

CONCEPTUAL FRAMEWORK FOR SUCCESS DRIVERS OF NPD PROCESS

SHAHRYAR SOROOSHIAN; NORZIMA ZULKIFLI; ALI ALIMORADI
*Department of Mechanical and Manufacturing Engineering
University Putra Malaysia*

ABSTRACT

The literature emphasizes the great importance of new product development (NPD) for the continuing success of a business. Its contribution to the growth of companies, its influence on profit performance, and its role as a key factor in business planning have been well documented. The competitive environment in which new products are marketed is undergoing fundamental changes. These changes are the key factors driving the NPD activities in service and manufacturing industries. New product development has been an important managerial issue for many firms as the number of new products marketed has grown and product life cycles have shortened. Therefore, the study of NPD and the processes through which they emerge is important. In recent years, much research has been directed towards uncovering the secrets to new product success.

Organizations are looking for a steady stream of successful and profitable new products. The challenge is to successfully manage the development of the product from research and development to market launch. Despite the extensive research on how to achieve success in NPD, firms continue to deliver products that fail and therefore NPD ranks among the riskiest and most challenging tasks for most companies. As the number of dollars invested in NPD goes up, the pressure to maximize the return on those investments also goes up. It becomes worse as estimated 46 percent of all the resources allocated to NPD by firms are spent on products that are canceled or fail to yield an adequate financial return. This is a shocking statistic when one considers the magnitude of human and financial resources invested and wasted.

This paper explores and analyzes the NPD process in detail. The focus is to develop a hierarchy framework that identifies the critical success factors (CSF) of each phase in the NPD process, and proposes metrics to measure them.

Keywords: New Product Development (NPD); Critical Success Factor (CSF); Analytic hierarchy process (AHP); Metrics.

INTRODUCTION

The new product development (NPD) literature emphasizes the great importance of developing new product for the continuing success of a business. In order to maintain competitive advantage in such rapidly changeable environment, these firms face an important strategic decision making in new product development (NPD) to increase their uniqueness. In fact many firms work hard on moving away from pure original equipment manufacturing (OEM) and to provide original design manufacturing (ODM), they even concentrate on generating a creative concept and idea for new product. Therefore how firm to engage in continuing research and development (R&D), to improve the added value and to maintain its competitiveness has become more important than before.

In business and engineering, NPD is the term used to describe the complete process of bringing a new product or service to market. With the globalization of market competition, short-lasting product life, all NPD must be completed in limited time to reduce the risk of uncertainty, and to make sure success. Typically firms see NPD as the first stage within overall strategic process and product life cycle management is used to maintain or grow their market share. Therefore, NPD play a key role within firm operation.

Engineering and recognizing new product cases and structure is an unending endeavor, as management seeks to improve new product success rates, yet reduce development cycle time. The first step in any redesign activity is to first understand the critical success factors (CSFs), those factors that make the difference between winning and losing at new products. NPD teams

must find the means for speeding time to market while also improving product quality and reducing product costs(Cooper,2000).Expert to meet the needs of the market NPD must be advanced and complex to close with firm's resources efficiently. During carrying out the NPD process NPD team has to face lots of challenges such as internal structure, technology, human resources and operating in thinking. Thus , how to identify the critical success factors(CSFs) and how the priorities are very important and worthy to study.

The specific objective of this paper are:

- 1- To identify CSFs of each phase in the NPD process
- 2- To identify the priority of CSFs in NPD process
- 3- To propose metrics to measure CSFs of NPD process.

Over the last two decades, several studies have examined the determinants of new product success and identified many factors. Factors that are necessary and guarantee commercial success are termed as critical success factors (CSF) and these make the difference between winning and losing: it is imperative to reflect on how one can benefit from each and how one can translate each into an operational aspect of the new product process. Sounder (2007) proposed that organizations need to identify factors that are critical to the success of that organization, and they suggested that the failure to achieve goals associated with those factors would result in organizational failure. In fact, it is even suggested that NPD itself is a CSF for many organizations. Given that this is now a well-known fact, the idea is to determine what factors in NPD are essential for success.

Next sections cover the literature of CSFs in NPD process , then the research methodology (AHP) is described, and the result reports with some guides about metrics of each CSF.

CSFS FOR STAGES OF THE NPD PROCESS

In what follows, each stage of the NPD process and its respective critical success factors are explained in detail.

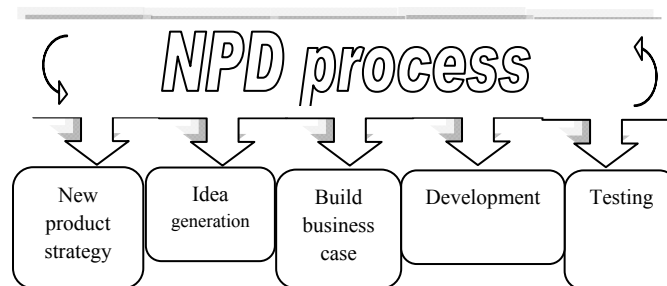


Figure 1 : stages of the NPD process

New Product Strategy (NPS):

Prior to commencing an NPD project, companies must set clear objectives (Winde, 2002).The purpose of the first step of the NPD process is to provide guidance for the new product effort. It identifies the strategic business requirements that the new product should comply with, and these are derived from the corporate objectives and strategy of the firm as a whole. These business requirements assign roles to be played by the new products, which in turn are influenced by the individual needs of the industry (Rosenau, 2004).

Critical Success Factor for NPS:

Clear Strategy: A clear strategy is required to achieve NPD goals. A firms' strategy should provide a clear understanding of the goals or objectives for the company's new product program, and should indicate the return-on-investment (ROI) expected such that the contribution of new products to corporate goals is well understood. Furthermore, clearly defined

arenas specified areas of strategic focus, such as products, markets, or technologies- are needed to give direction to the firm's total new product program.

Well Communicated Strategy: The problem at this stage of NPD is not only one of developing a clear strategy but also its implementation, i.e., translating the strategy into terms that everyone understands and thereby bringing focus to their day-to-day actions, and communicating the strategy with other members in the organization. Prior research suggests that companies that recognize the importance of interfunctional coordination and effectively sharing an NPS across departments will have more successful new products (somayeh,2009). The role of new products in achieving company goals was clearly communicated to all in such firms.

Idea Generation:

After setting a well-defined NPS for NPD, the idea generation stage begins. This is the stage where the search for product ideas is made to meet company objectives. The element of idea generation concerns the birth, development, and maturation of a concrete idea.

Firms that are effective at idea generation are those that do not focus solely on the first source to generate ideas, i.e. ideas that are originated from inside the firm, but that concentrate on all potential idea sources (Nadia,2004). The firm can derive new ideas from internal sources (i.e., employees, managers), external sources (i.e., customers, competitors, distributors, and suppliers), and from implementing formal research and development. The main purpose of this stage is to create a number of different ideas from which the firm can select the most feasible and promising one(s).

Critical Success Factor for Idea Generation Stage:

Customer Focused Idea Generation: Customer focused idea generation is a CSF for this stage as per studies done by many researchers that show that a thorough understanding of customer's needs and wants is vital for new product success (cohandel,2003). Successful businesses and teams that drive winning new products have a dedication towards the voice of the customer. A strong customer involvement is necessary right from the idea generation stage. According to Souder's (2007) review of causes of NPD success and failure, he concluded that internally generated ideas had lower success rates than externally generated ideas.

Screening and Business Analysis:

After gathering enough new product ideas through various sources from the idea generation stage, the problem that then arises for most firms is selecting which ideas to pursue in order to achieve the most business value. Making a good selection is critical to the future health and success of the business. The ideas that have been classified as "Go" ideas must be screened further using criteria set up by top management (Cooper,2004). These ideas must be described on a standard form that can be accessed by a new product committee. The ultimate result from the screening and evaluation i.e. "Gate 2" is a ranking of NPD proposals, such that the resources can be allocated to the projects that seem most promising (Winde, 2002).

The next stage in the NPD process which is very important is the business analysis or business case stage as per Copper (2000). This is the detailed investigation stage that clearly defines the product and verifies the attractiveness of the project prior to heavy spending. In Cooper's (2000) stage-gate model, the business evaluation step is defined as the "critical homework stage" and this business case stage is often found to be weakly handled. Inadequate market analysis and a lack of market research, moving directly from an idea into a full-fledged development effort, and a failure to spend time and money on the up-front steps, are familiar themes in product failures. Screening and business analysis are proposed as two different stages in the BAH model: in the screening stage, initial analysis is done based on the NPS, resources and competition, while in the business analysis stage, ideas are evaluated using quantitative performance criteria. In Cooper's stage-gate model, the Building the business case stage merges the screening and business analysis stages of BAH's model, and ideas are ranked ordered based on both screening and business analysis used by BAH model. Although this paper focuses on BAH's model, the two stages of BAH's model are considered as one for simplicity of the proposed framework.

Critical Success Factor for Screening and Business Analysis Stage:

Up-front Homework:

Up-front homework is a CSF for the screening and business analysis stage as too many new-product projects move from the idea stage right into development with little or no early preparation (Reza,2008). The results of this approach are usually disastrous. Up-front homework includes activities such as financial analysis, undertaking thorough market and competitive analyses, research on the customer needs and wants, concept testing, and technical and operations feasibility assessments. The conclusion is that more time and resources must be devoted to the activities that precede the design and development of the product.

Development:

Once the results of the business case of the new product conform to company objectives, the new product team can move on to the next stage, called development. On average, one third of total NPD expenditures are committed during this stage with 40 percent of total NPD time (Cooper, 2004). In the development stage, business case plans are translated into concrete deliverables. What is critical for success at this stage is 1) to move through development to launch as quickly as possible; and 2) to ensure that the product prototype or final design does indeed meet customer requirements, which requires seeking customer input and feedback throughout the entire development stage. It is important to gain competitive advantage and to enjoy the product's revenues as soon as possible and it also minimizes the impact of a changing environment.

Critical Success Factors for Development Stage:

Speed:

Development of new product takes months, in some firm years, and much that is unexpected can occur during this time frame. The market may change partway through development, making the original estimates of market size and product acceptance invalid. Customer requirements may shift, rendering the original set of product specifications obsolete. Competitors may introduce similar products in the meantime, creating a less receptive market environment. These and other external changes mean the original product definition and justification are no longer valid. In short, the challenge here is to shorten development time so as to minimize the chances that the development target has changed.

Customer Feedback:

Seeking customer feedback is a vital activity throughout development stage, both to ensure that the product design is right and also to speed development toward a correctly defined target. The original voice-of-customer research that was done prior to development may not be enough to resolve all the design problems during development (Cooper, 2004). Customer feedbacks are perhaps the most certain way of seeking continual and honest customer input during the development phase. Seeking customer input should become an integral part of the design team to speed up and make development stage successful.

Testing:

The purpose of this stage is to provide final and total validation of the entire project: the commercial viability of the product, its production, and its marketing (Cooper, 2000). Design and testing go hand in hand, with testing being conducted throughout the development stage. Information obtained during testing is used in developing the product. This phase is extremely important in that it may dramatically decrease the chances of failure in launch, since it has the capacity of revealing flaws that could cause market failure (Lillien,2002).

Critical Success Factor for Testing Stage:

Product Functionality:

Product functionality is critical for the testing stage as the aim here is to see whether the product with the attributes called for has been produced. The physical features, perceptual features, functional modes, and perceived benefits must be examined at this stage. It must be proven that claimed attributes exist and the causes for missing attributes must be found.

Customer Acceptance:

Customer acceptance is critical for this stage to gauge whether the product is acceptable to the customer, to measure the customer’s level of interest, liking, preferences, and intent to purchase, and to determine those benefits, attributes, and features of the product to which the customer responds. Not only must the product work right in the lab or development department, but, more importantly, it must also work right when the customer uses it. In short, the customer reaction must be sufficiently positive so as to establish purchase intent.

The CSFs proposed for successful NPD are all brought together in a framework proposed in Table 1.

Table 1 : CSF for stages of NPD process

Stage	CSF
New product strategy	<ul style="list-style-type: none"> • Clear strategy • Well communicated strategy
Idea generation	<ul style="list-style-type: none"> ○ Customer focused idea generation
Build business case	<ul style="list-style-type: none"> • Up-front homework
Development	<ul style="list-style-type: none"> ○ Speed ○ Customer feedback
Testing	<ul style="list-style-type: none"> • Product functionality • Customer acceptance

HIERARCHY FRAME WORK

The analytic hierarchy process (AHP) devised by Satty(1994)is a powerful technique .AHP works by developing priorities for goals in order to value different alternatives. This multi-criteria method has become very popular among operational researchers and decision scientists(Dyer,1992)

AHP is a subjective method wich does not require the involvement of a large number of experts. The use of small group (10 or below) has been adopted by abundant researches(handfield,2002).in this study , by brainstorming meeting , a small group of professionals consisting of 7 evaluation experts from universities participated in AHP analysis. The evaluation experts have ,on an average, more than 5 years of experience in NPD field. The experts are experienced and we assume they are knowledgeable that can well represent the views and opinions of industry .

The evaluators would assign a score to each comparison using the Satty's nine-point scale (Table 2). The process continues till all levels of the hierarchy and eventually a series of judgment matrices for the critical factors was obtained.

The scores obtained from individual assessors were into matrices and the normalized weighted averages were then calculated. The results prioritized the relative importance of CSFs.

Table 2 : Satty's nine-point scale

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak	–
3	Moderate importance	Experience and judgement slightly favour one activity over other
4	Moderate plus	–
5	Strong importance	Experience and judgement strongly favour one activity over other
6	Strong plus	–
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	–
9	Extreme importance	The evidence favouring one activity over another is of highest possible order of affirmation

Source: Saaty (1988)

We used on line analysis by using websites that do AHP analysis on line. Table 3 shows the output.

Table 3 : Hierarchy framework for CSFs of NPD process

CSF	weights	Rank
Clear strategy	0.114	5
Well communicated strategy	0.101	7
Customer focused idea generation	0.251	1
Up-front homework	0.120	4
Speed	0.101	7
Customer feedback	0.158	2
Product functionality	0.151	3
Customer acceptance	0.106	6

METRICS

A metric tracks product development and allow a firm to measure the impact of process improvement over time. Metrics can play an important role in helping companies to enhance their NPD efforts. The right metrics align employees' goals with those of the corporation; wrong metrics are counterproductive and lead to narrow, short-term, risk avoiding decisions and actions.

A lack of useful metrics is undoubtedly one reason that the success rate of NPD has not improved appreciably over the past 40 years (Ankush,2004). If companies had reliable metrics to gauge their performance, then specific problem areas could be addressed and managers might see the same improvement in their NPD efforts that they come to expect from their quantifiable total quality management programs (Lynn, 2000).

Metrics for new product strategy(NPS):

Return-On-Investment:

A company's ROI is one such metric that proves to be useful in setting the new product goals. An NPS must include an ROI as a metric. If the cost to implement an improvement exceeds the resulting benefit, or the payback does not exceed the resulting benefit, or does not affect the corporate bottom line, the value of implementing change must be questioned. In fact, the reason for the metric should also be questioned. The aim here is to compare the return expected to be received from the project with some pre-established requirement.

Degree of Communication:

The degree of communication among the members of the organization is dominated by sharing information and achieving the highest amount of coordination of shared activities. To reach a considerably high degree of collective intelligence, the range in communication has to be extended to cooperation and collaboration. Collaboration assumes a high level of coherence among individuals as the team pursues a common goal. Each individual member of the team has fuzzy knowledge regarding the strategy or objectives of organization, though being expert in a particular domain. Collaboration on the other hand has less stringent requirements for intellectual coherence and shared knowledge. The individual members of a team cooperate by carrying out their individual tasks without necessarily having knowledge of all contribution made by other to the project.

Metrics for Customer Focused Idea Generation:

Number of Customer Focused Ideas Generated:

Firms must devote more resources to customer based idea generation activities, such as focus groups with customers; detailed, one-on-one interviews with customers; customer site visits, especially by technical people; the active solicitation of ideas from customers by the sales force; and the development of a relationship with lead users (Cooper, 2000).

Metrics for Upfront Homework in the Screening and Business Analysis Stage:

Financial or economic models treat project evaluation much like a conventional investment decision. Returns on investment (ROI), net present value (NPV), internal rate of return (IRR), and the Profitability Index (PI), are metrics that are proposed as being most useful for measuring the success of the screening and business analysis stage. These metrics should be used to rate, rank order, and ultimately select projects. ROI metrics relates to strategic objective of NPD. These metrics together give clearer details about the project's financial performance to help select the best project from the group.

Metrics for Development Stage:

Development Time:

Development time is defined as the duration from the start to completion of the development stage, i.e., the length of time to develop a new product after passing business case stage to initial market sales. Precise definitions of the start and end point vary from one company to another, and may also vary from one project to another within the company. How quickly the team moves through this stage is critical for the reasons stated earlier, and as such, it is imperative that the team measures their progress according to time.

Degree of Functional Integration:

Cross-functional teams are essential for timely development, improving design quality, and lowering development costs. True cross-functional integration occurs at the working level. It rests on the foundation of tight linkages in time and in communication between individuals and groups working closely related problems. How these groups work together determines the extent and effectiveness of integration in the design and development of the product (Yeganegy,2007).

Degree of Team Commitment:

Related to the above is the degree to which team members are committed, or dedicated, to the project. Since project team members' time commitments are typically spread across a number of projects at any one time because departmental managers are vying for team members' time, team members are often on and off development projects. This creates a discontinuity and increases development time. It is in this stage that it is crucial to have a team with dedicated team members. A dedicated, accountable team leader- that is, not doing too many other projects or other assignments at the same time, and held accountable for the result.

Concurrency of Activities:

The new product process must make use of a cross-functional team to undertake its parallel activity. In parallel processing, the NPD process is far more intense than the sequential approach and more work gets done in shorter time period. There is less chance of an activity or task being overlooked or handled poorly because of lack of time; the activities are done in parallel, not in series, and hence the total elapsed project time is reduced.

Degree of Design Effort on real Customer Priorities:

The degree of design effort on real customer needs is a qualitative in-process metric which ensures as much as possible that the final design meets customer requirements. Customer needs and wants assessment must be a vital and ongoing activity throughout development, both to ensure that the product is designed right.

Metrics for Testing Stage:

Product Performance / Performance Indicators:

The performance of a product is how well the product achieves the functionality desired. Product performance is usually measured in such ways as testing physical features, perceptual features, functional modes, and perceived benefits.

Customer-Perceived Value:

Customer-perceived value is measured to determine whether the customer is willing to purchase the tested product or not and to gauge whether the product is acceptable to the customer. Important metrics for this stage are: perceived relative performance, customer satisfaction , and the preference score to determine the nature of the competitive situation.

DISCUSSION AND CONCLUSIONS

Table 4 :summery of paper

Stage of NPD	CSF	weights	Rank	Metrics
New product strategy	• Clear strategy	0.114	5	➤ Return on Investment
	• Well communicated strategy	0.101	7	➤ Degree of communication
Idea generation	○ Customer focused idea generation	0.251	1	✓ Number of Customer Focused Ideas generated
Build business case	• Up-front homework	0.120	4	➤ Expected Commercial value(ECV) ➤ Net Present Value(NPV) ➤ Internal Rate of Return(IRR) ➤ Productivity Index (PI)
Development	○ Speed	0.101	7	✓ Development time
	○ Customer feedback	0.158	2	✓ Degree of functional

				integration ✓ Degree of team commitment ✓ Concurrency of activities ✓ Degree of design effort on real customer priorities
Testing	• Product functionality	0.151	3	➤ Product Performance
	• Customer acceptance	0.106	6	➤ Customer-Perceived value

New product success still remains the critical challenge for companies. Many companies are aware of the major role new products must play in their future and quest for prosperity: companies are constantly searching for ways to revitalize, restructure and redesign their NPD practices and processes for better results.

This framework proposes that to achieve success, NPD firms should have a clear and well communicated new product strategy. These firms should have well defined new product arenas along with long term trust, with clear goals. Successful businesses and teams of NPD have a dedication towards the voice of the customer. It is critical that firm should gather as many ideas as possible and a large number of these should come from customers so that the firm can be in a position to design and develop winning new products. Up-front homework prior to the initiation of product design and development is found to be a key factor in a firm's success. The quality of execution of the predevelopment steps - initial screening, preliminary market and technical studies and business analysis - is closely tied to the products financial performance. Firms should try to shorten the development time so as to minimize the chances that the development and customer needs have changed when the product comes into the market. It is important to verify and validate product performance requirements and design specifications along with customer's acceptance before launching the product into the market via validation and user field testing.

This paper explored and analyzed the new product process and attempted to identify ways in which firms can improve their performance when developing new products, mainly through the study of factors that are critical to success. These factors were identified through an extensive study of the practices and performance of successful firms presented in the NPD literature. The CSF's which have been described in the literature are generally defined for the overall development process, rather than specifically addressing each stage. To overcome this problem, this thesis sought out CSF's for each stage of the process and rank the CSFs. Presumably, no other study to date has developed such a framework, which can be crucial for NPD success.

REFERENCES

- Ankush Agrawal(2004),CSF and metrics for NPD, second international conference on industrial management and Industrial techniques ,Iran.
- Bard J., (1990)The tradeoff analysis for rough terrain cargo handlers using the AHP, IEEE transaction on engineering management,37(3).222-228.
- Cooper, R. (2000). Product leadership: Creativity and launching superior new products. Perseus Books, Reading, Massachusetts.

- Cooper, R. (2003). *Winning at new products: accelerating the process from idea to launch*. (4rd ed.). Perseus Publishing, Massachusetts.
- Dyer RF.,(1992)group decision systems,8,99-104.
- Handfield R., Walton S.,(2002)a study in the application of the AHP. *European journal of operation research*.141,70-87.
- Rosenau,M.,Griffin,A(2004) *The PDMA Handbook of New Product development*. John Wiley and Sons, Inc.
- Lynn, G., & Reilly, R. (2000). *Measuring team performance*. Industrial Research Institute Inc., March-April, 48-56.
- Lillien, G., Morrison, P., Searls, K., Sonnack, M., & Hippel, E. (2002). Performance assessment of the lead user idea generation process for NPD. *Management Science*, 8(8), Aug, 1042-1059.
- Nadia Bhuiyan(2004),critical success factors for new product development process, second international conference on industrial management and Industrial techniques,Iran.
- Reza Vaseghy(2008)New product development,*Jurnal of Elm-o-Sanat*,9,56-67.
- Satty T.,(1988)multicriteria decision making .RWS publications,pittsburgh,PA.
- Saaty T.,(1994),*The analytic hierarchy process*,2nd edition.McGraw-hill,usa.
- Somayeh, Momeny., Farhad, Momeny. (2009). What separates Japanese new product winners from losers. *Journal of Product Innovation Management*, 17, 422-439.
- Souder, B. (2007). *Managing new products innovations*. D.C. Heath and Company, MA.
- Winde, S. (2002). *Product policy: Concepts, methods, and strategy*. Reading, Mass: Addison-Wesley
- Yeganegy,H(2007),*new product development process handbook*,1st edition, Tehran university.