

Improving new product development (NPD) process by analyzing failure cases

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Abstract

Purpose – The purpose of this study is to develop an appropriate new product development (NPD) process of Company “T”, a medium-sized firm, by analyzing the existing NPD process and failure cases of the Company.

Design/methodology/approach – The proposed research framework is as follows: first, prospective studies of the NPD process are performed using the existing literature and preliminary references; second, comparative analysis between the current processes and a NPD process is performed; third, phase-based evaluations upon failed product cases are conducted with a NPD process so as to identify the abridged steps and root-causes of failures; finally, renewed priorities are set forth by utilizing the analytic hierarchy process analysis and questionnaire analysis upon the above identified causes of failures.

Findings – The resulting accomplishments include the establishment of NPD processes that resonates with the current states of Company “T”, which, in turn, ensures the increase of efficiency, the decrease in development duration and the strategy of capacity-concentration and priority-selection.

Originality/value – As Company “T”’s development process is outdated and products are developed without adequate market information research and feasibility analysis, the percentage of failed development project is as high as 87 per cent. Thus, this study aims to develop an appropriate NPD process of Company “T” by analyzing the existing NPD process and failure cases of the Company.

Keywords Analytic hierarchy process (AHP), New product, New product development (NPD) process, Company, Failure

Paper type Research paper

1. Introduction

This is a case study that aims to develop an appropriate new product development (NPD) process of Company “T” by analyzing the existing NPD process and failure cases of the Company.

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Company “T” is a medium-sized radio-frequency (RF) business firm which develops, manufactures and sells various equipment and components for both domestic and international base stations of mobile communications. Established in 1999, its main engine of growth has come from the areas of RF connectors and coaxial cable assembly within the scope of mobile communication services.

Mobile communication markets can be divided, according to the level of integration and roles, into system operation (SO) carriers, system integration (SI) and equipment and components. The markets can be also divided by usage into filers, antenna, unit materials for construction work, measurements, national defense and terminal equipment. Company “T”’s business accounts range from SO firms to equipment firms, and the most active transactions come from the components in the fields of filers and antenna for remote radio head (RRH) equipment. Most systems that integrate equipment and components do go through the process of integration, and the time and scope required for the review on each integral production tend to increase. Considering the characteristics of connector components which play critical and basic roles for the telecommunication systems, completion of connector components alone can allow for the next phase reviews to begin. Because of these reasons, development time for connector component is much shorter, and its application potentials are much greater than those of other equipment and systems. Base stations, previously called as BTS, used various connectors and cables in large quantity. But, recent transformation into RRH systems drastically reduced the necessity of connectors and cables. Hence, the inevitable process of evolution was brought in to meet the requirements of increasingly complicated system environments to make the assembly much easier and make the breadth of movement much wider and easier to control. Such system changes necessitated much more vigorous reviews and certification and development. This creates situations where tasks go beyond the capacity of the all staff members and employees. This caused the situation where all these tasks require more than the existing human resources and their capacities. It may explain why the reviews and examination process of product development were repeating the simplistic specification verifications only. Although the lead time for development projects became shorter, Company “T” showed patterns of having to manage increasingly large number of projects.

Managing too many projects caused many challenges for the product development process of the Company “T”; cases of discontinued projects or development failures kept increasing. Even after the completion of product developments, the sales figures, more often than not, did not yield much increase. Overburdening assignments of development projects have caused the processes to overlook the principal check points for marketability, profitability and technological feasibility, and, in some extreme cases, products were not even launched in the market after the completion of development.

It is quite common that a great number of small- to medium-sized firms attempt to launch new products without preliminary planning or market research. Against this background, well aware of such circumstantial connotation, this study aims to establish an appropriate NPD process that fits the current status of the Company “T” by focusing on analyzing failure cases.

2. Literature and practice review

2.1 Concept of new product

There are many contending arguments with regard to the variegated definitions and boundaries of the term “new product”. Crawford (1991) defines that it is “a product for which the company needs a new marketing, and in which the substantial changes are conveyed but excludes any changes that may require simple promotions”.

Booze, Allen and Hamilton set out to make a new standard in 1982 for new product classification according to the newness to the market and the newness to the firm, with six different categories. Also, calculations for relative frequencies at each category were schematized into the diagrams (Figure 1). The diagram is schematized according to each classification of a new product.

2.2 Significance of new product development process and the meaning of process phase

In general, an NPD process is defined as the process of formalized planning or thoughts from the beginning stage of ideas down to market launching. Most of the previous studies on impacts and ramifications of the NPD process have their starting point where the definition of NPD phases is made. Despite the varying degrees of contenting theories, one can safely classify the whole process of NPD into 13 different phases. brain-storming of ideas; early stage idea screening; preliminary market evaluation; preliminary technology evaluation; preliminary production evaluation; preliminary financial evaluation; market survey and research; product development; in-house product evaluation; customer focus group test for new product; market test; financial evaluation before the product launch; and market launch. Studies in the past have proposed that the decision to go through each and every phase of the NPD process itself without any omission would guarantee a significant improvement of new product launch.

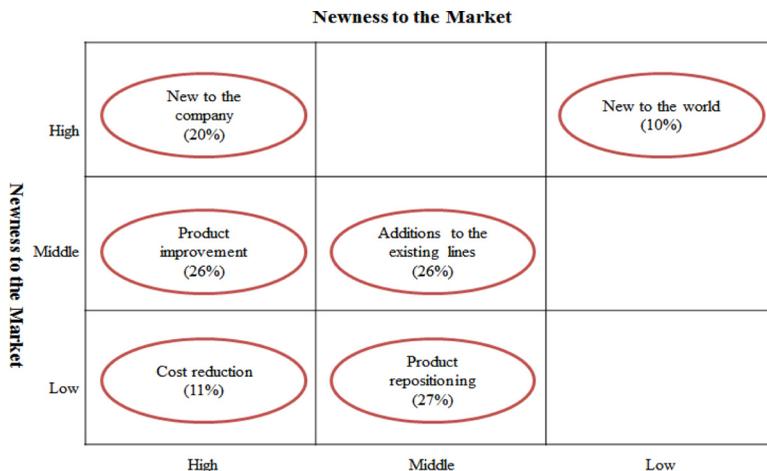


Figure 1.
Classification standard for new product

Source: Booz, Allen and Hamilton (1982)

Capacity that can perform well at each phase of the product development process has a close causal relationship with profitability. Previous studies show the positive (+) relationship between the level of excellence for the NPD process and the degree of resulting success of NPD. However, the relative importance of capacity in each developmental phase all defers. For instance, Cooper’s (1979) analysis came to conclusion that the most important phase of NPD is the market launch phase and product evaluation by consumers, whereas Mishra *et al.* (1996) contended that it is the detailed market evaluation/analysis and preliminary idea screening that are the most important phases of the development process.

2.3 Studies on new product development process

This study thus far examined which phases of the previous NPD processes were considered most valuable for the purpose of analyzing the full contents of the current product development process. Second, the study also examined the difference between Company “T”’s product development process and those of the other models chosen from the various product development processes. The following excerpt shows which phases are omitted in the case of Company “T”’s NPD process.

Each phase and sequence in the NPD process of the chosen model is as follows:

- Phase 1: It is idea discovery.
- Phase 2: It is idea screening.
- Phase 3: It is concept development and test.
- Phase 4: It is business analysis.
- Phase 5: It is the development of the mix between product and marketing.
- Phase 6: It is market test.
- Phase 7: It is product launch.

Dividing rules and standards might vary according to the choices of researchers and companies. But what remains rather identical is the overall flows of each development phases. It should be noted here that different analytic models may cause different changes in total length of process or the contents of each phase, which will eventually integrate into the development processes. Figure 2 shows the role of each gate to demonstrate that products face higher probability of failure if the NPD process proceeds to the next phase without proper assessments and evaluations, thus emphasizing that the gates necessitate preceding examinations and preparation.

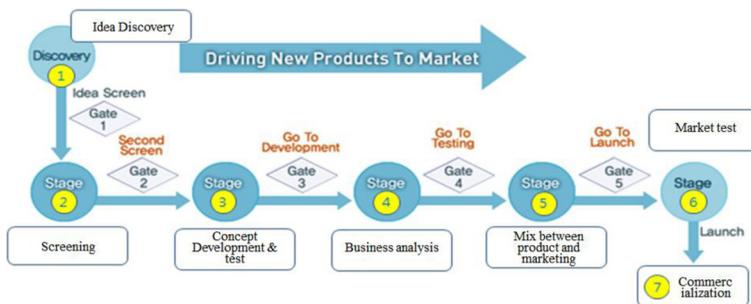


Figure 2. Role of gate (evaluation) in NPD phases

A general NPD process goes through each phase from idea management to product concept development and test, to business analysis and marketing plan, to product development and to market launch. This process can be either subdivided or simultaneously preceded according to the company size and particular business characteristics.

However, in the case of Company “T”, the firm is concentrating on the “product development phase in comparison to other NPD cases”. Nevertheless, one shall not disregard the evaluation process of pre-developmental processes such as the possibility of whether the product can be developed with current level of technology and the possibility of whether the product can expand to the main stream items by adding various similar product lines. Such consideration can unwittingly bring out the outcome which disregards the basic processes that could yield practical and tangible results.

2.4 New product development practices among small- and medium-sized Korean companies

A typical medium-sized company such as “T” comes up with the “new product idea” based on clients’ demands or direct order from the company owner, and the product development is launched without much selection processes. Once the prototype is completed, the company would begin to prepare for the commercialization and large-scale manufacturing plans (Figure 3). The figure shows that the CEO is occupying the largest percentage of where the idea of new product and product developments are initiated from. If the product development processes are repeated without adequate studies on profitability and marketability, a series of internal problems tend to rise from within. Sales department will request more and more projects to the research department for the purpose of sales increase. The development department will lose efficiency during the course of variegated product developments without full considerations on priority and strategic importance. The final outcome of such processes would include products with low level of perfection, reduced ratio of development completion AND rise of the employment separation rate for newly recruited researchers, resulting rise of workload upon senior researchers and the failures and discontinuation of projects, which go beyond the scope of product development issues.

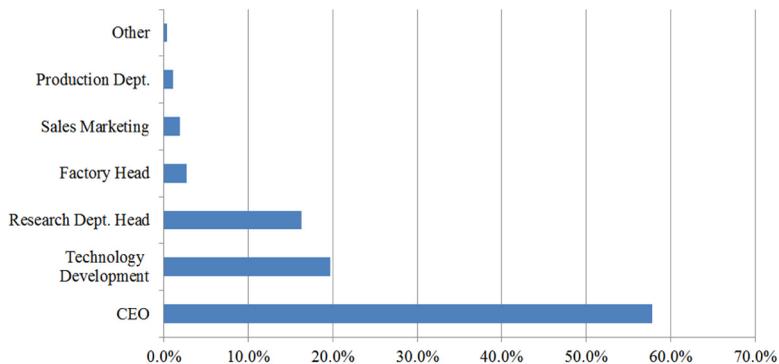


Figure 3.
Leaders of NPD in
small- and
medium-sized
businesses

Source: Survey on technology of the SMB, the Small and Medium Business Administration (2007)

3. Analysis and results

3.1 Outline of the analysis

The purpose of this study is to establish an improved NPD process which can substantially increase the efficiency of the product development. To this end, this paper chose to use the research methodology as the following.

First, existing references and prospective research materials are reviewed to recognize and define the concept of new product, the importance and concept of an NPD process and the significance of phased evaluation of performances. Second, the appropriate models and phases of the NPD process are selected for the Company “T”, and the comparative analysis is performed between the current development process and the newly selected development process to identify the omissions and shortcomings. Third, each project was divided into two categories of “success” and “failure” based upon the new definition of “failure” at the stage of each case analysis. It is followed by the performance analysis on each phase of the NPD process based upon the research models that are derived from the selected cases of actual failures that took place, thus being able to categorize the causes of failures. Finally, surveys and questionnaires are conducted to ask for the causes of the categorized failures. These results are reexamined under the analytic hierarchy process (AHP) method, and the conclusions are drawn for the evaluation of the different levels of significance.

3.2 Analysis methodology of failure cases

3.2.1 Definition of failure. The objective of this study is to establish an appropriate NPD process that fits the Company “T”’s needs. To that end, the failed project cases in the past have been analyzed with particular attention paid to phase-based actions and the following results of the process. Hence, the categories of failures among the development projects are divided into two. First category is projects that were suspended or those proved to be failed at the end of the development. Second category is when no sales were generated after the completion of development or no profits were earned after the sales.

3.2.2 Classification and selection of the project. Projects for analysis were selected among the ones that had been processed during the one year term of year 2014. Total number of registered projects was 877 cases, of which completed ones were 209 cases [Table I](#). Of these 209 cases, ones that generated sales were 119 cases (14 per cent), and the ones without sales generation were 90 cases (10 per cent). Also, uncompleted cases were 668 cases, of which sale-generating cases were 73 cases (8 per cent) and no sale cases were 595 (68 per cent). Sales results from the uncompleted projects are by sample supply, not by finished product production.

In 2014, the failure rate reached 87 per cent. With too many failure cases to analyze, the study reduced the total target numbers by way of verifying the ones to be excluded. First, a total of 119 cases that generated sales were excluded. The number of projects that were processed progressively for the purpose of

Index	Projects completed (209)		Projects incomplete (668)	
	Sales generated	No sales generated	Sales generated	No sales generated
Project number	119	90	73	595
Rate (%)	13	10	8	67
Success/failure	Success	Failure	Failure	Failure

Table I.
Classification of success and failure of development projects at “T” (unit: case)

measurement or JIG, review projects, one-time projects, preliminary projects and projects whose details cannot be determined because of the retirement of researchers and the likes were 476 cases in total. Analysis was processed with 80 cases in the sequence of initiation date, out of remaining 407 cases. The guiding principles include, first, the ones that were completed, but did not generate any sales, and second, the ones that did not complete. More than half of the projects excluded from the analysis were originally executed by the retired researchers. They are usually low performers and/or involved in declining product departments. Hence their projects were regarded as less important and by the time they leave the company, the projects were dropped and classified as failed projects. But, as those projects were dropped by the company's decision, they were excluded from the analysis.

3.2.3 Analysis of failure cases. As it seems evident during the NPD process, the role of the gate is meaningful at the time of evaluation between the two phases. It cannot be processed to the next phase unless there is no result or the contents are inadequate. It is because the idea at the evaluation can be considered to be a failure. This study made the comparison among each failed case at the corresponding phase levels to see whether each criteria of the gate was performed.

3.2.4 Analytic hierarchy process analysis. AHP is one of the supporting techniques to help make decisions by providing a structured evaluation scheme for alternatives when objectives and evaluation standards of the decision-making are multiple and mutually conflicting. Widely used for the decision-making with multi-criteria including qualitative factors. AHP methodology was invented by Thomas L. Saaty in the early 1970s for the purpose of assisting a rational decision-making process. Information necessary for the decision-making is collected by disassembling the stratum of evaluation index and alternatives. To determine relative importance of possible alternatives, weighted values of alternatives should be calculated using the pairwise comparison so as to clarify the priorities. It should be noted that qualitative standards are also accommodated for the sake of objectivity. That is, once the instrumentation was completed for the specific issue of decision-making, a pairwise comparison was performed upon the factors that belong to the sub-measurement categories, selected from the perspectives of the upper measurement categories, and such comparison will allegedly yield relative importance and weighted values, thus enabling us to attain priorities of the alternatives at the sub-measurement categories (Choi *et al.*, 2008). If there are multiple choices of alternatives for the comparison of evaluation index, it normally requires highly complex calculations, for which computation programs can be used for the accuracy and the ease of use. AHP applications encompass most of the establishment activities that relate to the priority-setting such as strategic planning, calculation of weighted value for performance measurement index, location allocation, resource allocation, establishment of enterprise/policy and program allocation. This study segmented and formalized the causes of failures as collected from the case analysis. These formalized causes were put into pairwise comparison by the method of questionnaire so as to identify the key factors for the establishment of process.

3.3 Analysis of failure cases

3.3.1 Selection of new product development process model. Currently available references and preliminary research materials were used to select an analytic research model that can fit the case of Company "T"'s NPD process. These models were adopted from seven-phase model of Booz, Allen and Hamilton. The model was used as a preliminary

working pattern for the analysis of Company “T”’s NPD process. The reasoning for selecting this particular model is that it could run the risk of oversimplification if the phases were fewer than seven, which makes it very difficult to review the contents and issues in detail at each phase. On the hand, it could run the risk of unrealistic pursuit away from the original objectives of the research if the phases were too many or too much segmented. It is certain that neither too few phases nor too much segmentation can bring the research outcomes that are expected. If the analysis is conducted according to the size of the company or the available resources, it might also cause difficulties in formulating an efficient NPD process. These are the main considerations for selecting the seven-phase model as proposed by Booze, Allen and Hamilton. Booze, Allen and Hamilton model comprises the following phases: idea creation and selection; establishment of product concept and test; establishment of marketing strategy; analysis of profitability; product development; market test; and commercialization.

3.3.2 Analysis of current new product development process. In case of Company “T”’s development process, no adequate NPD process can be found. Only partial development process was being used in some development phase:

- Idea discovery or selection phase was missing. But, in-house development evaluations were conducted if there were requests from the sales department or direct orders from the CEO. Most of the projects, however, proceeded to the next developmental phase of designing and development without proper examination and evaluation.
- Development process items and contents could not be found in the phase of establishment of product concept and testing.
- Phase of establishing marketing strategy did not include any contents and items of development process. In reality, the only evaluation that was done was basic information analysis. In most cases, any concrete target objectives other than the development did not exist. There were, of course, understandings of the target markets, but the competition analysis and exterior environment analysis were not conducted.
- Phase of business profitability analysis was substituted with the letters or request with specific details and contents. Evaluation of technological feasibility was analyzed, but, in most cases, any attempts to collect the information about market potential and demand estimation and to analyze the possible financial contribution were not found.
- The product development phase was usually included within the development process through reception of development requests, and the detailed contents were identified including the review, verification, validity examination and development completion.
- Phase of market test was included in the development process, but mostly within the scope of technological aspects. The review was performed upon standards of client’s request for development and upon the level of satisfaction about product specification. At this phase, some pilot manufacturing was performed to make sure that the large-scale production was ready.

- Phases of commercialization and product launch were considered completed by transferring technology-related materials, thus closing up the whole development process. Analysis of defection risk during the product manufacturing and consequential revision was performed, yet any strategies for competition or product life cycle could not be found.

These significant flaws in the Company “T”’s NPD process came from the management style of current CEO and founder. As a developer, he recorded huge success until few years ago, based not on well-developed NPD process, but on his own instinct and discretion when choosing new products to develop. But, as the market matures and the environment changes unfriendly, his decision-making based on intuition does not work anymore. So, it was the right time to assess current process and develop more adequate process of NPD for the company.

During the course of the comparative analysis of the processes, a few considerable discoveries were made that might work very well for the reality of the Company “T”, which has been trying to establish the NPD process. First, the internal consensus must be reached within the firm upon whether a revision of the current downstream development process is necessary and whether establishment of upper stream NPD process is appropriate. The reason that the company’s practice for the past 10 years has become the habit and fixation, and the necessity of discerning the two different processes was never recognized. Second, full mandate and responsibility for evaluating processes at each phase must be ensured so that the supervisors must be separately designated. Third, a rational separation is necessary, because it is impossible to evaluate every process which varies because of the different product particularities and different levels of development difficulties. It becomes much critical that the newness of the product in the market and the newness of the product in the company must be the guiding principles to classify each product development process and to evaluate separately. Especially, it has been noted that in the case of Company “T”, design and performance of the connectors for the base station do not vary too much. Also, the equipment, systems, base stations and the related environments used for the products of Company “T” do not differ much, either. These products can omit some of the NPD processes such as idea discovery, idea screening, establishment of product concepts, test of product and the product developments. These findings are summarized in [Figure 4](#).

3.3.3 Analysis of failure cases. Sequence of case analysis is as follows; first, classification of failed projects; second, selection of the failed project; third, identification of the causes and reasons for failure and formalize the pattern of causes; last, conducting surveys and questionnaires to select the categories necessary for the consideration with priority. At this phase, AHP analysis is conducted to confirm the reliability and consistency of the result.

First, this study went through the validation and matching task on the contents of the management register book of year 2014 and on the accumulated sales list on each product of year 2014 for the purpose of establishing a proper classification of failed projects, as seen in [Table II](#). Second, failed projects were selected with two categories; the failure Category © is the ones that are completed but did not yield any sales, and the failure Category ® is the ones that are interrupted in the middle or

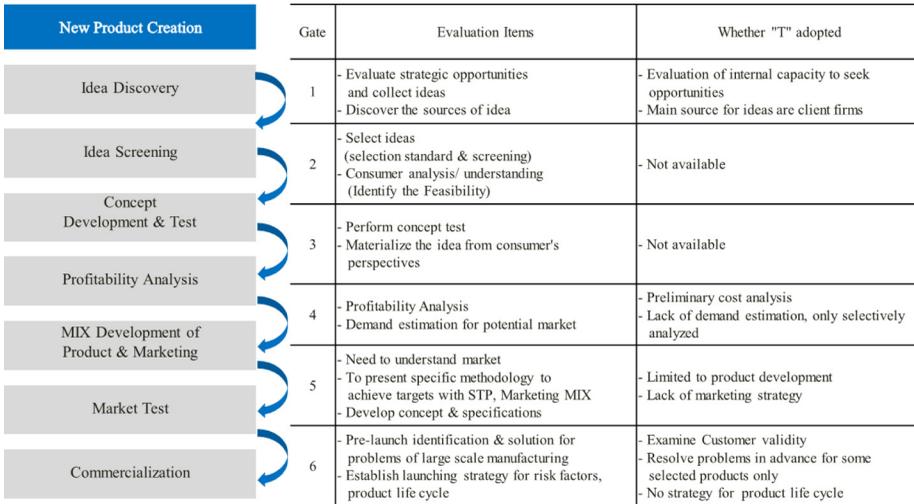


Figure 4. "T"'s NPD process compared to a standard process

Evaluation criteria	Failure Category <1> Development complete and no sales (40 cases)		Failure Category <2> Development stopped or failed (40 cases)		Category <1> + <2> (80 cases)
	Executed	Ratio (%)	Executed	Ratio (%)	Category <1> + <2> (80 cases) Acc. Ratio (%)
Gate 1 idea discovery	11	28	7	18	23
Gate 2 idea screening	16	40	3	8	24
Gate 3 concept development and test	9	23	13	33	28
Gate 4 business analysis	16	40	10	25	33
Gate 5 mix Development product and marketing	40	100	22	55	78
Gate 6 market test	0	0	0	0	0

Table II. Evaluation of completion ratios for failure Categories <1> and <2>

never made to completion. The total cases were 407 projects, excluding the ones caused by the retirement of researchers and the ones developed not for the direct purpose of product sales. A total of 40 cases were selected according to the failure categories and in the sequential order of initiation date. Third, the reasons and causes of project failures were identified according to the prepared categories.

Main causes for the failure Category © is the most frequent cases (40 per cent) where development was proceeded without much market information and where product development did not produce any sales. It is confirmed that these failed projects proceeded without estimation of expected market size, target price range, practical possibility of large scale manufacturing and the very minimum information necessary for the development process. One particularly interesting finding indicates that the strong capacity of the long-time client can unwittingly work against product sales. The lesson of this revelation is that one must examine and comprehend the market environment and exterior situation of both first-tier client companies and the second-tier client companies. Main causes of the failure

Category ® are the cases where the price competitiveness is very weak, followed by the cases where profitability evaluation was either omitted or poorly performed. Detailed reasons why the price competitiveness was weak were because of the poor information on competition companies, which caused the loss of competitive bidding and market dissatisfaction against product price. Lack of research capacities also contributed to the failures. In case where there was no evaluation for the business profitability and feasibility, the level of market information and intelligence was also weak. Also, some products with no potentials for the feasibility were also preceded for the development process.

This study continued with the analysis of the seven-phase gate evaluation for the NPD process, using the above-mentioned failed projects. The main findings are as follows: first, it is possible to calculate the failure costs for both expenditure and time at each phase if the concept of NPD process was properly comprehended or if the project management was properly executed; second, it is possible to calculate the additional failure costs for the cases of product completion without sales if the failure costs of the previous projects can be assessed. This is the direct consequence of the negligence toward the obviously expected failures. If those projects improperly executed at the very first phase could be decisively stopped in the middle of the development process, the additional costs could have been saved and the focus could have been rendered for the projects with higher probability for success.

3.3.4 Findings through analytic hierarchy process analysis. Causes of the project failures have been identified based upon the case analysis. Of the cases in the Category ©, the prominent reasons included the failures in market analysis, price competitiveness, bidding failures for the first-tier clients, developmental capacities, disruption of the project earmarked for the first-tier clients and poor managements of the projects. Of the failure Category ®, the major causes included the failures in price competitiveness, commercialization feasibilities, market analysis, developmental capacities, bidding failures for the first-tier clients and disruption of the project. As for the bidding failures for the first-tier clients, the causes included many probabilities involving the price competitiveness of either Company “T” or the clients. If there were clear responsibilities for the failure on the part of Company “T”, the reason for such result was price competitiveness issue. Also, if the reason or price competitiveness of the client company was unclear, then the responsibilities belonged to the first-tier client. [Figure 5](#) shows the summary of the findings.

AHP analysis using questionnaires and surveys was conducted for the purpose of determining the priorities among the important items that are worthy of careful attention while dealing with the NPD process of the categorized failure causes. Survey was conducted for 26 persons from five different departments (sales department, R&D department, technology department, quality control department and production department) Respondents’ average work experience was 13 years and 2 months. Those eight people who misunderstood the questionnaire were asked again to receive the answers. [Table III](#) shows survey items to determine priorities among the important items using the AHP methodology.

The results of questionnaires with weighted values are seen in [Figure 6](#), and the consistency ratio was 0.00896, which is deemed trustworthy based upon the examination of the weighted values of each factor and the criticality and consistency.

1. DEVELOPMENT COMPLETE, SALE×			Number	Ratio
1	MARKET ANALYSIS	SIZE, PRICE etc	16	40%
2	PRICE COMPETITIVENESS		5	13%
3	FIRST-TIER CLIENT'S BIDDING FAILURE	PRICE COMPETITION	7	18%
4	DEVELOPMENT CAPACITY		5	13%
5	FIRST-TIER CLIENT'S SUSPENSION OF PROJECT	PERFORMANCE SHORTFALLS	4	10%
6	MANAGEMENT OF DEVELOPMENT PROJECT	LOWER PRIORITY	3	8%
total			40	100%

2. SUSPENSION, FAILURE OF DEVELOPMENT			Number	Ratio
1	PRICE COMPETITIVENESS		10	25%
2	BUSINESS PROFITABILITY	TRANSFER STANDBY	10	25%
3	MARKET ANALYSIS	SIZE, PRICE etc	9	23%
4	DEVELOPMENT CAPACITY		2	5%
5	FIRST-TIER CLIENT'S BIDDING FAILURE		2	5%
6	FIRST-TIER CLIENT'S SUSPENSION OF PROJECT		3	8%
7	FIRST-TIER CLIENT'S DELAY FOR REVIEW		3	8%
8	FIRST-TIER CLIENT'S SPECIFICATION SHORTFALLS		1	3%
total			40	100%

DESIGNATION OF PRIORITY FACTOR OF FAILURE CATEGORIES FOR PROCESS IMPROVEMENTS	
CLASSIFICATION	Contents
F1	MARKET ANALYSIS
F2	PRICE COMPETITIVENESS
F3	BUSINESS PROFITABILITY ANALYSIS
F4	DEVELOPMENT CAPACITY
F5	MANAGEMENT CAPACITY OF DEVELOPMENT PROJECT
F6	FIRST-TIER CLIENT'S CAPACITIES

Figure 5. Categorized causes of failure

Evaluation criteria A	A is very important (three points)	A is important (two points)	A and B are equal (one point)	B is important (1/2 point)	B is very important (1/3 point)	Evaluation criteria B
	Market analysis capacity	Price competitiveness	Commercialization capability	Project management capability	Development capacity	
Market analysis capacity	Price competitiveness	Commercialization capability	Project management capability	Development capacity	First-tier client capacity	
Market analysis capacity	Price competitiveness	Commercialization capability	Project management capability	Development capacity	Commercialization capability	
Market analysis capacity	Price competitiveness	Commercialization capability	Project management capability	Development capacity	Development capacity	
Price competitiveness	Price competitiveness	Commercialization capability	Project management capability	Development capacity	Project management capacity	
Price competitiveness	Price competitiveness	Commercialization capability	Project management capability	Development capacity	First-tier client capacity	
Price competitiveness	Price competitiveness	Commercialization capability	Project management capability	Development capacity	Development capacity	
Commercialization capability	Price competitiveness	Commercialization capability	Project management capability	Development capacity	Project management capacity	
Commercialization capability	Price competitiveness	Commercialization capability	Project management capability	Development capacity	First-tier client capacity	
Commercialization capability	Price competitiveness	Commercialization capability	Project management capability	Development capacity	Project management	
Development capacity	Price competitiveness	Commercialization capability	Project management capability	Development capacity	First-tier client capacity	
Development capacity	Price competitiveness	Commercialization capability	Project management capability	Development capacity	Project management	
Project management capacity	Price competitiveness	Commercialization capability	Project management capability	Development capacity	First-tier client capacity	

Table III. AHP survey items for determining priorities among important items

4. Results

4.1 Establishment of N new product development PD process

The NPD process for Company “T” is seen in Figure 7. It was simplified into a six-phase model by integrating the first and second phases that were used for the research model

Evaluation Results Of The AHP With Weighted Value

	Factor 01	Factor 02	Factor 03	Factor 04	Factor 05	Factor 06	Weighted Value	Priority
Factor 01	0.1854	0.2037	0.1768	0.1634	0.1664	0.2172	0.18549	1
Factor 02	0.1651	0.1814	0.2289	0.2151	0.1728	0.1418	0.18420	2
Factor 03	0.1597	0.1208	0.1524	0.1912	0.1427	0.1578	0.15410	4
Factor 04	0.1942	0.1443	0.1364	0.1711	0.2192	0.1811	0.17438	3
Factor 05	0.1677	0.1581	0.1607	0.1175	0.1506	0.1522	0.15114	5
Factor 06	0.1279	0.1918	0.1448	0.1416	0.1482	0.1499	0.15069	6
TOTAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

Verification

• Step.1 Weighted sum vector, Consistency vector

	Weighted sum vector	Consistency vector
Factor 01	1.1231	6.0548
Factor 02	1.1162	6.0597
Factor 03	0.9333	6.0565
Factor 04	1.0552	6.0513
Factor 05	0.9148	6.0528
Factor 06	0.9129	6.0579

• Step.2 Find Maximum λ_{max}

$$\lambda_{max} = (6.0548 + 6.0597 + 6.0565 + 6.0513 + 6.0528 + 6.0579) / 6 = 6.0555$$

• Step.3 CI Index

$$CI = (\lambda_{max} - n) / (n - 1) = (6.0555 - 6) / (5) = 0.0111$$

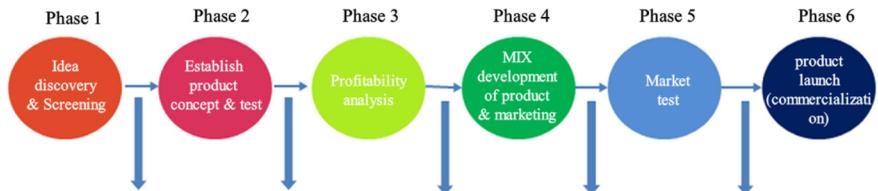
• Step.4 CR

$$CR = CI / RI = 0.0111 / 1.24 = 0.00896$$

RI = Random Index
n = 6 → RI = 1.24

Since CR Value 0.00896 < 0.1, Therefore Reliability Confirmed

Figure 6. Evaluation results with weighted value and verification using AHP analysis



	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5
Evaluation contents	- Commercialization potential of idea - Customer value	- Gist of concept - Purchasing intention by client	- Estimated demands - Target market	- Product test result - Development of marketing mix	- Evaluation of customer effectiveness - Pre-launch trouble shooting & solution
Evaluation targets (phase execution manager)	- Customer request (sales) - N-house development (research)	- Creation of multi-task team (task force to be formed at a later stage)	- Request / depends on idea origins	- Creation of multi-task team (task force to be formed at a later stage)	- R&D dept., Technology dept., & production dept.
Evaluation factors					

Figure 7. Suggested NPD process for company "T"

of seven phases. The biggest reason for such simplification is that the origin of the idea about business-to-business (B2B) products was the needs from the first-tier and second-tier clients.

Evaluation contents at each phase led to the decision of choosing the major projects that must be executed based upon the research contents this far. Each corresponding phase allocated both responsibilities and performance supervision appropriately so as to not overburden the research department to avoid the findings of previous development processes. For instance, at the phase of business profitability analysis, sales department shall share the overall information deriving from client preferences with other relevant internal departments, as it has been the cases. In the future, the task force organization will be formed and will be responsible for conducting marketing or profitability reviews.

At Gate 1, what needs to be identified includes which idea shall be adopted based on customers' needs and, subsequently, what the customer values should be and what requirements need to be met for the purpose of commercialization potentials from the technological points of view. At Gate 2, product concepts must be defined, and the analysis for client purchase intention must be evaluated. At Gate 3, further considerations must be articulated about future market demands, possible boundaries and scopes for the target markets apart from the existing clients. For the purpose of evaluating the targeted market potential, the timeline of review has to be set at least for a three-year-long period. At Gate 4, as the product development is completed, preliminary financial evaluation is in order based upon the materials from the preceding phases. Preliminary trouble shooting also has to be done in the preparation for the large-scale manufacturing. Accordingly, pilot product needs to be produced and product test has to be evaluated. Last, at Gate 5, post-production evaluation needs to be done from the large-scale manufacturing or from the already launched products. Such information as client satisfaction (possibly including that of the competitions) and other relevant issues must be collected. Also, further evaluation is necessary for examining the shortcomings at the preceding phases or the modifications so as to identify the future amendments for the next product development and for the extended applications.

4.2 Process verification

Performance evaluation for each phase of the failed projects was done to verify the validity of the NPD process. The projects for evaluations were seven in total, which were all completed but never generated the sales, as seen in [Table IV](#). Verification methodology is such that performances of each project and evaluation phases were substituted into the NPD process so as to confirm whether the assigned task at each phase was properly executed and the corresponding results were achieved.

Commercialization of potentials needs to be evaluated first with the technological feasibility as requested by the clients. Most of the products were technologically feasible. To judge whether there are purchase intentions from clients, the information previously collected from that client must be examined and further consideration must be given to future volume of manufacturing, production timing and target price for the clarification. If clients suggest such detailed requests, the client's purchase intention might be verified. Estimated demands can also be verified with the same methodology as the purchase intention, and the profitability verification must review preliminary production costs based upon the design-related materials. The results of the product test did not contribute at all for sorting out the project evaluation. Marketing strategy, too, did not contribute in a meaningful way under the B2B purchase conditions. However, each corresponding phase will certainly contribute meaningfully if the preceding phase proceeds with substantial integrity, and simultaneous marketing strategy is executed at the same time. Last, validity evaluation was executed persistently at the development process level, but it was evident that the failures at Gates 2 and 3 were not recognized, and further unnecessary resources were invested without interruption.

The results of process verification clearly demonstrated that the projects that are highly unlikely to succeed can be discontinued at Phases 2 and 3 instead of Phase 1. As the purpose of this process is to increase the odds for the project success and make sure the unpromising projects are stopped with substantial evaluation standards, this practice was deemed worthy of efforts.

Table IV.
Results of
verification for the
NPD process

Division	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5	Note (whether identifiable as failure cases)
Evaluation contents	Potential of idea commercialization Client value	Gist of concept Purchase intention of clients	Estimated demands Market expansion	Product test result Development of marketing mix	Client validity evaluation Pre-launch trouble shooting and solution	
Evaluation targets (Phase Execution Manager)	Client request (sales) development (research)	Creation of multi-task team (task force to be formed at a later stage)	Request/depends on idea origins	Creation of multi-task team (task force to be formed at a later stage)	R&D department, technology department and production department	
Task 1	Commercialization possibility 0	Purchase intention unclear	Expected demand Profitability × Market expansion ×	Product test result Marketing strategy ×	Execution (validity only) Launch strategy ×	Possible
Task 2	Commercialization possibility 0	Purchase intention unclear	Expected demand × Profitability × Market expansion ×	Product test result Marketing strategy ×	Execution (validity only) Launch strategy ×	Possible
Task 3	Commercialization possibility 0	Purchase intention clear	Expected demand × Profitability × Market expansion ×	Product test result Marketing strategy ×	Execution (validity only) Launch strategy ×	Possible
Task 4	Commercialization possibility 0	Purchase intention clear	Expected demand × Profitability × Market expansion ×	Product test result Marketing strategy ×	Execution (validity only) Launch strategy ×	Possible
Task 5	Commercialization possibility 0	Purchase intention unclear	Expected demand Profitability ○ Market expansion ×	Product test result Marketing strategy ×	Execution (validity only) Launch strategy ×	Possible
Task 6	Commercialization possibility 0	Purchase intention clear	Expected demand × Profitability × Market expansion ×	Product test result Marketing strategy ×	Execution (validity only) Launch strategy ×	Possible
Task 7	Commercialization possibility 0	Purchase intention unclear	Expected Demand Profitability × Market expansion ×	Product test result Marketing strategy ×	Execution (validity only) Launch strategy ×	Possible
Total	Commercialization possibility 7	Purchase intention clear 7	Expected demand 3 Profitability 1 Market expansion 0	Product test result Marketing strategy ×	Validity execution 7 Launch strategy 0	Possible

4.3 *Expected effects*

The following effects can be obtained from establishing a proper NPD process.

First, the rate of projects failed or suspended will be drastically reduced than the current level. Accordingly, the projects with no possibility to succeed after the launch will be more likely to be stopped in advance, and important projects will ensure much more time and costs. Second, there will be reduction of the incidents adding up the failure costs by continuing the projects without a proper evaluation phase. The fact is that there were frequent occasions where the completion and mass production of the products did not generate the sales, or occasions where fully developed products were not forwarded to the sales department. By establishing the process, sales department staff members will share as much responsibility as the development department members. Third, efforts will increase to secure the references and frameworks of objective and adequate decision-making for the proposition of project priority and its importance factors.

5. Conclusion

As Company “T”’s development process is outdated and products are developed without adequate market information research and feasibility analysis, the percentage of failed development project is as high as 87 per cent. Thus, study aims to develop an appropriate NPD process of Company “T” by analyzing the existing NPD process and failure cases of the Company.

To this end, We conduct our research as follows; first, prospective researches of the NPD process are conducted using existing literature and preliminary references; second, comparative analysis between current processes and an NPD process is conducted; third, phase-based evaluations upon failed product cases are conducted with an NPD process so as to identify the abridged steps and root-causes of failures; finally, renewed priorities are set forth by utilizing the AHP analysis and questionnaire analysis upon the above identified causes of failures. The resulting accomplishments include the establishment of NPD processes that resonate with the current states of Company “T”, which, in turn, ensures the increase of efficiency, the decrease in development duration and the strategy of capacity-concentration and priority-selection

However, this study has some limitations. First, it must be self-evident that the NPD process shall not be limited only to the R&D departments. Rather, it is a company-wide process, by definition, with this limited analysis falling short of cross-departmental examinations, which will bring out much valuable outcomes for the purpose of efficiency improvements. Second, there has been an omission of verification results for the new NPD process that was deduced for the research purpose of this paper on analysis and outcomes. It should be noted that the above-mentioned choices are indeed the superior directions for the market competition, given the limitation of resources and capacities which could optimize the efficiency of the process through verifying the feasibility evaluations upon NPD progress.

The future plans for establishing an NPD process appropriate for the overall environment of the Company “T” revolve around overcoming numerous challenges that have been identified.

First, it must be closely examined whether the evaluation results of each gate were meaningful, as it was verified through the validity tests of the NPD process. It must also be carefully examined whether data of the preliminary market analysis did contribute,

with certain acceptable degree of accuracy, to the forecast and the analysis that were performed. Next, the level of perfection and refinement has to be further improved by periodically analyzing the projects within the two failure categories, as it has been done throughout this study.

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