Return on Innovation Investment

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60 ECTS thesis submitted in partial fulfillment of a
Magister Scientiarum degree in Industrial Engineering

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Abstract

The objectives of this thesis is to examine how return on innovation investment can be measured and how financial techniques can help out with decision making in the NPD Process. Of special interest are differences between measuring returns from incremental and radical innoation, and sensitivity to different cost management approaches.

In an effort to answer these questions a case study was performed for a highly innovative global medical device company. Four products were examined with different level of innovation novelty and how cost management can affect the return on investment for product innovation.

Return on innovation investment (ROII) was measured for the products first of all by measuring ROII backwards. The cost of innovation was defined and used as a base case along with cost from different departments was excluded from the calculations to show their effect on the overall ROII. Secondly, the future return was evaluated for product innovation projects to predict the future ROII and to illustrate how dynamic financial techniques can help out with decision making in the NPD process.

The main conclusion was that it is important to know what should be included in the "Innovation Investment". Define cross-functional innovation process and set clear goals and measure accordingly. Distinguishing between innovation types is important because the nature of return is different for innovation of different novelty. It is also extremely important that radical innovation gets special treatment when it comes to project evaluation and investment decisions. It is more likely that a radical innovation will need more dynamic measures and valuation to tackle uncertainty and to help out with taking rapid decisions in the NPD process.

Útdráttur

Markmið verkefnisins er að rannsaka hvernig ávöxtun nýsköpunar er mæld og hvernig nýta má fjárhagslega mælikvarða til þess að aðstoða við ákvarðanatöku í nýsköpunarferlinu. Samhliða þessu var rannsakað hvort mælanlegur munur væri milli vörunýsköpunar með mismunandi nýnæmi og hvort að mat á kostnaði við nýsköpun geti haft áhrif á niðurstöður rannsóknar.

Til þess að svara þessum spruningum var framkvæmd rannsókn hjá alþjóðlegu fyrirtæki þar sem fjórar vörur af mismunandi nýnæmi voru rannsakaðar.

Ávöxtun fjárfestinga í vörunýsköpun var mæld afturvirkt. Það var gert með því að mæla nýsköpunarverkfni, útlagða vinnu við nýsköpun á vöru allt frá hugmynd og þar til hún er komin í hendurnar á notenda. Bera það saman við sölu og velgengni vöru á markaði yfir ákveðið tímabil. Einnig var spáð fyrir ávöxtun fjárfestinga fyrir framtíðar vörunýsköpunarverkefni. Þegar meta á ávöxtun fram í tímann þarf að gera ráð fyrir óvissu. Þar af leiðandi eykst þörfin á frekara mati og eru kvik aðferðalíkön góð leið til að hjálpa til við ákvarðanatöku í nýsköpunarferlinu.

Niðurstöður sýndu að til þess að hægt sé að mæla ávöxtun fjárfestinga í vörunýsköpun skiptir mestu máli að skilgreina nýsköpunarferil þvert á fyrirtækið. Þegar ferill hefur verið skilgreindur þarf að setja skýr markmið og mæla samkvæmt þeim. Allur nýsköpunarkostnaður þarf að vera mældur niður á vöru. Greina þarf á milli hvers konar vörunýsköpun á við hverju sinni þar sem eðli ávöxtunar getur verið mismunandi eftir nýnæmi vörunnar. Róttækari nýsköpun þarf frekara mat og meiri eftirfylgni á meðan nýsköpunarferlinu stendur. Kvik aðferðalíkön koma sér vel þegar sífellt þarf að meta óvæntar uppákomur sem gætu haft áhrif á ávöxtun verkefnisins.
Það er líklegra að falli til hulinn kostnaður við róttækari nýsköpun en aðra nýsköpun með minna nýnæmi.

My son.

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Abbreviations & Definitions

ROI – Return on investment

ROII – Return on innovation investment

ROA – Return on assets

ROE – Return on equity

R&D – Research and development

IT – Information technology

M&O – Manufacturing and operations

NPD – New product development: Is the complete process of bringing a new product to the market.

NPV- Net present value

PV – Present value

CF – Cash flow

FCF – Free cash flow

DCF – Discounted cash flow

IRR – Internal return rate

CAPEX – Capital expenditure

COGS – Cost of goods

WACC – Weighted average cost of capital

BOM – Bill of material

OLAP Cubes: Is an array of data understood in terms of its 0 or more dimensions. OLAP is an acronym for online analytical processing. OLAP is a computer-based technique for analyzing business data in the search for business intelligence.

Acknowledgements

This thesis was performed under the supervision of Docent, Rögnvaldur Sæmundsson at the Department of Industrial Engineering, Mechanical Engineering and Computer Science at the University of Iceland. I deeply thank him for great support, resource and quick response at every time. I also want to thank the company's team for all the support and ideas.

1 Introduction

This thesis will investigate how return on innovation investment (ROII) can be measured for different product innovation projects and how different types of financial techniques can help out with decision making in the new product development process. This will be done by making a case study where new product development (NPD) projects are reviewed backwards for a global medical device company. The projects selected are of different innovation novelty to investigate if there is a measureable difference between radical and incremental innovation and if cost management can affect the results.

Managers are under continued pressure to justify their investments and to investigate the amount of additional profits produced due to a certain investment. Therefore, investment analysis is an important part when companies are deciding to undertake a new investment opportunity. Before an investment decision is made, it is necessary to determine whether or not the planned investment idea is feasible considering several different aspects.

R&D and NPD activities in industry are challenged by an increased pace of innovation, shortened product life-cycle, rapid advances in Information and Communication Technologies (ICT), and globalization of NPD projects. In this blustered business reality, performance measurement in R&D and NPD is gaining increasing importance, because the performance of these activities can determine not only a firm´s overall success and competitive advantage, but also its very survival (Killen, Hunt, & Kleinschmidt, 2007).

Recent studies indicate that achieving successful outcomes for projects that differ radically in terms of innovativeness requires that firms adjust their NPD practices in line with the type of new product project they are developing (Brentani, 2001)

Some things are inherently easier to measure than others. One seemingly difficult to measure is “Innovation”. Innovation is often seen as a strategic objective in the internal process perspective (Kuczmarski, 2000).

Return on investment analysis are helpful to support decisions for an investment projects and many R&D managers favor financial techniques to evaluate innovation projects performance (Haley & Goldberg, 1995). There are different financial methods that can be used to measure return on investment.

Motivation & background

During my studies I worked within a company that was innovation driven and what got my interest was the selection of projects that the company invested in. How and when decisions are made along the NPD process and after the product is launched when does it start paying off? This was in line with what I had been emphasizing in my studies in product management and a part of my interest to get a better understanding of return on innovation.

Finding a proper way of measuring innovation is filled with complexity mainly because the process towards innovation is not as linear as it should be. The different variables that are expected to determine and incentive innovation are so numerous (Murro, 2013).
This study aims at contributing to analyze how return on innovation investment can be measured with a special focus on product innovation. Theoretical literature on innovation does not offer unequivocal predictions about how to measure the return on innovation.

The analysis carried was to examine all projects behind four different products. This set contains detailed information about projects behind each product and processes. It is also important to address that different level of innovation novelty is a complexity factor for firms to measure the return on innovation especially when you look forward.

It will be done by making a case study where new product development (NPD) projects are reviewed backwards for a medical device company. The projects selected are of different innovation novelty.

1.1 Objectives

The main purpose of this research is to investigate how return on innovation can be measured for product innovation. Case study will be put forward where it will show how ROII can be measured for product innovation and how financial techniques can help evaluating ROII both back in history and how financial methods can help out with decisions in the future NPD process.
This research will, presumably, give companies insight of the importance of estimating their return on innovation and how it can be done.

The aim will be to answer following questions:

1. *How can return on product innovation investment (ROII) be measured?*
2. *How can different financial techniques help with decision making in the New Product Development process?*

The remainder of the research is organized as follows. In the next section, I summarize related literature. Section three introduces the methodology and section four describes the analysis performed. Section five will present and interprets the results of how ROII can be calculated for these four products and how financial techniques can help out with decision making in the NPD process.

2 Theoretical background

This chapter gives the theoretical background and explains the essential concepts used in the research.

For this particular subject, it is various how different researchers measure ROII for product development. The theoretical background is divided into four sections, the first section defines return on investment and how it can be calculated with different methods. Section two compares investment options with and without uncertainty. Section three defines innovation, typologies, innovations that create new product life cycles and the innovation during the life cycle. Section four wil address how ROII can be calculated and how we can use the financial technique to help us with decisions in the innovation process.

2.1 Return on investment

Return on investment (ROI) is a performance measure that is used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. ROI measures the amount for return on an investment relative to the investment´s cost (Parrino & Kidwell, 2009).

If you buy an asset of any sort, your gain (or loss) from that investment is called the return on your investment (Hillier, Clacher , Ross, Westerfield, & Jordan, 2011).

Investments can involve both intangible and tangible assets. These include R&D advertising and marketing. Expenditures on an intangible asset, such as patents, trademarks. Licensing agreements, service contracts just like intangible expenditures on new plant and equipment. In each case, the company is spending money today in expectation that it will generate streams of future profits. Ideally, firms should apply the same criteria to all capital investments, regardless of whether they involve a tangible or intangible asset (Brealey & Mayers, 1996).

One of the most used project and company evaluation techniques is the return on investment. For ROI being useful, income and investment must be determined consistently and fairly. Accounting policies regarding the measurements of investments and the determination of income have a direct effect on ROI.

To calculate ROI, you simply take the gain of an investment, subtract the cost of the investment, and divide the total by the cost of the investment. Or:

$$ROI = \frac{Investment\ gain - Investment\ cost}{Investment\ Cost} \qquad \textbf{(1)}$$

It is usually more convenient to summarize information about returns in percentage terms, rather than cash terms, because that way your return does not depend on how much is actually invested.

ROI is a traditional financial measure based on historic data. ROI is a backward-looking metric that yields no insights into how to improve business results in the future. ROI calculations are also typically employed to monitor the performance of division or of a product line within the company. When all divisions are measured the same way, comparisons are possible across the board. Profitability, on the other hand is a forward-looking concept. It is based on projecting future behavior based on the present and the past. ROI can be used to evaluate the future, but other methods are more suitable for forward analysis (Parrino & Kidwell, 2009).

Investment decisions are often referred to as capital budgeting or capital expenditure (CAPEX) decisions because most large corporations prepare an annual capital budget listing the major projects approved for investment. There are many methods and techniques available to help the investor make wise economic decisions. These evaluation methods and techniques can be applied to several mutually exclusive projects for the purpose of determining which, is any should be pursued (Au & Au, 1992).

Money available at the present time is worth more than the same amount in the future due to its potential earning capacity. This core principle of finance holds that, provided money can earn interest, any amount of money is worth more the sooner it is received (Feinstein & Lander, 2002). The correct approach is to discount the cash flows, so the \$1 received in 1 year is actually worth \$1/ (1+*r*) today, where *r* is called discount rate and is the annual interest rate investor demand for receiving a later payment. This argument can be generalized to a series of cash flows $A_1, A_2, A_3....,A_n$ received in time periods 1, 2, 3,…,*n*. The value of these cash flows today is calculated from the discounted sum:

$$PV = A_1/(1+r) + A_2/(1+r)^2 + A_3/(1+r)^3 + ... + A_n / (1+r)^n. \quad \textbf{(2)}$$

Where *n* is the number of time periods and *PV* is called the present value of the cash flows. Discounting a series of cash flow is mathematically equivalent to weighting cash received in the near term more than cash received further in the future. The effect of inflation is generally ignored in cash flow so that $A_1, A_2, A_3....,A_n$ are given in today´s prices. Inflation can be included in the present value calculation by adding an inflation factor to the discount rate. This is particularly important in economies that have high inflation rates (Brealey & Mayers, 1996).

Because ROI is very subjective, and does not take uncertainty or risk into the calculations. It simply shows how returns compare to costs. This measurement will help to determine if the cost of the investment exceeding the resulting benefit, or if the payback affects the corporate bottom line. Since ROI does not completely cover the dimension of time, we cannot compare the economics of short-lived versus long-lived project; without accounting for risk, we cannot compare a project with its riskier competitor. For more accurate estimation the need for other financial techniques is helpful. The treatment of time and risk brings an analysis into the domain of valuation.

Net present value (NPV) analysis will level the playing fields for costs and benefits occurring near and far in the future by aligning them all to a single frame in the present. Valuation can help make sense of the numbers, giving proper weight to cost and benefits occurring at different points in time. By explicitly modeling the time value of money, NPV introduces fundamental concept into valuation. In the most general terms, the net present value criterion method can be divided into four matters: or, time analysis periods present worth method, future worth method, annual worth method, and capitalized worth method. (Brealey & Mayers, 1996).

2.2 Comparing investment options

Companies need procedures to ensure that every project is assessed consistently. When managers are presented with investment proposals, they do not accept the cash flow forecasts at face value. Instead, they try to understand what makes a project tick and what could go wrong with it. Here applies the Murphy´s Law, "if anything can go wrong, it will," and O'Reilly´s corollary, "at the worst possible time".
Once you know what makes a project tick, you may be able to reconfigure it to improve its chance of success. If you understand why the project could fail, you can decide whether it is worth trying or rule out the possible causes of failure.

In the real world, most investments are not independent. Taking an investment can often mean rejecting another investment at one extreme to being locked in to take an investment in the future. Using financial techniques to evaluate the investments can help the investor to choose which investment is better suited at each time (Hillier, Clacher, Ross, Westerfield & Jordan, 2011).

Liberatone and Titus (1983) presented eight most used techniques in management. Three of the eight were financial techniques, the NPV/internal rate of return (IRR), cost/benefit analysis, and payback period. A description of the NPV and IRR will be presented in this section.

2.2.1 Net Present Value & Internal Rate of Return

Net present value (NPV) is the difference between the present value of cash inflows and the present value of the cash outflows. NPV is used in capital budgeting to analyze the profitability of a projected investment or a project. Determining the value of a project can be challenging because there are different ways to measure the value of future cash flows.
The discount rate element of the NPV method is a way to account for this. Companies may often have different ways of identifying the discount rate. Common methods for determining the discount rate include using the expected return of other investment choices with a similar level of risk. The discount rate used for investments in a specific firm is defined by the expected return of the combined debt and equity of the firm for a given industry. However the most widely used discount rate for evaluating investment projects, and certainly the most

commonly suggested in finance textbooks, is the after-tax weighted average cost of capital (WACC) (Harris & Pringle , 1985).

The discount rate is related to the risk of an investment, so that firms in high risk industries (such as technology) have higher discount rates. Due to this risk-return relationship, the discount rate for more risky technology project investments is sometimes increased relative to that for less risky investments when NPV is calculated. A potential issue with this approach is the discount rates chosen for riskier projects can be somewhat random. When increasing the discount rate adds additional uncertainty into the NPV calculation and may reduce one´s objectivity in comparing projects. A better approach for technology investment decision making incorporating project risk, and other factors such as the business value of the project. (Brealey & Mayers , 1996).

In order to compare projects that have different costs, it is useful to subtract the initial investment cost *I* from the present value, thus obtaining the net present value (NPV):

$$NPV = PV - I \tag{3}$$

In the costs of the project are spread out over multiple time periods, then *I* is the present value of these costs. Hence from Equation (2), Equation (3) is equivalent to:

$$NPV = -C_0 + \frac{(A_1 - C_1)}{(1+r)} + \frac{(A_2 - C_2)}{(1+r)^2} + \frac{(A_3 - C_3)}{(1+r)^3} + \cdots + \frac{(A_n - C_n)}{(1+r)^n}, \tag{4}$$

Where the cost of the project $C_1, C_2, C_3 ...., C_n$ have been subtracted from the cash benefits $A_1, A_2, A_3 ...., A_n$ in the corresponding time periods 1,2,3,….,*n*.

When making investment decisions, one always strives to invest in positive NPV projects. If the NPV of a project is negative, this means that the initial investment is greater than the present value of the expected cash flows. Investments in projects with negative NPV should not be made, because they do not add value to the firm and actually extract value (Parrino & Kidwell, 2009).

Internal rate of return (IRR) is a metric used in capital budgeting measuring the profitability of potential investments. IRR is a discount rate that makes the NPV of all cash flows from a particular project equal to zero. Generally speaking, the higher a project´s IRR, the more desirable it is to undertake the project. IRR is uniform for investments of varying types and, as such IRR can be used to rank multiple prospective projects a firm is considering on a relatively even basis. Assuming the costs of investments are equal among various projects, the project with the highest IRR would probably be considered the best and undertaken first (Parrino & Kidwell, 2009).

The IRR is the compounded annual rate of return the project is expecting to generate and is related to the NPV of the project, defined in Equations (3) and (4) (Kerzner, 2003). From this definition, the internal rate of return is calculated:

$$NPV = -C_0 + \frac{(A_1 - C_1)}{(1+IRR)} + \frac{(A_2 - C_2)}{(1+IRR)^2} + \frac{(A_3 - C_3)}{(1+IRR)^3} + \cdots + \frac{(A_n - C_n)}{(1+IRR)^n} = 0, \quad \textbf{(5)}$$

Where $A_1, A_2, A_3 \ldots, A_n$ are the positive cash benefits and $C_1, C_2, C_3 \ldots, C_n$ are the cost of the project in each time period 0, 1, 2, 3,…,*n*. When IRR is greater than the project discount rate, or WACC, we should consider accepting the project – this is equivalent to a positive NPV project, When IRR is less than the WACC the project should be rejected, because investing in the project will reduce the value of the firm. The tenet of basic finance theory is that all projects that have positive NPV or IRR>WACC, should be funded (Brealey & Mayers, 1996).

You can think of IRR as the rate of growth a project is expected to generate. While the actual rate of return that a given project ends up generating will often differ from its estimated IRR rate.

Once the IRR of a project has been determined, it is a simple matter to compare it with the required rate of return to decide whether or not the project is acceptable.

For most projects, both IRR and NPV will generate the same accept-reject decision. However there are differences that can exist in the underlying assumptions that can cause the projects to be ranked differently. The major difference is the magnitude and timing of the cash inflow. NPV assumes that the cash inflows are reinvested at the cost of capital, whereas IRR assumes reinvestment at the project´s IRR. NPV tends to be more conservative approach (Parrino & Kidwell, 2009).

The NPV method recognizes the time value of money that a dollar today is worth more tomorrow, because the dollar today can be invested to start earning interest immediately. The NPV depends solely on the forecasted cash flows from the project and the opportunity cost of capital. Any investment rule that is affected by the manager´s tastes, the company´s choice of accounting method, the profitability of the company´s existing business, or the profitability of other independent projects will lead to decisions with uncertainty (Brealey & Mayers, 1996).

For most investments the usefulness of the financial techniques that do not count for uncertainty is severely limited. As a formal matter, it applies only in those cases where the investment opportunity instantly disappears if it is not immediately undertaken (Parrino & Kidwell, 2009). Both the NPV and ROI analysis are static valuation methods that tend to undervalue investments made under uncertainty. Almost every investment involves the option to undertake them when financing alternatives are more favorable, in general, the preferred way to deal with such investment decisions is to treat them as options. The cause of uncertainty in valuation of investment opportunities can be various, such as increased competition in the market, deregulation or new technology. The following section will introduce how investment decisions with uncertainty can be taken using dynamic methods (Parrino & Kidwell, 2009).

2.2.2 Dynamic Methods

Anyone who has tried to measure the value of a technology investment has, at some point discovered the difficulty of presenting a compelling business case using standard techniques like NPV or ROI. Projected cash flows seem meager in comparison to the investment required, or the discount rate chosen to compensate for the risk is so high that it renders the NPV unpalatable. Analysts often resort to instinctive appeals of “synergy,” “table stakes” or “strategic importance” to the shortfall (Teisberg, 1995).

A number of alternative valuation techniques are available that can help to make the valuation of flexibility tangible. Teisberg did a research on the conditions for applicability and relative merits and difficulties involved in three approaches: Dynamic discounted cash flow analysis, decision analysis and real options. Where each technique is appropriate in some conditions and not others, and they have their strengths and weaknesses (Teisberg, 1995).

The uncertainty in investments can be various, such as increased competition in the market, deregulation or new technology. Real option captures the uncertainty with volatility that can be difficult to predict in a project, especially one that has never been undertaken. Volatility is a statistical measure of the dispersion of returns for a given security or market index. It can be measured by using the standard deviation or variance between returns. A change in volatility can affect the value of an investment opportunity considerably. Companies most often try to predict the volatility their investment opportunity will have by comparing it with similar projects or similar companies in the market. Specialists in the industry may also try to use their knowledge to predict the investment volatility. The real option method can take an advantage of projects with high uncertainty which previous investment methods have not done (Latimore, 2002).

2.2.3 Dynamic Discounted Cash Flow Analysis

Discounted cash flow (DCF) analysis, and in particular, NPV analysis, has been widely used as a criterion for evaluating projects. A dynamic version of discounted cash flow analysis begins by considering uncertain cash flow more carefully. Instead of assuming a predetermined decision path and a single (expected) scenario of future cash flows, the dynamic version requires the analyst to lay out all important future uncertainties and the possible future contingent decisions by using a decision tree or a dynamic program. By solving the tree or dynamic program, the analyst correctly takes into account the possibility of many future states of the world and incorporates in the analysts the best possible set of decisions at each time and in each state.

NPV analysis does not deal well with real options. This is true because the riskiness of a project that has real options associated with it varies with time, and the appropriate discount rate varies with the risk.

The terminal value of a security is the present value at a future point in time of all future cash analysis, and allows for the limitation of cash flow projections to a several-year period. Forecasting results beyond such a period is impractical and exposes such projections to a variety of risks limiting their validity primarily the great uncertainty involved in predicting industry and macroeconomic conditions beyond a few years. The terminal value allows for the inclusion of the value of future cash flows occurring beyond a several-year projection period. The issue of the terminal value is of major concern for anyone using a discounted cash flow model.

2.2.4 Decision analysis using binomial methods

The decision tree analysis (DTA) go beyond NPV by not only representing the occurrence of costs and benefits over time, but by representing the decisions taken by management in reaction to these occurrences. DTA captures the lack of flexibility in the NPV method and allows the investor to delay an investment decision until more information about the project is available which can affect the value of the project. The decision tree maps out different probability events which can help investors to picture the project and make decision during the life of the project.

Our original, simple treelike representation is refined by distinguishing different kinds of nodes:

• *Outcome and state change nodes*: similar to those in our original representation, they represent possible outcomes or state changes, with associated probabilities, as we have seen before;

• *Decision nodes*: these nodes represent decision points in the tree, where management can actively intervene;

• *Action nodes:* represent the actions possibly associated with a decision, such as making a further investment outlay.

The full decision tree capturing this scenario, including all its possible decisions, actions, state changes, and outcomes together with their probabilities (Erdogmus , John , & Michael, 2006).

If the project has a positive NPV which indicates that it should be undertaken, however the company wants to evaluate the possibility of deferring the decision for a year, until more information is available, and see if it will cause a better outcome. If the project will show unsuccessful outcome after one year the company will not take on the project. However if it will show a successful outcome it will undertake the project.

2.2.5 Real option

Myers (1987) was the first one to introduce the method of real option valuation (ROV). It is based on the option approach used to value call and puts in financial markets. The financial option theory that involves valuing option in a risk-neutral world, where the investor´s attitude to risk is irrelevant was derived by Black and Scholes (1973) and Merton (1973). The option approach brings reversibility and the possibility to delay decisions and increase managerial flexibility into investment analysis (Brealey & Mayers (1996); Trigeorgis (1996)).

The real option method has been used to evaluate different kinds of options and essentially all proposed projects are real options. They are referred to as "real" because they usually pertain to tangible assets such as capital equipment, rather than financial instruments. Real option analysis is an attempt to quantify the value of "flexibility". Often times, valuation methods, such as NPV, do not include the benefits that real options provide.

Options can be useful for evaluating information technology projects that take a long time to implement. When a technology evolves over several years, the potential revolution in standards can predict an entirely new paradigm, leading to an unbridgeable gap between the old and new.

The solving of real options problems has two parts. The first part is "spotting options" and the second part is "valuing options". To spot options, we need to have a deep understanding of the whole decision landscape. For example, by investing in a particular project, a company may have the real option of expanding, downsizing or abandoning other projects in the future. Other examples of real options may be opportunities for R&D, M&A and licensing. In R&D settings, there are many possible applications. Most of these applications can be classified more naturally as either call option or put options. A *call option* gives the buyer the right, but not the obligation, to acquire an asset of uncertain future value at a specified price. The buyer of the call option is taking an optimistic view of the underlying asset the call option. Similarly, a capital investment today that gives the investor the future right, but not the obligation, to make a future investment is a real option. A variety of factors can influence the value of the option. For example, as the value of the stock (or the present value of the expected cash flows) increases, so does the value of the call option. In fact, real options are directly analogous to financial options in several ways, as is shown on figure 1 (Latimore, 2002).

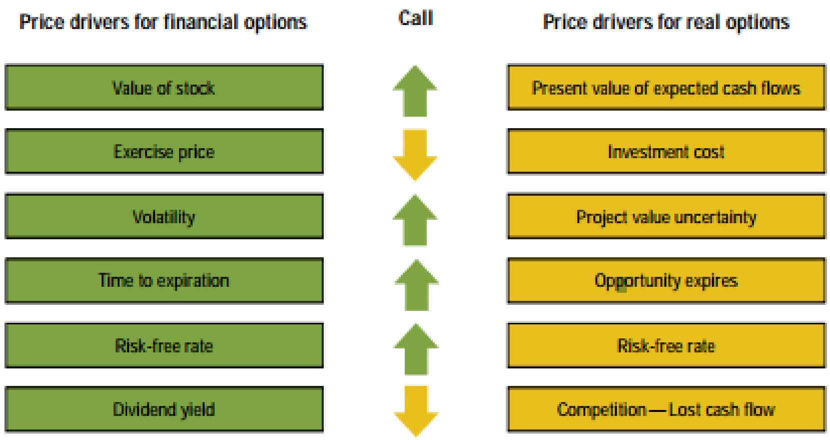


Figure 1 The fundamentals of financial options and real options **(Latimore, 2002)**.

Real options compensate for the uncertainty inherent in investments by *risk adjusting cash flows and discounting them at a risk free rate.* Adjusting cash flows forces analysts to be more explicit about assumptions underlying the projections and eliminates interminable discussions about the appropriateness of one discount rate versus another (Latimore, 2002). After an investment is made, time passes, uncertainty is resolved and the present value of cash flows can be calculated with more accuracy. If the environment is volatile, the chance that the value of the project in the future will have positive NPV. If you have two investments (see figure 2); one with a wide range of possible outcomes, the other with a relatively narrow range. In the former, more volatile scenario, there is a good chance of producing a project with a positive NPV in the future. Hence the real option under this set of outcomes would have value. The later, more stable scenario has no chance of producing a project with a positive NPV. An option using the latter set of outcomes would have no value.

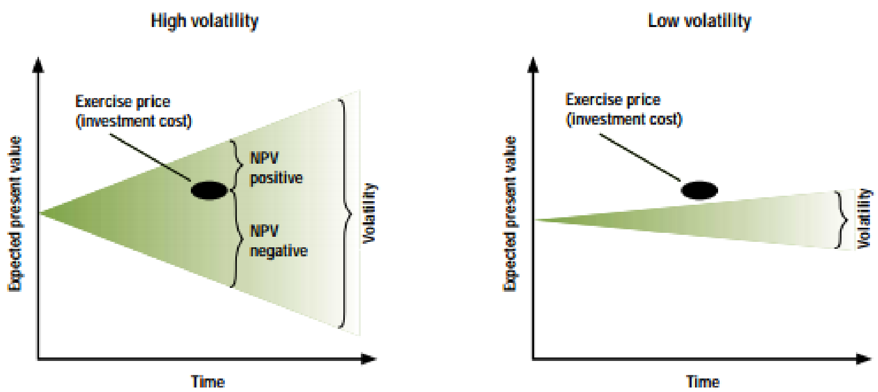


Figure 2 Volatility increases the value of real options **(Latimore, 2002)**.

Types of real options

One way to look at real options is that there are two types of options:

1. *Growth options* give a firm the ability to increase its future business. Examples include research and development, band development, mergers and acquisitions, leasing or developing land, or – most pertinent – launching a technology initiative.
2. *Flexibility option,* on the other hand, give a company the ability to change its plans in the future. Management can purchase the option to delay, expand, contract, Switch uses, outsource or abandon projects.

Types of real option can almost be endless as the flexibility for managers to make different decisions in their investment projects can be numerous. An option can be a standalone option for example to decide whether to renew equipment in a factory or it can be compound option where many different decisions need to be undertaken.

Where the projects scope is uncertain, flexibility as to the size of the relevant facilities is valuable, and constitutes optionality.

Option to expand

The option to expand is an option which enables a company to make changes or expand their current production. Expansion options are often involved with other option, a compound option. This is equivalent to a call option.

Option to contract

The option to contract is the opposite of the option to expand. It enables the company to reduce the scale of its production if market conditions turn out to be unfavorable for example. This is equivalent to a put option, and the excess upfront expenditure is the option premium.

Where there is timing uncertainty as to when, and how, business or conditions will eventuate.

Option to defer

An option to defer enables a company to defer its investment decision for some period of time or until more information about the project is available. This constitutes an American styled call option.

Option to abandon

If a project turns out to be unsuccessful it can have value for a company to have the option to abandon it and in some cases sell it for its salvage value instead of keeping it ongoing and experiencing substantial loss.

Sequencing options. Here, when the present value of the remaining cash flow falls below the liquidation value, the asset may be sold, and this act is effectively the exercising of a put option.

Real options can provide an extremely useful method of unlocking the value embedded in investments that many practitioners know exists, but have been unable to quantify. In making the decision to invest, companies usually use all elements of our valuation approach: Discounted cash flow, adjusted option value, and abandonment value. When they first consider a new investment, it looks at the target project projections and makes a discounted cash flow calculation as a base case valuation. The following section will cover the discounted cash flow analysis which have been widely used as a criterion for evaluating projects (Parrino & Kidwell, 2009).

2.3 Innovation

Innovation is the development of customer value through solutions that meet new, undefined, or existing needs in unique ways. Solutions may include new or more effective products, processes, services, technologies, or ideas that are more readily available to organizations, markets, governments, and society (Marywille 1992, Frakeliues 2009).

2.3.1 Innovation definitions

There are many definitions for innovation types that have resulted in the way the terms “innovation” and “innovativeness” are operationalized and utilized in the new product development literature (Garcia & Calantone, 2002). Garcia and Calantone talk about the importance of consistent typology for identifying innovation to advance our knowledge and understanding on innovation and the difference between innovation typologies.

It was Schumpeter who first brought the concept of innovation by distinguishing it from a new idea or innovation to a product, process or approach successfully applied to practice. He describes the act of new innovations replacing old innovations as creative destruction. He identifies five types of innovation; (1) Product innovation the introduction of a new good. (2) Process the introduction of a new method of production. (3) Business model the opening of a new market. (4) Source of supply the conquest of a new source of supply of raw materials of half manufactured goods. (5) Mergers and divestments the carrying out of the new organization of any industry. (Schumpeter 1934). One definitions of innovation simply states: A definition of innovation was proposed more recently by West and Anderson (1996) and quoted as recently as 2008 by Wong et al. (2008, p, 2); “Innovation can be defined as the effective application of processes and products new to organization and designed to benefit it and its stakeholders”.

2.3.2 Innovation typologies

The broader product and technological innovation literature often describes two types of innovation *radical innovation* which aims at developing new products, and *incremental innovation* which aims at improving existing products (Tatikonda & Rosenthal, 2000). The innovation could, for example, replace existing products, change the structure of the market or create new markets. In Schumpeter´s view “radical” innovation creates major disruptive changes whereas “incremental” innovation continuously advance the process of change. Incremental innovation concerns an existing product, service, process, organization or method whose performance has been significantly enhanced or updated. This can take two forms: For example, a simple product may be improved through use of higher performance components or materials, or a complex product comprising a number of integrated technical subsystems may be improved by partial changes to one of the subsystems (Garcia & Calantone, 2002).

Incremental innovations can easily be defined as products that provide new features, benefits, or improvements to the existing technology in existing market. Incremental innovations are important on two main counts: First as a competitive weapon in a technologically mature market; and second, because streamlined procedures based on existing technology can help alert a business in good times to threats and opportunities associated with the shift to a new technological plateau (Garcia & Calantone, 2002). For many firms incremental innovations are the lifeblood of the organization. Incremental innovation can occur at all stages of the new product development process. At the conceptualization stage, R&D may use existing technology to improve an existing product design. At the mature stage of a product´s life, line extensions may result in incremental innovations Rothwell and Gardiner pointed out that a borrowed technology from different industry may be new to a different market (Garcia & Calantone, 2002).

Radical innovation is generally a complex process, rather than a discrete event, and generally implies a difficult, lengthy and risky process. A tool that can aid in the identification of radical innovation is the technology S-curve introduced by Foster (Feinstein & Lander, 2002). The S-curve has been used to describe the origin and evolution of technologically discontinuous/radical innovations (Garcia & Calantone, 2002). This theory suggest that technological product performance moves along an S-curve until technical limitations cause research effort, time, and/or resource inefficiencies to result in diminishing returns. New innovations replace the old technology and a new S-curves initiated (see figure 3).

Figure 3 Technology/Marketing S-curve Phenomena (adapted from Foster 1986)

Thus, a radical innovation can be identified by the initiation of a new technology and new marketing S-curve. With this viewpoint it is easy to see that planning for radical innovation requires understanding how to statically plan for both the technological discontinuities and marketplace discontinuities for the global marketplace.

Griffin explains that the level of product newness and project complexity define inherent characteristics of the project and represent the overall strategy of the project. Although project characteristics are important, relatively literature addresses characteristics of the new product development project or associations between specific project characteristics and project success (Taktikonda & Rosenthal, 2000).
The novelty of innovation is context-specific and depends on an adopter´s experience. What seems routine in some context may in other context be seen as innovation. While innovation implies change, not all change involves innovation since “not everything that an organization adopts is perceived as new” (Zaltman, Duncan, & Holbek, 1973).

Technology causes uncertainty in respect of the skills and knowledge required to succeed in using new technology (e.g. Veryzer 1998; Nieto 2004). The newness of the idea means that some degree of uncertainty is involved in the innovation process. Given that the future entails uncertainty, it is reasonable to argue that uncertainty is inherent in every innovation process. Uncertainty results from the fact that, on one hand events in the future do not follow the course of past events, and, on the other, knowing about the future is always incomplete.

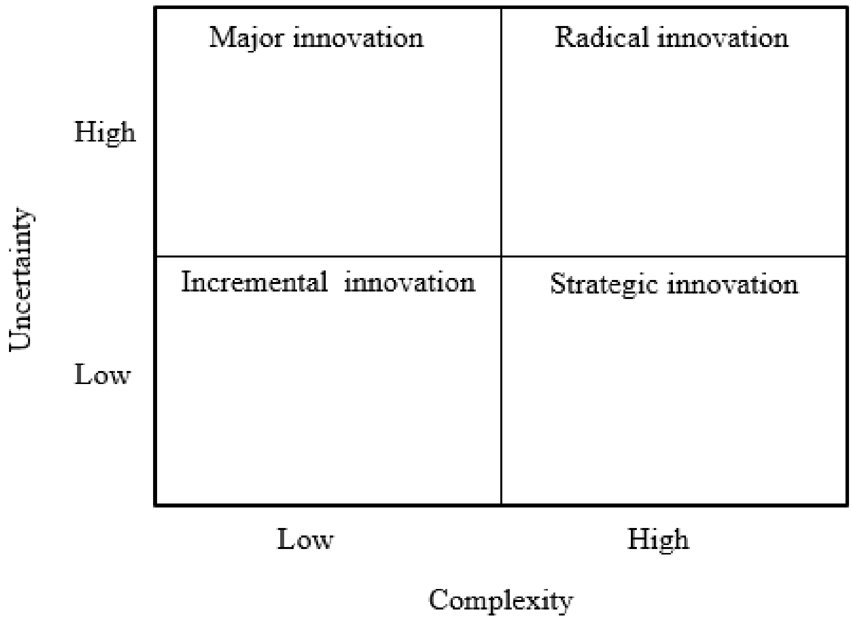


Figure 4 Effect of uncertainty and complexity on the management of innovation.

Figure 4 presents a simple two-by-two matrix with uncertainty as one dimension and complexity as the other dimension. Each quadrant raises different issues and is likely to require specific organizational structures and processes to manage innovation (Tidd, 2001).

Low uncertainty, low complexity: In this domain, product and service differentiation are the key issues, marketing competencies are critical, and a product or market multi-divisional structure typical e.g. fast-moving consumer products. This can be described as more incremental innovation.

High uncertainty, low complexity: In this domain, scientific or technological competencies are critical, and a functional structure typical, e.g. pharmaceuticals.

Low uncertainty, high complexity: In this domain, project management competencies are critical, and professional structures typical e.g. construction.

High uncertainty, high complexity: The presence of both high uncertainty and high complexity demand a range of competencies, including flexibility and adaption and learning. For example, the application of software to traditionally complex systems such as transportation, telecommunications and logistics has created new challenges to management and innovation. This can be described as radical innovation.

Together, these two contingencies may provide a more comprehensive typology of the environment of technology and innovation management, and help to guide management research and practice (Tidd, 2001).

Every introduction of a new product on the market tend to be characterized by a high degree of uncertainty (Aernathy and Utterback 1987). The interest of this research is focused on the development of "new" products or changes to existing products. The development of a new product requires an unknown amount of economic resources for R&D. The adoption of a new technique tends to present uncertainties with respect to quality, reliability, technical characteristics, the rate of improvement of those characteristics, price, etc. There are many things to look to from the idea generation and to the death of a product. Because innovation are of different types, occurs in many different ways, and have varying effects, they call for different strategic responses. For example, research has found that strategic responses that address the tail-end of the product innovation cycle and encourage demand for innovation are more likely to stimulate incremental innovation than to foster radical innovation (Nemet, 2009). It is not only that projects of different level of innovation need different processes, but it is also that it can be difficult for companies to compare these projects together with the decision in mind what project should be worked on that will create more benefit for the company in the future. To assist managers take care of this all the Product Lifecycle Management (PLM) process is a helpful system. The following section will expand on the PLC process.

2.3.3 Product life cycle and innovation

The concept of Product Lifecycle Management (PLM) appeared in the 1990´s with the aim of moving beyond engineering aspects of a product and providing a shared platform for the creation, organization and dissemination of product related information. In industry, PLM is the process of managing the entire lifecycle of product from inception, through engineering design and manufacture, to service and disposal of manufactured products (Kurikin & Januska, 1881-1886). PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise.

There are several life-cycle models in industry to consider, but most are rather similar. What follows below is one possible life-cycle model. Usually it has defined four stages, each with its own characteristics that mean different things for business that are trying to manage the life cycle of their particular products (Kurikin & Januska, 1881-1886).

Introduction stage

The introduction stage is the definition of the product requirements based on customer, company, market and regulatory bodies ‘viewpoints. This stage is likely to be the most expensive for a company. When launching product the size of the market is usually small, which means sales are low, although they will be increasing. On the other hand, the cost of things like research and development, consumer testing, and the marketing needed to launch the product can be very high, especially if it’s a competitive (Gecevska & Chiabert, 2010).

Growth stage

The growth stage is typically characterized by a strong growth in sales and profits, and because the company can start to benefit from economies of scale in production, the profit margins, as well as the overall amount of profit, will increase. This makes it possible for businesses to invest more money in the promotional activity to maximize the potential of this growth stage (Gecevska & Chiabert, 2010).

Maturity stage

During the maturity stage, the product is established and the aim for the manufacturer is now to maintain the market share they have built up. This is probably the most competitive time for most products and businesses need to invest wisely in any marketing they undertake. They also need to consider any product modifications or improvements to the production process which might give them a competitive advantage (Gecevska & Chiabert, 2010).

Decline stage

Eventually, the market for a product will start to shrink, and this is what’s known as the decline stage. This shrinkage could be due to the market becoming saturated (i.e. all the customers who will buy the product have already purchased it), or because the consumers are switching to a different type of product. While this decline may be inevitable, it may still be possible for companies to make some profit by switching to less-expensive production methods and cheaper markets (Gecevska & Chiabert, 2010).

The PLM is part of what is used to derive implications for innovation strategies of firms and policy. It describes the changing features if markets during the evolution. It may therefore serve as the theoretical framework within which the market changes can be explained (Klepper, 1997). The PLM translates closely to the model of innovation diffusion. In the beginning of a product life cycle, the consumer's preferences are not clearly defined. Moreover, firms have not yet agreed upon the kinds of knowledge that should be used to meet these blurred preferences. In the course of, the consumer's preferences become clearer and the knowledge used to generate innovation is relatively agreed upon, so that the generation of innovation finally falls back on the same kind of knowledge. The industry output displays the highest growth rates in the beginning of the product life cycle; these growth rates decrease and ultimately become zero when the market matures. The industry price decreases with high rates at the beginning of the product life cycle. Afterwards the price decrease slows down and becomes zero when the market matures. This pattern is also supported by several other studies (Kurikin & Januska, 1881-1886).

The field of product development and product life-cycles has been intensively studied during the last half of this century, and the last decade has seen a particular focus on high-technology products: computers, consumer electronics and the like. A number of these researchers have sought to identify patterns in the life-cycle of typical products.

Marketing innovation depends on a process whereby people gradually become favorably disposed to a new idea; it is a social learning process which results in consumers changing their attitudes and values. Marketing literature abounds with S-curves to depict processes which start slowly, then gradually gather pace until they move into fast growth, which continues until saturation is approached, when growth slows down and finally plateaus. S-curves visually depict how a product, service technology or business progresses and evolves over time. S-curves can be viewed on an incremental level to map product evolutions and opportunities, or on macro scale to describe the evolution of business industries. On a product, service, or technology level, S-curves are usually connected to "market adoption" like is defined here above were the beginning of curve relates to the birth of a new market opportunity, while the end of the curve represents the death, or obsolescence of the product, service or technology in the market. Usually the end of one S-curve marks the emergence of a new S-curve, the one that displaces it. Past research has generally shown that the adoption of an innovation follows a normal, bell-shaped curve when plotted over time on a frequency basis. If the cumulative number of adopters is plotted, the result is an s-shaped curve (see figure 5). Note that both of these curves are for the same data, the adoption of an innovation over time by the members of a social system (Rogers, 1983).

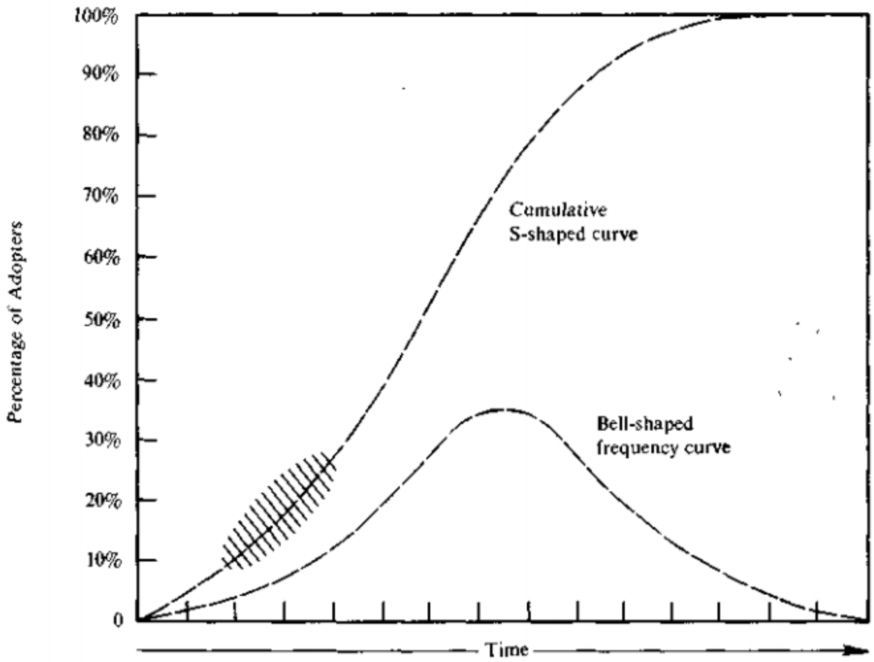


Figure 5 Adoption of innovation can be shown in a bell-shaped frequency curve and the s-shaped cumulative curve **(Rogers, 1983)**.

Some industries and technologies move along S-curves faster than others. High tech S-curves tend to cycle more quickly while certain consumer products move more slowly (Christensen, 1992).

Rogers (1995) classifies stages in the technology life-cycle by the relative percentage of customers who adopt it at each stage. Early on are innovators and early adopters, then come in succession the early majority pragmatists, the late majority conservatives and lastly the laggards (see figure 6).

Moore (1991) based on Rogers´work depicts the transition between the early adopters and early majority pragmatists as a chasm that many high-technology companies never successful cross.

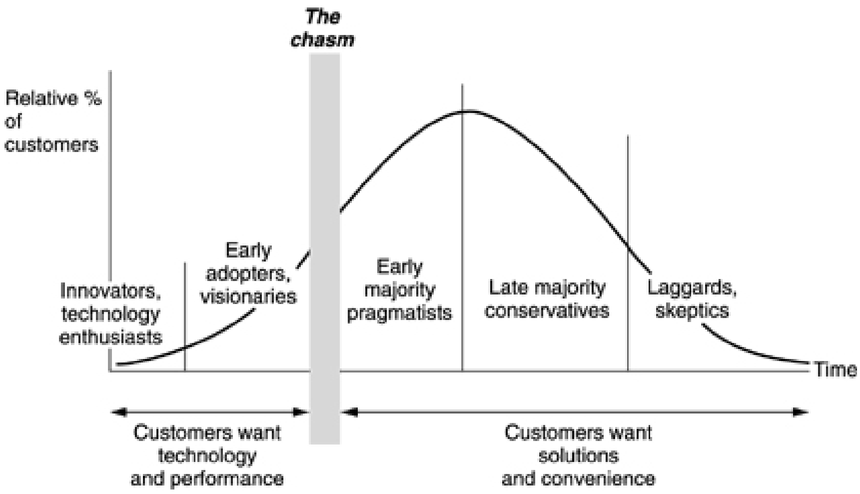


Figure 6 Customer change as technology matures (Christensen 1997).

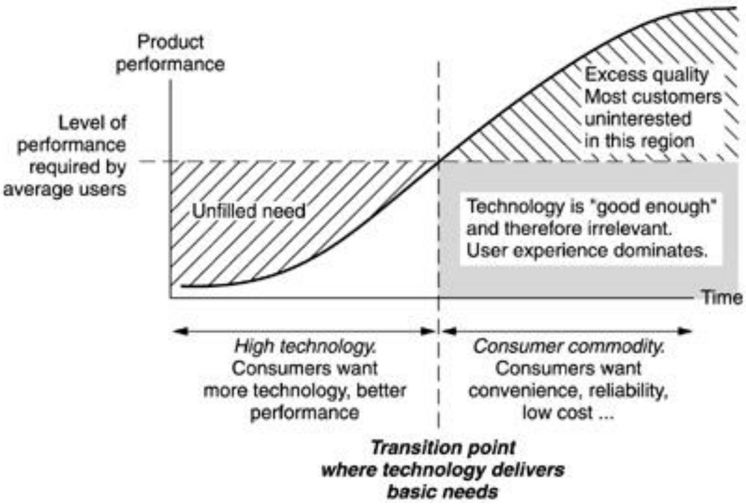


Figure 7 Moving from high technology to consumer commodity (Christensen 1997).

It is only when the technology becomes good enough that it Christensen (1997) focuses instead on why new technologies often cause problems for existing industries. He argues that innovative technologies are often underrated or viewed as inferior by dominant players until it is too late: the new technologies have achieved a momentum towards adoption and the environment for the existing industries is changing around them and out of their control. He looks at the phenomenon of technology take-up from the perspective of the level of performance required by average users. He argues that once a technology product meets customers´ basic needs they regard it as „good enough“ and no longer care about the underlying technology (see figure 7).

Between early adopters and late adopters is crossed (see figure 7). It is the very process of innovation that provides this improvement in technology and drives the shift from high technology product to consumer commodity.

Innovation is included in all PLM in one way or another and the product life cycle can be various for different types of innovation, because of that there is a need to treat the measurement for unlike innovation differently both when it comes to NPD processes, measurements and after the product is launched. The front-end of the product life-cycle will be reviewed in more detail in the following section. Going through the New Product Development process like mentioned here above includes uncertainty and can be the most expensive part of the entire process.

2.3.4 New product development (NPD) process

In the literature product development is defined as the transformation of a market opportunity and a set of assumptions about product technology into a product available for sale (V & Ullrich, 2001).

Numerous descriptive, predictive, and prescriptive NPD studies exist. Descriptive studies typically outline the steps involved in NPD, either as a sequential or concurrent process. Predictive studies have attempted to identify NPD success factors. (Dooley, Subra, & Anderson, 2002).

There are at least four common perspectives in the design and development research community: Marketing, organizations, engineering design, and operations management. These perspectives often differ in the level of abstraction at which they study product development (V & Ullrich, 2001).

The Product Development Management Association Best Practices Study (Barczak, Griffin, and Kahn, 2009) found that firms deemed only about 59% of new products commercialized to be "successful" (in general terms), while 54% of commercialized new products were considered successful specifically in terms of a profit perspective (Slater, Mohr, & Sengupta, 2014).

There are many uncertainties and challenges throughout the NPD process where the use of best practices and the elimination of the barriers to communication are the main concerns.

Project Portfolio Management (PPM) processes are responsible for the alignment of projects with the innovation strategy, maintaining a balance of project types, and ensuring that the project portfolio fits with resource capability so that the organization can gain the maximum from the investment in NPD (Killen, Hunt, & Kleinschmidt, 2007). Definitions of PPM have been evolving as the discipline has become established during the past decade. A widely accepted and often referred to definition of NPD PPM developed by Cooper et al. [29, 3] is that "Portfolio management for new products is a dynamic decision process wherein the list of active new products and R&D projects is constantly revised. In this process, new projects are evaluated, selected, and prioritized. Existing projects may be accelerated, killed, or deprioritized and resources are allocated and reallocated to the active projects" (Killen, Hunt, & Kleinschmidt, 2007).

The pattern of relationships between a segment´s stage of development and innovation can be conceptualized. Rate of innovation are shown on the vertical axis and related to the stage of process and product development on the horizontal axis. This implies an orderly and even progression of product and process development, standardization and increase in sales volume. Process segments that show the highest rates of improvement in productivity do seem to progress rapidly through the state indicated (Utterback & Abernathy, 1975). There is reason to believe that in many cases the progression may stop for long periods, or even reverse.

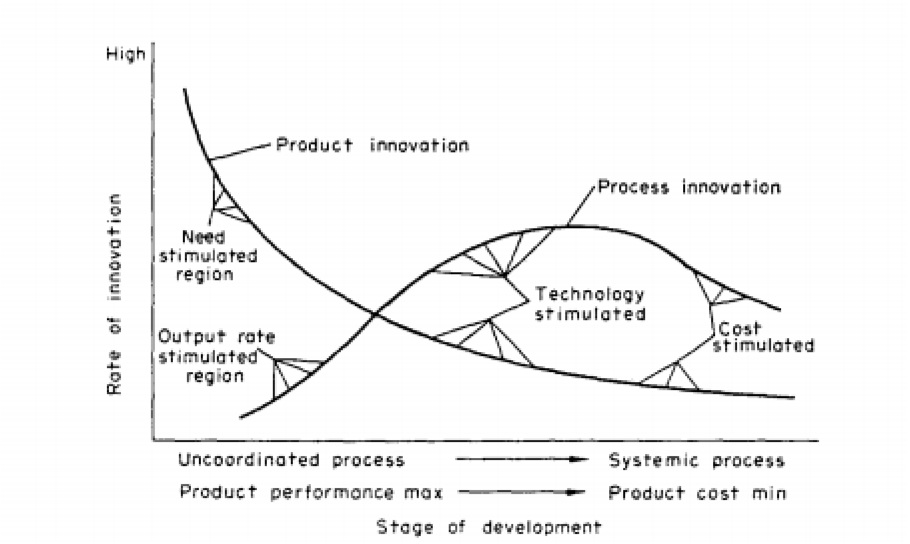


Figure 8 Innovation and stage of development (Utterback & Abernathy 1975).

As figure 8 shows for product innovation the rate of innovation is high in the beginning of the NPD process and decreases with time.

Decision making in the NPD Process

Success of a new product is depending on customer needs and wants, the competitive environment and the nature for the market representing the top required factors cost, time and quality (Kenneth, 2013).

In the study that Krishnan and Ulrich (2001) they focused on decision making in the development the academic literature, reviewing focusing on product development at the fundamental decisions that are made by intention or default. They observed that while products are developed differs not only across firms but within them seems to remain fairly consistent at a certain level of abstraction.

There are many uncertainties and challenges throughout the NPD process where the use of best practices and the elimination of the barriers to communication are the main concerns. In an effort to gain effectiveness in NPD, firms increasingly use formalized and structured processes. Though they vary in their levels of complexity, virtually all NPD processes have two core features – activities and decisions (Griffin & Hauser, 1993).

Innovation encompasses different level of novelty, since innovation by definition, involves the creation and marketing of the new, these gauntlets, singly and in combination, make the outcome of innovation a highly uncertain process. Unfortunately, the effects of innovation are hard to measure. There is no single, simple dimensionality of innovation. There are, rather, many sorts of dimensions covering a variety of activities. NPD project continuation decisions, like other strategic investment decisions, are prone to managerial decisional errors (Cooper, 1996), found that stringent go/stop decisions are strongly associated with successful NPD, though managers rated NPD decisions as weakest aspect of the NPD process.

Decisions that are made in the NPD process to estimate the investment opportunity that answer questions like "*Why should we invest in the innovation project"*. Different organizations will make different choices and may use different methods, but all of them make decisions about a collection of issues such as the product concept, architecture, configuration, procurement and product schedule, etc. Product development decisions are organized into two broad categories (Hultink 1997). Decisions made within a single project are actually innovating, and developing the product and decisions a firm makes when setting up a development project. Than we are talking about decisions related to product strategy and planning, product development organization, and project management.

The task of developing new products, presents an organizational challenge in that it introduces a discontinuity in ongoing operations. Typically the marking function is responsible for many of the product planning decisions and the operations function for the supply-chain decisions. Engineering design is entrusted with the task of making the bulk of concept and detailed design decisions (Killen, Hunt, & Kleinschmidt, 2007).

Product planning decisions and development metrics seem particularly ad hoc in industrial practice. For example, there are few research results that inform the question of how to integrate the efficiency issues associated with the use of product platforms with the market benefits of high product variety. There is an opportunity to bring together market product, and process considerations on the decision: of what products to develop, and when (Lawrence & Kosuke, 2005).

A phase-gate model or a stage gate process is a project management technique in which an initiative or project is divided into stages or phases, separated by gates. At each gate, the continuation of the process time, including the business case, risk analysis, and availability of necessary resources. The stage gate process refers to the use of funnel tools in decision making when dealing with NPD projects. “Gates” or decision points are placed at places in the product development process that are most beneficial to making decisions regarding continuance of product development. These production areas between the gates are idea generation, establishment of feasibility, development of capability, testing and validation and product management to make a decision as to whether or not the product should continue to be developed. The passing of gate to gate can be accomplished either formally, with some sort of documentation, or informally decided upon based on the preferences and culture of the organization (Lawrence & Kosuke, 2005).

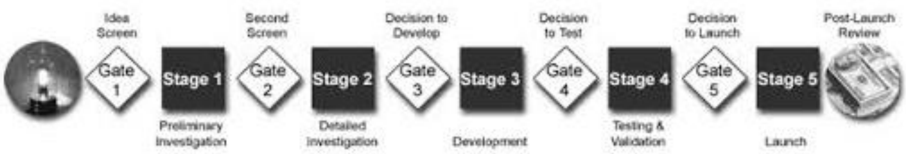


Figure 9 Stage-Gate process

The development of new information technologies appears to be revolutionizing commerce generally and product development to a considerable degree. The benefit of new tools to manage product knowledge and support development decision making within the extended enterprise needs to be explored in greater detail (Libertone and Stylian 1995, Rucker Serring 1996).

Decisions that need to take place in the NPD process on how to spend money and time in R&D has always been an important priority for business, and this trend is increasing. In principle, managing the ROI of innovation is simple: work out how much you spend on innovation and where you spend it, compare this with the added-value that each part of the portfolio delivers to the business, and take appropriate management actions to improve performance. However, in practice, many companies struggle for a variety of reasons which are mainly concerned with the lack of clear, shared view about what "managing the ROI of innovation really means (Kuczmarski, 2000).

2.4 Return on innovation

What does "Innovation Investment" mean? It is a challenge to define what should be included in "innovation investment". Spend on R&D is clearly a significant part of this, but in many companies R&D spending also includes activities such as technical support, troubleshooting, product reformulations, operational excellence, quality testing etc. These activities add value and cost, but also in terms of risk mitigation, improved assurance and loss avoidance than in terms of growth. Should they be part of ROII?

Here above both ROII has been defined, but when you combine it to one measurement it can be fraught with difficulty. The biggest challenge is that of dealing with risk and uncertainty, especially for investment in early-stages research, platform developments with multiple applications, and R&D which might be enabling for example.

Very few companies, calculate actual returns on innovation. Instead, they assess their innovation efforts from high-level, strategic, conceptual perspective. Researchers have shown that financial and NPV techniques and criteria dominate managerial R&D decision making (Haley & Goldberg, 1995).

Sometimes they calculate a NPV for their projects, but NPV cannot be directly connected with either expected growth or the overall revenue companies would like to get out of their innovation portfolio (Parrino & Kidwell, 2009). In addition to being comprehensive measure of innovation performance, the ROI methodology allows companies to compare innovation returns with returns from other types of investments, such as marketing, or returns from small projects versus large projects. It makes comparison across innovation initiatives much easier, and that allows you to manage innovation returns very explicitly because you are measuring them. One of the most useful characteristics of ROI is that it correlates with organic growth and can be effectively used for managing innovation for growth (Brealey & Mayers, 1996).

First of all, it is important to be clear about why you are managing ROI and who the outputs are intended for. An effective management approach for the ROII it will balance both realizing ambitions on what innovation should be delivered. Distinguishing between different innovation types is important because the nature of the value (returns) is different between different types of innovation. And secondly, optimizing value.

One study showed that that there is significant correlation between the level and effectiveness of innovation investment and future earnings growth and shareholder return. He also talks about the importance of measuring what matters and by looking at every project and tracking the effectiveness of R&D expenditures across business and time, it has been proofed that there are major controllable factors that can drive output (Drake, Sakkab, & Jonash, 2006).

There are also several researches on project management´s return on innovation. Young and Willians research describes a procedure that can help managers measure their return on investment for project management (Young & Williams, 2000).

When companies invest in innovation projects analytics, they do so understanding that it will provide competitive advantage. Hence the ROII of undertaking an analysis of the ROII to improve the project. ROII can be categorized into two different actionable buckets: Forward and backwards (Hauser, 2013).

Since it is a complex task to measure ROII it is necessary to evaluate what options are available. There are two different ways of measuring ROII. You can both calculate how much you have made by investing and, you can use ROII to help you decide how to spend your budget.

Backward ROII

If the decision maker wants to understand the drivers of the market during a specific span of time, the answer is a backward analysis. During historically good period of time or product launch the decision makers may want to understand why the investment was successful; likewise for unsuccessful investment why they were week.

Most companies need to defend and grow their core activities by launching improved products in order to cater to known needs of existing customers. Development costs, time to market, product volumes and price points can be reviewed backwards, and normal financial evaluations based on cash flows can be applied, such as NPV (Net Present Value) and IRR (Internal Rate of Return) (Hauser , Common (Mis)understandings of Marketing ROI, 2013).

Forward ROII

When executing new investments, in terms of ROII calculations, they rely more on forecasts beyond historical data and include uncertainty. Forward looking ROII analysis have several benefits. They enable the decision maker to distinguish between short-term and long-term effects, exposing marketing half-life issues. Hence the forward ROII is the metric of choice when trying to understand precisely what one can expect in the future for a given investment in a specific period of time (Hauser, Common (Mis)understanding of Marekting ROI, 2013).

When evaluating the forward ROII it includes uncertainty that, on one hand events in the future do not follow the course of past events, and, on the other, knowing about the future is always incomplete. Every introduction of a new product on the market tend to be characterized by a high degree of uncertainty (Aernathy and Utterback 1987). The uncertainty related to product specification is dependent on the novelty if the technology (Taktikonda & Montoya-Weiss, 2001).

With increased level of uncertainty the importance of valuation increases. Selection of the right valuation approaches for parts of the portfolio with different risk and regard profiles is one of the most important aspects of good practice. To properly evaluate projects that involve high uncertainty and risk, some companies use more dynamic approach like option valuation (ROV) (Parrino & Kidwell, 2009).

As we have seen above, companies increasingly need to grow beyond their existing core, developing opportunities in selling modified or enhanced products and services and/or to adjacent markets and customers. Given their intrinsic uncertainties, simply applying DCF calculations to such business cases will usually yield flawed results. Many companies therefore apply a probability-related discount factor, for which a robust and calibrated assessment of the probability of success during development and after product launch is required. Some companies use standard check-lists for this, others have more sophisticated databases of similar projects in the past to which new opportunities can be compared. In any event, it is essential that business cases are not represented as a single number, but are accompanied by sensitivity analyses on key assumptions, and also show the results of possible alternatives in development or launch (for instance, using probability-weighted decision trees). Decision tree approaches are also useful for investments in platform developments with multiple applications, although care has to be taken that the methodology does not become too labor intensive.

In practice, each ROII form is an important function that when correctly used provides a great deal of effectiveness insight. Forward ROIIs indicate what to expect from an investment, backward ROIIs show which dates contributed a specific success, and average ROIs show the general ebbs and flows of marketing successes. Therefore when planning a future flight, one should focus attention on the forward ROII information. When trying to understand the success of past sales periods, one should focus attention on the backward ROII (Hauser, Common (Mis)understanding of Marekting ROI, 2013).

The logical place to begin measuring innovation is to start at the end, the end of return on innovation investment. Measuring ROII makes the intangible tangible, thus providing managers, employees, and the investment community with valuable information. The first step in managing innovation is to develop common consistent standard for measuring all aspect of the innovation investment among all possible dimensions and business units. ROII looks at the firm´s total profit from new products divided by its total expenditures for new products. Total expenditures should contain all components of all costs, which are related to innovation. (Kuczmarski, 2000).

2.4.1 Cost Management

Cost management is a broad concept. It is the information the manager needs to effectively manage the firm or not-for- profit organization and includes both financial information about costs and revenues as well as relevant nonfinancial information about productivity, quality, and other key success factors for the firm (Blocher E. J., Stout, Cokins , & Chen, 2008). In this research the focus will be on manufacturing firm that produces and sells innovative products, and that will reflect in this section.

For ROII to be useful, income and investment must be determined consistently and fairly. When measuring ROII it is really important that the overall cost is correctly calculated. This section will go through the cost analysis that are needed being able to calculate ROII for a product.

Cost Planning for the Product Life Cycle

The life-cycle costing provides a comprehensive evaluation of the profitability of the different products, including costs throughout the product life cycle.

The cost life cycle is the sequence of activities within the firm that begins with research and development followed by design, manufacturing (or providing the service), marketing/distribution and customer service. It is the life cycle of the product or service from the viewpoint of costs incurred. The sales life cycle is than the sequence of phases in the product´s or service´s life in the market from the introduction of the product or service to the market, the growth in sales, and finally maturity, decline, and withdrawal from the market (Blocher E. J., Stout, Cokins , & Chen, 2008).

Research and Development & Design Cost

The research and development can be different between organizations but here are mentioned common cost factors for the R&D department. (1) Basic engineering in which engineering is done separately from marketing and production, (2) prototyping in which a working model of the product is developed for testing, (3) templating in which a new product is developed from the design of a similar existing product, and (4) concurrent engineering, that integrates marketing, manufacturing, and design to continually improve product design. These are costs incurred to develop new product or processes that may or may not result in commercially viable items.

Manufacturing Cost

Product inventory for both manufacturing and merchandising firms is treated as an asset on their balance sheets. As long as the inventory has market value, it is considered an asset until the inventory is sold; then the cost of the inventory is transferred to the income statement as cost of goods sold (COGS). This sequence is the value chain of product costs for a manufacturing firm, from the upstream activities of design and marketing research, to manufacture of the product, and finally to the downstream activities of sales and service (Blocher E. J., Stout, Cokins, & Chen, 2008).

Product costs for manufacturing firm includes only the costs necessary to complete the product at the manufacturing step in the value chain:

1. Direct materials. The materials used to manufacture the product, which become a physical part of it.
2. Direct labor. The labor used to manufacture the product.
3. Factory overhead. The indirect costs for materials, labor, and facilities used to support the manufacturing process.

Manufacturing firms often use three inventory accounts: (1) Materials Inventory, where the cost of the supply of materials used in the manufacturing process is kept; (2) Work-in-Process Inventory, which contains all costs put into the manufacture of products that are started but not complete at the financial statement date; and (3) Finished Goods Inventory, which holds the cost of goods that are ready for sale (Blocher E. J., Stout, Cokins , & Chen, 2008).

Sales & Marketing Cost

The cost of marketing is the cost of making and producing all the (1) marketing material, to explain the product and advertise it, (2) advertising expenses, and (3) translation cost.

The cost of sales and customer service is the cost of selling the product and supporting the customers (1) that have already bought the product, (2) want to buy the product, and ask for the product.

All other costs for managing the firm and selling the product are expensed in the period in which they are incurred; for that reason, they are called period costs. Period costs primarily include the general, selling, and administrative costs that are necessary for the management of the company but are not involved directly or indirectly in the manufacturing process. Advertising costs, data processing costs, and executive and staff salaries are good examples of period costs.

Innovation cost

The innovation cost is often not detailed and thoroughly analyzed as R&D costs because of the absence of a strict official definition of the innovation process itself. Innovation expenditures include following categories of costs (Blocher E. J., Stout, Cokins , & Chen, 2008).

Costs of drafting designing prototypes, other test models, and samples at the factory stage (industrial prototypes and batches) and developing processes for their manufacture or improving process for manufacture of old products (Louvan , 1985).

Cost of adjusting and correcting new products and processes before and during serial production.

Costs of redesigning production shops and modifying equipment to accommodate new technology. Costs of testing new technology and making trial runs in order to establish new operational expenditure norms conforming to the potentialities of the new technology. Cost of producing the first experimental batch of new products or old products with new processes. Initial expenditures of manufacturing original new equipment and products exceeding the expenditure normally established for old or analogous products during the first year or in some cases first 2 years of regular production. All normal outlays entailed in carrying out the above named processes: Salaries, materials, equipment, amortization (Blocher E. J., Stout, Cokins , & Chen, 2008).

Sunk cost

Sunk cost are costs that have been incurred or committed in the past and are therefore irrelevant for decision making because the decision maker no longer has discretion over them.

An important issue related to sunk cost must be considered. There is apparently an inherent bias for decision makers to include sunk cost as relevant to the analysis. Research has shown that decision makers are more willing to invest money to “recover” sunk cost than to invest the money to earn the same return (Blocher E. J., Stout, Cokins , & Chen, 2008).

3 Methodology

A case-based methodology was executed to examine how ROII for product innovation can be measured and to show how different financial techniques can help out with decision making in the NPD process.

The company analyzed is a highly innovative medical device company. That has been launching products of different level of innovation novelty and complexity for years. Behind each product are multiple projects from various departments in the company.

To answer the first research question on how ROII can be measured, four products of different level of both complexity and innovation novelty were selected to be examined. The projects behind each product were reviewed and financial techniques used to show how ROII can be measured. To answer the second research question on how financial techniques can help out with decision making in the NPD process the companies' processes were examined and it was showed how decisions can be improved for product innovation projects using financial techniques.

3.1 Case Study

The company analyzed is a global medical device company and has nurtured an innovative mindset and innovation is always at the forefront.

3.1.1 Data collection

The data collection for the case study was based on interviews and data from the company on the total product innovation projects for four selected products. The data that was collected from four departments within the company or R&D, M&O, Sales and marketing department. Information on the current status for the company for products, process, cost, revenues and other important data being able to measure return on product innovation and to improve how decision management in the NPD process.

3.1.1.1 Company current status

Investments are monitored in the company at some degree, but they have not been measuring ROII even though innovation is one of three of their strategic pillars. The company addresses many good innovative ideas and it is really important to choose the right projects to work with being able to maximize the ROI.

Four products were selected to be examined and they were selected because they are a cross section of the products that the company launches. The company is frequently involved in incremental product innovation meaning that it entails improvements, extensions or adaptions to a currently available product. Typically the company has a good understanding of the product itself, of the technology required to produce it, and of the specific customers for which it is designed. The opposite of incremental product are the radical innovation, which involves venture that takes both developer and customer much farther afield in terms of knowledge and experience. These radical innovation typically involve technologies that are more advanced or are very different from industry norms.

3.1.1.2 Products selected to be examined

The products selected are of different type of innovations that are being developed by the company. Product innovativeness or newness refers to the degree of familiarity organization or users have with a product and there is both theoretical and empirical evidence to suggest that it is important to distinguish among different degree of innovativeness when undertaking new product development. This is because product newness is potentially linked to levels of uncertainty and risk, to new product development difficulty and performance, and to the effort and resources required when undertaking NPD ventures (Brentani, 2001). The intention with the product selection here was to help improving the understanding of how to achieve increased return on product innovation. Behind each product there are multiple projects. All projects available for each product was reviewed and information from each project was collected.

There are indications about different level of innovation needing different management because of increased complexity and uncertainty. More innovative innovations are often longer term projects that should be tracked or measured in a different manner than more incremental innovations. In this case study the products where selected to fit into the innovation matrix. They were chosen because of different innovation level. Figure 10 shows where the product belong in the innovation matrix (Tidd, 2001).

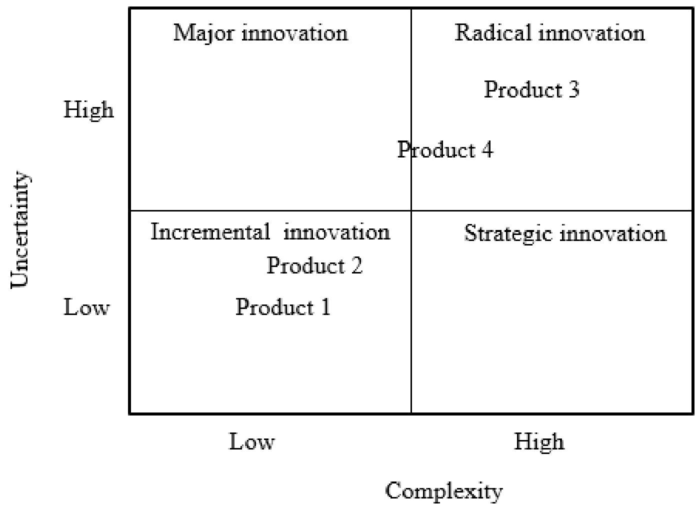


Figure 10 Type of product innovation

When the innovation level rises and the effect of innovation on both established firms, customer habits and behavior the uncertainty for the project increases. We can assume from the risk that arises as the innovation level grows that the need for further financial analysis to evaluate the project increase. With increased level of innovation novelty usually the cost of investment increases and therefor it is also important to define the innovation cost and take all innovation cost into account. What is described here above is also known in the company even though they are aware of different treatment is needed for product innovation of different level they are still comparing and measuring these projects together in the same way.

Here below the selected products will be described:

Product 1

This product was launched 2005 and it has been a successful product through the years. This product was a typical incremental product innovation and was neither new to the company or the market. This product needed a separate manufacturing setup, but the same manufacturing methods where in place. This product has been improved several time from the initial launch.

Product 2

This product was launched in the year 2012 the company started this project because of increased competition in the market. This project was started because product 1 had been declining sales along with other similar products. It was estimated that product 2 would slightly cannibalize the sales for product 1, but what happened when product 2 was launched product 1 also increased sales so it had positive affect on both products. A incremental product innovation project that benefited from earlier projects both for manufacturing methods, setup and marketing material. The sales team was also getting more experienced in selling the products and this product was a great fit into the current sales process.

Product 3

In October 2004 the company introduced product 3 which has been the largest and most complex development project that has ever been undertaken by the company. Based on a totally new design and the product was leading in its market. This product is a radical innovation were the design was based on several technical platforms like mechanical engineering, electronics and software for example meanwhile product 1 and 2 are only built on mechanical engineering.

Today they have the third version of product 3 on the market and the fourth upcoming. Even though they are bringing new versions to the market the projects are always filled with complexity and uncertainty.

Both sales and marketing for a radical product like this one is much bigger process than for the incremental products. The effort to sell one unit is a lot more work and the need for both internal and external marketing material is high. Being able to buy this product training is needed and a lot of effort needed to close just one sale. This product has now 3 versions, but only two versions included in this project.

Product 4

Product 4 was like the product 3 first of its kind in the world.

The company bought the design from another company in the year 2005 and they launched a second version in 2011. The product is high maintenance and has not been meeting expectations from the beginning. Both manufacturing, sales and marketing for product 4 is a lot like product 3 and are great effort needed to sell only one unit. The difference between those two radical designs are that the market for product 4 might still not be ready for the product and further enhancement might be needed for the product to take off. This product has two versions and an upcoming NPD project to make a new version.

When a product is launched it can need variant support from R&D. Service rate for the products can be variable and it can be divergent how much sales and marketing efforts are planned for each product. These factors are often not taken into the calculation and therefore can give inaccurate information between prosperity for different products and product lines. Meaning that one product can be showing more return than the other even if that is certainly not correct.

In the company investigated this is not bargain for, R&D projects are measured and some other projects are as well, but for example no manufacturing, sales or marketing cost is measured down to products. Each department has their measurements and KPI´s that they track, but for the overall product process this is not measured.

The importance of brining all investment measurements for a product into the process will be investigated in this case study by gathering cost data from all departments. This can be really important to get an overview of the entire investment for each product and can be helpful for management to get a better overview of the innovation process and what the actual return for each product.

3.1.1.3 The company investment decisions

Data was collected from four different departments within the company:

Sales department

Sales employees were asked to answer the questions on how long time it took them to sell one unit of each of those four products. This was done to estimate the average time behind selling one unit.

There is a big difference in selling an incremental product versus a radical product. The incremental products are almost juts one phone call away and then delivered by the sales people, but the radical products is a much heavier process that typically involves more than one person from the company to sell the products. Training is needed for the customer being able to buy the product and a special training is needed so that a sales person can sell the product. Therefor it is usually a specialist that sells the product and he or she sometime need to travel long way to sell only one unit.

Marketing department

The marketing department is driven by a budget planning. They are not measuring any projects and it is not visible what and how much they spend in product innovation.

To begin with the marketing cost is expensive for all products, even though they are incremental, because there is always a start-up cost for all products that are entering the market. The information collected from the marketing department was current and old material available for the products and the cost was estimated from real cost numbers for similar marketing material.

Manufacturing department

The manufacturing department falls under the same process as R&D when it comes to storing the data for projects. All information collected for manufacturing projects was available in the project database. There were a lot of projects missing and it was various between employees how efficiently they had filed their projects. Sometimes part of the manufacturing cost was included in the R&D cost, but often it was hidden so it was difficult to measure what had been done in the past.

Research and Development department

All new product development projects go through the NPD process.

All NPD projects are evaluated from the R&D cost, but when including innovation cost for the products from other departments it changes the overall image more than expected. For a project that looks successful when only including the R&D cost might when all comes to an end not be yielding positive return.

NPD PROCESS

The company NPD process is pursuant to the stage-gate process. The NPD process in the company has been growing and getting better as the company grows. That is obvious when reviewing data backwards that with time the company is getting much better in managing the NPD process and the material stored is more consistent and with increased quality.

This process helps managers to decide what projects should be invested in. The process is controlled by checklists for documents and tasks that are divided down to five main gates or decision knots (see figure 11). When all tasks and documents are finished for the first gate the gate is completed with a gate meeting where the product concept is approved or declined. If it is approved the project keeps on to the next gate and so on. Figure 14 explains the NPD process in more detail, but after gate 4 the product has been launched out to the markets.

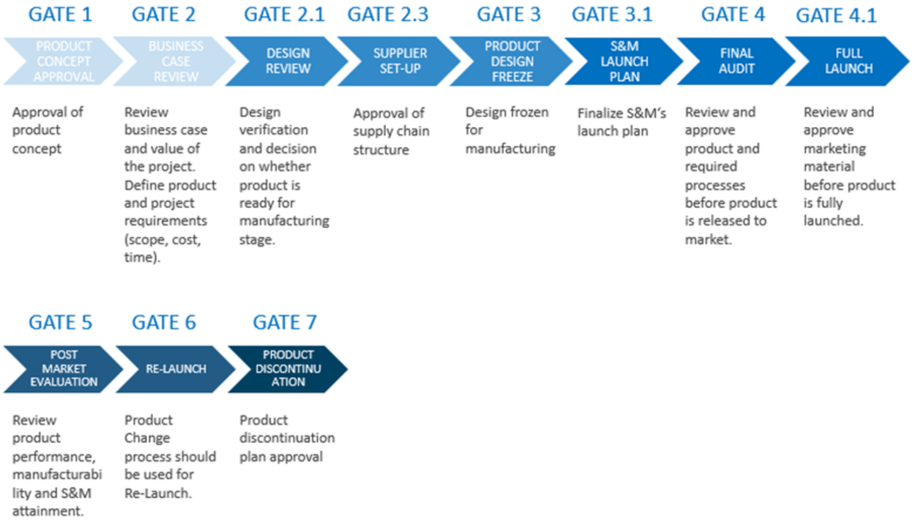


Figure 11 NPD decision process

In the NPD process, data is collected for the project, forecasts are made for the product to estimate the success on the market. The data for the four products was collected from the project portals, both from the current one and the older version Project Database V1. The data that was taken from the Project Portals was information about the project behind a product, project cost data, and other useful information about the projects performed and the reasoning behind why the company decided to invest in them.

When collecting the data from the NPD process, data for some projects that were filed are missing. For those projects were the data was missing, the cost of the investment was evaluated using project cost for similar projects, including both project length and number of resources. This can cause inaccuracy in cost estimation.

Four products of different level of innovation novelty and complexity where reviewed backwards. The aim with this selection was to see the difference between radical and incremental product innovation. There is possible difference between these types of innovations that is created because radical projects are often more lengthy projects, usually involve more risk, heavier processes, usually are more expensive and often more effort is needed to bring the product to the end user. This is all done to see if there is a measureable difference between the results for radical versus incremental innovation when measuring ROII.

Different financial techniques will be applied on the data to show how ROII can be measured. This will be done by both looking backwards to answer the question on how ROII can be measured. Than secondly, it will be calculated to show how financial techniques can help decision makers to evaluate the future and how they can help out with decision making in the NPD process.

The first step in setting up any ROII analysis for a product innovation investment is to understand the base business case. That is to define clearly what is included in "Innovation Investment". What is the level of innovation novelty for the products, the overall cost factors and revenues for the products examined. In the following analysis the cost will be specially investigated and the calculations will be done by using different innovation cost from each department to show the effect of including it or excluding it when measuring ROII.

3.1.1.4 Numerical Data

The company has been using OLAP cubes to collect data over the years. These data cover different things that are measured within the company and can be difference between projects how good or bad information were available depending on what they are measuring. The following data were collected from the OLAP cube:

Revenue, Net Unit Sold, COGS and information about project resources.

Here I came across the same issue when collecting data, especially for older projects information was missing for project cost and resources and evaluation was needed.

REVENUE & NET SOLD UNITS

All information on sales where collected from the OLAP cubes being able to see the sales trends and to calculate the overall ROI for each product.

COST OF GOODS SOLD (COGS)

COGS often appears on the income statement and can be deducted from revenue to calculate a company´s gross profit margin. The exact costs included in the COGS calculation will differ from one type of business to another. There are several ways to calculate COGS. Here below it will be described how the company calculates COGS today:

The company defines cost of good in following way:

COGS-I = Inventory value where the item is originally produced

COGS-II = Inventory value at sales center

COGS-I +Warehouse Cost at sales unit

+ Navision Bill of Material (BOM)

+ Routings/Resource cost allocation

+ Transport cost between sales units

+ Warehouse Cost at new location

COGS III = COG-II + Transport Cost to customer

+ Royalties

+ Corporate overhead in Manufacturing

The direct costs attributable to the production of the goods sold by company. In this research COGS III will be utilized as COGS.

COST MANAGEMENT

The cost management structure in the company is calculated down to departments. The departments than decide how they manage their budgets and costs. It is different between departments how they focus their measurements and KPI´s efforts.

Since innovation is cross functional for all departments this is not measured overall. R&D measures the project cost for the product launch and then measures the product success on the market for the first 12 months after the product is launched. R&D has other projects that they monitor beside NPD projects like engineering change projects, CA (corrective action) projects, and technical projects which they often use to explore new technology before the project enters the NPD process and research projects. M&O measures the overall CAPEX cost and they have many other measurements related to their daily operations. When it comes to innovation they have couple of projects that like CAPA (corrective and preventive action) projects, NC (none conformity) projects and sourcing projects. This has been better managed for the last two to three years than in the past. This project cost both for R&D and M&O is not linked to the product after it is launched so there is no way of having an overview of what has been done for a specific product in the past.

Then there is a wide open gap with unanswered questions about both sales- and marketing cost for products which can be really variant between products. The marketing department is budget driven and they are not monitoring the overall cost for a product. They are a cost center that created all marketing material for products that are launched that includes instructions for use manuals, photo shoots, videos, brochures, catalogs, websites and all the material needed to support a product out in the market. The material that is created needs to be translated into all languages for the appropriate markets that sell the product.

The cost behind products can be significant for a radical product where addition to the R&D project might need a new manufacturing station, filled with new machines. Extra marketing material to support more complicated products with additional sales cost because of increased complexity in the sales process for the product. This is not always the case because for other product that are more incremental innovation almost everything to manufacture the product could already be in place so no extra CAPEX cost is needed. When launching a product there is always part of the cost for marketing that is unavoidable, but it is variant how much material is created and often less material is needed for an incremental product and if it is similar to another product it is often possible to reuse some of the material again. It is important to highlight this difference in cost for radical and incremental product innovation because this could give reverse image on the overall business.

All data available for cost was collected and missing data was estimated case by case compared with real examples.

3.1.1.5 Innovation cost

In principle, managing the ROII of product innovation is simple if you work out how much you spend on innovation and where you spend it, compare this with the added-value from selling the product. However this is not as easy as it sounds and many companies struggle for a variety of reasons which are mainly concerned with the lack of clear, shared view about what "managing the ROII of product innovation" really means. A key early challenge is to define clearly what is included in "Innovation Investment". Spend on R&D is clearly a significant part of this, but often other departments greatly support product innovation when thinking about bringing the product to the end user. For example marketing, branding, manufacturing etc. If companies only stick to R&D spend, then they are missing the full picture.

In the company the cost of innovation is not measured or defined for all departments. They have a fairly accurate cost estimate for most of their projects today and are getting better with time. In this research, the cost of innovation were defined as table 1 describes, demonstratively describes the cost of innovation that is embraced in the literature.

Innovation Cost	
Research and Development Cost	
	New Product Development Project
	CA Project
	Technical Project
	Design Project
	Research Project
	Other R&D Labor cost; Supporting the Product-Life Cycle Cost
	Engineering Change Project
Manufacturing and Operation Cost	
	Production Project
	CAPA Project
	NC Project
	Sourcing Project
	Other M&O labor cost; supporting the Product-Life Cycle Cost
Marketing Cost	
	Internal training material
	External training material
	Material supporting the product; e.g. Instructions for use & QRC.
	Product photoshoot
	Lifestyle photos
	Videos
	Product website
	Product catalog page, sell sheet & brouchers
	Technical presenation & other product presentations
	Translation cost
	Other: Material cost supporting the Product-Life Cycle Cost
Sales and Customer Service Cost	
	Working hours behind product sales
	Bonus payments for sales representative
	Clinical sales support
* Data collected from the companies OLAP cubes & Project Database	

Table 1 Innovation Cost

3.2 Assumptions

Behind each product are multiple projects. The number of projects often depend on the product type and the complexity behind the product. In the company there are many different kind of projects that are linked to a product. These projects can be in every department of the company. After a product is launched today the projects behind the product often get lost because projects are not linked together for each product. The only change today to calculate the overall project cost for a product is by knowing the history. Because almost every time projects have different names than the product that they are related to.

It is obvious that with time the company is always improving and getting better collecting data, but it is variant between projects what data was collected and how it was filed.

Because of this complexity and missing information it was necessary to put forward assumptions being able to calculate the overall ROI:

ASSUMPTION 1: PROJECT COST

For those projects that were missing cost information it was assumed that the missing cost was either:

I. Similar to other identical or alike projects.
II. Based on how many man hours where estimated in the project.

ASSUMPTION 2: SALES COST

Sales cost was predicted in the following way:

I. Estimation from sales people on how much time is spent selling one unit of each selected product.
II. Bonus for selling a product is usually 0.78% of the revenue for product 3 and 4.
III. Salary per man hour was estimated to increase 30% in the year 2010.
IV. It was estimated that it would take sales person on average ½ hour to sell an incremental product.
V. After a radical product was first launched to the market it was estimated that it would take extra man hours to sell the product for the first years after a product was launched. This was estimated with following assumptions for product 3 and 4:
   - In the year 2005-2009 it was estimated that it would take 32 hours to sell one product.
   - In the year 2010-2011 it was estimated that it would take 24 hours to sell one product.
   - In the year 2012-2015 it was estimated that it would take 10 hours to sell one product.

ASSUMPTION 3: MARKETING COST

Marketing cost was predicted in the following way:

The marketing cost was split up into two groups (Academy program cost and marketing material cost). The Academy is a team that trains the people selling the product along with the people that buy the product. They take part in creating the training material which is needed being able to sell a product. Marketing cost includes the cost of the creation of all clinical training material both internally and externally.

The Marketing material cost includes everything that comes or goes along with the product like instructions for use, product photos, videos, and websites for the first time and adjustments and updates that are needed first after a product is launched.

Information for marketing cost was estimated according to the material that had been created in the past with the estimation of what it would actually cost today to make the material.

Note that it might have an effect on the results that the cost could have been less in the past, but it is also a possibility that some unknown cost was not included in these analysis.

3.3 Financial techniques calculations

In this section the data collected and the assumptions given here above are used to show how ROII can be calculated. This section will be divided into two parts; first calculations for backward ROII will be executed than secondly financial techniques will be used to calculate forward ROII to show how they can help out with decision making in the NPD process for product innovation.

3.3.1 How ROII can be measured for product innovation

When measuring ROII backwards for the products, different financial techniques where utilized and a model created to evaluate the investments. The financial analysis will start by evaluating the history with backward analysis to both understand the history for the product and to measure how successful they have been for the company. The backward-looking ROII analysis is based on fixing the numerator in time. What is meant with calculating ROII backward is that you are in the past and using actual numbers from the history to calculate until today. For this analysis, sales generated in a specific period of time are influenced by investments from a number of prior periods, and the ROII is not fully defined unless the entire impact from all relevant prior periods is included. In both cases sales during a specific period of time are partially due to activities from that period and from those in prior periods.

Cost management introduced here above was inbuilt into the model to show how different cost can affect the result of evaluation if some cost is excluded from the analysis.

Three financial methods were used to execute the first part of the analysis ROI, NPV and IRR. First of all ROI was selected because it is one of the most used financial techniques today to both evaluate firms and projects. The NPV analysis was selected because the company examined is currently using NPV to evaluate all NPD projects. IRR was selected to evaluate the desirability of the product innovation investment projects.

For both IRR and NPV the discount rate of the dollar value at present and in the future. The discount rate can be different between companies, in the next section it will be calculated for this project.

3.1.1.1 Discount rate

Base discount rate for valuation was assumed to equal to the Weighted Average Cost of Capital (WACC). The WACC amounted 12%.

Discount rate determination

The WACC was determined and calculation of the discount rate are presented below:

WACC was calculated employing estimates of required equity rates of return and after-tax costs of debt base

Following formula was applied:

$$After-tax\ WACC = \frac{D}{V} * (1-\tau) * r_d + \frac{E}{V} * r_e \qquad (6)$$

D = Debt worth

E = Equity worth

$r_d = return\ of\ debt, r_e = return\ of\ equity$

τ = interest rate on the firm´s debt.

To calculate the WACC following formula was applied:

$$WACC = k_D \frac{D}{D+E} + k_E \frac{E}{D+E} \qquad (7)$$

Comparable firms have similar business risk βA and, consequently, similar unlevered cost of capital kA. Comparable firms can have different Financial risk (βE—βA) if they have different capital structures. Different βE and thus different required return on equity kE. .

The current cost of debt capital kd and cost of equity capital kE was estimated.

The companies' asset beta Re-lever was calculated:

$$\beta_A = \beta_E \frac{E}{E+D} \qquad (8)$$

The unlevered industry beta, risk-free rate and equity risk premium was based on the SEB WACC.

CAPM	
Risk free rate (%)	4,0%
Equity risk premium (%)	4,1%
Beta Re-lever	
Unlevered industry beta	1,98
Debt % assumption	5,0%
Equity % assumption	95,0%
Levered Company Beta	2,06
Equity	
Cost of equity	12,5%
% of enterprise value	95,0%
Debt	
Pre-tax cost of debt (%)	4,1%
After-tax cost of debt (%)	3,3%
% of enterprise value	5,0%
WACC (%)	**12,0%**

It was assumed that the projects would maintain a relatively stable D/V over time, so the WACC is also stable over time.

Sensitivity analysis were performed for the WACC calculation to show the effect on increase of decrease for the debt as percentage of enterprise value from -1% to 11% and the after-tax cost of debt from 2.3% to 4.3%. The impact of these variable for WACC can be 1%.

WACC		After-Tax Cost of Debt				
		2,3%	2,8%	3,3%	3,8%	4,3%
Debt as % of Enterprise Value	-1,0%	12,5%	12,5%	12,5%	12,5%	12,5%
	2,0%	12,2%	**12,2%**	**12,2%**	**12,2%**	12,3%
	5,0%	12,0%	**11,9%**	**11,9%**	**12,0%**	12,0%
	8,0%	11,7%	**11,6%**	**11,6%**	**11,7%**	11,7%
	11,0%	11,4%	11,3%	11,3%	11,4%	11,5%

When idea has been generated and managers are phasing an investment decision if a project should be undertaken. When using financial techniques to help out with decision making in the NPD process one part that is affecting the evaluation is the discount rate calculated for the projects. To see how the discount rate affects the calculation performed to measure return on product innovation a sensitivity analysis were performed for IRR and NPV calculations using various discount rates; 12%, 15%, 18% and 21%. The discount rate does not have an effect on how product innovation can be measured when looking at the overall difference between incremental and radical innovation and the cost management introduced to measure return on innovation. It affects the change in return greatly and could change what projects would be undertaken if the discount rate is higher it is more likely that a radical project would not be undertaken because the revenue income usually enters later than for incremental products and therefore it would be more likely that an incremental product innovation project would be undertaken instead.

3.3.1.2 ROI

ROI was calculated according to equation 1. The net revenue was calculated by subtracting the cost of goods from the gross revenue. The projects inputs were the present value calculated for the revenue without any discount rate. The project input was then divided by the cost of the investment. These calculations were performed for all four products defined in chapter 2.1 for a ten year historical period.

The ROI was calculated for four different cost measurements. The base case was calculated using total innovation cost that is defined in section 3.1.1.4. Than ROI was calculated (1) only including R&D, M&O and marketing related cost, (2) only including R&D and M&O related cost and last (3) only including R&D cost.

3.3.1.3 NPV calculations

A typical NPV analysis was performed according to equation 3 and 4. The cost of the investment was subtracted from the cash benefits in the corresponding time period. These calculations were performed for the ten year time period. A traditional NPV model is used to measure the present value of the cash flow. The present value used here were the actual revenue minus the cost of goods.

12% discount rate was calculated for the time interval for all the products and the calculations for the discount rate are found in section 3.3.1.1

The NPV was calculated for four different cost measurements. The base case was calculated using total innovation cost defined in section 3.1.1.4. Than ROI was calculated (1) only including R&D, M&O and marketing related cost, (2) only including R&D and M&O related cost and last (3) only including R&D cost.

3.3.1.4 IRR calculations

The internal rate of return (IRR) for the products was calculated according to equation 5.

Same as for the NPV calculations in section 3.3.1.4. A 12% discount rate was calculated for the time interval for all the products.

The IRR was calculated for four different cost measurements. The base case was calculated using total innovation cost defined in section 3.1.1.4. Than ROI was calculated (1) only including R&D, M&O and marketing related cost, (2) only including R&D and M&O related cost and last (3) only including R&D cost.

3.3.1.5 Sensitivity analysis

Sensitivity analysis is a variation on scenario analysis that is useful in pinpointing the areas where forecasting risk is especially severe. The basic idea with a sensitivity analysis is to freeze all of the variables except one, and then see how sensitive the estimation is.

Sensitivity analysis is often used in investment decision making related with the investment project evaluation under conditions of uncertainty.

In the investment project evaluation we have at our disposal a set of criteria as the basis for evaluation (set of output values), and the set of values (income, costs, discount rate, value of investments, etc.) on the basis of which we can calculate certain individual criteria (input values).

Some of the quantities in a decision analysis, particularly the probabilities, are often intelligent guesses at best. It is important, especially in real-world business problems, to accompany any decision analysis with a sensitivity analysis. Usually, the most important information from a sensitivity analysis is whether the optimal as one or more inputs change (Parrino & Kidwell, 2009).

Sensitivity analysis were performed for the backward ROII calculations. Since there are probabilities that the cost estimate for some of the projects either was missed, under estimated or over estimated it was reasonable to do sensitivity analysis by increase and decrease the cost for different departments to note the sensitivity for the ROI calculations. The sensitivity analysis were performed for change in cost for each product on the interval from -20%-30%. The entire set of possible sensitivities for ROI of each product are presented in the table below. They represent that if the cost is underestimated or overly estimated has overall some impact on the results and it has the most effect on product 1.

Table 2 ROI sensitivity analysis for Product 1

Sensitivity analysis ROI						
Cost effect on ROI	**Base Case**	**-20%**	**-10%**	**10%**	**20%**	**30%**
Innovation cost	10%	13%	11%	9%	8%	7%
R&D + M&O + Marketing	13%	17%	14%	12%	11%	9%
R&D + M&O	57%	72%	63%	53%	47%	42%
R&D	61%	76%	66%	55%	50%	44%

Table 3 ROI sensitivity analysis for Product 2

Sensitivity analysis ROI						
Cost effect on ROI	**Base Case**	**-20%**	**-10%**	**10%**	**20%**	**30%**
Innovation cost	10%	8%	9%	11%	13%	15%
R&D + M&O + Marketing	10%	8%	9%	11%	13%	15%
R&D + M&O	10%	9%	9%	12%	13%	15%
R&D	11%	9%	10%	12%	14%	16%

Table 4 ROI sensitivity analysis for Product 3

Sensitivity analysis ROI						
Cost effect on ROI	**Base Case**	**-20%**	**-10%**	**10%**	**20%**	**30%**
Innovation cost	10%	15%	18%	15%	11%	6%
R&D + M&O + Marketing	16%	22%	26%	23%	17%	11%
R&D + M&O	23%	32%	37%	32%	25%	17%
R&D	24%	33%	38%	33%	26%	18%

Table 5 ROI sensitivity analysis for Product 1

Sensitivity analysis ROI						
Cost effect on ROI	**Base Case**	**-20%**	**-10%**	**10%**	**20%**	**30%**
Innovation cost	-10%	-1%	-2%	-1%	0%	1%
R&D + M&O + Marketing	-8%	-4%	-5%	-4%	-3%	-1%
R&D + M&O	-3%	-10%	-12%	-11%	-8%	-5%
R&D	-1%	-12%	-14%	-12%	-9%	-6%

This section on introductory finance was not depreciation in the analysis. The reader should note that depreciation is an important factors that could have an effect on the results.

3.3.2 How financial techniques can help with future decisions in the NPD process

As the backward looking ROII is reviewing the history this section will be on how financial techniques can help analyzing the future and help out with decision making in the NPD process.

In section 3.1.1 it was analyzed how the decisions in the company are made today on what projects to invest in. Since the projects that are selected are of different level of complexity, risk and uncertainty it is important to know what can affect the decision that are made.

3.3.2.1 Projects of differing risk

Projects can be of a different risk from that of a firm´s “average risk” project. Incremental and radical projects usually have different risk involved in the projects. Should they be evaluated in the same manner?

What is possibly affecting current decisions in the NPD process today is the discount rate that is used to evaluate projects. Should all projects be evaluated based on the same discount rate?

To obtain a discount rate for a particular project, one needs to address two separate but related questions. First given the operating risk involved, what required rate will suppliers of capital place on the project? Second, how the project should be financed?

The weighted average cost of capital is suggested frequently as a discount rate for average-risk projects (Harris & Pringle , 1985). Methods for adjusting the discount rate when projects are not of average operating risk, and are financed in ways different from the firm´s typical capital structure, are both difficult to apply and to explain. One practical possibility would be to use the firm´s target debt ratio for all projects that have the same or less risk than the firm´s average-risk project. For projects of risk greater than the firm´s average-risk project might be one half the firm´s debt ratio (Harris & Pringle , 1985).
To see how the discount rate affects the evaluation in section 3.3.1.1.

When idea is generated and managers are standing in front of the decision of investing in a project or not. If the difference between radical and incremental innovation projects is reviewed it is more likely that the radical innovation project would need more analysis than the incremental projects because of increased uncertainty. There are several ways to evaluate projects. In the prior section 3.3.1 three financial methods were used to evaluate projects.

The analysis that will be executed in this section are when phasing an investment decision at the begging of a project and when, one is comparing investment options how financial methods can help out with the investment decisions in the NPD process. This will be done by using more dynamic approach to calculate the NPV for the four products and then it will be compared to regular NPV calculations and the Gate 4 forecast.

Here the focus will be on the second launch for the products and the reason for choosing the second launch is because more data is available for each project and therefore no estimations needed. Even though actual numbers are used they are used to show how this can be evaluated.

3.3.2.2 NPV

The NPV was collected from gate 4 was collected on the forecasted NPV. The NPV in Gate 4 is a five year forecast calculated for a 21% discount rate.
The actual NPV was then calculated for all products by using the real numbers from the beginning of the second launch. This was done by using equations 3 and 4.

All calculations were performed for the cost management that applied here above with the innovation cost as the base case. Than excluding cost from one department at a time ending with only the R&D cost.

The calculations were performed for a four year time period.

Managers recognize that the NPV analysis is incomplete and shortsighted. The NPV fails because it assumes the decision to invest in a project is all or nothing. Hence, it ignores the presence of many incremental points in a project where the option exists to go forward or abort (Trigeorgis, 1996). Taking a realistic view of the capital budgeting process portrays projects as a sequence of options (Luehrman, 1997).

Real option valuation maps out the possibilities available to a company, including those not readily apparent in the decision tree. By varying the discount rate through the tree, it accounts for the relative level of risk for different cash flows. Real option valuation can also identify the optimal course of the company at each stage in the process.

3.3.2.3 Real option analysis

The flexibility that the real option value offers can be helpful method to both see the big picture and to eliminate uncertainty of the future projects.

With each project variant uncertainty is associated. The traditional NPV method used in the static base case is limited in its capabilities to deal with the flexibility that is involved in the

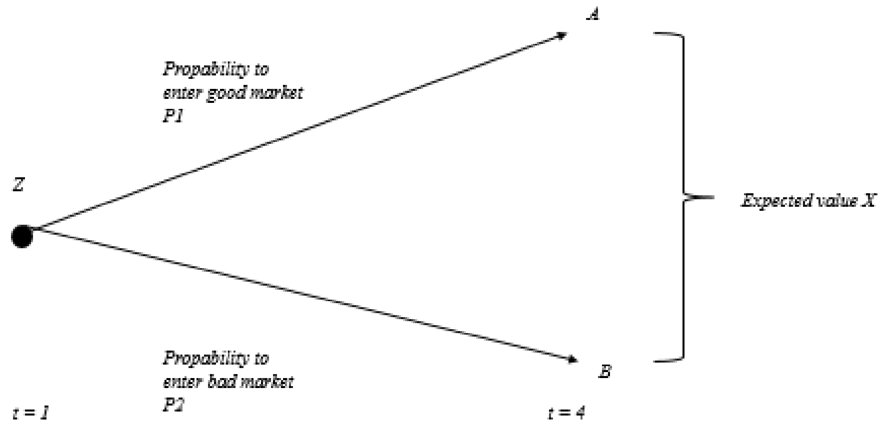
NPD process. By definition, a research and development initiative involves creating something new and unique or developing more enhanced products. The nature of most research and development initiatives is that they are highly risky and involve a significant investment up-front, with highly variable potential cash flows in the future that are generally skewed toward the low end. In other words, most R&D projects fail to meet expectations and generally lower incremental revenues than deemed profitable. The real option approach considers multiple decision pathways as a consequence of high uncertainty coupled with management´s flexibility in choosing the optimal strategies or options along the way when new information becomes available.
That is, management has the flexibility to make midcourse strategy corrections when there is uncertainty involved in the future. This often applies to the radical innovation projects similar to for example product 4. Even though the product is not selling well today this technology could have future potential and might need more time and development to get to a successful stage.

Here the real option method was applied to the expansion projects to show how the method can be used to evaluate the real option value (ROV) for the projects. This will give us a clear view on the second launch for the products and too see whether there is a measureable difference between radical and incremental innovation.

The following calculation provides analogy to why optionality is important and should be considered in company investment strategies. If we take example for one of the incremental projects here above the expansion project for product 1. The ROV_{NPV} is calculate to be equal to the overall payoff of the investment *X* discounted at *r* minus the investment cost is for the project is *Z*.
Using the method that Harris and Pringles presented earlier to evaluate the discount rate for these calculations. The WACC of the company 12% and a debt percent assumption of 5% the discount rate for these calculations will be 17% and a risk-free rate (*Rf*) of 4%.

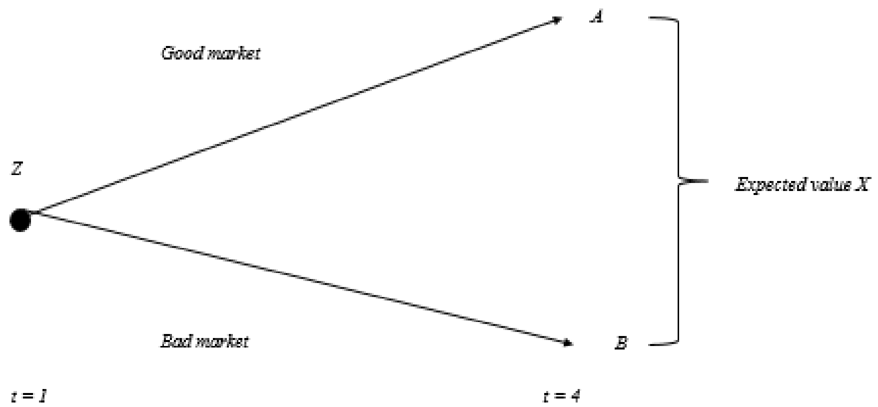
$$ROV_{NPV} = \frac{X}{r} - Z$$

An initial investment *Z* of an investment opportunity is *X* and the objective probability (P1) that the cash flow will be *A* in four years from now is 50% and with the same probability (P2) the cash flow can become *B*. The standard ROV_{NPV} value of the project with no flexibility and the discount rate of 17% is:



$$ROV_{NPV\ without\ flexibility} = \frac{0{,}5(A) + 0{,}5(B)}{(1+r)^4}$$

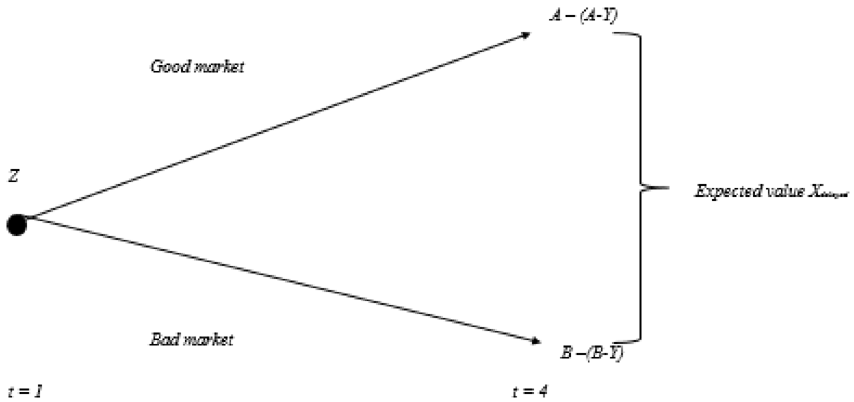
By waiting with the investment, we get the profile here below, where the initial investment outlay occurs at time one and positive inflows are going to occur. If the initial expected value were correct and that the average or ROV_{NPV} came to be *X* with good market demand providing ROV_{NPV} *A* cash flow and in the case of bad demand, ROV_{NPV} would only be *B*. If we had the option to wait with the project for one year and the payoff profile bifurcating into two scenarios.



$$ROV_{NPV\ delayed\ entering\ good\ market} = \frac{A_4}{(1+r)^4} - \frac{Z}{Rf^1}$$

However, by waiting with the investment, you are also defraying the cost of investing in that the cost outlay will only occur a year later. Therefore, the value of flexibility is *X-A*.

A more realistic case should look like the example here below. By waiting one year and putting off the investment until year two, you are giving up the potential for a cash flow now, and the leakage or opportunity cost by not investing now is the *Y* less you could have receive (*A* – (*A*-*Y*)). By putting off the investment, we are also defraying the cost of investing in that the cost outlay will only occur a year later.



$$ROV_{NPV\ delayed\ entering\ good\ market} = \frac{A_4}{(1+r)^4} - \frac{Z}{Rf^1}$$

The same is done if entering bad market, just calculated for B. Then you have the flexible NPV for the project.

This upper state and lower state was calculated for all products with using 0.5 probability.

Discounted Cash Flow (DCF)

If a company needs to make an investment decision but at the same time has the option to wait and defer on making the decision until later. If financial analysis are performed for the projects in the real option section here above with an economic life of 4 years like presented in the table 9 here below. The implementation cost is above the innovation cost for the product and the project´s risk-adjusted discount rate is 12%.

There are risk and return diversification effect among projects as well as investor psychology and overreaction in the market that are not accounted for. There are also other more robust asset-pricing models that can be used to estimate a project discount rate, but they require great care.

When the discount rate had been decided, the free cash flow stream was discounted appropriately. Forecasting cash flow into the future is often very difficult here actual numbers are used from the past to show how the future can be evaluated.

Decision tree analysis

The company has been evaluating to start another project to improve or launch another version of product 4. Because of the product not being as successful as the company would have hoped for. It is important to do further analysis before moving forward with the project. Decision tree analysis is a good way to evaluate projects with high risk, it is helpful to see the effect from different scenarios.

The investment cost was high to begin with and to keep the product on the market is not beneficial for the company. The product needs a lot of support from the manufacturing and constant support from R&D. The sales cost for the product is really high so when it all comes to an end the product is not as profitable. The company stands in front of a juncture with the product, since improvements are needed being able to keep the sales from decreasing.

4 Results

In this section all results will be presented and the research questions will be answered.

Research question 1: How can return on product innovation investment (ROII) be measured?

When measuring ROII for products it is important to start with defining the product innovation in your company, what is included in the innovation, how much should be spend on the innovation and where should it be spend. When this has been defined and measured it can be compared with the added-value from selling the product using financial techniques.

The key early challenge is to define clearly what is included in “innovation investment”. Spend on R&D is clearly a significant part of this, but many other departments include work and innovation effort bringing a product to the market. It is worth mentioning sales and marketing, brand development, manufacturing operations that typically contribute to innovation. If companies only include R&D spend in measurements, then they are missing the full picture.

Financial techniques to measure product innovation

To show how return can be measured for product innovation three financial techniques were used to calculate the return for four products ROI, NPV and IRR. All calculations for the projects are performed by looking backward, meaning historical numbers were used to show how return on product innovation investment can be measured. The results of the calculations are presented in table 6 here below. It is important to note that table 6 is normalized to hide the actual data for the company analyzed. It was done by using the total innovation cost as the base case and was product 1 used as a reference for the normalization for all calculations. Total innovation cost was defined for all four departments R&D, M&O, Sales and marketing.

Tafla 6 Return on product innovation measured with ROI, NPV and IRR

ROI calculation for variable cost				
Cost includede when calculating ROI *ROI Calculated for variable cost*	**Product 1** **Incremental Innovation**	**Product 2** **Incremental Innovation**	**Product 3** **Radical Innovation**	**Product 4** **Radical Innovation**
R&D+M&O+Marketing & Sales Cost[1]	10%	13%	2%	-1%
R&D+M&O+Marketing & Sales Cost (Base Case)[2]	10%	10%	10%	-10%
R&D + M&O + Marketing[3]	13%	10%	15%	-8%
R&D + M&O[3]	57%	10%	21%	-3%
R&D[3]	61%	11%	22%	-1%
NPV calculation for variable cost				
Cost includede when calculating NPV *NPV Calculated for variable cost*	**Product 1** **Incremental Innovation**	**Product 2** **Incremental Innovation**	**Product 3** **Radical Innovation**	**Product 4** **Radical Innovation**
R&D+M&O+Marketing & Sales Cost[4]	100	23	2	-63
R&D+M&O+Marketing & Sales Cost (Base Case)[5]	100	100	100	-100
R&D + M&O + Marketing[6]	106	100	780	-63
R&D + M&O[6]	121	100	2006	-29
R&D[6]	121	101	2082	-24
IRR calculation for variable cost				
Cost includede when calculating IRR *IRR Calculated for variable cost*	**Product 1** **Incremental Innovation**	**Product 2** **Incremental Innovation**	**Product 3** **Radical Innovation**	**Product 4** **Radical Innovation**
R&D+M&O+Marketing & Sales Cost[7]	10%	33%	2%	-2%
R&D+M&O+Marketing & Sales Cost (Base Case)[8]	10%	10%	10%	-10%
R&D + M&O + Marketing[9]	12%	10%	14%	-7%
R&D + M&O[9]	44%	10%	20%	-2%
R&D[9]	47%	11%	21%	-1%

[1] Normalized to 10% for product 1
[2] Normalized to 10% for each product
[3] As compared to base case (For example for product 1, 13% means that it is 30% higher ROI than for th
[4] Normalized to 100 for product 1
[5] Normalized to 100 for each product
[6] As compared to base case
[7] Normalized to 10% for product 1
[8] Normalized to 10% for each product
[9] As compared to base case

When comparing the three measures used and how they can measure product innovation for companies the ROI is an equation that measures the efficiency of the project investment. The ROI simply calculated the return that the investment produces. It is a useful starting point for sizing up any investment. ROI is a historical measure, meaning it calculates all the past returns. ROI does not take into account the time value of money, which is included in calculations for both the NPV and IRR when calculating the return for product innovation investment.

When looking at the results for the ROI calculations, the obvious is stated that return increases when less cost is taken into the calculations. Meaning when including all innovation cost into the calculations, it has an effect on the overall return for the product. This can have a great impact for the company the actually return from the innovation project.

The NPV is a method used to evaluate investments, whereby the net present value of all cash outflows such as the cost of the investment and cash inflows is calculated using a given discount rate. An investment is acceptable if the NPV is positive. The NPV shows the actual benefit received over and above from the product innovation investment made.

When comparing the results for the NPV calculation to the calculation for ROI the overall outcome is the same but with a different return for the products, that is mainly because ROI is calculated as a percentage, but NPV is money value for a discounted cash flow.

The IRR is also called the dollar weighted rate of return. IRR is calculated as the interest rate that makes the present value of the cash flows from all the sub-periods in an evaluation period plus the terminal market value of the portfolio equal to the initial market value of the portfolio.

The results for the IRR is simply stated to be the percentage rate earned on each dollar invested for each period it is invested. It gives an investor the means to compare alternative investments based on their yield. The IRR for product innovation project is the discount rate at which the present value of expected net cash inflow equates the cash outlays.

The key differences between NPV and IRR are the calculation of NPV is to determine the surplus from the project, whereas IRR represents the state of no profit no loss. When the amount of initial investment is high, the NPV will always show large cash flows while IRR will represent the profitability of the project irrespective of the initial investment.

When calculating both NPV and IRR the cash flow was discounted with 12% discount rate that equals the companies WACC. The calculations for the discount rate are found in section 3.3.1.1.

Incremental versus radical

When looking at the results between incremental and radical innovation that table 6 presents It is notable that the radical products can be affected from how late the revenue are entering. Resulting in a higher discount for the revenue stream for the radical products than for the incremental products that benefit from the revenues entering early or almost immediately to tick in after the product is launched. The risk for the radical innovation is much higher but when it gets time to develop and adjust to the market the reward from it is much higher and that is for example the case with product 3. This is an indication that radical products might need a different treatment when it is measured. It is comfortable to select the incremental innovation product investment because of the known factor that it will immediately return revenue.

It is surprising that there is not outstanding difference between radical and incremental for these products and that is somewhat disappointing. There is though difference between the products individually that is possible to take some conclusions from like the need for more measures for radical innovation and other cost management related factors that will be described in the following section.

Cost management

When looking at table 6 again the cost management is having an extreme impact for the products and this is highlighting the importance of including the product innovation cost from all departments so that the company is aware of how much actual return is from the product innovation investment.

The change in return for the radical products is significant for each department and this is supporting that the radical products have much more expensive process than the incremental products and it is highly important for the company to be aware of this cost.

The marketing cost is having a great impact on the outcome for all the products except for product 2. When looking at the difference for the effect of marketing cost for product 1 and 2 than it is having much more effect on product 1 than 2. This is mainly because product was intended to replace product 1 a lot of the marketing material for product 1 was used when creating the marketing material for product 2 and therefore the marketing cost was less. The marketing cost for product 1 is effecting the ROI more than for the radical products, that is mainly because the marketing cost is a much higher ratio of the overall innovation cost for product 1 than for product 3 and 4 because the R&D cost is much higher for the radical products.

When looking at the M&O cost it is likely that it has been underestimated for the radical products or partly included in the R&D cost. It is not showing the affect that it should for the radical products. For the incremental products it is more likely to be correctly evaluated.

The result shows that the incremental product 1 was the most successful investment of those four products. The radical product 4 has not been a successful investment yet but there is a possibility that it needs more time on the market before it takes off similar to what happened with product 3. The results for product 4 are though unexpected for the company since the product is showing steady income year to year, but when including all the cost that has not been included in the cost of goods it is showing negative outcome for the company. Product 3 has been nominated as the growth driver of the company, but when all comes to an end product 1 has been the product providing the most income of those four products. Product 2 has not been on the market for that long, but it has potential to grow and it is sure a successful investment. These results give the indication that it is highly important to include all expenditures into the calculation to see the full picture. If that is not done it can give companies wrong ideas on their product performance and return.

The cost that lies behind the radical products is obviously affecting the overall return for the products. It is important to take into account all the innovation cost, including the marketing cost and the cost of selling the product being able to see the actual return of the product investment.

When bringing a product to the market, it always includes a minimum startup cost that obviously effects the incremental product more, because the cost can be more that the cost of the R&D project by it its self. For the Radical products that are more expensive projects it does not hurt them as much, but still it is an important factor to take into the calculation of return on innovation.

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Research question 2: How can financial techniques help out with decision making in the NPD process?

When looking forward showing how return on product innovation can be evaluated or estimated to help out with future decision making, the data for the second launch of each product was used except for product 2 was initial launch. Table 7 presents the results for two different financial techniques that can be used to evaluate product innovation projects to help out with decision making in the NPD process. Table 7 is normalized to hide the data to fulfill privacy for the company included in this research.

The NPV analysis can help out evaluating the future return from a product innovation project. When the NPV is positive the project should be undertaken and if it is negative the investment should not be made. The base case for product 4 shows a negative NPV so that investment should not be undertaken. For the other three investments they are positive, so they are beneficial investments.

There are number of disadvantages to the NPV method but it is still commonly used. The first disadvantage is that NPV is only as accurate as the inputted information. It requires that the investor know the exact discount rate, the size of each cash flow, and when each cash flow will occur. The cost of developing a new product can be unknown for example and the revenues from the sales of the product can be hard to estimate, especially for radical innovation that needs to be predicted maybe many years into the future. The NPV is only useful for comparing projects at the same time, it does not fully build in the opportunity cost. If For example, the day after the company makes a decision about which investment to undertake based on the NPV, it may discover there is a new option that offers a superior NPV. The NPV does not provide an overall picture of the gain or loss executing a certain project. To see a percentage gain relative to the investments for the project, there can IRR be helpful.

Table 7 Dynamic calculation evaluating forward return

Dynamic				
Forecast vs. Actual **5 years after launch**	**Product 1** **Incremental**	**Product 2** **Incremental**	**Product 3** **Radical**	**Product 4** **Radical**
Total innovation cost (R&D+M&O+ Sales and Marketing cost)[1]	10	3	9	-5
Total innovation cost base case [2]	10	10	10	-10
Actual NPV (R&D + M&O+Marketing Cost) [3]	11	10	11	-10
Actual NPV (R&D + M&O)[3]	11	10	15	-7
Actual NPV (R&D)[3]	11	10	15	-4
Total innovation cost (R&D+M&O+ Sales and Marketing cost)[4]	10	3	7	-5
Total innovation cost base case [5]	10	10	10	-10
ROVNPV (R&D + M&O + Marketing Cost) [6]	10	10	11	-10
ROVNPV (R&D + M&O) [6]	11	10	15	-7
ROVNPV (R&D) [6]	11	10	15	-5
[1 & 4] **Normalized to 10 for product 1** [2 & 5] **Normalized to 10 for each product** [3 & 6] **As compared to base case (For example, product 1, 11 means 10 times higher NPV than for the base case)**				

The ROV calculations show similar results as the NPV here above, they show a little less return, but overall the result is the same. In these calculations, it shows more need for measuring the overall innovation cost for all departments for radical innovation.
The results here show that there is more change in return for the radical products when looking at different cost included for in the calculations for the second launch of the products.

The real option method offers to evaluate different kinds of options and essentially all proposed projects are real options. Options can be useful for evaluating information technology projects that take a long time to implement. When a technology evolves over several years, the potential revolution in standards can predict an entirely new paradigm, leading to an unbridgeable gap between the old and new.

When evaluating radical innovation the real option approach is a useful tool to deal with the uncertainty and risk that follows with the newness in such projects.

Decision tree analysis

The decision tree analysis (DTA) is used in investment analysis to try to capture the lack of flexibility in the NPV method. The DTA method allows the investor to delay an investment decision until more information about the project is available which can affect the value of the project. The decision tree maps out different events which can help investors to picture the project and make decision during the life of the project.

It can be helpful when phasing an investment decisoin to set up a probability event tree based on the knowledge that is available for a project, perhaps based on similar project. Information about the project can also be obtained from some other sources such as specialists which are experts in a specific industry where the project will be undertaken, often at some cost.

Product 4 has not been successful in the past. For the company to know if it is beneficial to invest in an NPD project for the product to make a new version decision tree analysis were executed.

The results from the analysis is that if the company would start the project, it is estimated that it would increase sales 10%, the NPV would be $10. If the sales would increase 60% the NPV would be $19. If the sales for the product would not change from what they are today the NPV would be negative and the project not beneficial for the company. The project is positive, but would need to be evaluated along with other projects to see if the NPV for this project would be more beneficial than others in the project portfolio.

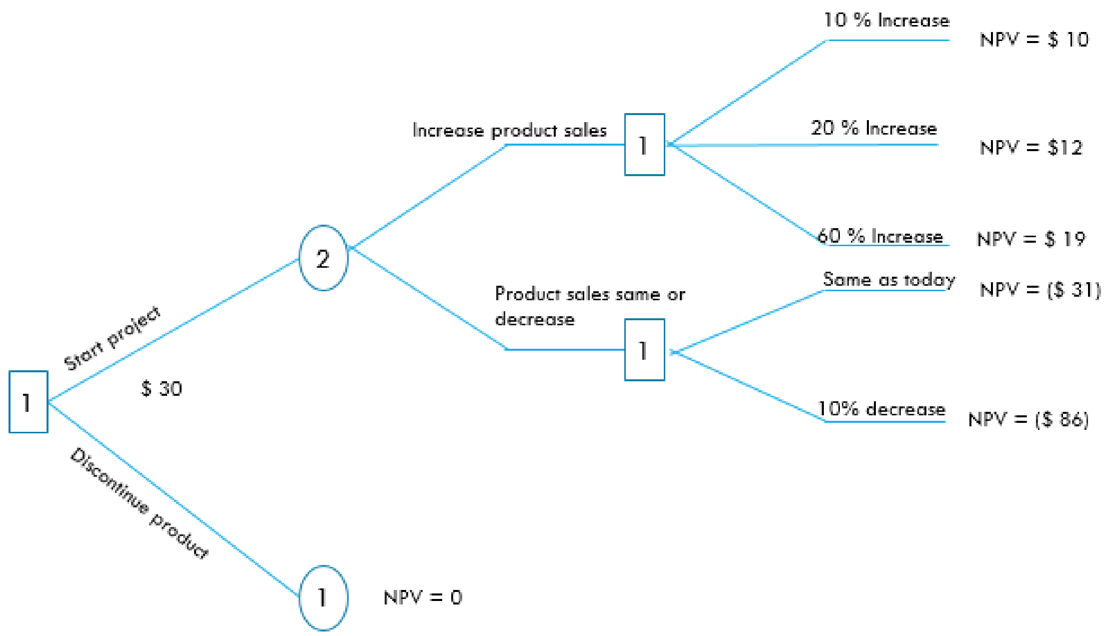

Figure 12 Decision tree for product 4 analyzing options to invest in the product or to start the discontinue route. The numbers are normalized with 10% increase using 10 for each outcome.

Figure 12 shows the decision tree that analysis the options that the company has for product 4. Either to invest in the product to bring a better product to the market or to discontinue the product.

It is estimated that the investment for the project would be around $ 30. If the company would start the project it is estimated that it would increase sales 10%, the NPV would be $10. If the sales would increase 60% the NPV would be $19. If the sales for the product would not change from what they are today the NPV would be negative and the project not beneficial for the company. The project is positive, but would need to be evaluated along with other projects to see if the NPV for this project would be more beneficial than others in the project portfolio

Calculation Deviation

There are several factors that can impact the results and they are following:

Sales cost could have more impact on the incremental products than radical products since the sales cost is estimated down to each sold units. The number of units sold is for a product 1 is much higher than for the other product 3 for example and that could impact what is being investigated.

There is a possibility that product 2 is not showing the results expected because it is reviewed over a shorter time than the other three products. The marketing cost is likely to be underestimated for product 2.

The marketing cost is impacting the incremental products more than radical products because the difference in cost is much higher for incremental than radical when comparing for example marketing cost and R&D cost.

Cost estimated can be underestimated or overestimated and that could affect the results of this study to some degree. The sensitivity analysis were performed measured the sensitivity of the cost estimation for each product shows that it could skew the results if the cost was underestimated or overestimated. The also showed that the incremental products are more sensitive for under- or overestimated cost than the radical products.

There are several way of evaluating the future for a project and many methods have been developed and proposed to companies to improve decision making in the NPD process.

Discounted cash flow (DCF) analysis, and in particular, NPV analysis, has been widely used as a criterion for evaluating projects. A dynamic version of discounted cash flow analysis begins by considering uncertain cash flow more carefully.

It has been stated that NPV analysis does not deal well with real options. This is true because the riskiness of a project that has real options associated with it varies with time, and the appropriate discount rate varies with the risk. The uncertainty in investments can be various, such as increased competition in the market, deregulation or new technology. Real option captures the uncertainty with volatility that can be difficult to predict in a project, especially one that has never been undertaken. The real option method can take an advantage of projects with high uncertainty which previous investment methods have not done.

The decision tree analysis (DTA) go beyond NPV by not only representing the occurrence of costs and benefits over time, but by representing the decisions taken by management in reaction to these occurrences. DTA captures the lack of flexibility in the NPV method and allows the investor to delay an investment decision until more information about the project is available which can affect the value of the project. The decision tree maps out different probability events which can help investors to picture the project and make decision during the life of the project.

The decision making, evaluation and selection in the NPD process will always have an impact on the company. When there is high risk and uncertainty included in the innovation project there is more need for flexibility in the methods used. For high uncertainty and risk it is necessary that the project will be monitored closely and that it is possible to react to new information available that can affect the project rapidly.

5 Discussion and conclusions

First of all it is important to know why you are managing ROII and who the outputs are intended for. The company needs to setup a cross-functional innovation process to measure what should come under innovation in each department in the company. This needs to be linked with each product being able to know the actual return on innovation investment for products that are launched.

Distinguishing between different innovation types is important because the nature of return is different between different levels of innovation. There is no doubt about that it is important for both radical and incremental innovation. Secondly, it is extremely important that radical innovation gets special treatment when it comes to project evaluation and investment decisions. For a company, it is recommended that they set their processes according to incremental innovation, but make exemptions for the radical innovations when they are taking place. From incremental to radical innovation project, managers need to handle different activities and with them dissimilar venues of risk. This uncertainty needs to be evaluated and it is more likely that a radical innovation will need more evaluation and quicker response when new information are available. Therefor more flexibility is needed in the process of radical innovation because of more complexity.

Setting clear objectives and measuring performance against them by creating a cross-functional body with sufficient authority to take rapid decisions. Avoiding the separations between departments. Use a commonly shared data, consistent methods, shared ownership across departments, post-launch feedback, and tailor the approach to the scale of the investment.

The first step in measuring ROII is to develop common, consistent standards for measuring all aspects of the innovation investment among all departments in the company.

It is also worth mentioning that for product innovation projects and especially for radical innovation it is not only the money returned that the company earns from the investment it is also knowledge and technology that can be brought into other products and innovation. Because highly innovative, new to the world products tend to have a much weaker fit with the company established resources, they require a great learning, more sophisticated resource teams, longer life cycle times, and thus clearly represent a more significant risk for firms. For radical products like 3 and 4 there is also a value in the brand equity that those products have gained from being the first to the market. This is something that was not calculated in this project but is highly important to take into account.

The results of this research supports empirically what most of us already know intuitively: That radically different types of new product ventures require a different approach to achieving NPD success. In particular, when charged with the development of new products at opposite ends of the innovativeness spectrum, managers must adjust their focus and approach to account for difference in uncertainty, risk, company competencies and market reactions.

The results and the implication of the study are clear: depending on the degree of innovativeness, managers need to adjust their focus and their approach for developing successful new products.

Probably the single most important factor in achieving success for highly innovative, or new-to-the-world products, is the type of corporate culture and management attitude that permeates the firm. Success at developing highly innovative products that involve new technologies and completely different ways of dealing with problems, require a corporate environment that encourages and supports creativeness and “stepping out” beyond the norm.

When measuring ROII it needs to be clear how and what is measured each time. ROII can be measured backwards to guide companies on how they have been doing in the past and then it can predict the future with help of financial techniques.

When looking backward it needs to be defined what should be included in the innovation cost. In principle, managing the backwards ROII can be rather simple by working out how much you spend on innovation and where you spend it, compare this with the added-value that each part of the portfolio delivers to the business, and take appropriate management actions to improve the performance. However many companies struggle with this for variety of reasons which are mainly concerned with the lack of clear, shared view about what managing ROII means. Innovation is much broader than just R&D. Innovation is across functions and needs to be managed as such.

The management tools and approaches can be variant between businesses and companies so the importance here is that each company finds their way of managing their innovation. It is important to be clear about why you are managing ROII and who the outputs are intended for.

The time perspective to look at ROI moving forward and when calculating backwards from the history are important because there are many circumstances where these are conflicting even though at other times they may be consistent. If not matched correctly, these can lead to the development of faulty investment recommendations. An ROII analysis consider impact over the ensuing days, weeks, and months following execution. Given the delayed effect of some investments, time spans can be incorporated into the ROII estimates.
Knowing which of the two perspectives is most appropriate for the situation at hand is vital for optimal understanding of the insights from ROII measurements.

What innovation should be delivered, distinguishing between innovation types with different level of novelty is important because the nature of value is different.

Further analysis

In this research I would have liked to see more difference between incremental and radical and for those products it is not showing. It would be interesting to see more products reviewed backwards to get better trend analysis between radical and incremental innovation.

Do a similar research for other companies in the same industry and then further analysis on other companies to examine how return for product innovation is measured in companies. Include both other companies in the medical device industry in the coming researches and then broaden the research for other innovative companies.

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