AN EXPLORATION ON NEW PRODUCT DEVELOPMENT PROCESS OF MALAYSIAN SMALL-SIZED AUTOMAKER

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ABSTRACT: This paper focused on the identification and description of a new product development (NPD) approach adopted by one of the small-sized car producers in Malaysia. The NPD processes for European, Japanese and American auto makers have been studied and discussed in literature. However, the business strategy of NPD approach of small-sized car makers remains unidentified and less understood. This research involved semi-structured face-to-face interview sessions at several occasions with senior project managers and development team members, a senior product planning manager together with a selected first tier vendor. The information obtained through literature on the NPD process was used as secondary data to correlate with the data obtained from the primary source (interview). Results derived from both sources later were used to completely identify and describe the NPD process of this car maker. The results indicated that the NPD process of the automaker was not that distinct as compared with the generic product development of others. In addition, the findings also showed the automaker has adopted the concurrent engineering practices in the product development process. This paper also highlighted the importance of a formal NPD with regard to the frequency of the new product introduction and managing risks and uncertainty.

KEYWORDS: *New Product Development; automaker; New Product Introduction; Development Routines; Development Phase*

1.0 INTRODUCTION

An effective NPD process has become an important factor for competitive advantage to automaker or the automotive manufacturing-base industry. The NPD consists of a set of activities within integrated development phases: product planning, concept development, manufacturing, production, sales and distribution, in which a particular product is built based on the customers' demand and requirements. It is also known that the NPD varies from one industry to another [1]. In simple term, this depends on the firm situations such as types of projects or design solutions, expertise and capacity available, as well as the financial strength. Regardless of product types, a well-defined NPD is essential and crucial for success. According to Ulrich and Eppinger [2], a well-defined NPD is beneficial for several reasons: better product quality, improved information and communication through task coordination and development team assignment, better timing for project scheduling, performance benchmarking and reference for future projects. Therefore, having a well-structured NPD process is a crucial factor for any type of project performance [3]. Moreover, being competitive requires an efficient and well-organized NPD process by which a firm must effectively utilize its resources such as man power, monetary investment, time, technology and vendors, to confirm the deliverables and/or milestones at every phase of the NPD process. Many prior researches have inferred that an excellent NPD process enables a firm to reduce errors and/or eliminate impairment in development time, and would also enable a project to be completed on time and finally satisfy customers' wants and needs at the right time. The best strategy and approach in NPD process, therefore, results in better NPD performance in terms of time-to-market or speedy introduction of products to market, improves product quality and profit, reduces development cost, and improves in-house resource capability and ability such as product development knowledge [4-8]. Previous works from researchers suggest that the adoption of an integration of personnel from different functional backgrounds and co-location [8-9], organizational and management practices i.e. project leadership and top management support [10-12] along with decent project strategies [13] and concurrent engineering environment [14] have become mandatory to product development program as they improve the performance of NPD. Achieving this critical goal is not an individual functional department problem, but it is a product development problem that involves all functions.

2.0 THE NEW PRODUCT DEVELOPMENT PROCESS

The NPD process varies from one firm to the other, and there is no single process ideal for all situations and industries. The selection of processes is normally based on the structure a firm uses to manage uncertainties and risks [15]. Generally, a firm adopts at least a process with phases or stages; product planning, concept generation, engineering design, testing, and mass production. For example, the NPD process through generic process by Ulrich and Eppinger [2] and a stage-gate process [16]. The generic product development process by Ulrich and Eppinger [2] consists of six phases as illustrated in Figure 1. Every output from a particular phase will be an input towards the next phase substantially. Table 1 shows the generic development process activities.

Figure 1: Generic product development process [2]

Table 1: The generic NPD process activities [2]

PHASE	*ACTIVITY*
Product Planning (Phase 0)	The planning takes place before the product development (PD) efforts even started. It involves activities such as market objectives, assessment of existing technological developments and business strategy.
Concept development (Phase 1)	During this phase target market requirements are identified, several alternatives of product concepts are generated and evaluated; one or two selected concepts undergo further development and testing. At this stage the alternative concepts are geometrically vague, and a set of imaginary specific specifications come with them.
System-level design (Phase 2)	This is also known as the configuration design and parametric design phases. The design activities include the determination of the locations and positions for components, parts and features. The established parameters are identified for first order calculation and study. The function decomposition diagrams are also ready for functional specifications of each components and subsystems.
Detail design (Phase 3)	The detail design phase outputs include the part drawings, sub assembly and assembly drawings, bill of material (BOM), quantity of parts and components, and tolerances of parts and components. The standard parts and special purpose parts are all identified to be purchased from suppliers. A process plan is established and tooling is designed for each part to be fabricated within the production system, and the process plans for the fabrication and assembly of the product.
Testing and refinement. (Phase 4)	The testing and refinement phase involves the construction and evaluation of prototypes versions of the product. Early (alpha) prototypes are usually built with materials that simulate the actual material. Parts are fabricated via soft tooling or any rapid tooling method. Later prototypes (beta) are usually fabricated parts supplied by the actual manufacturing processes but may not be assembled using the actual assembly line facilities. Beta prototypes are extensively evaluated internally and are also typically tested by customers in their own use environment.
Mass Production (Phase 5)	In the production ramp-up phase, the product is made using the actual manufacturing process. This sometimes requires a pilot project where the product is manufactured in actual production line as if it is the training for production line operators. It is also a phase where the remaining problems that relate to production are resolved.

Figure 2 shows the product development based on a stage-gate process with the 5-stage and 5-gate approach that was developed by Cooper [16]. A summary of the main activities per stage is shown in Table 2.

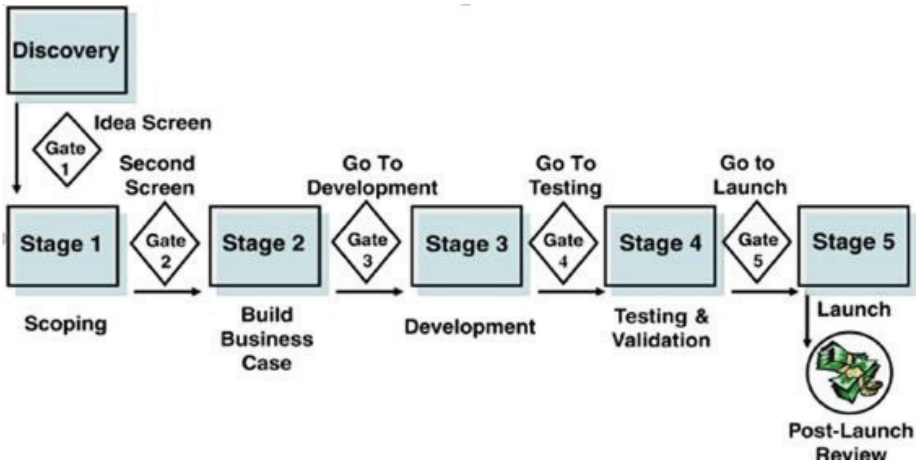

Figure 2: A five-stage and five-gate system with Discovery and Post-Launch Review [16]

Table 2: A five-stage and five-gate NPD process [16]

STAGE	*ACTIVITY*
Stage 1: Scoping	There is a quick investigation and sculpting of the project in order to determine the project's technical and marketplace merits
Stage 2: Build Business Case	Detailed homework and upfront investigation work is carried out. Detailed market analysis, competitive benchmarking, concept testing, detailed technical assessment, source of supply assessment, and detailed financial and business analysis all form Stage 2.
Stage 3: Development	This stage involves the actual design and development of the new product. Stage 3 witnesses the implementation of the development plan and the physical development of the product. The deliverable of this stage is a prototype product.
Stage 4: Testing and validation	This involves the verification and validation of the proposed new product, its marketing and production. This stage tests and validates the entire viability of the project.
Stage 5: Launch	This stage deals with full commercialization of the product, full production, the commercial launch, and sales. The post launch is for monitoring and fixing.

3.0 METHODOLOGY

The study on the NPD process of this small-sized automaker has been inspired by the new product introduction (NPI) rate of its new passenger vehicles which has recently increased drastically. The firm came up with several models of different product families. These development projects include new models and their enhancement launched throughout the year of 2000 up to 2014. The frequency of the NPI is expected to increase with some other new models that will be released in the near future to come. The exploratory study was first undertaken to gain insight into two selected NPD processes; the generic and also the 5-stage and 5-gate system as previously illustrated in Figures 1 and 2, respectively. These two processes are well accepted due to the fact that they have been adopted by many companies to solve deficiencies in their new product development efforts [17]. The combination of both processes in product development efforts has been the key characteristic of benchmarking in the present work. The data from the literature were used to run pre-test questionnaires during the first semi-structured interview session with one of the senior project managers (contact person) at the automaker's assembly plant in Shah Alam, Selangor. The questionnaires were fine-tuned for the second semi-structured face-to-face interview session that was conducted with selected respondents. The research questions for the present study are as follows:

(a) What makes the automaker able to increase its new product introduction (NPI) frequency? Has the automaker successfully established a well-defined NPD?
(b) What happens at each phase of the NPD? What do the people do?

In order to answer those research questions, a study on the firm's NPD was carried out, and only data from projects that were finally released to the market were taken into account for this article. The second interview was conducted with respondents from various groups: two senior project managers including the contact person, two development team members, a manager of product planning, and a senior executive from the NPI unit, and finally a first-tier vendor. These selected senior project managers were the person-in-charge for two different vehicle programs available under project management office (PMO). Prior to the interview, the consents from those respondents were obtained by inviting them to participate in the study. Similarly, the round of interviews also took place at the same site, and was conducted over a period of three months after the first interview because it was hard to get those respondents together at the same time. The respondents were randomly asked to explain and relate the information of each previous project from each vehicle program, starting from idea generation to product launch. The interview session took about 4-5 hours per session based on open and closed questions. The participants were asked about development phases within the product development process, and each activity within a phase was probed in detail, using mostly open-ended questions (verbal and descriptive). To help the respondents with the questions, the phase and its activities were briefly described based on Ulrich and Eppinger [2] and Cooper [16] studies. The questions also covered topics related to CE principles of parallelism and multidisciplinary team issues. Data from the interview sessions were gathered and observed before comparative analysis was conducted. The data were divided into two main categories namely the development phase and gateway.

4.0 RESULTS AND DISCUSSION

The observation yielded that the automaker has managed to develop its own NPD process successfully. It is known as New Product Introduction (NPI). The efforts to establish a formal NPD process started in mid 90s, and the automaker managed to come with a formal NPI in 2007. The NPI has served as a guideline to those who are involved in the product development process. The NPI has so far been revised twice in order to suit the automaker's development process requirements and standards. It has been implemented in the development procedures for all development projects particularly in the long range production planning (LRPP). In short, this process has been applied onto projects that are classified as new design or new platform. The NPI uses both the phase and stage-gate models which indicate phases and gateways. Figure 3 shows the latest NPI that consists of 4 phases.

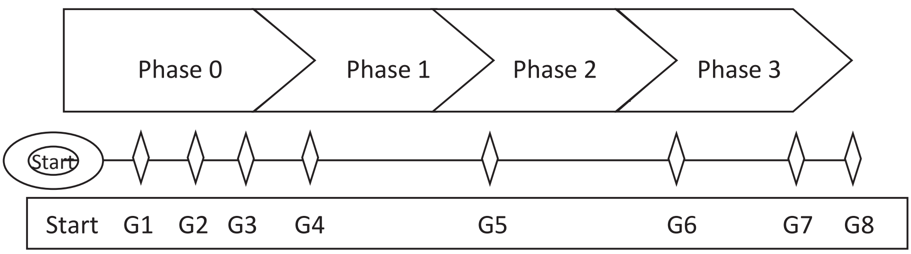

Figure 3: Malaysian small-sized automaker's product development process

Table 3: The NPI development phase

PHASE	*MAIN ACTIVITIES*
Market & Product Feasibility, Technology & Concept development. (Phase 0)	Identification of target market and market size, financial commitment, benchmarking, business case & risks study. Product alternative concept development (styling), product specifications, master schedule, product packaging, project strategy, manufacturing strategy, bill of material (BOM) cost, carry over identification.
Product & Process Development and Prototype Build & Design Validation. (Phase 1)	Engineering design and development, prototype fabrications and testing and product validation, quality assessment,
Process Validation & Product Confirmation. (Phase 2)	Production preparation & production trial, assembly verification, quality verification and improvement, pre-production build-up, launching plan and homologation.
Production & Process Improvement. (Phase 3)	Mass production & ramp-up product volume, production control, launching preparation, project review, project budget allocation review, project closeout.

It also consists of eight gateways (G1 – G8) altogether across the NPI. The development routines vary from one phase to the other. In each phase, there are significant, related main activities that are progressing in parallel with the process as described in Table 3. For each phase, there are gateway(s) indicating activities of monitoring and controlling the on-going development process. The distribution of the gateways in the NPI is as follows: four gateways within Phase 0, one each for Phase 1 and Phase 2 and two in Phase 3 (Figure 3). Table 4 shows the descriptions of the activities involved in each of the gateways.

Table 4: The gateways of the NPI

PHASE	GATEWAY	GATEWAY DESCRIPTION (Go/No-Go decisions)
Phase 0	G1	Go/No-Go for product concepts initiation, product launch concept, business strategy, project business case, project's timeline, financial commitments, technology development, project organizational structure, project strategy, vendor involvement, and general packaging of product.
	G2	Go/No-Go for concept selection, product packaging, master schedules, and product technical specifications. This includes the design contents and overall package versus competitors.
	G3	Go/No-Go for the design concept for the full model scale. Evaluating criteria such as weight, cost, design, and detail product packaging. Design concept based on results from simulations with regard to safety, performance, and handling.
	G4	Go/No-Go for engineering design of the vehicle, including freeze of exterior and interior styling, final packaging, equipment level, product specifications, quality target, manufacturing plan, BOM cost, and risks
Phase 1	G5	Go/No-Go for production trial to signify the completion of phase 1 and the commencing of phase 2 of pilot trial.
Phase 2	G6	Go/No-Go for mass production to begin.
Phase 3	G7	Go/No-Go for product launch.
	G8	Go/No-Go for project close-out.

Phase 0 contains the front end activities that include the marketing department from which data or customer requirements are compiled and studied. Customer wants and needs are captured and gathered through the voice of customer, and the results of the market study are presented to the management. During this phase some other studies are also considered, including business case and risks study, target product specifications and the initial concept generation. In addition, planning on master schedule, manufacturing, project strategy, product packaging (features and available technology to be used) are also identified. This scenario is important to the NPI as satisfactory completion of marketing activities is critical to new product success [18]. The G1 in Phase 0 is the first gateway in the NPI. It refers to the initiation of the concept design where decisions are made on product launch concept, business strategy, project business case, project's timeline, financial commitments, technology development, project organizational structure, project strategy, vendor involvement and general packaging of product. Prior to G1, the event start indicates the project kick start. Top management appoints the project director and managers as well as the cross-functional development teams. In short, G1 is the gate to determine progress status of the initial event start. Next gateway in Phase 0 is the G2 where the decisions revolve around the concept selection process of the 1/3 scaled models. The related activities include the generation of the target specifications, the benchmarking process and design content issue and the appropriate product packaging as well as the master schedule. Finally, the concept designs of two full-scaled models are presented for selection. The selection process of these models is refined and presented for the final selection at G3. Ultimately, the concept design stage in Phase 0 is fixed (model fixed) to allow other decisions to be firmly made according to the optimum interior and exterior styling. The Go/No-go decision over the concept design stage of the fixed model is made at G4. The results determine whether the project proceeds to the next level or vice versa.

In Phase 1, the main activities involve the engineering design work where the product undergoes design activities such as configuration and preliminary designs, and prototype fabrication to validate the design. Heavy design activities occur in this phase and the designs conform to specifications and manufacturing requirements. The production engineering team uses data of the preliminary designs for various testing and simulations to check the product and process desired performance, the feedbacks are sent back to engineering design group for iterations if necessary. This is known as the product design engineering – manufacturing engineering interface as mentioned by Dekkers [19] and Vandevelde and Dierdonck [20] where the communication between these two functions is very intense. After the main development activities of engineering design in Phase 1 are accomplished, the G5 indicates that the progress is signed off and approved for production trial.

For Phase 2 of the NPI, the detailed engineering activities take turn once the design tasks are totally completed. The significant activities in this phase can be concluded as activities that relate to the mass production stage. These include the preparations for production and trial, assembly and sub-assembly verification and improvement, pre-production and launching plans, as well as homologation. These production-related activities are reviewed at gateway G6. Similarly, in Phase 2 if there are errors or mistakes to the product, an engineering change request will be sent to the production engineering team or engineering design team for the iteration process. These teams' interactions take place regularly at many occasions within the NPI. This allows better integration as cross functional team integration is one of the important factors for successful NPD [21]. The outputs from this phase are the manufacturing engineering documents that relate to production routines. For instance, the manufacturing and control plan, process layout, a list of assembly tools and jigs and fixtures, process and operation sheets. All important decisions pertaining production activities are determined at G6.

In the final stage, Phase 3, the activities are dedicated to production ramp-up and launching. The development of the product is now moved into pre-production activities known as pilot-trial. The individual component and sub-assemblies are built and tested using the production equipment. During this phase both the product and its assembly lines and the assembly equipment are put in place and ready for volume production. Meantime, the launching plan is executed and the product would be introduced to the customers starting with the relatively low level of volume. This allows the development of the confident level of the development team and the suppliers in producing the product and the build-up of the marketing abilities to sell the product. G7 is the gateway dedicated to product launch. At the end of this phase, reviews on the project are made to verify the achievements of the product in terms of quality, cost, volume (lesson learned) and closeout. The review takes place at G8.

Obviously, the difference can be seen from the numbers of phases involved in the NPD. Ulrich and Eppinger [2] suggested 6 phases, and Cooper [16] suggested 5 stage - 5 gate of product development processes. Meanwhile, this automaker has 4 development phases in its NPD which is similar to the process reported by Wheelwright and Clark [5] and Clark and Fujimoto [22]. Therefore, this indicates that the NPD differs between manufacturing-based industries [15], but for this Malaysian car manufacturer, the development phase is similar to the one described by Clark and Fujimoto [22]. However, regardless the numbers of phases or stages, the main activities within a phase or across phases remain identical. The product goes through specific stages or phases from idea to launch in its development process that can be generally broken down into two main activities which are the concept generation of the product and the concept development of the product [9].

Unlike Fredericks [9] and Kettunen [23] who suggested and proposed a three phases NPD: the proposed first phase is known as initial development where the duration is defined as fixed development time, and the product goes through iterations to improve its performance during this phase. The second one is the additional development where the performance of the product is finalized, and in contrary the duration is considered to be not fixed. Finally, the market phase is where the product is already in the market. Again, with reference to these two concepts of NPD, it is found that the phases of the development process could be different but with a closer look into the key activities; they are mostly the same.

The decisions made at gateways normally indicate that the activities in a particular phase are successfully executed and whether the development process proceeds to the next stage or not. Cooper [16] used the terms gate in 5–stage, 5–gate system and labeled gates representing decisions whether the project proceeds or not with Go/Kill. Similarly, this automaker uses gateway to define its gate (review), and to determine the status of the development process with GO/No-go decision. In contrast, with eight gateways; the automaker has the highest number of gates as compared to both approaches. The generic product development framework consists of six gates, and the 5- stage, 5–gate only has five gates. However, the number of gateways of the automaker is only four if they are considered and counted between phases (G4, G5, G6, and G8). The highest number of gateways in the NPI is in Phase 0 where there are four gateways available, indicating how critical Phase 0 is. It is believed that this initial phase is where both the uncertainties and risks are at the highest level as compared to the other phases. Handling this initial stage known as the fuzzy front-end is an important and difficult task in NPD [24]. Since 1985 and prior to the year 2000, the automaker introduced 7 models only which are classified under either modification or facelift type of product development projects. However, starting from the year 2000 onward with the adoption of CE, the automaker has produced 16 new models under different types of projects, including new platform with new engine. In other words, the automaker has increased the frequency of its NPI by more than 100% after the adoption of the well-defined NPD.

5.0 CONCLUSIONS

In comparison to Ulrich and Eppinger [2] and Cooper [16], in general; the NPI of the Malaysian automaker is similar to both approaches in terms of the designation of phases or stages. However, the NPI is more likely similar to the NPD proposed by Clark and Fujimoto [23] in terms of number of phases and development routines. The main development activities in the NPI infer significant similarity of both benchmarked NPD frameworks. As a result, this scenario opines that a well-defined NPD is crucial for both the small-sized and top players in automotive industry in order to sustain company's performance and competitive advantage. An effective product development routine is considered to be one of the key determinants in a firm success [25]. The designation of gate or gateway is an important characteristic in NPD. It allows management of the progression of development activities to be double checked for improvement, retention or elimination. It also minimizes the intensity of the uncertainties and the risks during the development process especially at the front-end of the development framework [24].

A passenger car is a complex product that consists of thousands of components and sub-assemblies, and the level of risks and uncertainties is high and intense at the beginning of the development phase. For a small-sized automaker with a limited pool of R&D resources, relatively poor experience in new product development project, and lack of international recognition and competitiveness; the planning phase seems to be the most crucial phase in its NPD process. These challenges have become the driving factor for the automaker to have four gateways in the initial phase. Moreover, the organizational and managerial related issues at any phase during NPI can also be resolved at gateway meetings as it involves top management personnel from various functions.

The adoption of CE for its current development framework has improved the frequency of the NPI. With a traditional or sequential development approach, the automaker is merely focusing on facelift and minor modification types of development projects. However, with CE where development process are paralleled and executed through cross-functional integration [26-27], the Malaysian automaker manages to increase the frequency of the NPI. In addition, CE allows the automaker to introduce its products between 2-3 years, depending on the product development project characteristics i.e. project and product complexity, project schedule and innovativeness. The new organizational and managerial strategies are important for the automaker as the cross-functional team has become the problem-solving tool during NPI as well. This study ,therefore, concludes that the small-sized automaker is now owns an effective product development approach known as NPI in which the automaker efficiently manages to sustain its competitiveness in the auto industry in the emerging market of Malaysia.

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