

Innovation and New Product Development Management

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1. Introduction

Businesses are currently in a realm of global competition and the rapid pace of development in technology and communication has made the competition even tenser as product cycles are shortened. Constant innovation is required to keep businesses afloat and grow continuously. However, in an attempt to achieve these goals, ad hoc innovation is an inadequate response to keep businesses at the forefront as it is not systematic and efficient enough to provide a constant edge over rivals. Thus, there is a need for a more systematic approach i.e. innovation management. Unfortunately, the task remains difficult for managers as there are many disciplines within innovation management. There are also no universal innovation management models that suit all industries. Rather this paper attempts to suggest tools that improve innovation management by facilitating the process of decision making according to strategic risk management and allocation of resources.

In order to allow readers to view the topic in the greater realm of innovation management, the importance of innovation and the management of it will be explained in more detail prior to the discussion on risk management and allocation of resources within an innovation portfolio. Some of the current tools available will be looked at and a gap analysis will be performed to discuss its present shortcomings. An extra tool on resources allocation would then be suggested to supplement the existing tools in an attempt to further nourish the study of and the practice in innovation management. Case analyses will then be provided to look at the practical side of innovation management.

2. The Importance of Innovation

Innovation now plays a vital role for businesses to survive and grow. There is no longer one long lasting formula or product that a business could rely on for long-term survival. Successful businesses are able to keep themselves at the top because they understand that constant innovation is essential. According to a study by PricewaterhouseCoopers in 2005¹, rapid changes due to customer demands and rival competition makes 70% of current sales outdated in 5 years' time. Therefore, if a business fails to innovate, it is also very likely that the business will fail eventually.

It is manifest that the fundamental objective of a business is to generate profit. In a poll conducted by Boston Consulting Group and data from *Business Week* on 15 August 2005, companies that lead in the realm of innovation are much more profitable than companies that do not. They outperform in returns and profit margins. Therefore the role of innovation in leading to a business's success is unquestionable.

¹ SmartPros Editorial Staff 2005

However, innovation which is often associated with creativity could be very spontaneous in nature, lacks steadiness and creates too much uncertainty if it is not properly managed. Hence in order to recognize the importance of innovation, the management of it is inseparable in order to create continuous success.

3. Innovation and New Product Development (NPD) Management

Innovation by itself is often ad hoc in nature and it is often agreed that innovators should be left as free as possible, unsuppressed by restraints as creativity seem to work best without them. However, a business flourishing with innovative ideas is just an initial step to success. Imagine that an innovation team comes up with 1000 ideas per year and that the company can only proceed with 10 of them. The problem is then how the company digs through the numerous ideas and filter them to obtain the wanted and suitable residual ideas that ought to be pursued. This would then put them in the realm of management, 'innovation management' to be precise.

Innovation management arguably plays an even more important role than innovation as the quality of implementation of the innovative ideas often determines the outcome i.e. the successfulness of a product or development project. The two extreme cases include banning an innovative idea that would have been a success and pursuing an idea that leads to a total failure which both adversely affect the business.

Innovation management is a broad discipline and there has been extensive analysis in what the most proper model is for an innovation process. This paper focuses instead on the aspects of risk management and allocation of resources in innovation management. It would be helpful to businesses by first choosing the right innovative ideas to implement according to their risk-tolerance levels and their corporate strategies. The question they ought to ask is: Out of all the ideas, 'What to innovate'?

3.1 What to Innovate?

Businesses often have to decide what projects or innovations to pursue and what ought to be abandoned. This is part of the innovation process which could either be driven by technological push (by inventing new technology) or customer pull (by addressing customer demands and needs). The former approach believes that customer cannot realize their latent need because they are familiar with the latest technological development which can be applied in new product development. The latter approach believes that customer needs can be expressed through articulated and unarticulated expressions. Articulated needs involve information dealing with what customers say. Data can be collected through traditional methods such as focus groups, personal depth interviews, surveys, questionnaires, and product clinics. Unarticulated needs generally involve information dealing with what customers do and what customers make. Information can be gathered through participant observation, applied ethnography, and contextual enquiry. The context is the

everyday situation of use and includes the environment, the people, their goals and processes, and other products (Conley C. V., 2005). Contextual research gives the type of information companies can use to develop innovation product ideas which requires an empathetic viewpoint and an ability to suspend an organization's focus on its own products. The process involves gathering rich data from everyday situation, rigorously analyzing it for significant patterns and using these patterns to generate ideas about functions, product lines and strategy.

Understanding customer needs leads to products that are desirable, feasible, and salable (Bayus, B., 2008). However, it has been explained that profitability is usually the ultimate goal of businesses and that successful innovation for the most part equates to profitability. Therefore innovations that proves to be the most marketable leads to success. The problem lies in the element of uncertainty in projecting market response, which introduces the 'risk factor' in the decision making process.

In fact, there are many innovation management models which attempt to tackle the problem of 'what to innovate', but it is also recognized that there is no one-size-fits-all model and what is suitable very much depends on a particular industry. The choice of innovation would also vary even within the same industry as it is pointed out by Shlomo Maital and D.V.R. Seshadri in "*Innovation Management*" that "*Innovation is fundamentally different for entrepreneurial startup companies than it is for established organizations*". This is due to the fact that startups need to provide radical innovations to compete over industry veterans while established companies may seek more incremental innovations instead to serve their existing customers. Therefore innovation portfolios would differ among companies even in the same industry as their needs and capabilities in risk taking differ. What is definitely true, however, is that innovation involves risk, the risk of not knowing whether an innovative idea would ultimately succeed.

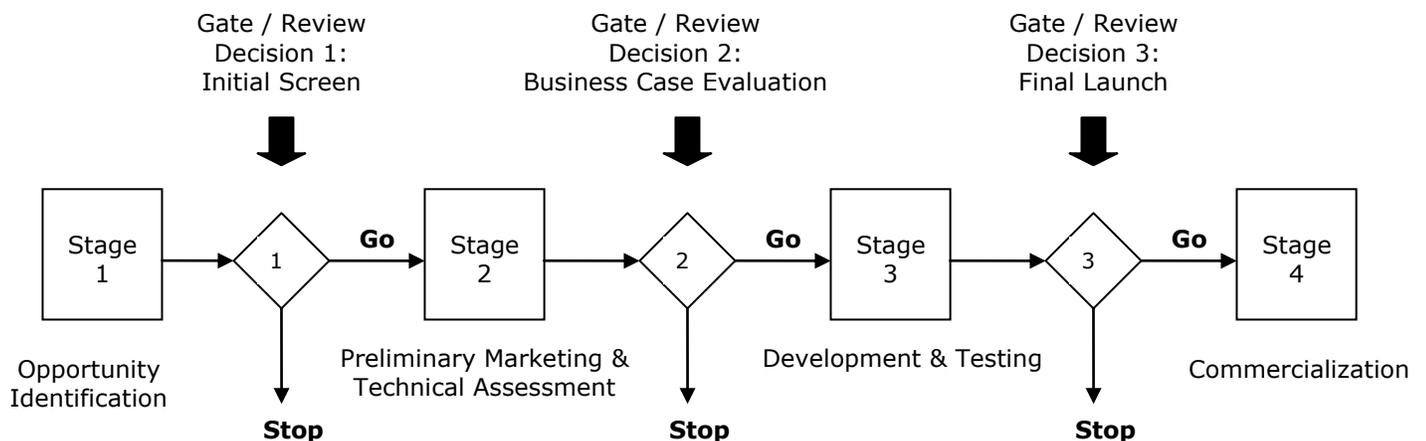
Businesses must consider risk when considering 'what to innovate'. Implementing unseen new products increases the element of risks and the returns become more unpredictable. Most Companies may feel that the best place to look for growth is outside of, but not too far from, their core business. However, it does not mean that well-established businesses should refrain from implementing 'breakthrough' ideas as they should also continuously expand their customer base and strive to produce new leading products to maintain their market share. Starting businesses, facing the competition of well-established companies, may, on the other hand, consider the creation of a new market a better strategy.

There is no general rule as to how much risk a business should shoulder. Low risk doesn't ensure success while high risk doesn't equate to failure. Rather it's the management of risks that managers should keep in mind. Let us first look at how managers could manage the risk factor in the innovation process to suit the needs of different businesses.

3.2 Innovation Risk/Portfolio Management

Innovation Portfolio is defined as a set of R&D projects, technology, and new product or service efforts currently funded and underway. Innovation Risk/Portfolio Management is a dynamic decision process by which new projects are evaluated, selected and prioritized; existing projects may be accelerated, de-prioritized or killed. The portfolio decision process encompasses and overlaps a number of decision making processes from technical, marketing, and financial consideration throughout the development process. The idea of portfolio management is to handle risks within acceptable boundaries by making decisions based on analyzed justifications and appropriate allocation of resources. Recognizing that ‘appropriateness’ differs among companies as what is appropriate depends on their degree of tolerance of risks, a structured tool for risk assessment is what businesses need in order to facilitate decision making. This is especially important when a business has numerous innovation projects at hand to choose from and needs to filter ideas to pursue projects that optimally fit into their innovation portfolio. Risk management acts as a filtering process. A commonly used model is the variant of a Stage-Gate (registered trademark of Robert G. Cooper and the Product Development Institute, <http://www.stage-gate.com>) as depicted in the following figure 1:

Figure 1: A Typical New Product Development Process Adapted from Cooper (1990)



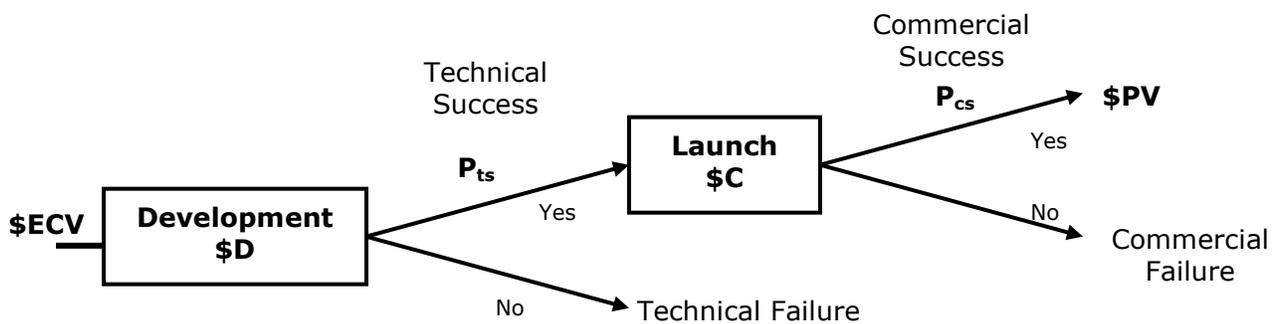
Source: Cooper, Robert G. (1990), Stage-Gate Systems: A New Tool for Managing New Products. Business Horizons 33: 44-54 (May-June).

The primary purposes of the stages are to decide the resource allocation. A set of evaluation criteria was proposed by a study by Carbonell-Foulque et al., (2004) including five dimensions: strategic fit, technical feasibility, customer acceptance, market opportunity, and financial performance. Thus, the review team should comprise of senior managers from marketing, finance, research and development, or manufacturing. Schmidt, J.B. et al., (2009) further explored NPD project review

practice on 425 Product Development & Management Association members and found that more review points are used for radical NPD project than incremental ones. The number of criteria used increases as NPD projects progress and the number of review team members grows over the stages. Surprisingly, they found that only review proficiency which reveals the familiarity of the review team to the innovation is found significantly associated with the product performance. The number of review points, review team size, and number of review criteria are not associated with new product performance. The implication is that product knowledge, market trend, and competitor information has to be continuously updated to the review team in order to improve the proficiency over the entire development process. A number of new product portfolio methods have been used in recent years. The most common ones are revealed hereby:

3.2.1 Financial methods: This is the most popular method in the screening stage. This includes various profitability and return metrics, such as payback period, net present value (NPV), return on investment (ROI), internal rate of return (IRR) etc. A typical financial method, the Expected Commercial Value (ECV) is depicted in the following figure 2 (Cooper, R.G. et al., 2006). The method tries to quantify the process for decision making, however, it does not take into account of qualitative factors such as strategic consideration, opportunity cost, and synergy effect with existing product/service:

Figure 2: Rank Ordered Against Financial Criterion – Determination of Expected Commercial Value of Project



$$ECV = [(NPV * P_{cs} - C) * P_{ts} - D]$$

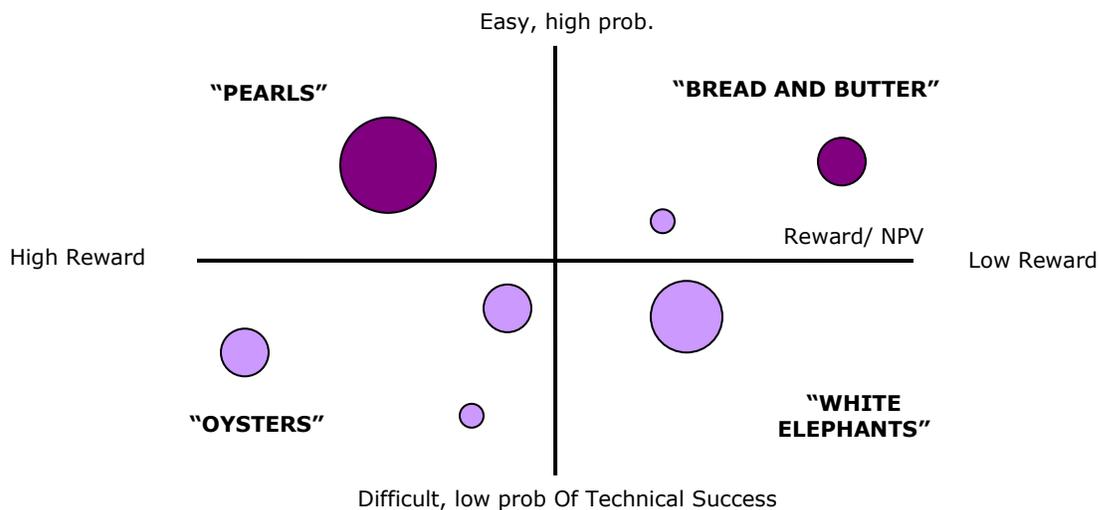
- \$ECV = Expected Commercial Value of the project
- \$PV = Income stream from project (discounted to preset)
- \$C = Commercialization costs (capital equipment & market launch)
- \$D = Development costs
- P_{ts} = Probability of technical success
- P_{cs} = Probability of commercial success (given technical success)

The ECV (Expected Commercial Value) is determined for each project, and divided by the constraining resource (e.g., by R&D cost per project). Projects are then rank-ordered according to this ECV/R&D index.

Source: Cooper, Robert G.; Edgett, Scott J.; Kleinschmidt, Elko J., (2006-2007), Portfolio Management for New Product Development: Results of an Industry Practices Study, Product Development Institute Inc.

3.2.2 Bubble diagrams: This approach separates risk and reward in a two-dimensional matrix as shown in the following figure 3 (Roussel et al., 1991). The size of the bubbles represents the expenditure required and the color can be used to indicate how close each project is to be finished. It appears more to be a supporting tool rather than a dominant portfolio method. The drawback of this method is that it cannot show the priority of the projects which is related to the financial situation, available resource of the Company:

Figure 3: Example of a ‘bubble diagram’

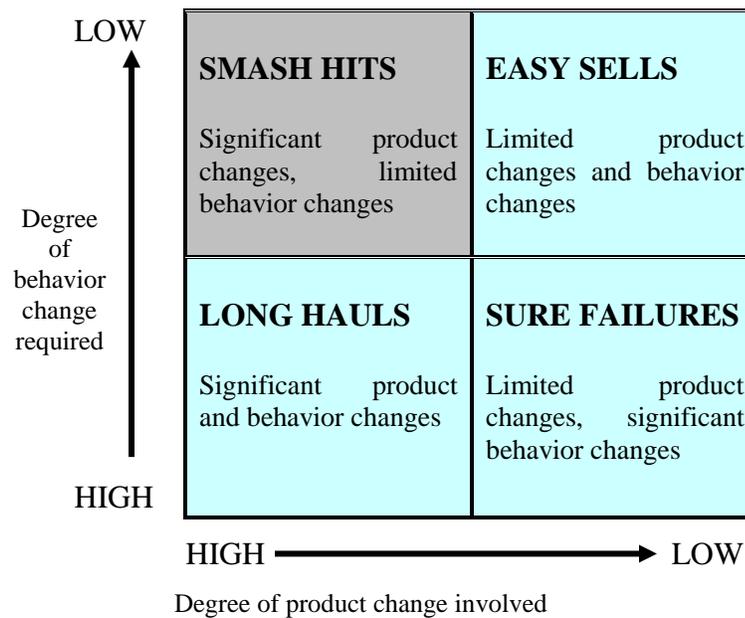


Source: Roussel, P.A., Saad, K. N. and Erickson, T. J. (1991), Third Generation R & D. Managing the Link to Corporate Strategy, Arthur D. Little.

3.2.3 Business strategy: Business strategy decides the allocation of resource across different categories by markets, product lines or type of projects. Innovation, even to the least extent, requires businesses to step out of their

comfort zone as it invites a variation to the current state of business. Very often, the greater the scope and complexity of an innovation, the higher the risks of failure it is exposed to. Therefore risks are always associated with innovation and the handling of risks within an innovation portfolio becomes necessary. Ideally, there is some significant product improvement but minimizing the change for the consumer behavior in order to create a smash hit as posited by Gourville J.T. (2006) as shown in Figure 4

Figure 4: Consumer Behavior



Source: Gourville, John T. (2006), Eager Seller and Story Buyers: Understanding the Psychology of New-Product Adoption, Harvard Business Review, June 2006

Acquiring new technology not only requires more resource with high degrees of risk, but also may sometime cannibalize the existing products using the old technology. To fully address the reasons for retaining part of an innovation portfolio in higher risk projects, explaining the disruptive innovation theory is necessary. ‘Disruptive innovation’, which is also known as ‘disruptive technology’, is an innovation that improves a product or service in ways that the market does not expect, typically by being lower priced or designed for a different set of consumers. The disruptive innovation theory is explained in a book named “*The innovator’s Solution*” by Clayton M. Christensen. Disruptive innovation is to be distinguished from ‘sustaining innovation’. Sustaining innovation aims at delivering to existing customers new and improved products. They are usually routine and only breakthrough occasionally. They *sustain* the

performance improvement in an established customer plane. Customers on this plane are used to the products and are aware of the improvements and features brought by the new products. This is usually where incumbents of an industry take control and are aiming at maintaining the existing client base and market share. Competition on this plane is a commonplace and usually fierce as an 'apple to apple' comparison is readily expected from customers who know the products well. Therefore businesses which lack the status of a veteran in the industry or starter businesses may want to pursue the route of 'disruptive innovation' by battling on a different plane as opposed to battling on a plane with huge disadvantage against the incumbents. Disruptive innovation, on the other hand, is not necessarily a breakthrough but it contrasts with 'sustaining innovation' because it disrupts the trajectory by coming from a different direction. The products of disruptive innovation are usually not as good as the ones provided by competitors on the plane of sustaining innovation but are usually cheaper in price while retaining fundamentally important features. The upside is that although these products do not attract existing customers, they open up to a market of 'non-consumers' due to the discount in price. In essence, disruptive innovators challenge industry incumbents not on the plane where competition is fierce and product feature comparison provides them with a disadvantage but from an unexpected direction by attracting a new customer group with an affordable product price.

If the intended market is relatively new to the company, the risks involved increase as uncertainty also increases. However, it does not mean that pursuing such a route spells nonsense for the company as disruptive innovations could indeed be an unexpected weapon that puts the company ahead and improves market share and profitability. Therefore when assessing the risk allocation in an innovation portfolio, managers need to keep in mind that 'risky' projects which are disruptive in nature could very well be a good strategic choice despite the higher 'risks' involved.

With the advance of Information technology, the success of a product very often depends on the availability of complementary product or the whole innovation ecosystem which has become a core element in the growth strategy of firm in a wide range of industries. It presents a new set of risks. The success of its own innovation is determined as much as the firm's partners as by its own performance. Once the Company develops a vision of what market they what to enter, it has to uncover, and access the interdependence risks, initiative risks, and integration risks (Adner R, 2006). It may lead to revision in performance expectations and rethinking the initial plan.

The growth of a Company can be achieved through expanding markets or/and offering new or improved products with new technology. Ansoff (1965) developed a matrix that combines these two variables as shown in

Figure 5. It assumes that there are opportunities for growth. This may not be true in times of economic downturn, and may lead to consolidation and retrenchment.

Figure 5: Ansoff matrix

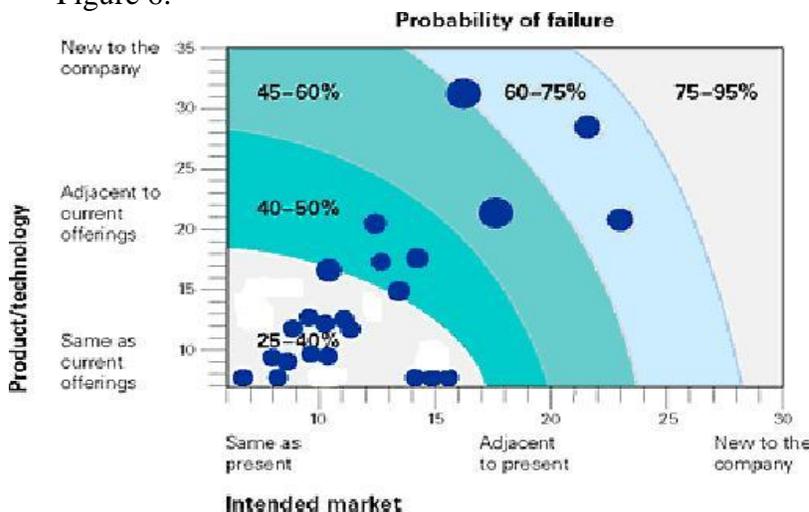
		New Products	Current Products
New Markets		1. Diversification Strategy	3. Market development strategy
		2. Product development strategy	4. Market penetration strategy
Current Markets			

Source: Trott, Paul, (2008), Fourth Edition, New product development, Innovation Management and New Product Development, Prentice Hall, Chp 12, 386-421

3.2.4 Scoring models: A scoring system developed by George S. Day (2007) called risk matrix is introduced hereby. It makes use of a scoring system which is determined by several answers given by an innovation team to some questions. This requires no complex calculation and the results could be posted on a chart which could be easily read and allows the manager to quickly view the degree of risk exposure of an innovation portfolio.

Figure 6 below is used for assessing the probability of failure of projects within an innovation portfolio. The size of the dots is determined by the project's estimated revenue.

Figure 6:



Source: Day, George S. (2007), "Is it real? Can we win? Is it worth doing?: Managing risk and reward in an innovation portfolio", Harvard Business Review, 12

The x axis represents the familiarity of the intended market to the business and the y axis represents the familiarity of the product to the business. It is noted that radical innovation, i.e. innovation that creates significantly new attributes compared to the existing ones, are more risky than incremental innovation, i.e. innovation that improves or changes existing attributes. This is due to the fact that incremental innovation aims at serving a customer group which is in existence and only seeks to improve an existing product and hence less risky as market responses are relative more predictable than products which are totally new to the existing or intended customer group. The acknowledgement of this fact is reflected in the chart as it consists of different areas that represent different degree of risks or probability of failure. As mentioned previously, different businesses have different capacities and degree of preparedness to take on risky projects and there is no golden rule as to what the appropriate balance is. However, the tool would serve to reflect to managers a clearer view as to the spectrum of risks that their projects are exposed to and allows better management.

The risk matrix suggested allows the assessment of risks in a simple manner as it requires no complex mathematical calculation and only requires a competent team of innovators to give scores to a few important questions. It is also a tool universal to all industries and businesses and hence easily usable. It helps managers to determine for themselves the appropriate allocation of risks.

- 3.2.5 Collective customer commitment method: Some companies got customer involvement, such as focus group to test new product concept. The limitations are unreliable indication from a small number of consumers, underestimation of the benefits of a unique product, and do not measure people's real purchasing behavior. S. Ogawa and F. T. Piller (2006) posited a collective customer commitment method which asks for purchase commitments from customers before commencing any final development and manufacturing. This method can be particularly effective for testing really innovative product for which little customer experience exists, and developing products for relatively small and very heterogeneous market segments. Collective customer commitment offers substantial opportunities for reducing the risks of NPD; however, it requires a full disclosure of the entire process from initial consumer comments to final product commercialization. Thus, it may not be desirable for most companies which prefer to keep the product development confidential.

4. The Link between Method Used and Portfolio Performance

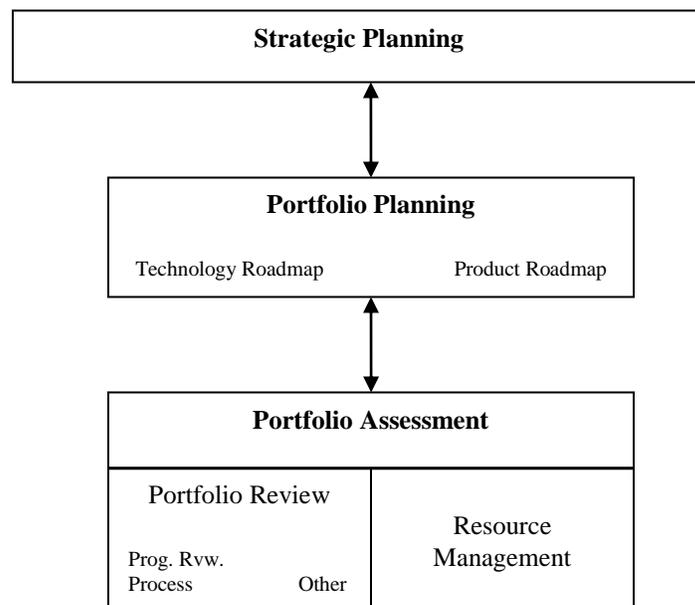
A portfolio planning and management framework posited by Patterson M.L. (2005) shows an integration of Strategic Planning, Portfolio Planning, and Portfolio Assessment as shown the Figure 7.

The strategic planning is to move the Company from the present stage to a desirable future by new product investments involving competitive, perhaps newly emerging, technologies and practices. The objectives are to provide strategic guidance to the firm capability development activities including hiring new employees, training, gaining new tools, developing new business process, adding new manufacturing abilities, and developing new strategic partnership.

The objectives of the portfolio planning are to create a strategic plan for new products and technologies in terms of a future product/service roadmap, and future technology roadmap. This process should gather external information related to markets and technology development. These include conditions and market trends, emerging market conditions, actions of competitors, local and global business environment, and emerging technology trends.

Portfolio management involves a set of activities in portfolio review and resource allocation with the objectives of producing anticipated return, moving the firm align with the desired strategic direction, and reflecting the best use of available resource in view of changing conditions.

Figure 7: Portfolio Planning & Management with Related Activities



Source: Patterson, Marvin L. (2005), New Product Portfolio Planning and Management, The PDMA Handbook of New Product Development, Second Edition, Edited by Kenneth B. Kahn, Chp 3, pp46-58

Multiple portfolio management methods are used in most Companies. Cooper R.G. et al., (1999) investigated the relative popularity of various portfolio methods and their respective relationship with portfolio performance. They found that despite the fact the financial approaches are the most popular one, strategic methods, along with scoring approaches yield the best portfolio results. The results as shown in Figure 8 supporting Patterson’s framework:

Figure 8: Relationships between Dominant Methods and Portfolio Performance

Performance Metric	Financial Methods	Strategic Methods	Scoring Model	Bubble Diagrams	Methods That Are Better
Projects are aligned with business’s objectives	3.74	4.08	3.95	4.11	-----
Portfolio contains very-high-value projects	3.37	3.77	3.82	3.70	Scoring and Strategic > Financial
Spending reflects the business’s strategy	3.50	3.72	3.59	3.00	-----
Projects are done on time – no gridlock	2.79	3.22	3.13	2.90	Strategic > Financial
Portfolio has good balance of projects	2.80	3.08	3.20	3.20	-----
Portfolio has right number of projects	2.50	2.93	2.70	2.50	Strategic > Financial

Ratings are 1 – 5 mean scores for each method, when used as dominant portfolio method where, 1 = poor and 5 = excellent.

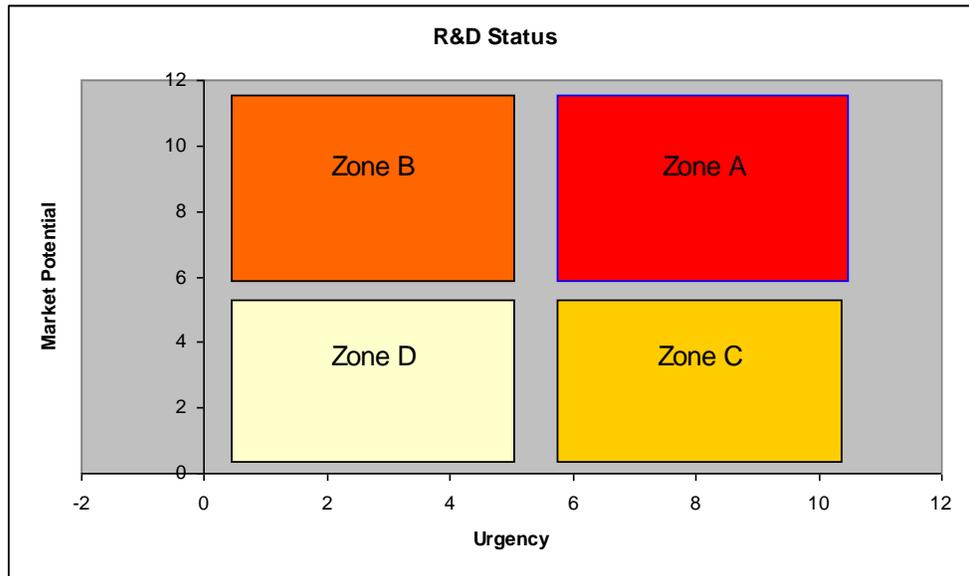
Source: Cooper, Robert G.; Edgett, Scott J.; Kleinschmidt, Elko J., (1999), *New Product Portfolio Management: Practices and Performance*, Elsevier Science Inc.,p.333-351.

5. Project Prioritizing

After the determination of “What to innovate?” in the initial screening stage, the next critical question to answer: “How should the projects be prioritized?” This is an important question to ask because with the limitation of resources that many businesses are facing, it is probable that all the projects within the innovation portfolio could not be pursued at the same time. The goal of improving innovation management is to maximize the returns on capital injected into a project. Choosing a right timing to launch a project can undoubtedly improve the returns. Therefore it is necessary to reap the benefits by responding in a timely manner, i.e. timing is of the essence. A business could decide to pursue 10 projects in a year, but facing with the limitation such as the number of employees, the allocation of the right employees due to their different skills and expertise, the projects might have to be pursued one after another. There could be many reasons for a product failure and one of them is the unexpected changes in consumer tastes or fashion (Cooper (1988a), Urban et al. (1987), Crawford (1997)). This can occur in a short period of time and if businesses are not aware of such change, it could possibly lead to failure for their products. There are many sophisticated project/NPD software available in the market with quite substantial price. Building on the concept of bubble diagram, this paper attempts to propose a practical and economic model simply by using an EXCEL spreadsheet with the built in Chart Wizard to prioritize the projects on hand. The chart should be used to monitor the spectrum of projects on a regular basis (e.g. once every month) as depicted in Figure 9. The tool should take into account the following factors which change over time: the market potential of the product under development, the effort required in completing a project (for projects under way) which is proportional to risk and cost incurred, and the urgency.

5.1 Concept of Project Prioritizing Model

Figure 9:



The projects are meant to be positioned onto the above model to help determine what the priority of implementation should be. The x axis represents the urgency of the projects while the y axis represents the market potential. Those projects which have been committed to a delivery or completion date are regarded as more urgent. The 'market potential' of a product is determined by feedbacks and opinions from the marketing department of the company. Both parameters use the scale of 1-10 in this model.

The model is separated into 4 different areas to facilitate prioritization. Zone A indicate top priority as it is most urgent while capturing a high market potential. Projects within Zone A should undoubtedly be pursued with higher priority as these projects should give the highest return on investment to the company. The order of priority is then followed by Zone C or B, and then D.

Where numerous projects lie within the same area, managers should take into account more detailed factors to determine priority. The factors include effort required in completing the product, skills of employees and risks. Here are the reasons why these factors are important:

5.1.1 Effort required in completion (Work done)

This refers to the work that is left in order to complete the project. All projects have an initial work done of 0%. However, as the projects get prioritized and are updated on a monthly basis, the percentage work done would differ from project to project as time goes by. The reason for this is that when comparing two projects with all other factors remaining the same, it is more natural and efficient to work on a project which requires relatively less effort in completing the project. As could be seen from the

illustration of the model later, the percentage work done of the projects changes over time and affects the decision making.

5.1.2 Skills of employees

In reality, employees are not always available at all times to work on a project. The skills of employees are also specific. A certain group of employees may be more productive when working on one type of project and less productive when dealing with other projects if their skills are incompatible. Therefore it is indeed the issue of employee allocation. In general, employees are assigned to the area of work where they perform best in order to increase a company's efficiency and hence profitability. However, it may also be desirable for letting an employee to gain more knowledge and skill in a new area i.e. employee training for the long term). In fact, innovation management has been associated with knowledge management. Sharing knowledge and re-using experience can strengthen the overall capability of the Company. The traditional idea that innovation is based on research (technology-push theory) and interaction between firms and other actors has been replaced by the current social network theory of innovation, where knowledge plays a crucial role in fostering innovation particularly in this knowledge-driven economy (Hidalgo & Albors, 2008).

G.C. O'Connor et al (2009) revealed that many big companies mismanaged their innovation talent because they keep on rotating high potential managers in and out of the innovation leadership role. Meaningful growth opportunities for the innovation professionals are limited. It is suggested that breakthrough innovation consists of three phases:

Discovery: The mission is to create and identify opportunities in the marketplace.

Incubation: The mission is to experiment with technology and business concepts to design a viable model in order to create a new business.

Acceleration: The mission is to nurture the business until it can stand on its own. This may serve as a guide to build a career path for the innovations.

5.1.3 Risks

Risk is addressed and projects are filtered in the risk matrix. However for projects that are to be pursued, risk is once again considered for the purpose of prioritization. Knowledge of the market and experience plays an important role in deciding what works best for the company. What

should the priority be when there are two projects in the same area in the resources allocation model? A more conservative and less aggressive company may give priority to the less risky project while a company which is trying to catch up with the incumbents of the industry may choose to give priority to a more risky project because success of it could increase its market share. One common consideration is whether the company wishes to go for a disruptive innovation on the one hand and sustaining innovation on the other which is mentioned above.

It must be noted that prioritization is not a purely scientific exercise and managers are required to strike a balance among those factors in determining the correct order of action.

5.2 Model Illustration

Let us assume that a company decides to take on five innovation projects this year i.e. projects ‘AAA’ to ‘EEE’ and is now deciding to prioritize the projects for this month. Open a spreadsheet with columns as shown in figure 10. Then proceed with the following manner:

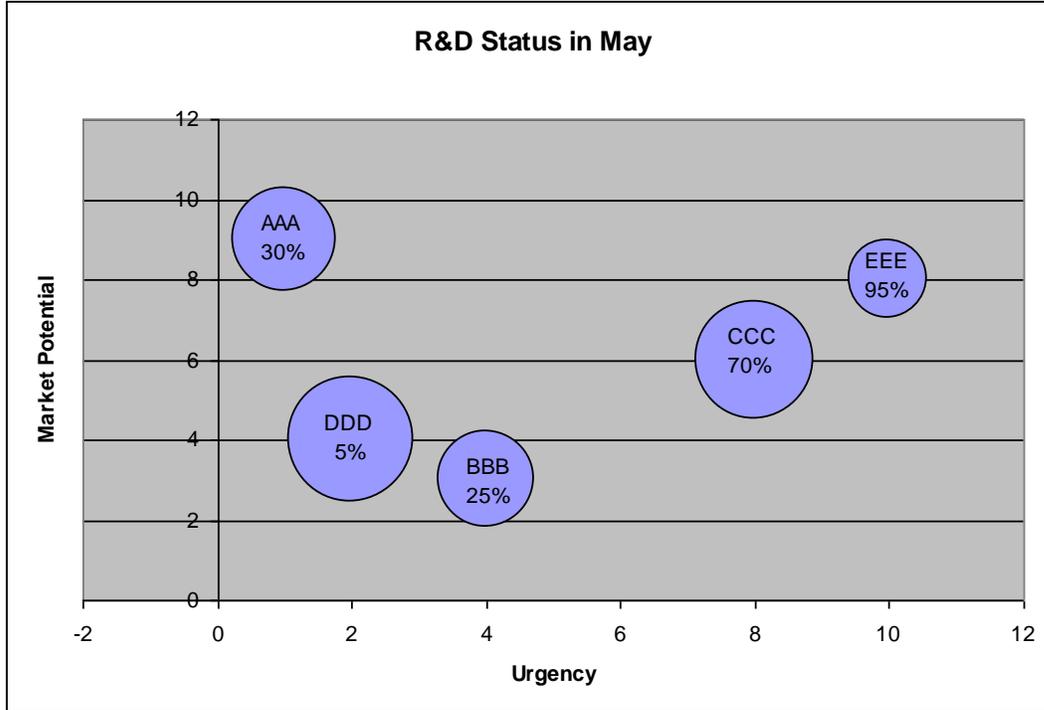
1. Input the scales (1-10) for each column into the table, and then click the ‘chart wizard’.
2. Choose ‘bubble’ in the ‘standard type’, and then go to ‘next’
3. Define the data range, and choose ‘column’ in the ‘series in’. Go to ‘next’
4. Input the chart title, x-axis, and y-axis, choose the gridline if you want, and then ‘finish’
5. Use the text box to input the project names, and percentage of work done for each project in that month.

The chart is shown in figure 10. According to the explanation of the distribution of projects in different areas, the company should put project ‘EEE’ in the first place as it has a relatively high market potential while the development effort required is relatively small, and in urgency. Going down the list, projects ‘AAA’ and ‘CCC’ should be considered prior to projects ‘DDD’ and ‘BBB’. It must be kept in mind that this proposed model is not a purely quantitative exercise and what is most suitable still ultimately depends on the actual situation. The percentage in the bubble indicates the stage of completion. The top priority project ‘EEE’ in this example has been 95% completed, while low priority project ‘DDD’ has just been started. Other relevant factors include strategic consideration, skills of employees and sequential relationship in the projects. Some project are interrelated with each other, it cannot be started until the other one is completed.

Figure 10:

Project	Urgency(1-10)	Market Potential(1-10)	Effort(man-month)
AAA	1	9	7

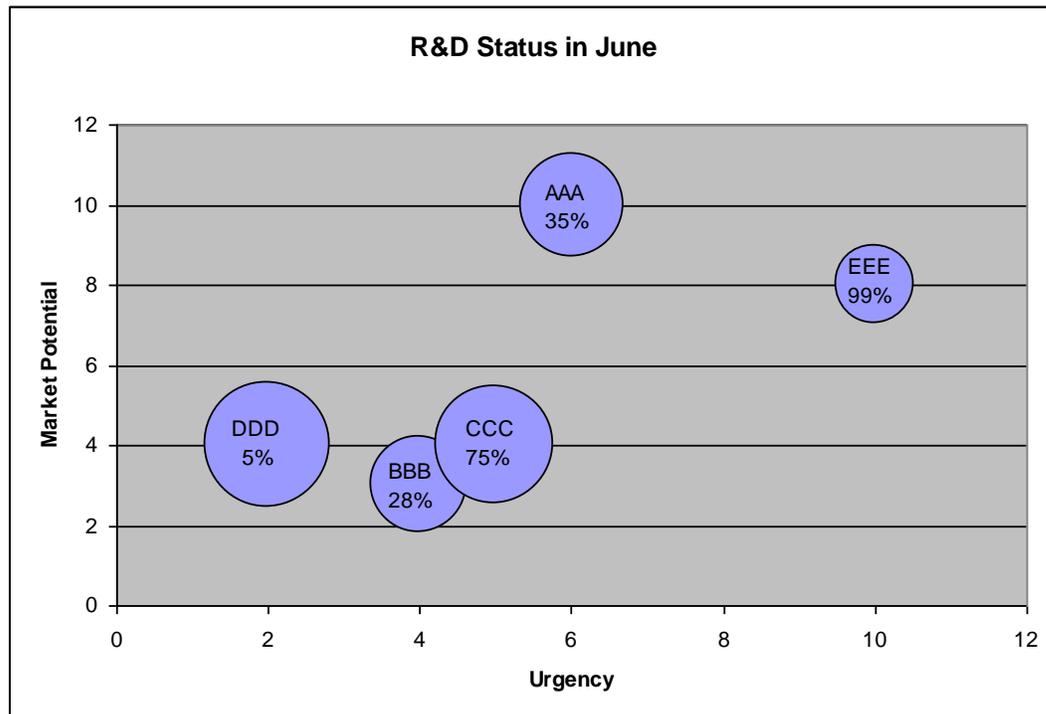
BBB	4	3	6
CCC	8	6	9
DDD	2	4	10
EEE	10	8	4



The projects on the chart shift up and down as the market potential of the projects changed. This may due to changes in consumer preference, similar product has just been launched by competitor, or government policy such as tax incentives or mandatory regulation. The projects may also move along the x axis as the urgency may change according to market or customer requirement. What has also changed is the percentage of work done of each project. This is a result of the prioritization of the projects last month. What the manager needs to decide for this month is what changes in priority need to take place in order to adapt to the change in market response by changing the data in the spreadsheet and generate a new chart. Let us take a look at how the model could look like in the following month as shown in figure 11.

Figure 11:

Project	Urgency(1-10)	Market Potential(1-10)	Effort(man-month)
AAA	6	10	7
BBB	4	3	6
CCC	5	4	9
DDD	2	4	10
EEE	10	8	4



Project ‘CCC’ has drifted from Zone A to Zone D over the last month. One possible explanation is that there was an unexpected change in customer taste or market trend. It should be put in lower priority accordingly. The first priority should now be given to project ‘AAA’ as the market potential has been elevated, so as the urgency. This could be due to an expected enthusiastic response from customers after a market preview, and thus the Company decided to take the advantage of being the first mover. Therefore allocating more resources for project ‘AAA’ may be more suitable this month in an attempt to capture the market share of this product as soon as possible.

This is a simple illustration of how a Company, particularly a SME could make use of the Project Prioritizing model to make the right decisions in allocation of the scarce resource and catching up the changing market requirement.

6. Knowledge Management and Innovation

Knowledge Management (KM) helps the organization to recognize the importance of external organizational linkages, often called networks, as sources of external knowledge, and the process of associating these with the internal knowledge base of the company. It is this notion that helps identify a different approach to how companies can generate new business opportunities. (Trott P. 2008). In the traditions of most Western Management,

the organization is a machine for 'information processing'. Thus, the only useful knowledge is formal and systematic (like the data, codified procedures, universal principles and etc.); and the only measure of knowledge is quantifiable – to increase efficiency, lower costs, improve ROI and so on.

On the contrary, the Japanese approach relies on managing the creation of new knowledge. The core of this idea is the recognition that creating new knowledge is not a simple 'processing' procedure of information. Rather, it depends on tapping the tacit and often highly subjective insights, intuitions, and hunches of individual employees and making those insights available for testing and use by the company as a whole. (Nonaka I., 2007) In this approach, personal commitment, employees' sense of belongings and the company's mission form the key to success.

If you take an overview in China, you would probably find out that China has a high-priority effort to become a more knowledge-based economy and society, which means that knowledge management (KM), is increasingly important. For example, the timely transfer and use of business knowledge can provide a competitive advantage in practically any given industry. KM in China is distinctive, constrained somewhat by technological limitations, but influenced more significantly by psychological factors (such as cultural values) among groups and social levels.

6.1 Technological Strength

The advocates of the Japanese approach attribute their success to managing the creation of new knowledge. The management fully recognize the quality of innovation; so as their executives manage the knowledge to the benefit of the company, employees and customers.

The fundamental insight is just the opposite of the traditional view – a company is not a machine but a living organism in which the management would try every mean to mobilize the commitment and embody tacit knowledge in actual technologies and products. As a result, the organization becomes a melting pot where understandings, information and knowledge are shared. Sparks of thoughts emerges, so as the technological enhancement achieves. This approach not only encourages the innovation, brings out the environment to innovate, but also take 'innovation' into the business and operation model. Innovation has been implanted into every employee's mind, so has the company's soul; innovation is part of the organization at last.

In contrast, companies with a traditional view would process the known information, integrate the data on hand, and analyze through bunches of available metrics and charts. Things are getting done instead of creating, not to mention innovating.

In the fast pace digital era, customers chase for new products and services, which exactly push the organization to put more efforts on innovation. As a result, knowledge-creating company is becoming more and more in favor. Except for the concept behind KM to

accelerate high-tech development and learning exploitation, the knowledge-creating company is also under the ideal condition which fuels innovation. With regard to what Nonaka I. (2007) posited, the essence of innovation is to re-create the world according to a particular vision or ideal. In the knowledge-creating company, inventing new knowledge is not a specialized activity – the province of the R&D department or marketing or strategic planning. It is a way of behaving, indeed a way of being, in which everyone is a knowledge worker – that is to say, an entrepreneur.

Chinese enterprises may draw lessons from the steps taken by those initiators. Having opened the door not far ago, millions of information and new technologies are pouring in; standing on the threshold of becoming a powerful country with advanced technology and stable economy, useful experiences should be learnt from and customized for adoption. Chinese enterprises may have achieved some success in the ICT field with the back up of government funding and great talents; they may still in their infancy of knowledge management. With technology outshine with others, a company may blossom, but more in a way of morning glory. A sustained technological strength requires a circle of knowledge learning -> knowledge selection & absorption -> knowledge customization -> knowledge creating (innovation) -> knowledge learning.

6.2 Knowledge Management & People

New knowledge always begins with the individual. Dispersion of the knowledge always involves person-to-person communications. Proliferation of the knowledge always needs teams' wisdoms. Adoption of the knowledge always comes with management's leadership and colleagues' co operations. In a word, 'people' is the crucial factor along the knowledge management chain.

Making personal knowledge available to others is the central activity of the knowledge-creating company. It takes place continuously and at all levels of the organization. Moreover, tacit knowledge consists not only part of technical skills, but also an important cognitive dimension. The hard to articulate mental models, beliefs and perspectives appeal for a standard model so as to transfer the tacit knowledge into explicit knowledge. Hence, the knowledge recipient can also use what he/she has learnt to create and innovate actively.

Put the theory in China, the top-down model for cognitive learning may take an easier way while the way in reverse may be hard to take a step due to Chinese deep-rooted culture. How to encourage the relative young staff to innovate and express, and how to make the higher rankers listen to and accept the new idea is the crucial point in Chinese enterprises' transformation into learning organizations which have the soul of innovation. Nonetheless, it's glad to see some organizations like Hong Kong Police having taken initiative roles to adopt some pilot plan of innovative projects for young colleagues who have relatively less experience.

6.3 Knowledge Management & Learning Organization

The ultimate goal is to build up a learning organization with a customized knowledge management mechanism to seek business opportunities and turn them into commercial success.

In the static market, the traditional way of information processing and evaluation might be enough for a company to survive and grow; while in the fast changing and unpredictable global market, learning and creating are the only ways for an organization to make a breakthrough and keep a long-term development.

With the 'guidelines and policies' in mind, organizations are taking different steps which seem suitable to explore the 'learning model' and achieve the goal. As mentioned in the interview section, Hong Kong Police has adopted a bi-directional channel for top-down and bottom-up learning and sharing; Octopus has formed an 'elite force' from different departments and levels to collect information both internally and externally, and make innovation based on the information selection, brainstorming, knowledge sharing and discussions; Hong Kong Jockey Club has designed classes for staffs to learn and share; Cisco has implanted the 'learning to be professional' concept into every employee's mind.

From the above cases, we may find out that companies and organizations varies in the ways of knowledge management, learning & sharing models and innovation practices. However, some similarities loom as well. The organizations which have achieved successes under the changing and competitive environment believe in the learning model to keep innovation with the tide. Inside the model, there're advanced technologies either from internal R&D department or from external learning and mergers; there're talents with a mind to innovate; there is a platform for staffs to learn and share inside the company; and there is a channel for information and technologies exchanging with other organizations. In a word, knowledge management takes a pivotal role in innovation which drives the learning organization to a commercial success and a long-term growth.

7. Lessons learned from outstanding Corporate

Although academics have developed various models in innovation management and R&D project selection, there is persistent gap between theory and practice (Brunner D. et al., 2008). The qualitative analysis based on multiple case studies method is adopted to explore the why, what, and how in Innovation and NPD Management (Yin, Bateman, & Moore, 1983). I conducted a series of interview with nine leading practitioners who were willing to share their valuable set of successful experience (please refer to the detail interview content in the previous section of this book).

Miller, W.L. (2010) posited that the new generation of Innovation Management (4th Generation, 4G) not only focus on incremental improvements in products, service, and process but also on the capability to radically improvement on business models, industry structures, and internal capability of R&D, marketing, and manufacturing. There are 12 principles and practices in 4G:

1. Radical innovation is required in addition to incremental innovation.
2. Use an internal capability with competitive advantage to create value to customer.
3. The structure of capability includes people with knowledge, tools, technology, and process; business models with partners; and industry/market structure.
4. Financial-accounting models can reflect the capability and architecture which are the building blocks of economic value and competitiveness.
5. There are dual distribution channels- sales and delivery of product/services, and bi-directional knowledge flow between the suppliers and users.
6. Innovation is a process driven by a process for capability and architecture development. Analysis of stakeholder needs is required to identify problems and roots causes.
7. Product/service development, tools/processes, lifecycles, innovation roadmap, technology portfolios, internal R&D and external acquisitions (open innovation), and the discovery of unmet needs for radical innovations are all need to be managed in strategic planning.
8. Several value attributes for multiple stakeholders need to be defined to target solutions for problems.
9. Leaders with greater breadth and depth of capability need to be created.
10. Collaboration with academics to support innovations, and testing of prototypes with customers are required.
11. A new corporate organization with a chief technology offer manages all the radical innovation may be formed.
12. Organization ecology with partners with different capability and architectures in innovations must be managed.

I would like to apply these 12 principles in the expert interview summary as an illustration depicted in Figure 12.

Figure 12: Innovation Management Interview Summary

	Company Name	Interviewee	Why to Innovate?	What to Innovate?	How to Innovate?	Summary	Applied Principles
1	Police Force	Jolly Wong - Chief Telecommunications Engineer	1) Educations of the citizens and expectations are different from the old times, change and innovation makes a different.	1) Each fire station has changed their color from ‘tradition red’ to ‘healthy green’	1) Unremitting endeavors from the top management in the form of “top-down”; Colleagues' sharing; as well as the top management actively get to understand the difficulties of the frontline workers.	Know how to use “P (people), M (machine), M (material), R (Rule)” theory properly, so as to achieve “Pay back to the society after taking”.	6: Process for Capability and architecture development;
				2) Police station has used bright and highly transparent decoration, together with adding mild accessories and green plant	2) Infections among colleagues - new innovative projects will usually make pilot plan on the young colleagues who have guts for the changes		7: Strategic planning;
				3) Police's multi-functional and multi-media communication equipment, mobile report room, and GPS	3) keep close contact with international institutions from now and then - learn from each other as well as review per from time to time		9: Leaders with breath and depth of capability.
2	Hong Kong Exchange (HKEx)	Mr. Alfred Wong - Information Technology Officer and the Chief Director of Science & Technology	1) Keeping the functions of transaction system be diversified, the speed of trading system be high, the reaction be quick, the capacity and extensibility of transaction system be high so as to provide a stable and reliable exchange environment to the citizens.	1) From June, 1992, Central Clearing and Settlement System (CCASS)'s appearance, to Automatic Order Matching and Execution System evolving to its third generation - AMS/3	1) With positive and aggressive attitude, cooperate with the efforts of the staff from information technology R&D department.	Hoped the development of RMB products could be enhanced in the Hong Kong financial market so as to strengthen Hong Kong's global financial market position.	2: Internal capability;
				2) launch of ‘HKExnews’, the electronic disclosure system, to upgrade issuer’s information issuance mechanism	2) As all the lines from various systems have been transferred to the network of SDNet, the transaction participants, clearing participants, information provider and even HKEx itself can enjoy high bandwidth, smooth and stable network services, as well as save network cost significantly.		3: Structure of capability;
				3) Having been awarded several representative prizes through 2005 and 2008. For example, AMS/3 won the gold award of ‘IT Excellence Awards’ issued by Hong Kong Computer Society in 2004; CCASS/3.	3) Choose a reliable telecom company for the system network; and keep close connection within the company as well.		
				4) Completed the SDNet Project which is a set of integrated optical fiber Ethernet infrastructure			

3	Octopus Cards Ltd.	Mr. Sammy Kam - Technical Director	1) Aiming at ‘an easier life’ for the public	1) Expand scope of application and mode: nearly all the Hong Kong transportations accept ‘Octopus’ payment; more than 9,000 retail shops accept ‘Octopus’ payment	1) Rely on a creative team of management and staff members and their innovative spirit	Pointed out that ‘We should not innovate for the sake of innovation’; thought that all the innovation or reform plans and projects should achieve triple-win – to make benefit to customers, merchants and Octopus corporation – which is the project worthy of launching.	2: Internal capability;
			2) Improve market competitiveness	2) Explore innovative services and products: Octopus Automatic Add-value Service, Octopus Rewards, Octopus credit card/ATM card and etc.	2) There is a specified department in the company which is responsible for collecting and studying the public’s opinions, as well as keeping a close contact with partner merchants to get to know customers’ needs.		3: Structure of capability;
				3) Explore the overseas’ market, covering the Netherlands, Dubai and New Zealand.	3) Will consider the feasibility of technique and operation in order to measure different products and services plans; will implement gradually thereafter as well as check the progress and improvement regularly so as to make the project meeting the market need in a more mature manner.		9: Leaders with breath and depth of capability; 10: Collaboration with academics and prototypes.
4	MTR Corporation	JP Daniel Lai - Head of Information Technology	1) In order to face the challenges and to embrace the changing things, as well as to keep its competitiveness to a certain degree	1) Conducting a project named ‘RaiLOvation Week’ so as to have collected 4,000 new ideas as a result.	1) Focus on development of the four key areas which are: 1) develop and release innovative competence, 2) build up innovative platform of Hong Kong railway, 3) deepen the learning and developing ability, and 4) provide support through communication and culture exchange.	‘Starting from education’ is the rule of thumb.	2: Internal capability;
			2) Emerged with organization’s concepts and annual objectives	2) Formation of ‘MTR Club’ in MTR Corporation; the members have amounted to over one million.	2) ‘MTR Creator’ - for improving efficiencies in knowledge sharing and learning of employees in the organization.		4: Financial-accounting models; 5: dual distribution channels and bi-directional knowledge flow;
				3) The creation of ‘eInstant Bonus’	3) Operates in the cooperative mode of ‘Information Service Management Cycle’ in order to select, study, execute and manage.		7: Strategic planning; 11: new corporate organization.
5	Hong Kong Jockey Club	Mr. Sunny Lee - Executive Director	1) The competition threat from the market - have to keep competitiveness	1) Pointed out that ‘innovative technology idea’ was not a ‘brand new thing’ under the	1) Refer to Information & Communications Technology – ICT’s direction and objective.	Reform and innovation can be started from the small place; collect	2: Internal capability;

				definition of Hong Kong Jockey Club; thought it would make good effect if exploring new angles or new directions based on the current products or systems with further consolidations or transformations.	2) Staff of ICT department will join a training program called 'LIVE & BREATHE WITH THE BUSINESS' to get to know the market.	and accumulate tiny piece of thoughts to achieve the long-term objective.	3: Structure of capability;
			2) Reform and innovation are the operation objective and idea of Hong Kong Jockey Club	2) Successfully launched soccer's betting - 'Football'	3) Carried out staff reward plan inside the company - any plan to improve the services of the company from colleagues is welcome.		4: Financial-accounting models;
					4) Mature software systems and mechanism to monitor the development and operation of all the plan or projects of the company		5: dual distribution channels and bi-directional knowledge flow;
							7: Strategic planning.
6	Cisco System Hong Kong Ltd.	Ms. Barbara Chiu - General Manager, HK Macau	1) Cisco carries an enterprise's mission to improve peoples' mode of work, life, entertainment and learning through innovation technology.	1) Inheriting the tradition of innovating on IP technology continuously, Cisco kept on developing industry-leading products and solutions. In the meantime, Cisco paid much attention on 'innovation on idea'. The idea of 'Smart + Connected Communities' was certainly the best instance among all.	1) Cisco has perfectly combined the assist tools with information sharing tools. Help the city to use resources more effectively through building up 'City Service Platform' so as to improve citizens' life quality and ensure the sustainable development of the environment.		3: Structure of capability;
			2) Facing the urbanization trend, Cisco, as the world renowned internet equipment and solution provision company, has been devoted to drive and develop the 'Smart + Connected Communities' which based on innovative technology and internet platform in order to meet future development of global urbanization as well as solving the challenges brought by it.	2) Cisco has devoted to drive and develop 'Smart + Connected Communities' so as to assist on economic development, citizens' life quality improvement, carbon reduction and to ensure the sustainable development on environment.	2) Working closely with various local governments in order to drive and develop 'Smart + Connected Community' more efficiently.	Cisco's innovation technology can provide people a better life and a better city.	4: Financial-accounting models;
				3) As the leader of innovation technology industry, Cisco actively use innovation technology like WebEx™ or TelePresence to enhance operation efficiency and to	3) Its advanced cooperative tools made staffs to keep close connections with clients and also enabled cross-boundary conferences so as to curtail company's operation cost and in the mean time, to make the employees' works more flexible, balancing their works and lives. Cisco		7: Strategic planning;

			3) The application of innovation technology can greatly enhance company's operation efficiency and flexibility, maintaining company's competitiveness	make employees' work more flexible so as to achieve a balance between their life and work.	would also hold some spectacular activities through advanced technology for employees' balancing on works and lives.		10: Collaboration with academics and prototypes;
				4) Cisco has also rigorously taken use of information technology to assist all levels of the community, rolling out multiple local education and public welfare affair so as to bring benefits to the society.	4) Cisco has also enthusiastically assist all levels of the society with information technology, such as providing technique activities and information & technology trainings which is helpful to careers and further education to youngsters through 'Cisco Networking Academy Plan' so as to enhance their competitiveness for recruitment.		12: Organization ecology.
7	Airport Authority of Hong Kong	1) Mr. Henry Y.M. Ma - General Manager, Airfield	1) The mission is to keep improving the service quality of the airport and to provide a safer, more comfortable, more convenient and more efficient international airport for the passengers.	1) The application of RFID has increased the average data read rate of the baggage label and the capability of the system to track the baggage.	1) With an open attitude, regularly review and refer to the market suggestions.	Future prospect: create comfortable, efficient and relaxing airport environment.	2: Internal capability;
		2) Ir. Paul W.K. Wu - Senior Manager, Special Systems Technical Services	2) In order to cope with increasing passenger and luggage flow	2) Change the sequence of passengers' exits, rearrange the exit and inspection hall and add security checking channels and X-ray machines. 3) Launch Passengers' Self Check-in Procedures and cooperate with Shenzhen airport of transferring procedures.	2) Talent management: organize various kinds of training courses and Management Trainee Programs.		3: Structure of capability.
8	Cathay Pacific Services Ltd.	Mr. Peter Lui - Head of Engineering and IT	1) The nature of CPSL's establishment is an innovative plan - for cost reduction and operation benefit increase, market competitiveness enhancement, and for meeting with fast-changing development of world technology as well as for its expansion on diversified business opportunity.	1) Application of Radio Frequency Identification (RFID) - the RFID would be put in use at freight traffic monitoring system, managing and monitoring the cars in and out of the terminal more efficiently.	1) Refer to the past experience and current plan of Cathay Pacific cargo, conducting conferences with administrative staff and technical department regularly so that colleagues can communicate and share with each other.	1) Imposing Green concept daily to pursuing environmental protection	2: Internal capability;
				2) Outsourcing some step procedures to other companies to increase cost effectiveness.	2) Seek advice and consultations from experts of consulting firms.	2) Expectation on the future new cargo terminal: stimulate	3: Structure of capability;
							4: Financial-accounting models;

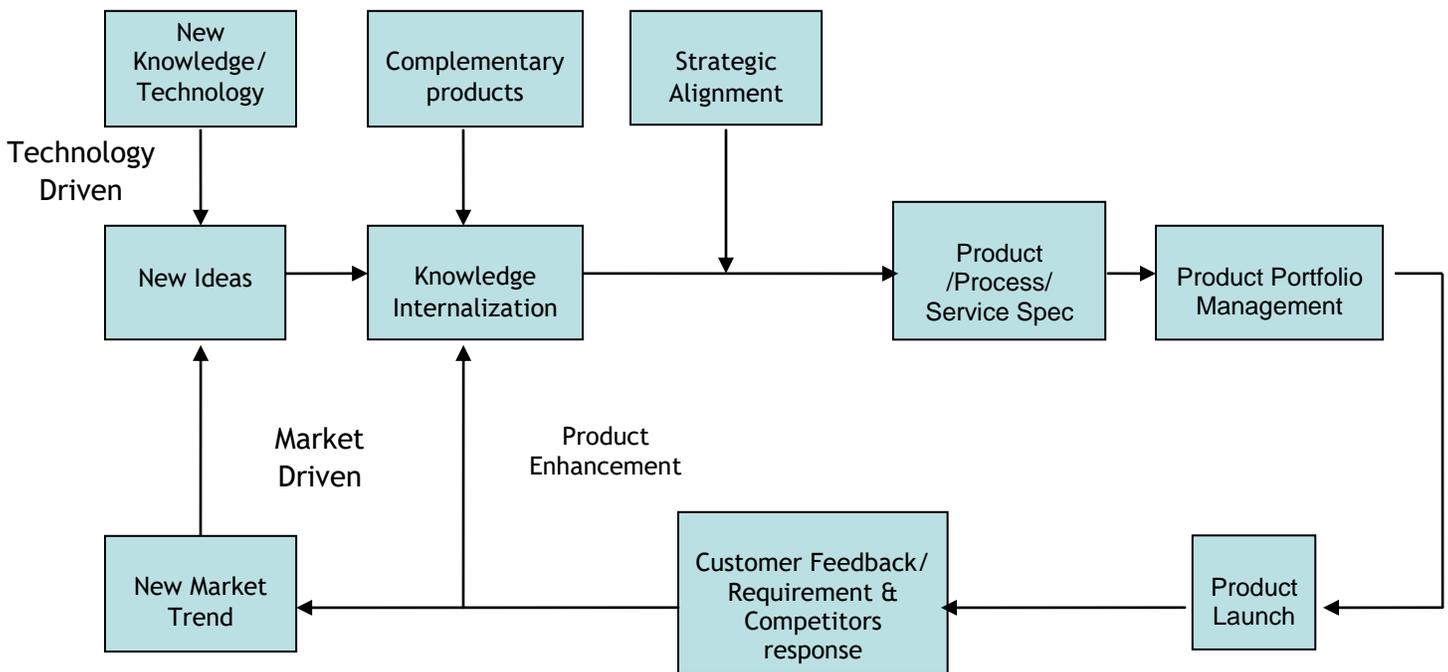
				Thus, CPSL can focus on overall operation management and information connections between departments.		Hong Kong air cargo industry and at the same time, handle the increased cargo needs more efficiently so as to enhance the competitiveness of Hong Kong as a global and regional cargo centre.	6: Process for capability and architecture development; 11: new corporate organization.
9	Hong Kong Observatory	Dr. Lee Boon-ying - Director of the Hong Kong Observatory	1) The ambition and mission is to put the public's safety as the first priority, making weather forecast more accurate. 2) In order to keep world advanced observatory unit.	1) Take use of the mature development of the internet and the prevalent information to create an automatic posing system - My Observatory; and has developed 'Observatory @ YouTube'. 2) Public's participation in developing community observatory website - install some receivers on climate information at school or associations' expenses. The instrument would broadcast district climate data automatically and reissued after consolidation by polytechnic university.	1) Encourage employees to voluntarily continue on further education, implementing Continuing Professional Development. 2) Open attitude to accept citizens' opinions and reflections.	1) Facing the future challenge: continue to improve forecast & alarm system and educate the citizen, infusing the latest information on global climate change. 2) Future expectation: hope that Hong Kong people should pay more attention to the global climate change, cherishing the environment and caring the earth with more efforts.	2: Internal capability; 3: Structure of capability;

8. Discussion and Summary

The success factors in Innovation and NPD Management has been revealed in the multiple cases study. It has been shown that we are very good in application and service development. HK Police force has been recognized as one of the most efficient disciplinary troops in the world. Our Stock Exchange is the most valuable platform in the world in term of market capitalization. The Octopus services have been exporting to Netherland, Dubai and New Zealand. Our MTR service is a world class public transportation system. The HK Jockey Club is the largest horse and football betting organization in the world. The HK Airport Authority has been recognized by numerous International Awards. Cathay Pacific is one of the most profitable airlines with superb hospitality services. The HK Observatory website is one of the most popular one because of its creativity and informative design. All these glories are being enabled by an excellent Innovation Management. With reference to the 12 principles mentioned above (Miller, W.L., 2010), principle 2 (internal capability with competitive advantage to create value to customer) and principle 3 (structure of capability includes people with knowledge, tools, technology, and process; business models with partners; and industry/market structure) are proven to be most frequently applied. This aligns with the resource-based view strategy (Barnes, 1991) which states that resources and capabilities of a firm must be valuable, rare, and isolated from imitation and substitution in order to create sustainable competitive advantages. It has been found that most Companies build up their capabilities through training, education, customer involvement, and multi-level colleagues' participation. Strategic planning is still the most popular principle in portfolio management. This echoes the findings of Patterson M.L. (2005). Radical innovation was seldom mentioned in the interview. It may be due to the fact that most of the Companies are either public utility or big Corporate, and thus more prudent procedure is preferred.

I try to propose the following framework so as to summarize a generic innovation process for a quick review. It involves market feedback and internalization process. As what postulated by Peter Drucker, 1959- "Business has only two basic functions- marketing and innovation".

New Product/Process Development Process



Product success mostly depended on the “better understand of the customer needs”. It has been argued that the managers, front line engineers, and marketing people who have long term experience in the market and close to the customer, are those who know the customer requirement, and thus little market research is required. Furthermore, sometimes customers do not really know what they want or what is the latest technology available particularly in the high-tech products, and again market research is of little help. Technology driven is not always a “pull”. It can be a “push” as well when Innovators use technology indentifying core problem & solving it with competitive innovation. However, customer feedback is important after the new product launch to improve the customer experience. Hence, product development/enhancement is a continuous process with customer feedback, new technology, and new market trend. Another driving force is the complementary products which will enrich your product features or user interface, and in turn influence your product development strategy. As an illustration, the applications of iPad in various scenario and Industry such as monitoring/control, education, and text/video communications are typical examples.

In summary, successful Innovation Companies have a long term relationship with customer, suppliers, and its employees. The managerial style and structure encourage internal and external communications with multi-levels and cross functions employee, and customer participation. Knowledge Internalization which includes analysis, reflection, & synthesis (Xu J. et al., 2010) is used in stead of knowledge management in the above flow diagram because the support to innovation through Knowledge Management deliberately has still not found its way explicitly into all companies. Internal capability

(principle 2) is built up by Internalization while customers and partners involvement enhances the structure of capability (principle 3). Creative people can come up with many creative ideas to enhance their products/services. However, not all the ideas can align with the strategy of the Company. Sometimes we have not only to decide what to be innovated, but also have to decide what not to be innovated through a constant review the strategic alignment. Hence, strategic alignment within the Company is proposed as being the moderator between Knowledge Internalization and New product/process/business model generation. After all, the ultimate success depends on solid Execution.

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