Cooper and Kleinschmidt (1986) thought it need to go through product development, in-house product testing, customer tests of product, test market/trial sell, trial production, and pre-commercialization business analysis. And Song (1988) argued that it includes technical development and product testing. Kuczmariski (1992) pointed out that it combines prototype development, plant scale-up and market testing. Ulrich et al. (1995) thought it is the phase of testing and refinement system-level design and detail design.

From the concept to the product, it is necessary to consider the reality, which may not be considered in the design stage, such as compatibility, technical ability, user preferences, etc. Matutes and Regibeau (1988) pointed out that firms must decide whether to make their components compatible with those of their competitors, and the

symmetric perfect Nash equilibrium of this game is shown to involve full compatibility.

Based on the above discussion, this study suggests that compatibility, technical ability, and product testing should be included in prototype development and testing phase.

2.5 Product Commercialization

After the completion of prototype development and testing, the product enters the phase of production and commercialization. Cooper and Kleinschmidt (1986) thought it need to go through production start-up and market launch. And Song (1988) argued that it is the phase of product commercialization. Kuczmarski (1992) pointed out that it combines commercialization and post-launch checkup. Ulrich et al. (1995) thought it is the production ramp-up phase.

When the product enters a mass production phase, it must be considered “make or buy” decision (Walker & Weber, 1984) Chesbrough and Teece, D. J. (2002) argued that it depends on the core competition, if the capabilities is existing outside and the innovation type is autonomous, then it can go virtual, and the opposite situation is to bring in house or ally. Spekman et al., (1994) provided a perspective on partnerships into supply chain management, which means success is no longer measured by a single transaction; competition is evaluated as a network of co - operating companies competing with other firms along the entire supply chain. Whether outsourcing, self-made or cooperation, enterprises are facing a problem, is when to protecting the core competence, the specification limit expression. Especially in the case of layers of outsourcing, may make the ‘knowledge gap’ between the manufacturer and designer. (Molcho et al., 2008)

Based on the above discussion, this study suggests that resources (Budget/Time/People), knowledge gap, and commercialization should be included in product Commercialization phase.

3. Research methodology

3.1 The Research model

According to the above discussion, I conclude the following research model (see figure 4). In phase one, the designers will consider design thinking, user ideal point, and technical assessment to complete the design concept. And then they do screen the design concept, business and market analysis and the house of quality analysis to have the screening strategy in phase two. In phase three, they will evaluate compatibility, technical ability, and product testing to get the prototype. In the final, they will consider the resource, knowledge gap, and commercialization in phase four.

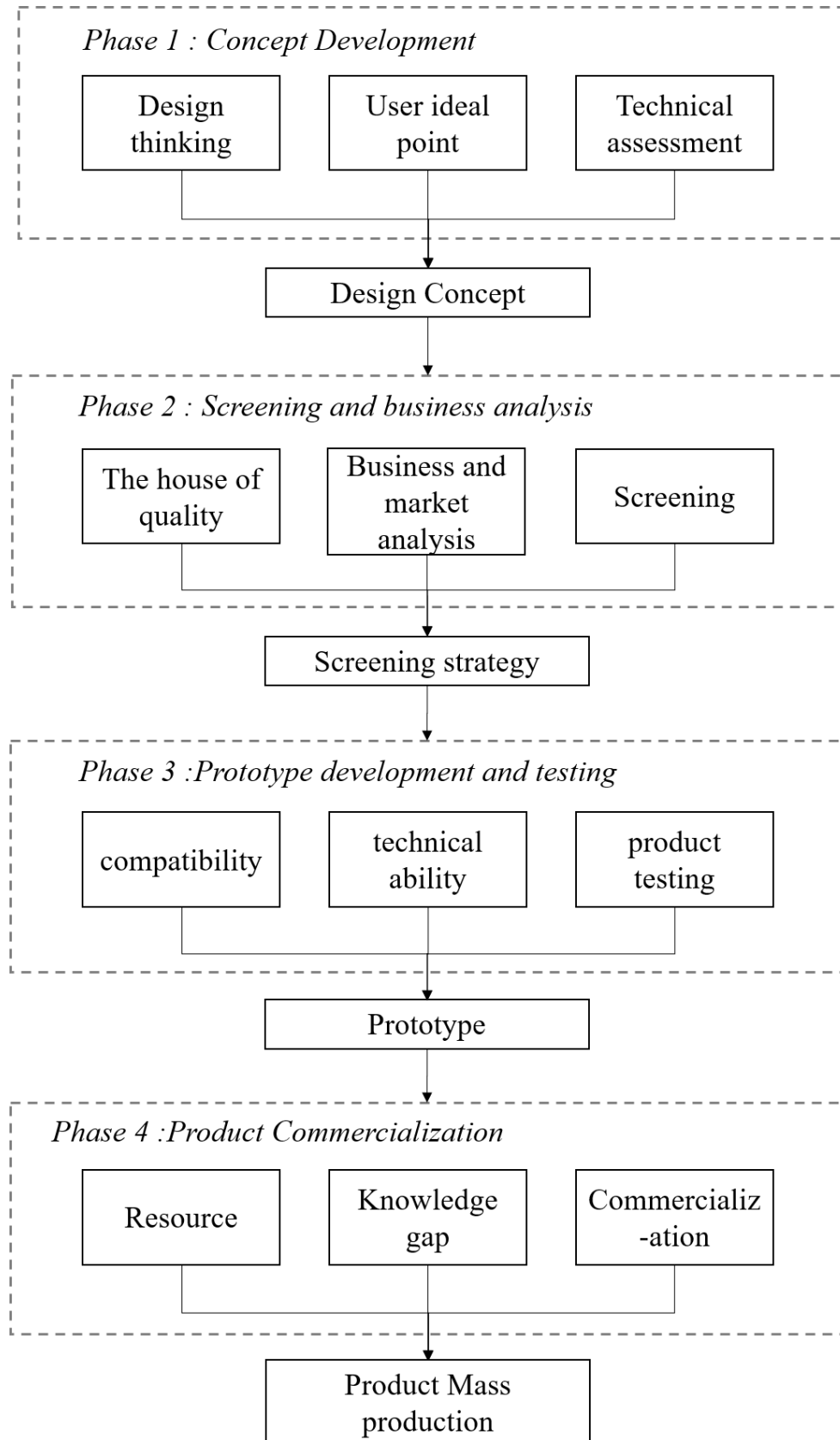


Figure 4: The research model

3.2 The Research Methodology

For better identifying the factors, this study was used the content validity method and list all potential factors which may existed in the stages, and use R-test to find out those factors are independent to others. According to those independent factors, I design a PZB-like questionnaire survey and reference the approach of Parasuraman, Zeithaml & Berry (1985) to four groups of people involved in the product design procedures (Designers, Engineers in manufacturing department, Suppliers/Vendors, Users, and 100 for each). Gathering the data could have much more understanding on factors which impact to the product design quality, and do the reliability and validity to make sure the study is effective and reliable (see figure 5).

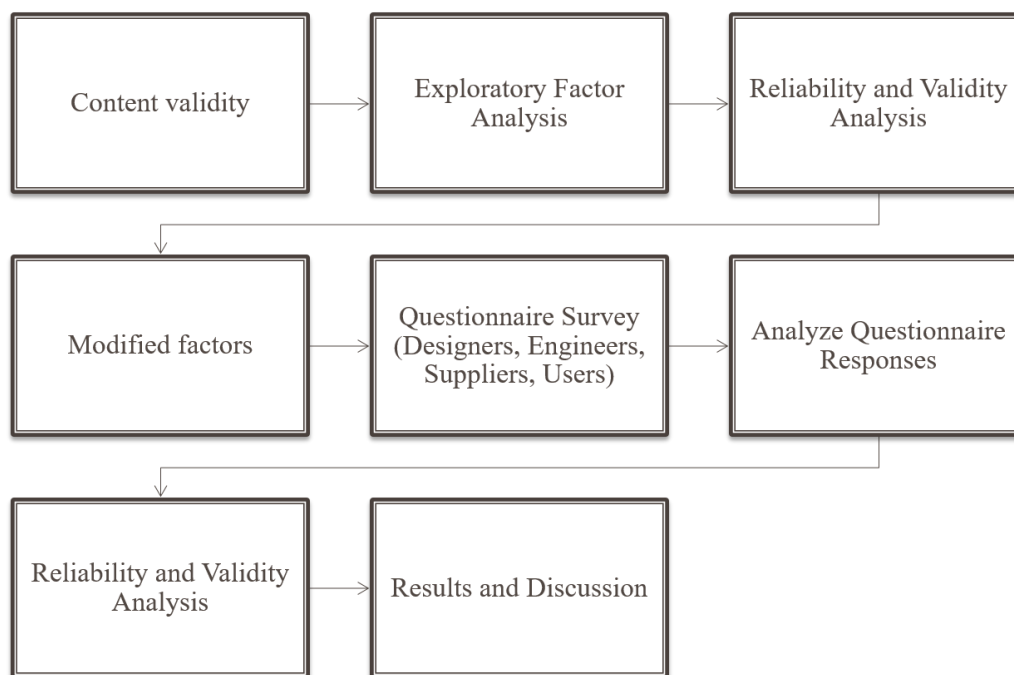


Figure 5: The process of research methodology

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