



New product development management issues and decision-making approaches

NPD
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Abstract

Purpose – The purpose of this paper is to report findings related to new product development (NPD) management issues and their corresponding decision-making approaches undertaken by senior managers.

Design/methodology/approach – The study adopts grounded theory research method using interview as the primary data source. 100 NPD management issues, sourced from 16 senior managers from six technology-based organizations in Malaysia, were investigated and analyzed.

Findings – The study revealed four categories of NPD management issues; strategic NPD management issues, NPD project management issues, NPD process and structural issues, and NPD people management issues. The study also found that senior managers apply different patterns of decision-making approaches in dealing with each category of NPD management issues.

Research limitations/implications – Although the findings from this study are within the specific context of technology-based organizations in Malaysia, this exploratory study opens up a number of questions for further investigation.

Practical implications – The discussion from this paper should also stimulate senior managers from other organizations or from other locations to reexamine categories of management issues in their organizations and how they approach them from a decision-making perspective. This reflection could help identify areas which need further decision-making skills development.

Originality/value – The classification of NPD management issues provides description of NPD management issues and the corresponding common decision-making approaches. The study which was carried out at technology-based organizations in Malaysia contributed to narrow down the geographical imbalances of NPD literatures, contributed to the body of NPD management literatures by bridging it with decision-making theoretical perspective, and contributed to the naturalistic decision research stream.

Keywords New product development, Decision making, Malaysia

Paper type Research paper

Introduction

The high failure rate of new product development (NPD) projects suggests that NPD is a challenging pursuit. Balachandra and Friar (1997) quoted almost 90 percent of products introduced in 1991 did not reach their business objectives. Schilling and Hill (1998) quoted that between 33 percent and 60 percent of all new products that reach the market fail to generate an economic return in North America, and Cooper (2005) quoted



33 percent failure rate of NPD projects. At any rate, making NPD projects successful has been a major challenge for the manager in the past, and will undoubtedly continue to be a major challenge for tomorrow's manager (Souder and Sherman, 1994).

The challenging nature of NPD management can be attributed to the characteristics of NPD which managers have to contend with, such as managing trade off, dynamics of technology and customer preference, level of details, time pressure, and large economic investment and impact (Ulrich and Eppinger, 2004). The unsettled contentious matter requiring decisions that were associated by such challenges is defined in this paper as NPD management issue.

The challenging characteristics of NPD have prompted a great deal of interest by the researchers and academicians contributing to the continuing broadening of the NPD management bodies of knowledge. From hardly anything written on NPD topic in the early 1970s (Cooper, 2005), research studies on NPD management are now large and diverse (Montoya-Weiss and Calantone, 1994; Souder and Sherman, 1994; Schilling and Hill, 1998).

This growth helps providing insights into the success factors of managing NPD. Past studies on NPD practices have shown that there are as many as 72 determinants of NPD success (Montoya-Weiss and Calantone, 1994) and 53 ways to measure NPD success (Hart, 1993). Other literatures disseminate knowledge and/or best-known solutions in dealing with NPD management issues and challenges. They include in the areas of business and product strategy making (Porter, 1996; Burgelman, 2002; Christensen *et al.*, 2004; Mankins and Steele, 2006; Ali *et al.*, 1993; Ding and Eliashberg, 2002; Halman *et al.*, 2003; Wheelwright and Clark, 1992; Lyne, 2003; McGrath, 2004; Cooper, 2005), portfolio management (Cooper *et al.*, 1997a, b; Cooper *et al.*, 1998; Cooper *et al.*, 2000; Cooper *et al.*, 2001a, b), new product process (Cooper, 1990; Souder and Sherman, 1994), and people management and organization design (McDonough III and Leifer, 1986; Kahn, 1996; Pitagorsky, 1998; Mullins *et al.*, 1999; Schmidt *et al.*, 2001; Hoopes, 2001; Sarin and McDermott, 2003; Cooper *et al.*, 2004; de Brentani and Kleinschmidt, 2006).

However, studies focusing on NPD decision-making aspect of NPD management had not been as widespread. Two past decision-making studies which for the most part include NPD decision making are that of Mintzberg *et al.* (1976), and that of Bourgeois III and Eisenhardt (1988). Bourgeois III and Eisenhardt (1988) investigates strategic decision making from system perspective through four case studies in the microcomputer industry. Mintzberg *et al.* (1976) investigates strategic decision making from process perspective. Our study was aimed to broaden this specific body of literatures. In our previous report (Yahaya and Abu Bakar, 2007a, b), we described NPD decision-making modus operandi and approaches. In this paper, we intend to report differences in NPD decision-making approaches from the purview of NPD management issues.

About the study

An in-depth exploratory study was carried out to investigate the functioning of NPD decision making in the context of coping with the challenging nature of NPD management. This study falls into the naturalistic decision research movement (Zsombok, 1997) since it studied how decision makers make NPD decisions in their natural business setting. Naturalistic decision research is aimed at understanding how

people use their experience to make decisions in complex, dynamic and real time environments, and explores methods and approaches used by decision makers to identify and assess their situations, make decisions and take actions meaningful to them and to the organizations in which they operate (Gordon and Gill, 1997; Zsombok, 1997).

We narrowed down the scope of our study to technology-based business organizations because most firms in technology-based industry tend to focus more on product research and development (Sawhney *et al.*, 2006). In addition, technology-based industry has a special challenge of shortening product development cycle and accelerating product obsolesces (Wheelwright and Clark, 1992; Mikkola, 2001) which makes this industry sector unrelenting and pervasive – circumstances that make it a fertile ground for research (Christensen, 1997).

Since the location of the prior studies on NPD is geographically biased to the western industrialized nations such as those in North America and Europe (Montoya-Weiss and Calantone, 1994), we chose to study technology-based organizations in an Asian developing country, Malaysia, because in this way this study could also contribute to narrow the geographical imbalances of NPD literatures. We recognized that since we could not identify past studies on the functioning of NPD decision making in the context of coping with challenging nature of NPD management in western nations, our study could not make comparison on cultural, socio-economic or other country-specific factors which could influence NPD management issues or decision-making approaches.

We did not have a preconceived theory or proposed theoretical framework on NPD decision making to validate. Our study was inductive and exploratory in nature with the intent of providing descriptive account of decision making in an NPD context. In our study, we applied grounded theory qualitative research method which does not mandate producing a theory, albeit its name (Strauss and Corbin, 1998). We depended on interview as our only data inquiry technique since we were restricted from making participant observation in company meetings where NPD decision making mostly take place, and from examination of archived meeting minutes due to confidentiality policy. The research data that we analyzed comes from culmination of sources based on interviews. The first source is the transcript of recorded verbal responses of the research participants to the interview questions and follow-up questions asked. The second source is the interview notes captured during the interviews. And the third source is the follow up conversation with the research participants held after the interviews to verify that the first and second sources are reflective of the actual situations.

The application of grounded theory method

According to Baker (2002), grounded theory methodology has become a widely used technique in business and management research despite their earlier use in the field of nursing since Glaser and Strauss's 1997 book, *The Discovery of Grounded Theory*. As the methodology progresses over the past 40 years, two variants of grounded theory developed (Partington, 2000; Reetley, 2003); that of Glaser, and that of Strauss and Corbin. Glaser's variant focuses on maintaining the seminal grounded theory methodology, whereas Strauss and Corbin's variant attempts to address the need for uncompromising formalization of procedures through their 1990 book, *Basics of Qualitative Research: Grounded Theory Procedures and Technique*.

Many researches found the step-by-step method in *Basics of Qualitative Research* as difficult to follow in practice except in a loose, non-rigid fashion which inevitably draws them back towards Glaser's variant of conducting grounded theory research (Partington, 2000). Strauss and Corbin however, addressed the critiques when they clarified and rewrote their perspective of grounded theory in the second edition of *Basics of Qualitative Research: Grounded Theory Procedures and Technique* in 1998. We adopted the latter method of grounded theory methodology because the maintained processual approach addresses the need of our purposeful research agenda, and provide general structure which the stakeholders of our research expected, while the removed appearance of formalized procedures gives back some sense of openness to allow constructs to emerge inferentially from the analysis.

Data collection process started with preparatory activities which include development of provisional interview questions, identification of candidates for research sites and research participants, and undertaking efforts to gain access to those sites. This is followed by the actual interview proper with the first research participant, during which we captured interview notes and audio-recorded the conversations. Interviewees were asked, among others, about issues and challenges they faced through the product development phases and how they were dealt with. Then we performed post processing steps which consist of data transcription and archival. We analyzed the interview data through coding techniques outlined by Strauss and Corbin (1998) and Goulding (2002). After that we repeated the process with the second research participant. The data collection and analysis processes were carried out iteratively using theoretical sampling process for the subsequent research participants, until theoretical saturation was reached. The information from the initial data analysis guided what data to be collected next and where to find it – which resulted to modification of interview questions and selection of next research participants as we progressed. In the end, the developed core concepts saturated, after 16 research participants from six organizations participated in the study. Our research participants were those who, in one way or another, participated in making NPD decisions and they happen to be the senior managers of those organizations. The variability of the characteristics of the research participants is shown in Table I, whereas the variability of the characteristics of the organizations studied is shown in Table II.

Analysis of findings

Based on the iterative analysis of our research data, several concepts which described NPD decision-making process characteristics, approaches and modus operandi emerged and these aspects of the findings were reported in our prior work (Yahaya and Abu Bakar, 2007a, b). Another aspect which is central to this paper is pertaining to NPD management issues and their relationships to NPD decision-making approaches. The unit of analysis here is the NPD management issue, which is defined as the unsettled contentious matter requiring decisions. Based on the analysis of our research data, we identified 100 different cases of NPD management issues until four categories of NPD management issues saturate. The categories of NPD management issues are strategic NPD management issues, NPD project management issues, NPD process and structural issues, and NPD people management issues. The examples of each category of NPD management issues and their characteristics, as well as the characteristics of NPD decision making in dealing with those issues are summarized in Table III.

Characteristics	Variation	Count	NPD management issues
Gender	Male	14	1127
	Female	2	
Years of NPD experience	1-5 years	8	
	6-10 years	6	
	11-15 years	0	
	16-20 years	1	
	20 years and above	1	
Years of working experience in current organization	1-5 years	10	
	6-10 years	1	
	11-15 years	1	
	16-20 years	2	
	20 years and above	2	
Years of accumulated working experience	1-5 years	0	
	6-10 years	1	
	11-15 years	4	
	16-20 years	6	
	20 years and above	5	
Highest education	Bachelor	10	
	Master	2	
	Doctorate	4	
Education discipline	Engineering	6	
	Science/Technology	7	
	Business/Management	3	
	Other social science	0	

Table I.
Variability of the characteristics of the research participants

Strategic NPD management issues

Strategic NPD management issues are related to or important to the strategic objectives of the organization. NPD strategic management issues include product positioning issues (e.g. competitive threat, positioning conflict), portfolio issues (e.g. constraint to allocation), market acceptance issues (e.g. first mover advantage/disadvantage, setback of lacking complementary products), technology issues (e.g. de facto standard, disruptive technology), and support network (e.g. discontinuance of supplier support). The common traits of strategic NPD management issues are their high uncertainty, high ambiguity and risky characteristics.

An example of strategic NPD management issue can be dissected in this quotation.

Certain products . . . for example you want to buy from a supplier but they do it only using technology S. Then we weigh it, does technology S make sense. If it is too expensive, we ask them – why don't you use technology U, or is it on the product roadmap 6 months down the road – they may not have it yet. Then you have to weigh the question of time, cost, do you want to wait until technology U, or should it be phase two with technology U. So there are a lot of decisions you made from a business perspective, not from technical perspective. Business perspective to say, does it make sense to use it? Cost and user experience, which is better? . . . From what we know of the other competitor is doing and then from what we know, how do we redefine it? Or do we just want to accept it just it is? So there are a lot of things from the product perspective we need to know, is it cheaper, is it better, can we do it in a different form? (Interviewee #16).

Table II.
Variability of
characteristics of the
organizations studied

Organization	A	B	C	D	E	F
Type of organization studied	Company	Strategic business unit	Company	Company	Company	Strategic business unit
Ownership	Government-link	Corporatized government body	Privately-owned	Public-listed	Foreign-owned subsidiary	Multinational corporation subsidiary
Type of products	Services	Manufactured goods	Manufactured goods	Services	Manufactured goods	Manufactured goods
Industry sector	Tele-communication	Biotechnology	Optical networking	Mobile communication	Automotive	Computing
Typical product development period	6-12 months	3-5 years	6-20 months	2-12 Months	1-3 years	2-12 months
Market of product	Local consumer and local corporate	Local consumer and local corporate	Local corporate	Local consumer and local corporate	Regional consumer	Global consumer and global corporate

	Strategic NPD management issues	NPD project management issues	NPD process/structural issues	NPD people management issues
Examples	Product positioning issues Portfolio issues Market acceptance issues Strategic technology issues	Escalated technical issues Project planning issues Project execution issues	Bureaucratic issues Efficiency issues Oversight, control issues	Resource management issues Competency development Performance management issues Support working environment issues “Soft” issues Require people management skills Severe consequences to capacity for NPD
Characteristics of issues	High uncertainty Ambiguity Risky Ranges of decision alternatives	Variety of issues Urgency, less ambiguous but more manageable Narrow decision alternatives	Require balancing of quality factors Dilemma of formality/informality	Group decision making Project/resource reprioritization Staff reassignment
Characteristics of approaches	Group decision making Scenario analysis Use strategic objective, business objective, long term business plan as references	Group decision making Trade off Project/resource reprioritization Assume additional risk	Group decision making No definitive tactics Intuition or subjective judgment Applying experience	Group decision making Project/resource reprioritization Staff reassignment

Table III.
Summary of findings

Senior managers whom we talked to make use of industry and market knowledge, entrepreneurship skills, and scenario analysis to ask the right questions, to weigh various factors, and eventually to make their final judgment in reaching their group decisions to deal with strategic NPD management issues. In addition, they also sometimes make reference to the established organizations' vision, mission, strategic objectives, or long term business plan as guidance to make consistent decisions.

Since strategic NPD management issues are about predicting the success of product or technology in the market, predicting reaction of competitors, suppliers and customers, and predicting how a product plan and strategy will work out based on limited control of the future, senior managers are dealing with risk, high uncertainty and ambiguity. This classification of NPD management issues fits into "Level 3" uncertainty, of which a range of potential futures can be identified, and this range is defined by a limited number of key variables; but the actual outcome may lie anywhere along a continuum bounded by that range (Courtney *et al.*, 1997). Incomplete information about the future and past experience are only able to give some guidance to a limited extent. This explains why we see more intuition than empirical analysis employed in making decisions in dealing with strategic NPD management issues. Sadler-Smith and Shefy (2004) shows that when rational thought is not achievable or desirable, one way of managing and coping with uncertainty and complexity is by relying upon intuition. One senior manager said:

We use the data, and after that we have to use the hunch . . . the gut feelings. Somehow or rather I think that element has to come to being as well . . . because . . . whatever things that we do, there will be connection to the market . . . what the user wants and so forth – what the customer wants rather than what we think the customer wants. But on the other hand, we also have that situation – existing sense – that you can create the need for certain product so it is not a matter of what the customer wants – sometimes the customer doesn't know what they need . . . maybe they do not need it now, maybe they need it in the future. So that is basically where we create the awareness and basically we sell the idea to them (Interviewee #13).

The used of scenario analysis is a sensible method to identify the best decision choice among its alternatives. In this respect, more extensive industry experience, and broader and deeper market knowledge is able to help senior managers paint a more complete picture of a given scenario. More complete picture of a given scenario means more variables will be taken into account in evaluating decision alternatives. A scenario can be used as an "experimental laboratory" where strategic decision alternatives can be tested for their robustness in a variety of plausible worlds (Wright, 2005). A decision that is seen to produce a successful outcome in each scenario is considered a "safer bet" than one that flourishes in only one or two of the possible scenarios. Quoting the same senior manager:

When you put everything in the data, they are all facts and figures. But there are things . . . basically you will not be able to get from those information . . . maybe it is based on what-if scenarios . . . What if scenario would be a situation when we said what happen if a suddenly there is a merger, there is acquisition – trying to figure out what would happen – but you are not going to get all this data from market research report . . . (Interviewee #13).

Senior managers whom we talked to also make references to the established organizations' vision, mission, strategic objectives, or long term business plan as guidance to make consistent decisions. These planned strategies are the performance

drivers for NPD, which help senior managers focus on new product ideas, and assist in the product selection of NPD projects at gate meetings and portfolio reviews (Cooper *et al.*, 2004).

NPD project management issues

NPD project management issues are related to the administration of the NPD project activities. There are wide varieties of NPD project management issues because there are overwhelming details in NPD projects. In other words there are many things which could possibly go wrong and become project issues in the course of managing NPD projects. NPD project management issues include escalated technical issues (e.g. design, validation or testing issues) which require management attention, project planning issues (e.g. omission of tasks in work breakdown structure), and project execution issues (e.g. schedule slip, cost overrun). Day-to-day NPD project issues which are normally handled by an NPD project manager can become issues for senior managers when they require higher management involvement to make trade-off decision, reprioritization decision, or “executive decision” to revise the previously decided NPD project plan of record. NPD project management issues are also characterized by their narrow decision alternatives and high urgency, but they are relatively less ambiguous and more manageable as compared to strategic NPD management issues.

One senior manager said the following about NPD project management issues:

There is none I have seen having no problem, technical problems are everywhere ... then what we do is we do mitigation. Let's say for example we have a very tight timeline, we have to launch on a certain day – this is what we do. We look at the problems that we encounter then we categorize them. We call them severity one, two, three and four. One means you have to do one – we have to have before launch. Two means yes you don't have to have before launch but what is the mitigating factor. ... Four and three are normally nice to have ... it never impacts the business. One is normally the ones that impact the business. Two is close – pending, normally we still launch with two. There is no product that we launched without defects. Every products that we launch has got some defects in it, then we weigh what is the impact, what is the chance of occurrence. You actually weight the risk – high, low, medium. For every risk we put a mitigating factor. What are the mitigating things that you need to put in place if it should happen. Some of them is risk but is very very low – the chance of happening is very very low (Interviewee #16).

Some kind of routines, rule of thumb, and guidelines are commonly applied in reaching a decision to deal with the issues. In addition, senior managers need to make use of business and product knowledge, and historical experience to ask the right questions, to weigh various factors, and eventually to make decision choices among narrow decision alternatives. Their decision-making process involves making trade off, reprioritization of NPD projects and/or resources, and making judgment to assume additional risk.

A breadth of NPD project management issues have been studied and can be found in the literatures. Among other NPD project management issues are project scope not defined detailed enough, too strict schedules, changing objectives, some experts need to do many project works, need to train teams in teamwork and conflict resolution, and inter- and intra-team coordination, need to make decision on relative priority of objectives for the project, major project milestones and prototypes, and means of

monitoring and controlling the project (Elonen and Artto, 2003; Scott, 1998; Krishnan and Ulrich, 2001). All these issues are important to the quality of NPD project execution which is no less pivotal to companies' performance (Cooper *et al.*, 2004).

Senior managers articulated relatively easier what decisions need to be made and what sensible decision choices are available to deal with these NPD project management issues. As compared to the characteristics of strategic NPD management issues, NPD project management issues are more concrete and clear because they are easily identifiable, less ambiguous because they are not about predicting future situations as much, and more manageable because decision makers can take more risks in their decision making. The perceived ability to control such issues helps senior managers take risks in their decision making (March and Shapira, 1987).

Dealing with NPD project management issues require trading off and balancing between competing factors, commonly described by a triangle representing time, cost and performance (Mantel *et al.*, 2005). Having the right business and product knowledge helps senior managers ask the right questions to understand credible decision alternatives, judge the trade off implication, and make prioritization decisions. Making such judgment is where experienced senior managers have advantages over inexperienced senior manager. This is in line with recognition-primed model. Recognition-primed model postulates that expert decision makers can make good decision without having to perform extensive analysis by employing their experience to recognize problems that they have previously encountered and for which they already know the solutions which work and do not (Beach *et al.*, 1997). Our findings show that experience directly helps senior managers make the right decision to deal with NPD project management issues, in contrast to making decisions to deal with strategic NPD management issues where experience only help senior managers describe a more complete picture of future scenarios.

NPD process and structural issues

NPD process and structural issues are related to the continuous effective operation in managing NPD activities. Different from NPD project management issues which are about the running of the NPD project, NPD process and structural issues are about the system under which the NPD project is running. NPD process and structural issues include bureaucratic issues (e.g. approval, paperwork, procedure), efficiency issues (e.g. speed, rigorousness), and oversight issues (e.g. monitoring, delegation). The need for balancing a number of competing quality factors, for example balancing between formality and informality, is the characteristic of NPD process and structural issues. Senior managers interviewed indicated that NPD process and structural issues received their attention least, underscoring the non-urgency of dealing with such issues. The following two questions indicate examples of NPD process management issues, and the third quotation indicates one way it is dealt with.

There are two drivers in the product area. One is time-to-market. If you do too much scrutiny, then the time-to-market can be compromised. There is also innovation. If . . . it is going to be excessive . . . , then you actually killing off some part of the innovation in the company (Interviewee #6).

I think the change that we are constantly trying to make is how to get speed to market without losing the evaluation accuracy. You don't want to get so fast out to market but when you get to the market you don't know what you have and lose certain evaluation criteria

which you think is important. We try to adapt to those processes, I think the most important thing that we are trying to do is to achieve speed to the market. How to make processes more efficient, quicker – without losing the accuracy of the information that we have – from the evaluation that we do? (Interviewee #2).

If it is a promotion, then we say it doesn't require technical documents, we quickly drop that and say it stops at the business case. If product that doesn't affect certain areas of technology development, then we say okay, let's not go through that feasibility analysis of doing something which is not required and drop that and move (Interviewee #2).

Senior managers consistently make use of past organizational learning and experience in reaching a decision to deal with NPD process and structural issues. Their decision-making process involves weighing and balancing various competing factors, and making intuitive judgment on trade off. In addition, the consequence of NPD process and structural issues and the consequence of making wrong decision in dealing with the issues are not perceived to lead to severe impact to NPD project. As new factors unfold, or as the outcome of the decision becomes visible, the decisions can be revisited and overridden with a new decision. This decision-making approach to NPD process and structural issues can be explained from cognitive perspective. Cognitive dissonance theory contends that to ensure there is less dissonance, a decision maker would seek or choose a decision alternative which is consistent with his believe (in this case new believe), or to change his behavior to be consistent with his knowledge (Festinger and Carlsmith, 1959).

NPD process and structural issues are about the efficiency of system in which NPD projects run. The decision alternatives that senior managers have to choose lie on a continuum of choice, for example, in order to deal with a bureaucratic issue, senior managers need to make a decision on how much a product proposal must be scrutinized before it is approved before adjusting the stage-gate process. Senior managers indicated that they normally face dilemma in making decisions in dealing with NPD process and structural issue although the urgency of making such decisions is lower and the consequence of making blundered decision is not as severe as that of NPD project management issues.

Senior managers need to decide between “evaluation accuracy” versus “speed-to-market. as said by the senior managers we talked to. Senior managers have to decide how much scrutiny or evaluation accuracy, for example the accuracy of market projection analysis that they have to concede in order to save time to be ahead in developing and launching a new product. Making that decision is a delicate balancing act. There is a risk to the product launch schedule if the development of the product is delayed or slowed down by excessive scrutiny of evaluation accuracy.

Again, senior managers rely more on intuitive judgment than on analytical evaluation in dealing with NPD process and structural issues. This senior manager viewed that intuitive judgment call as a “business call”:

Look at the process, is the process right? If the process is not right, can we change the process? Let's say the process is right already that you need to skip a few, one or two, then it is a business call. That means what the guy needs to do is to ask and seek . . . because we have to know what is the risk involved. You cannot have a situation and say I am just going to drop, no! We said, we will drop this but there might be a possibility that we may end up like this . . . back to the situation of this management (Interviewee #13).

One way such issue is dealt with is by simplifying or reducing processes which have lower risk implication. The decision choice may call for deformatizing or loosening existing formal process that mandates stringent analysis steps. However there is an opposing force which drives decision makers to maintain the formality of review process to ensure consistency of quality of market analysis. There is no perfectly right or wrong solution, and that explains why senior managers were found to be relying on their intuitive judgment and past organizational experience in deciding the change to the NPD process or structure. Senior managers utilize the result of previous trial and error to fine tune the amount of formality, scrutiny and bureaucracy in their NPD process and structure. As the outcome of a decision becomes visible, a new decision is made to adjust the NPD process and structure.

NPD people management issues

NPD people management issues are related to the organizational or human aspect of the NPD management. NPD people management issues include that of human resource management (e.g. hiring, compensation, motivation and resignation), competency (e.g. training, organizational learning), job performance (e.g. work load, goal setting), and supporting environment (e.g. norms, working condition, reward). The consequences of an NPD people management issue may lead to a more severe impact to the capacity to plan and execute NPD projects.

Cases of work leveling and training issues, job satisfaction and retention issues, resignation issues, and staffing issues, and their impact to NPD activities can be dissected from the following quotations:

We have resources in each group to look at the respective products. At the same time, when we have groups which are overloaded, in this case group X, we have quite a number of additional products that they want to do, and some come in in-surge and so on. That one we need to work out the distribution and spread out the load. Although it is not a norm, we also have cases where Y members actually handle X products. That is mainly for two reasons; one is to share the load, the other one is also to give exposure to the engineers (Interviewee #6).

The situation we have with this company is that . . . all the good people left because they have been quite frustrated. They tried, they tried, they tried and they keep failing because of the DNA of the organization. And because of that you know we are still trying. There are a lot of good people in this organization; however they have gone through so much beating over the past six, seven years. It reaches a point that you can only do so much (Interviewee #7).

There are cases due to resignation, capacity was lost. So we cannot support that project anymore. Again, the project dies off. Then we have to kill that project also (Interviewee #1).

Due to our limitation in terms of resources, we have four or five or six people only. What we try to do now is something like that priority. You do A, then you do B then you do C. The expertise is more or less the same for these products – all they can do. So it is not really separated (as we would like it to be) (Interviewee #8).

Senior managers consistently make use of their managerial and supervisory skills, creative problem solving, and organizational rules to make credible decision in dealing with NPD people management issues. Decision-making process involves consideration for NPD project or resource prioritization and reassignment of project tasks to the remaining or existing staffs.

NPD people management issues are “soft” issues that are related to human factors and organizational aspects and thus have significant impact to the capacity to plan and execute NPD projects. Trying to do too many NPD projects for a limited resource available without clear prioritization, is another common NPD people management issue (Cooper and Edgett, 2003). Except that they have significant impact specifically to NPD projects, NPD people management issues are basically similar to other non-NPD organizational management issues. As such, the common approach of utilizing managerial and supervisory skills, creative problem solving and organizational rules are found as the practical decision-making approaches taken by the senior managers.

However, senior managers studied have needs to make decision not only to solve the human or organizational issue at hand, but also to disposition the resource arrangement for the affected NPD projects. For example, when an engineer who is assigned to an NPD project resigns, there is a resignation issue which his manager and several other managers need to deal with collectively. In this case, the engineer’s direct manager needed to hire a replacement and make a hiring decision, which took some time. In order to keep the affected NPD project running, the job left behind by the engineer needed to be reassigned to another engineer, probably from a different department, who was working on another NPD project. Thus, decisions needed to be made were on who was the replacement engineer, and what was the priority of ensuring the affected NPD project running, versus another NPD project. The cascading impact of NPD people management issues forces functional managers and NPD project managers to make many decisions to deal with any given issue.

Additional discussion on other findings

Risk and risk taking

The findings from this research also suggest risk taking as an essential component of decision making in dealing with all categories of NPD management issues. However, we observed risk taking and risk control more prominently in decision making undertaken in dealing with NPD project management issues. Among sources of risk identified in our study are lack of time to complete certain tasks prior to a preset event, lack of resources predictably able to complete certain tasks, and lack of reliable and adequate information. In the following two quotations, the senior managers also indicated their attitude towards risks.

Sometimes you need to execute this project within two to three months; you bypass a lot of critical items. It jumps straight because you know that this is something you can afford to do without causing a lot of risks. If you have so much process, you will be doing too many things; screening it (Interviewee #7).

We would not be able to get all the information. We are not living in the world of denial. There will be uncertainties. As far as possible we try to identify what are those uncertainties and try to see what would be the risk be. It will be on calculated risk. When you feel that the risk is overwhelming, then we will not proceed . . . (Interviewee #13).

Senior managers’ view of risk as a negative connotation and as quantification of lost is consistent with March and Shapira (1987). They found that managers see risk in ways that are less precise than the definition of risk as “variation in distribution of possible

outcome” in classical decision theory. In a noticeable connection to the previous quotation from Interviewee #13, March and Shapira (1987) also quoted one of their respondent as saying “you don’t quantify the risk, but you have to be able to feel it” which points out the emotional aspect of risk taking.

According to Jarrett (2000), although representation of risk could be complex, managers are able to deal with only three general levels of conceptual risk associated with them which are high risk, medium risk and low risk. Low risk may not require any mitigation plan. That claim is supported by this research. Establishing risk mitigation is one way to control risk and consequently to control potential outcome. With regard to control of potential outcome, Forlani (2002) demonstrates that the perceived outcome control does affect the decision outcome. In the previous quotation of Interviewee #13, the research participant described lack of outcome control as “overwhelming risk” which had caused a project development proposal to be killed.

Group decision making

A characteristic of decision making which cuts across all categories of NPD management issue is group decision making. We found that in all cases of NPD management issues, decisions are made by two or more senior managers. Through a group decision-making process, a variety of opinions can be tapped to provide a greater array of ideas and thereby enhance creativity in decision making (Ketchen *et al.*, 2004). This is important for decisions which cannot use statistical decision-making method, which according to Souder and Bethay (1993), is not suitable when there is a great need for decision-making process that structures rational analyses, provokes open exchange of opinion, uncover hidden agendas and flaws, and foster consensual organizational commitment to some course of action. What is seen in group NPD decision making is the process of sensemaking which is driven by plausibility rather than accuracy (Weick, 1995). Group NPD decision making thereby provides a mechanism to ensure sanity check is performed on critical “opinions” which are used in NPD decision making.

Use of intuition and group decision making

Simon (1987) suggests that we will find a continuum of decision-making styles involving an intimate combination of the two kinds of skills; one of whom relies almost exclusively on intuition, the other on analytic techniques. He also suggests that the nature of the problem to be solved will be a principal determinant of the mix, which the findings of this research do concur. Our findings on how senior managers make NPD decisions in dealing with strategic NPD management issues and NPD process and structural issues indicates situations in which intuition was basically used as the primary decision-making approach. As explained by Simon (1987), we also observe from our analysis that the senior managers often arrive at problem diagnoses and solutions rapidly and intuitively in dealing with strategic NPD management issues and NPD process and structural issues; and this ability is best explained by postulating a recognition and retrieval process that employs a large number of chunks or patterns stored in long term memory. Isenberg (1984) explains this as a situation when the managers have a repertoire of familiar problematic situations match with the necessary responses and in this case are able to come up with a plausible solution

bypassing in-depth analysis. Used in this way, intuition is an almost instantaneous cognitive process in which a manager recognizes familiar patterns in much the same way people can immediately recognize faces that were familiar years ago.

When intuition is used in group decision-making setting, the credibility of intuition used by the decision maker is challenged and questioned. Decision makers with good intuition record are able to articulate and argue better. This seemingly organized way of dealing with decision makers' intuition substantiates Hayashi (2001). Hayashi (2001) notes that the process of self-checking and feedback were made part of the culture in some organizations because they are crucial for sound intuitive decision.

Uncertainty and group decision making

All categories of NPD management issues have an inherent uncertainty characteristic. The level of uncertainty influences NPD decision-making approaches taken by senior managers in dealing with them. Our study indicates senior managers sparingly make assumptions regarding uncertain things, prominently observed in dealing with strategic NPD management issues. Again, group decision making provides a mechanism for senior managers to question decision alternatives or decision choices which has elements of uncertainties. The one who brings in a suggestion is asked to open up and articulate his basic assumption, his frame of reference and his mental model that leads him to believe in something about the uncertainties. When assumptions, frames of reference and mental models are exchanged and challenged, they are tested until the best one prevails. Looking into a decision problem from multiple frames of reference is useful because decision maker respond differently if the decision choice is framed in terms of gain or in terms of loses (Kahneman and Tversky, 1979; Tversky and Kahneman, 1986). Group decision making provides avenue for intentional questioning process which make senior managers feel more comfortable that they are alleviating hidden psychological decision-making traps. Hidden psychological decision-making traps, according to Hammond *et al.* (2006), includes framing trap that affects goal of decision, overconfidence trap that leads to judgment error, and prudence trap that is an over-adjustment to be on the safe side. Group decision making provides a mechanism in which these psychological traps are put at check.

Implications and conclusion

The objective of this paper was to provide descriptive accounts of NPD management issues and the corresponding NPD decision-making approaches at selected technology-based organizations in Malaysia. It was achieved through the explication and discussion of four different categories of NPD management issues, grounded on our research findings. The classification of four categories of NPD management issues – strategic NPD management issues, NPD project management issues, NPD process and structural issues, and NPD people management issues, and the corresponding common approaches in dealing with them – is useful because it distinguishes the characteristics and factors important to each one of them.

Utilization of market knowledge, industry experience and organizational strategic objectives, as well as intuitive judgment capability were found as important factors in making decisions to deal with strategic NPD management issues. Utilization of

business and product knowledge, project management experience, and risk taking ability were found as important factors in making trade-off and prioritization decisions to deal with NPD project management issues. Knowledge on past organizational learning and intuitive judgment capability were found as important factors in deciding how to balance competing factors in dealing with NPD process and structural issues. Managerial and supervisory skills as well as familiarity with organizational rules and norms were found as important factors in making decisions in dealing with NPD people management issues. Decision making to deal with a combination of categories of NPD management issues is undoubtedly more complex since it would require the application of multitude of decision-making approaches.

In its present form, our study opens up a number of questions for further investigation. Among the out-of-scope areas which our study has taken note of without exploring in details are pertaining to decision makers' skills and their influences to the undertaken decision-making approaches, cultural or socio-economic influences on decision-making approaches, and influences of high-technology environment on the characteristics of NPD management issues. Future study in these areas may be built on our present research. Although our study is within the specific context of technology-based organizations in Malaysia, it should stimulate senior managers from other organizations or from other geography to reexamine categories of management issues and the how they approach them from decision-making perspective. This reflection could help identify areas which need further decision-making skills development.

Lastly, our study contributed to narrow down the geographical imbalances of general NPD literatures, contributed to the body of NPD management literatures by bridging it with decision-making theoretical perspective, and contributed to the naturalistic decision research stream.

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