FACULTY OF TECHNOLOGY

Performance Management for Product Portfolio Management, New Product Development & Rapid Product Development

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2509842

MS Product Management

Master's thesis

August 2017

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ABSTRACT
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Abstract

Ever evolving and changing market scenarios have increased the competition between organizations to maximize the performance of their products and operations. In this challenging environment performance of product portfolio management (PPM), new product development (NPD), rapid product development (RaDe) have significant impact on their monetary values. To deal with the existing scenarios, the performance management of the product development and its related internal process of portfolio management is very crucial. NPD and RaDe processes result in a new sales item which needs to be effectively introduced in the product portfolio, but the performance measurement is required to develop the sales item and maintain them in the portfolio.

This study is researched and worked upon in five stages. The existing targets and KPIs are studied after a through literature review. The current practices of case companies were identified and the similarities and differences were observed. In the end, a new performance management frameworks was developed to manage NPD and RaDe projects including their impacts to the product portfolio.

The developed new performance management framework for NPD and RaDe divides the activities into two phases, planning and development. During the planning phase the PPM targets and KPIs will provide analysis and decision making concept to start NPD or RaDe type of product development to create new sales items into the portfolio. The second phase, the NPD and RaDe development, provides metrics for the NPD and RaDe project execution.

The developed framework is generic and will be suitable for both RaDe and NPD activities. In the framework, the company and PPM strategy is aligned with the success factors to achieve the required targets, measured through quantifiable or non-quantifiable KPIs to evaluate the success of the new product and its impact to the product portfolio.

Additional Information

Keywords: Product portfolio management, New product development, Rapid product development, Performance management, Performance measurement, Targets, KPIs, Product Development, Balanced scorecard

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During this research based thesis work, a deep understanding of the importance and performance management of product portfolio management, new product development, and rapid product development techniques have been acquired by the author. Furthermore, the literature review and empirical study have provided a clear view of what is happening right now in academics and case companies. Therefore, it was an incalculable learning experience which equipped the author with roots of academic and professional roots in the field of Industrial Engineering & Management.

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Oulu, 14.8.2017 Bukhari, Syed Ammar

TABLE OF CONTENTS

ABBREVIATIONS AND DEFINITIONS

PPM	Product Portfolio Management
NPD	New Product Development
RaDe	Rapid Product Development
PMS	Performance Management System
MCS	Management Control System
CRM	Customer Relationship Management
KPI	Key Performance Indicator
BSC	Balanced Scorecard
CSF	Critical Success Factor
DfX	Design for Excellence
OEM	Original Equipment Manufacturers
R&D	Research & Development
PMG	Product Management Group
POP	Product Offer Plan
PDP	Product Development Plan
CTO	Chief Technical Officer
PDA	Product Development Activity

INTRODUCTION

1.1 Background

Ever evolving industries tend to seek competitive advantage over their competitors in the form of their internal processes. Internal processes of an organization, provide a pivotal role in increasing the company's profits. As Hall & Brummer (1999) presented that management's attempts to increase the market value of the company is inspired by decisions to increase the shareholder's wealth. The increase in company's market value is directly related to the internal processes and their effective performance management. Since the organizational processes of portfolio management and product development are considered as an internal process, and the activities if run smoothly help the organization to gain the edge over their competitors.

Product portfolio management (PPM) involves taking an overall view of the products of the organization arguing about its current and prospective products (Cooper, 1999). Any failure to do so, halts the organizational path to maximize their profits and continue their competitive advantage. Therefore, the study of the existing products and the products that will be developed using new product development (NPD) or rapid product development (RaDe) techniques, which are or will be a part of portfolio need an effective performance management practice. The effective performance management practice will highlight the targets and key performing indicators (KPIs) for the PPM and NPD.

This study is carried out to explore and align the PPM and NPD performance measures and to classify which of them are more valid for the PPM and which of them measures better the NPD.

1.2 Research scope and objectives

This study is a part of Rapid Product Development (RaDe) II project in the research unit of Industrial Engineering & Management at University of Oulu, in cooperation with partner case companies. The scope of this touches the performance management in NPD, RaDe, PPM and many important areas in product management.

RaDe is a product development methodology, which needs effective performance management for its development and post development activities. This study will focus on performance management for RaDe projects and related performance management of the PPM. The performance management related targets and KPIs are studied from the literature and by empirical analysis of the case companies to draw the results of effective performance management practices including targets and KPIs.

The objective of this study can be formulated to four research questions:

- RQ1: *What are the PPM, NPD and RaDe related targets and KPIs according to earlier research and literature?*
- RQ2: *What are the PPM, NPD and RaDe related targets and KPIs in case companies as they have defined them currently?*
- RQ3: *How should the NPD and RaDe related targets and KPIs be connected to PPM targets and KPIs?*
- RQ4: *What is the difference between NPD and RaDe targets and KPIs?*

1.3 Research process

The research process for this study will be comprised of three integrated parts. The research process will answer to RQ1 by conducting the literature review of PPM, NPD and RaDe related performance management. After the literature review, a questionnaire for current state analysis is prepared to record responses from the case companies. The questionnaire is attached at the end of the thesis document (Appendix A). RQ2 will be answered by an empirical current state analysis of PPM, NPD and RaDe performance management in the case companies. The answers for RQ3 and RQ4 will be constructed throughout the study and is presented in the results section. The result section will highlight clearly the targets and KPIs needed for PPM, NPD and RaDe. Apart from that, a performance management framework is constructed as a new contribution to the earlier research and for the case companies to implement effective performance management practices in their organizations.

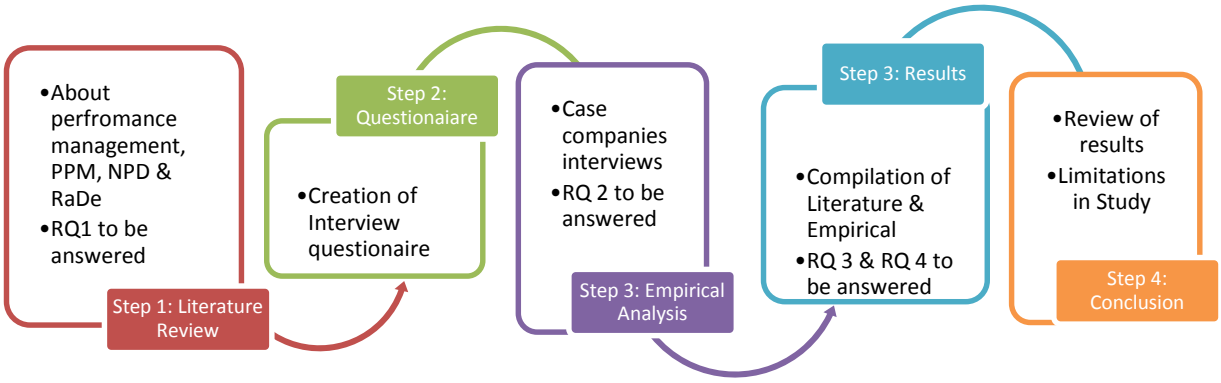

Figure 1: The research process

2 LITERATURE REVIEW

2.1 Performance management process

A *performance management system* (PMS) in an organization is often considered to be a part *of management control system* (MCS), and there has been an evolving debate over this, which was concluded by (Baglieri et al., 2014). Baglieri (2014) defined PMS to be a complex tool comprising of many functions where it covers the areas of MCS. Performance is perceived in achieving the organizational goals, performance measurement and performance management are often referred as *management control system* (MCS) and vice versa (Siska, 2015). Performance is fundamentally defined as profitability, and a measure of performance is when the budgeting process tries to keep overall output in the form of revenue and input in the form of cost for the process, in balance (Otley. 1999). MCS is a process, which aids the organizational managers to effectively utilize their resources for the attainment of their objectives (Anthony, 1965) whereas Simon (1995) refers to MCS as the tool used by management of the organization to implement their strategies. MCS indicates to the establishment of the procedures and processes which are used by the leadership of an organization to safeguard the completion of their goals and targets (Otley & Berry, 1994). The strength of a PMS or MCS can be determined by an organization, through various measures. Chenhall (2003) suggests that a PMS can understand by an assessment of MCS and how that system "consider(s) multiple stakeholders; measure(s) efficiency, effectiveness and equity; capture(s) financial and non-financial outcomes; provide(s) vertical links between strategy and operations and horizontal links across the value chain; provide(s) information on how the organization relates to its external environment and its ability to adapt."

Generally, performance management is only measured in quantifiable items and other factors are very less considered (Hertenstein & Platt, 2000). As argued, to effectively analyse the performance of an organization's goals and its goal realization, is not just financial in nature, the performance of production process, defect rates and cycle times, delivery statistics, product innovativeness or customer satisfaction (Otley, 1999). Strategy plays an important role in driving performance management of the organization. The alignment between PMS and strategy, affects the performance, especially the use of non-financial performance measures paired with manufacturing strategies have very positive

effects on performance, which acts as an evidence of the role of non-financial performance measures for an organization (Van der Stede et al., 2006).

In an organization, success is measured in different ways, and management control systems play a vital role in achieving this success. Effective use of MCS in an organization would lead to higher product innovation, eventually resulting in better performance, also impacting the performance of innovative products to be immense for a long term (Bisbe & Otley, 2004). It can be said that PMS in an organization plays an important role to determine the track of their performance, which covers many aspects in an organization. Mainly, PMS constitutes processes from budgeting, but the realization of the importance of PMS has led the organizations to include balanced scorecards, production, quality control, logistics systems and *customer relationship management* (CRM) modules in their PMS process (Ferreira & Otley, 2009).

Operations of an organization vary very much from each other, as each organization has their own culture and structure. This has been the reason, it was often ignored in PMS and MCS developed by early researchers (Anthony, 1965). MCS, performance management and performance measurement is evolving day by day to compete with fast pace industry standards. Performance management systems are itself defined by Ferreira and Otley (2009) as "We view PMSs as the evolving formal and informal mechanisms, processes, systems, and networks used by organizations for conveying the key objectives and goals elicited by management, for assisting the strategic process and ongoing management through analysis, planning, measurement, control, rewarding, and broadly managing performance, and for supporting and facilitating organizational learning and change". However, the use of performance management is dependent on the organization and how they plan to investigate and evaluate their performance. As top management of an organization may look into different performance measures but they only adopt simplified strategies to determine which factors are used in the evaluation of the performance and how it is weighted (Lipe & Salterio, 2000). Performance management in its own self is a wide area, where targets and KPIs are used for effective performance measurement. Performance measures are essential for an organization to achieve sustainable business success in the demanding and competitive world marketplace (Neely et al., 2000).

2.1.1 Strategic and operational performance management

In addition to MCS and PMS, any other control system will need targets and goals which are to be set and across which its performance can be measured, managed or checked (Otley & Berry, 1980). These targets and goals are usually set by the organization's strategy and as advocated by (Johnson et al., 2005; Thompson & Strickland, 2003) strategy of an organization is the guideline to seek the means for the accomplishment of the long-term the targets and goals of an organization. Since each organization is different in a lot of aspects from the other, it can be said that there is no performance management system, which would be applicable for every organization, but in all organizations optimal course of action for effective performance is the strategy and objectives, which organization would go after (Otley, 1999).

From the literature, it can be concluded that PMS systems need to be smart to measure all different aspects influencing the performance of an organization. Strategic and operational performance management is needed to be implemented. Other performance management practices need to be evaluated from the social, behavioural, and managerial perspective, apart from financial (Otley, 1999). To measure this holistic practices, effective strategic and operational performance management is required as a necessity. Performance evaluation of businesses can be through balanced scorecard (BSC) (Kaplan & Norton, 1996) or integrate PMS framework (Ferreira & Otley, 2009). It is said that businesses which use BSC, they are greatly influenced by strategy integration that it is communicated in detail to their evaluators (Banker et al., 2004).

Otley (1999) paid importance of operational and strategic performance management in his framework for performance management. He identified strategic and operational performance as one of the core practical issues of business process and operational management and how they are necessarily required for attaining business objectives.

The strategy is an integral part of organizations and it defines the operations of the organization (Kaplan & Norton, 1996). As Griffin and Page (1996) highlights that most of the organizations measure their performance as a combination of both financial and non-financial measures, to effectively measure the performance from all the aspects. Since the strategy is the integral part of the organization, best and most effective performance measures are the ones that are linked with organization's strategy (Kaplan & Norton, 1992). Organizational managers should establish and set targets to drive

organizational change which would transform the company in three to five years' time span (Kaplan & Norton, 1996). To achieve the targets, organization's core competence is required, which is defined by their strategy. As Otley (1999) mentioned that aims of organizations could only be achieved through strategy. For performance management and business processes development, strategic alignment is pointed to be one of the most important factors in an organization (Bai & Sarkis, 2013). It is said that productivity can be achieved by working efficiently, keeping in mind organization's strategic objectives rather than just increasing the amount of input (Pekuri et al., 2011). Therefore, the aligned strategy will not only drive the organizational success but will also provide business strength. Organization's business process and its performance management should be linked together in an integrated framework for effective results (Pinheiro de Lima et al. 2012). In general, *Strategic performance management* will help the organization to apply their strategy throughout and ensure that goals are met.

Operations management is a process that can produce and deliver the products/services of an organization to their customers (Kaplan & Norton, 2004). However the *operational performance management* is the arrangement of all business units of the organization, when they are working together to achieve a common strategic goal. Kaplan and Norton, also highlighted the importance of activity based management and quality management for achieving effective operations performance management process. However, operational performance management in an organization can be influenced by factors of supplier relationships, production, distribution and managing business risks, to effectively run business operations (Kaplan & Norton, 2004). Since, organizations need to reduce their product cost, improve the delivery process, maintain quality, thereby creating value for customers is vital in today's business and this is where technology plays an important role. Technology is defined vital for operational performance as it would create an end to end process, provide supporting tools, and effectively keep a track record of all the operations (Keller & Price, 2011). As mentioned by Ferreira and Otley (2009) an organizational structure is responsible for highlighting the resources responsibility and their contribution to achieving business objectives. It can be drawn that how operational excellence is achieved because of factors of organization's structure, its culture and behaviour. In an organization, performance of operations and enhancing their operational capabilities lies with the management systems, how information flows in an organization, how is the talent management process driven, what are the knowledge management approaches, how the resources are rewarded and how the performance is evaluated is all

a part of management system (Keller & Price, 2011). The operational performance can be divided into three areas for effective operational performance of organizations, such as, organizational culture, technology and management system. Collective and effective use of these three cornerstones will drive an organization to effective operational performance.

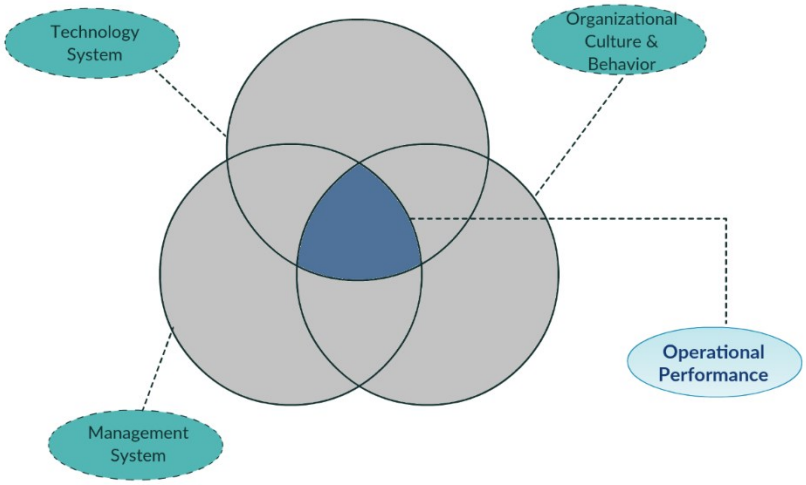

Figure 2: Operational performance achieved through three cornerstones of organization (modified from Keller & Price, 2011)

2.1.2 Targets and KPIs

Organization's mission statement directs their customers, employees and shareholders in the socially acceptable way (Chenhall, 2003). The mission and success factors, in an organization are supported by measurable and quantifiable targets and indicators. To translate the statements of mission into clear targets and KPIs are used to monitor progress as an evidence of success for the organization to reach their targets (Oakland, 2014). An organization defines the targets and agrees upon the associated *key performance indicators* (KPIs) to ensure that these quantifiable measure help in monitoring the progress towards achieving the targets.

As Box and White (1993) clearly mentions that targets should be stated explicitly and clearly for effective performance measurement and act as a challenge to employees to achieve them with good performance. Targets are reflected to be the stepping stones of achieving organizational success. However, success factors are often considered to be

critical in maintaining the performance, as Bauer (2004) mentions that to translate the organization's vision to KPIs, intermediary steps to include strategy, objectives and *critical success factors* (CSF) needs to be defined. Freund (1988), defined CSF as important factors to achieve overall goals and objectives, which are relatively few in number and applicable to all industries with a similar objective and strategy and are expressed as things which must be done. Performance indicators are more commonly linked to the organization's success factors (Paramenter, 2010). As the CSF are specific areas which are important for organizational success. To ensure the performance, special attention is needed to define and decide the CSF as they decide upon the future and present success of the organization (Boynotn & Zmud, 1984).

Despite the clear difference, the CSF is often confused with KPIs which are derived from the CSF. BSCDesigner (2013), a popular decision-making tool for the manager, define the difference between the CSF and KPIs which highlight the major differences, by indicating qualitative and quantitative measurement in CSF and KPIs respectively. How CSF are decided using insights and KPIs are used to generate insights. More detailed differences can be found in the image below.

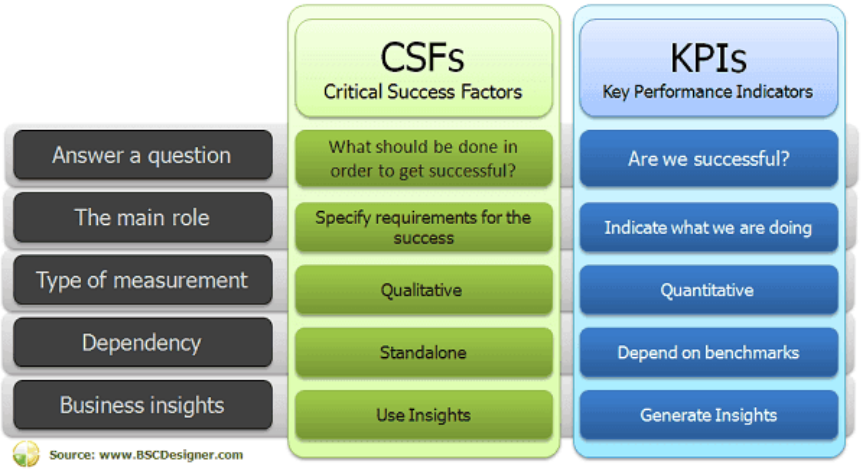

Figure 3: Difference between CSF and KPIs (modified from BSCDesigner, 2013)

According to Parmenter (2010), measures which focus on the most demanding aspects of organizational performance can be termed as KPIs. KPIs are the quantifiable measures used by businesses to reflect their performance in fulfilling or completing their targets and objects (Bauer, 2004). Despite this, organizations fail to work up on finding key performance indicators, which impact the business most. Paramenter (2010) defined the

characteristics of KPIs to be ones that are measured frequently, have a significant impact, indicate what type of action is required by the resources and encourage appropriate actions. Moreover, KPIs are not just about measurement, they should be robust indicators focused on effective implementation of the strategy and behind the numbers of KPIs (Marr, 2012).

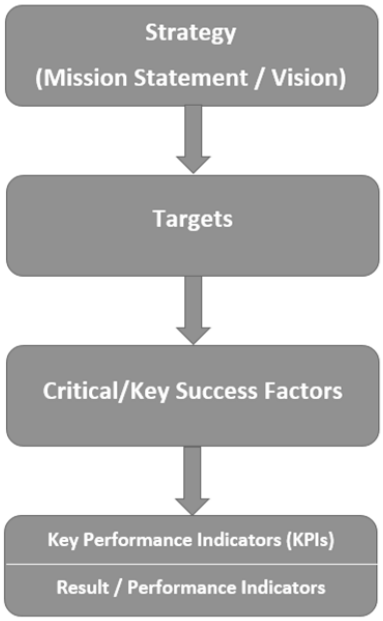

Figure 4: Performance measures derivation from strategy (modified from Parmenter 2010 & Bauer 2004)

2.1.3 Balanced scorecard

As performance measures are deemed important in today's world, Kaplan and Norton (1992) published that at that time there was no measure could provide a clear performance target with an amalgamation of both financial and operational measures to get a balanced presentation. The *balanced scorecard* (BSC) is a model which integrates financial and non-financial strategic performance measures together, it contains result measures and execution drivers of the results which are connected together in a *cause and effect relationship* (Kaplan & Norton, 1996a; Kaplan & Norton, 1996b). It creates a holistic model of the strategy, which links non-financial measures into the strategic framework (Norreklit, 2000). The BSC allows the employees to view their contribution to the organizational success, which is very fruitful when they have to reform their performance (Kaplan & Norton, 1996a). BSC (Kaplan & Norton, 1992) is a combination of four different perspectives to link the overall performance, it comprised of financial, customer,

internal processes and innovation & learning. The idea put through this balanced scorecard was to answer a question of improving and creating the business value. Over the years many organizations have used the BSC a performance management tool, and it has evolved with the passage of time. From measuring performance (Kaplan & Norton, 1992) to be used as a strategic management system linking measures with strategy and vision (Kaplan & Norton, 1996), to translate strategy into operational terms by building strategy maps and making strategy a part of daily work of employees (Kaplan & Norton, 2001), from converting intangible assets into tangible outcomes (Kaplan & Norton, 2004) by visual cause and effect relation of visually map strategy. After a thorough analysis of research and literature on BSC over more than 20 years, Hoque (2014) hints that unless a completely new performance management tool with strategy linking arises, BSC will continue its role in organizations as a provider of strategy maps, enabling policy implementation and as an organizational management control.

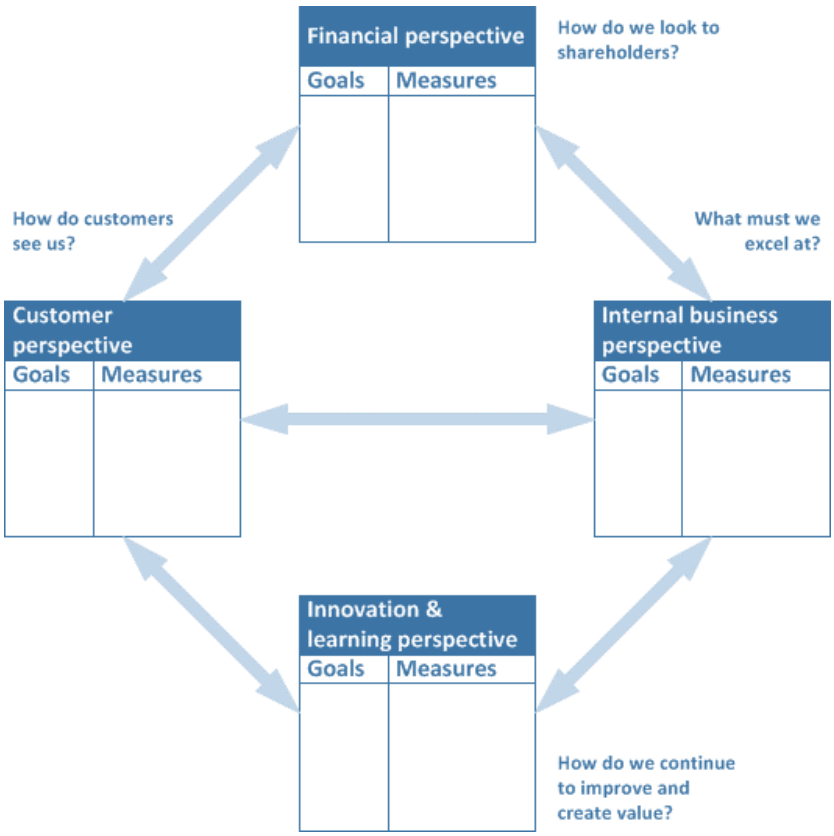

Figure 5: The Balanced scorecard (modified from Kaplan & Norton, 1992)

2.2 Product portfolio management (PPM) and related targets and KPIs

A product portfolio is defined as a collection of multiple products which might be linked together or not (Cooper et al., 1999). A product portfolio is said to accomplish few definite business objectives. As the products are carefully selected to go into the portfolio, to be aligned in a way, which will be able to achieve specific business objectives.

A *product portfolio management* (PPM) is a higher-level management decision making the process for effective management of uncertainty, dynamic opportunities, strategic goals, and interdependencies between the business's portfolios to achieve deterministic actions for the business objectives (Cooper et al., 1999). To achieve those objectives, portfolio's performance measures are set, which is often referred as PPM targets and KPIs. To measure the portfolio performance, different portfolio controls are used, high achieving portfolios have their strategy aligned over a carefully chosen portfolio and attaining portfolio purpose is associated with effective portfolio reporting (Müller et al., 2008). Generally, portfolio management is not well managed in an organization, it was rated as the weakest area in product management process by benchmarking studies (Cooper & Kleinschmidt, 1995).

Portfolio management is a dynamic decision-making process, whereby a business's list of active new product development (and research) projects is constantly updated and revised. In this process, new projects are evaluated, selected and prioritized. In addition, existing projects may be accelerated, killed, or de-prioritized, and resources are allocated and reallocated to the active projects (Cooper et al., 1999). The products are carefully selected to go into the portfolio, to align them in a way to achieve specific business objectives. Organizations with success in their businesses, use effective practices to select and prioritize their projects in alignment to their strategy (Müller et al., 2008). Portfolio management practices for projects and products is same, depending on the type of work an organization is associated with. Performance measures in a portfolio can be defined as a search for optimizing the relationship between the input and output of a system, with the purpose of achieving a fixed objective and is measurable with the quantification of the effectiveness and/or the efficiency of an action or activity (Poulet et al., 2010). As optimization of the relation between input and output is needed, where the products in the portfolio are evaluated and maintained over lifecycle (Tolonen et al., 2014) and products become more productive in achieving organizational targets.

Product portfolio in an organization has targets reflecting the vision of the company, generally to remain competitive, increase/retain their market share, and follow company's strategy to reach those goals. PPM targets can be defined as three basic principles, which are highlighted (Cooper et al., 1999) as:

1. Strategic Fit
2. Maximize the value of portfolio
3. Achieving balance in the portfolio
    a. Picking the right number of projects
    b. Ensuring portfolio sufficiency versus development goals

Targets defined by Cooper et al., (1999) highlights the three areas of performance measurement in PPM practices. The targets of strategic fit, value maximization and portfolio balance are needed to maintain the long term stability. As these defined PPM targets help the organization in developing their portfolio, evaluate the performance of which products are being sold, delivered, maintained and cared by the organization (Tolonen et al., 2014). By analysing their nature to be strategic or not, returning the revenue or not and is it causing any imbalance in the portfolio to other products. Mikkola (2001) highlighted how the long term growth and profitability of the organization are impacted by the correct portfolio selections.

A measurement through indicators can provide results, but these indicators vary over a wide range from financial to non-financial factors. It was measured in new product development (NPD) benchmarking study (Cooper et al., 2004), that there is an interrelationship of an organization's business success and efficient use of PPM performance. As in their study, best performing organizations used frequent & efficient PPM practices and analysed their NPD phase of the product portfolio.

As company's mission statement is argued to be defining the purpose of an organization (David, 2009). All the R&D targets should be in line with company's strategy (Cooper, 1999) and the company's product portfolio should also be in line with the strategy (Tolonen et al., 2014).

However, apart from strategy, other factors contribute in setting up the targets for PPM practices. Value maximization and portfolio balance (Cooper et al., 1999) act as other two targets for PPM performance management. A portfolio balances about market segments

and shares each product of the portfolio is having in the market. Such type of balance is necessary to avoid the possible effects of '*product cannibalism*'. Product cannibalization has been defined as an issue by which a new product gains sales by diverting sales from an existing product (Srinivasan et al., 2005). The other important need to set portfolio balance as a target is to avoid the explosion of the product portfolio as a size, when new products are added to the portfolio, and previous product generations are not ramped down. Too wide and big product portfolio, seriously affects the portfolio as an additional cost, and eventually the company's growth, as the total sales revenue may not increase by the addition of new products in the portfolio (Tolonen et al., 2015). However, to maintain a portfolio balance (Cooper, 1999), organization's portfolio management process should be successfully developed to balance between short term pressure and the long term opportunities, in order to remain strategic (Cooper, 2000). Such measures to maintain the stability of the portfolio has made it more important to quantify the performance of product development process (Johnson & Kirchain, 2011). The NPD process should include the effects of other products in the portfolio, as to move them over the lifecycle to maximise the value and maintaining the balance of the portfolio (Tolonen et al., 2015). With such mapping of the portfolio over the lifecycle, sub-portfolios can be seen with more clarity and each product's current lifecycle phase can be understood. PPM targets and KPI are to evaluated over the lifecycle phase based on NPD, maintain, warranty, and archive sub-portfolios (Tolonen et al., 2015). Such type of portfolios over the lifecycle is defined as *'Horizontal sub-portfolios'*. The nature of targets and KPIs differ during each stage of the lifecycle of the PPM, and proper identification is needed for it. The horizontal sub-portfolios of the portfolio can be seen in the figure below (Tolonen et al., 2015).

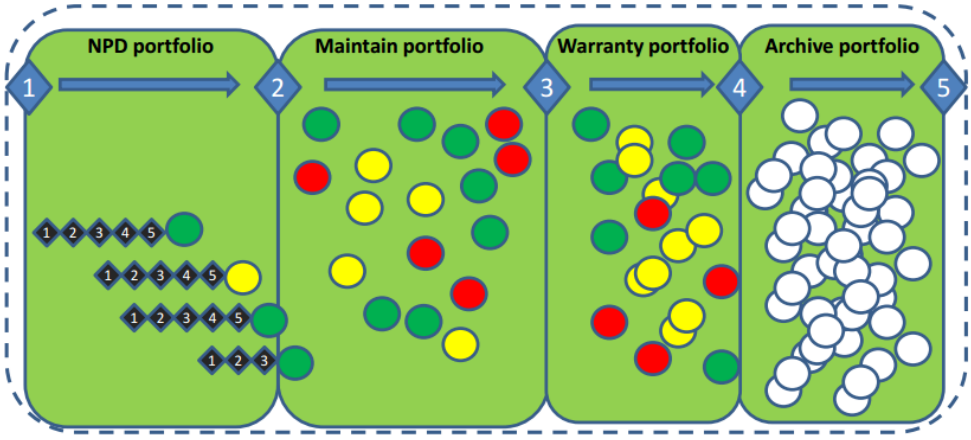

Figure 6: Horizontal sub-portfolios over lifecycle (Tolonen et al., 2015)

KPIs are important to a PPM performance management, because they are the checkpoints which an organization needs to pass to stay in line with their portfolio targets. The most common PPM related KPIs are presented in Table 1 (Cooper, 2008; Cooper et al., 2001; Cooper et al., 1999; Cooper et al., 1997; O'Reilly and Tushman, 2004; Kamensky, 2000; Griffin, 1997; Porter, 1996; Dickinson et al., 2001; Saaksvuori & Immonen, 2008; Tolonen et al., 2015; Taylor, 2012; Dombrowski et al., 2013).

Table 1: KPIs for PPM from literature

Strategic Fit	Value Maximization	Portfolio Balance
•Strategic Investment Value •Resources avaliablity •Spending alignment •Resources in product development •Strategically aligned	•Commercial prospect •ECV •Market attractiveness •Time to market •Sales turnover •Gross Margin •Net-margin •Profitability •Output vs resource allocation •Number of high value and return projects •IRR •NPV •Development cost •Cost per hour •Unit labor cost •Reduced unit labor cost	•Resource demand vs capacity •Long term / short terms products •High risk / low risk products •Balance of technology •Technical feasibility •Size of portfolio •Resource availability •Balance of markets •Market position and share

2.2.1 KPIs of Strategic Fit

In this section, KPIs pointed out in Table 1 are explained which are suitable to quantify the target of Strategic fit in PPM performance management (Cooper et al., 1999).

1. Strategic Investment Value:

   The targeted value of strategic investment for research and development activities of the organization is measured in comparison with the actual investment in R&D.
   Strategic Investment Value = Target € / Actual €
2. Resources availability:

   A number of available resources in the organization available for product development activities, both short and long term.
3. Spending alignment:

The indicator to highlight the expenditure of the allocated budget of the product and how resources are spent during the process.

4. Resources Index (Resources in product development):

   The ratio of a number of resources in the organization which was intended to be utilized (target) to the number of resources which were actually available. Resources are used for different operations in product development from R&D, sales, operations and services functions.

5. Strategically aligned:

   An indicator to highlight whether the products are aligned with the business strategy or not. Using techniques like strategic bucket and building strategic criteria using scoring models, can help to prioritize projects and products to be chosen for development (Cooper et al., 2001).

2.2.2 KPIs of Value Maximization

In this section, KPIs pointed out in Table 1 are explained which are suitable to quantify the target of Value Maximization in ideal PPM practices (Cooper et al., 1999).

1. Commercial prospect

   Solid commercial prospects of the products are analysed and financial opportunity is expected to get a quantifiable data about the product. It is a ratio or comparison between the expected value €, least expected value € and actual value €.

2. ECV

   Expected commercial value, determines the value or commercial standing of each product to the organization. It is a calculation based decision-making tool to make a decision tree and analyse the projects based on the future earnings it can bring, probabilities of commercial and technical success (Cooper et al., 2002).

3. Market attractiveness

   This would highlight the target size of the market and what are the opportunities of this market to grow potentially in future. The market would provide customer base, so competition and competitive products in the market are studied to highlight the indication of maximizing value from the product.

4. Time to market

   Time from product idea to its development and to its launch, this time is very critical for managers, to be the first in the market or at a reasonable time to maximize the profits.

5. Sales turnover

   The total amount of revenue generated by the organization during the calculation period, which is mostly a year without any tax calculation. It provides information about goods or services sold to the customers over calculation period.

6. Gross Margin

   It is a margin ratio to measure the efficiency in converting revenue dollars into profits over a given period of time. In simple words, it is the difference between the revenue and cost of products.

7. Net-margin

   It is calculated as the net profit.

8. Profitability

   This measures the net profit of an organization over a reporting period.

9. Output vs resource allocation

   The output is the product, and the profit it brings to the organization needs to analyse in comparison with the resources spent on the product.

10. Number of high value and return projects

    A number of highly valued products in the portfolio, which brings maximized value to the organization.

11. IRR

    The internal rate of return, on investment of the project is the effective compounded return rate. It is the rate of return in an organization, which sets the net present value of all the monetary cash flows from the investment to zero.

12. NPV

    By definition net present value, NPV is the difference between the present value of monetary inflows and the present value of monetary outflows. NPV is to be used with a bunch of other tools and KPIs to get an idea about other considerations such as strategy, constrained resources, using it alone will give false projections to run a business, which might be wrong (Cooper et al., 2002).

13. Development cost

    Cost beard by the organization to develop a product.

14. Cost per hour

    Cost beard by the organization, divided over per hour. Based on the calculations from total resources utilized.

15. Unit labour cost

It is the average cost of labour per unit output, and is calculated as a ratio of total labour costs to real output (product) in respect of the portfolio.

16. Reduced unit labour cost

    Reduction in the cost of labour per unit output, to the real output in respect of the portfolio.

2.2.3 KPIs of Portfolio Balance

In this section, KPIs pointed out in Table 1 are explained which are suitable to quantify the target of Value Maximization in ideal PPM practices (Cooper et al., 1999).

1. Resource demand vs capacity

   A balance between demand by the development teams for resources against the capacity of the organization. If demand is increasing way too much, there is a risk of portfolio explosion.

2. Long term / short terms products

   Outline the targeted long term and short term products, against the actual developed in both categories, to maintain the balance.

3. High risk / low risk products

   Outline the targeted high risk and low risk products, against the actual developed in both categories, to maintain the balance.

4. Balance of technology

   It is also an outline between the target and actual products of the technology that was planned and what was achieved.

5. Technical feasibility

   Where technical gap, the familiarity of the technology, technical track record and proof of concept from technical results are analysed to keep the technology balanced in the portfolio.

6. Size of portfolio

   A number of product families, sales items, components, common modules, are identified to keep a size of the portfolio realistic with organizational operations and to avoid risks like product cannibalism and portfolio explosion.

7. Resource availability

   Resource availability from marketing, sales, R&D, technical, operational, services to develop and maintain the products over life cycle which remain in the portfolio.

8. Balance of markets

Outline of the targeted vs actual markets that were planned, to analyse market penetration and impact of the portfolio.

9. Market position and share

   The products share in the market and how well they are performing against the other competitors.

The use of KPIs is not restricted only to measure performances, it can also be used as an effective forecasting tool, alike many product development activities, it is also ideal to implement a hybrid stage gate methodology for PPM practices. During the product development gates to see the progress of targets, projects and portfolio evaluation are orchestrated to verify the planned targets, and KPIs are used for this purpose, (Sanchez & Robert, 2010). As this approach, helps the companies and organizations to align their product portfolio based on strategy, maximised value and a portfolio balance related targets and KPIs.

2.3 New product development (NPD) and related targets and KPIs

2.3.1 NPD Process

NPD is considered to be the development of totally new products, improved products, modified products and new brands which are internally researched and developed by an organization (Kotler, 1991). NPD is the planning and execution of new products from a potential idea phase (Krishnan & Ulrich, 2001) to executing it through a streamlined process and ramping up the production to bring it to the market for customers (Ulrich & Eppinger, 2012).

However, in an NPD process, new sales item is developed, through extensive processes which Cooper (1981) defined as a step by step process of idea generation, preliminary assessment, review of concept, product development, prototype testing, trial sales and product introduction. Later Cooper (1983) proposed seven stages of new product development: 1) Idea generation 2) Preliminary assessment 3) Review of the concept 4) Product development 5) Prototype testing 6) Trial sales 7) Product introduction. But to define clearly the new product development Ulrich and Eppinger (2012) model is explained in more detail. This model divides the development of products into five stages, preceded by planning phase where the idea of the product and development activities are thought out and planned. In planning phase the opportunities are identified, evaluated and

prioritized, resources are allocated and pre-planning of the project starts by finalizing the product development plan. At this phase compliance with a mission statement and strategic alignment are evaluated (Cooper, 1999) to kick off the product development process (Ulrich & Eppinger, 2012).

New product development process continues by concept development, where needs are identified, targets are set, a product concept is created and tested and analysis of the possible financial benefits and competitors analysis is performed to understand the different products (Ulrich & Eppinger, 2012). In system level design phase the key elements of the product are defined and assembly of its sub elements/modules are designed. In detail design part, already established feasibility study about DfX is explored more in detail where the design requirements are coordinated and communicated with internal and external partners. In next phase, product prototypes are tested and refined to meet the requirements. After successful prototypes the new product is ramped up to prepare volume production (Ulrich & Eppinger, 2012).

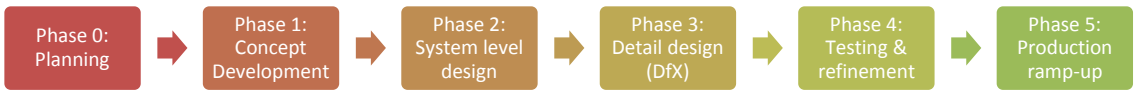

Figure 7: New product development process (Ulrich & Eppinger, 2012)

In addition to the NPD model by Ulrich and Eppinger (2012) there are many other theoretical approaches, such as *Stage-gate model* developed by Cooper (1990), where stages between phases are introduced to analyse the progress of each stage/phase. In a normal stage gate process, there are traditionally five stages. However Cooper (2008) realized that not all development projects go through these five stages, they are developed more rapidly. Therefore, Cooper (2008) has modified and altered the standard five-stage stage processes to multiple versions to fit the customized development method with different business case and project needs. The picture of the different type of product development can be seen below.

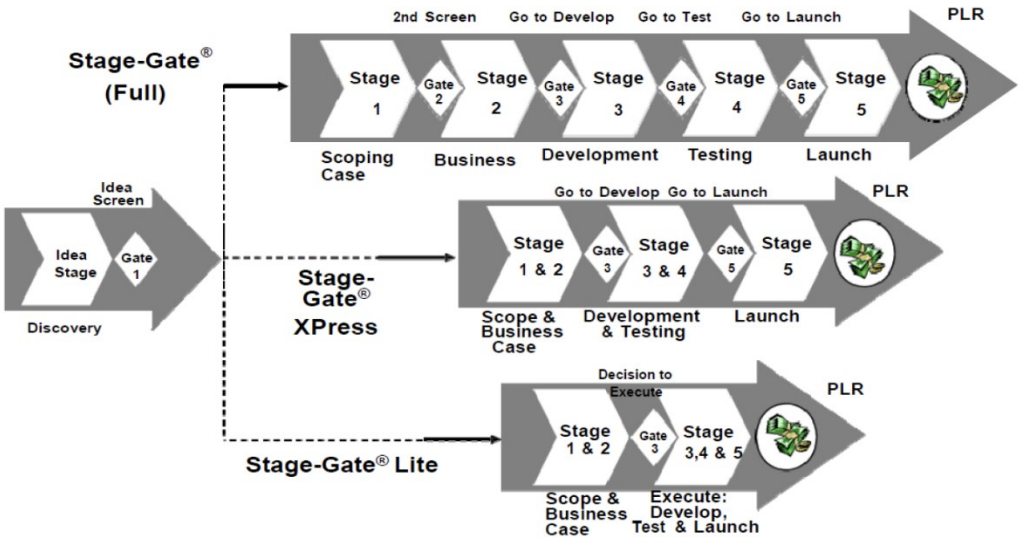

Figure 8: Overview of modified stage gate processes (Cooper 2008).

The modified version of stage gate process can be used to describe a normal full length NPD process, followed by stage gate process for minor development and improvements with moderate risks and lastly explaining very small development cycle for fast track development projects based on customer requests (Cooper, 2008).

In an organization, product development is given a lot of attention and importance thus new products can positively impact on their revenue, market share, share prices and net results (Cooper, 2011). Alike, portfolio management, performance management of NPD is important, as Neely et al. (2009) are persistent on the importance of performance measures for an organization to remain competitive. To make a strategic contribution to the organization, the management must link the NPD process with the strategy (Hertenstein & Platt, 2000).

2.3.2 NPD related targets and KPIs

To align the strategy with NPD, the NPD objectives must outline the targets and KPIs of NPD process. Highlighting such objectives and targets of NPD is very tricky, as less empirical research is available on specific objectives and targets which an organization tends to achieve. Cooper (2011) highlights that new products do bring positive impact on business in the organization. Targets of the product development process can be derived from the organization's strategy (Paramenter, 2010; Dombrowski et al., 2013). New products must be in line with organization's strategy and organizations are working to

link the strategy more and more in their NPD process (Hertenstein & Platt, 2000). Smith & Reinertsen (1998) identified four key objectives of NPD as project timeliness, product performance, development expense and product cost. Similarly, Dombrowski et al. (2013) categorized and identified the work from Mahidhar (2005) and Zheng et al. (2009) to classify three more targets for product development, along with sets of KPIs. Targets defined by Dombrowski et al. (2013) are effectiveness in product design, efficiency in product design and capability.

NPD targets can be categorized as following (Hertenstein & Platt, 2000; Smith & Reinertsen, 1998; Dombrowski et al., 2013; Mahidhar, 2005; Zheng et al..2009; Bhuiyan, 2011 and Ulrich & Epinger, 2012):

I. Strategic product
II. Cost bound
III. Quality
IV. Timeliness
V. Project performance

NPD managers prefer non-financial performance measures that assess the performance from critical strategic dimensions (Hertenstein & Platt 1997). The NPD related KPIs following indicators could be identified and categorized as follows (Ulrich & Epinger 2012, Taylor 2012, Dombrowski et al. 2013, Bhuiyan 2011 and Cooper 2001):

Strategic Product	Cost bound	Quality	Timeliness	Project performance
• Strategic Investment Value •Resources allocated •Strategically aligned •Return on Investment	• Development cost • Cost per hour • Economic Value added • Expected commercial value • Compliance to target cost • Economic efficiency over lifecycle	• Benchmark testing? • Compliance with requirements • Customer satisfaction • Use of existing manufacturing resources •Use of existing supplier resources	•Time to Market • Project lead time • Number of delays in project plan • Number of goals met on time • Project launched on time • Capability of supplier delivery • Supplier satisfaction index	• Customer participation • Output vs resource allocation • Clarity of requirements • Avaliablity of documentation

Figure 9: Targets and KPIs of NPD process

2.3.3 KPIs for Strategic product in NPD

In this section, KPIs pointed out in Figure 9 are explained which are suitable to quantify the target of Strategic product in NPD (Hertenstein & Platt, 2000, Hertenstein & Platt, 2000; Smith & Reinertsen, 1998; Dombrowski et al., 2013; Mahidhar, 2005; Zheng et al..2009; Bhuiyan, 2011 and Ulrich & Epinger, 2012).

1. Strategic Investment Value

   The targeted value of strategic investment for research and development activity of the organization is measured in comparison with the actual investment in R&D for development of new products. Strategic Investment Value = Target € / Actual €
2. Resources allocated

   A number of available resources in the organization available for new product development activities.
3. Strategically aligned

   Whether the new product is performing with the organization's strategy or not, however strategy is more heavily checked on a portfolio level. Using techniques like Strategic Bucket and building strategic criteria using scoring models, can help to prioritize projects and products to be chosen for development (Cooper et al., 2001).
4. Return on Investment (ROI)

   ROI compares the organization's yearly income with investment in the assets. Organization's ROI is useful is setting up the new product goals, as the metric will help to choose and select a returning product, which will align it more strategically (Bhuiyan, 2011).

2.3.4 KPIs for Cost bound in NPD

In this section, KPIs pointed out in Figure 9 are explained which are suitable to quantify the target of cost bound in NPD (Hertenstein & Platt, 2000, Hertenstein & Platt, 2000; Smith & Reinertsen, 1998; Dombrowski et al., 2013; Mahidhar, 2005; Zheng et al..2009; Bhuiyan, 2011 and Ulrich & Epinger, 2012).

1. Development cost

   How much it has cost the organization to develop the product by utilizing the resources, and is it exceeding the expected development cost. As sales and cost planning needs to be considered here.

2. Cost per hour

   The cost for an organization over the course of time, in unit hours on the development of the product.

3. Economic Value added

   It is an estimate of firm's economic profit, or the value the new sales item has created for the shareholders.

4. Expected commercial value

   Expected commercial value, determines the value or commercial standing of each product to the organization. It is a calculation based decision-making tool to make a decision tree and analyse the projects based on the future earnings it can bring, probabilities of commercial and technical success (Cooper et al., 2002).

5. Compliance to target cost

   The target cost, on which the organization planned to develop their new sales item, is it compliant with the target cost or not.

6. Economic efficiency over life cycle

   The new sales item has a lifecycle from development to production ramp-up till ramp-down. The sales plan and cost plan for the new product needs to be efficient over the lifecycle, so the product remains compliant to organization strategy and keeps on bringing profits.

2.3.5 KPIs for Quality in NPD

In this section, KPIs pointed out in Figure 9 are explained which are suitable to quantify the target of product performance in NPD are termed as a target of Quality in NPD (Hertenstein & Platt, 2000, Hertenstein & Platt, 2000; Smith & Reinertsen, 1998; Dombrowski et al., 2013; Mahidhar, 2005; Zheng et al..2009; Bhuiyan, 2011 and Ulrich & Epinger, 2012)..

1. Benchmark testing

   The benchmark test, to measure the product performance and quality in compliance with existing benchmark of quality which is set by the organization.

2. Compliance with requirements

The new sales item which is made is it compliant with the requirements put forward by the customers or the marketing department.

3. Customer satisfaction

   The lead users, customers find the product compliant with their uses

4. Use of existing manufacturing resources

   Whether the organization is relying on the existing manufacturing resources or looking for new options, then the error ratio of the manufacturer is also needed to be considered.

5. Use of existing supplier resources

   Whether the organization is relying on the existing supplier resources or looking for new options, then the error ratio of the supplier is also needed to be considered.

2.3.6 KPIs for Timeliness in NPD

In this section, KPIs pointed out in Figure 9 are explained which are suitable to quantify the target of project timeliness in NPD (Hertenstein & Platt, 2000, Hertenstein & Platt, 2000; Smith & Reinertsen, 1998; Dombrowski et al., 2013; Mahidhar, 2005; Zheng et al..2009; Bhuiyan, 2011 and Ulrich & Epinger, 2012).

1. Time to Market

   Time to market is one of the most important metrics for the new product success. After the product development, the organization needs to maintain their project timeline, when to ramp up the production and send the product to market, delay in time to market, decreases chances of product success.

2. Project lead time

   It is the latency between the initiation and the completion of a project. This indicator measure is the project on time, or how much early/late it was completed in comparison to the actual schedule.

3. Number of delays in project plan

   The development process is divided into small phases and stages, just like a stage gate process, and delays in the plan are noted and fixed for effective product performance.

4. Number of goals met on time

   Similarly to stage gate models, a number of project goals that were completed, and milestones which were completed as planned.

5. Project launched on time

   Similar to project lead time, but just an indicator to highlight the overall project timeliness.
6. Capability of supplier delivery

2.3.7 KPIs for project performance in NPD

In this section, KPIs pointed out in Figure 9 are explained which are suitable to quantify the target of effectivity and capability of product and product performance (Hertenstein & Platt, 2000, Hertenstein & Platt, 2000; Smith & Reinertsen, 1998; Dombrowski et al., 2013; Mahidhar, 2005; Zheng et al..2009; Bhuiyan, 2011 and Ulrich & Epinger, 2012).

1. Customer participation

   The involvement of customer in the product development process to come up with requirements and to test the prototypes.
2. Output vs resource allocation

   The new sales item or product developed over a certain period of time divided by the total number of product development employees to check the effectivity of the product development process and utilization of the resources.
3. Clarity of requirements

   The product development team works on requirements, and need to match time, clarity in requirements is needed for development process to work smoothly, and delay in requirements will lead to delay in project time.
4. Availability of documentation

   Availability of the product documentation from the idea stage to the entire development process.

2.4 Rapid product development (RaDe) and related targets and KPIs

2.4.1 Rapid product development (RaDe)

A remarkably innovative product and rapid time to market are the critical objectives of an NPD manager (Fang, 2008). Short product lifecycles and development times are

important for an organization, which is achieved by rapid and successful positioning of new products to the market (Bollinger et al. 2000). The rapid positioning of the product, is in response to a shortened product development time. However, as argued by Harter et al. (2000), rapid and faster development of products have also been linked with effective and enhanced team coordination, less redundancy in work and fewer errors. Ali et al. (1995) argue that development team is consolidated with the rapid pace of work, which allows the team to focus on the elements of product design, which is more relevant and important for the customers. Seeing the past studies, it can be said that reduction of time in product development may improve the acceptance rate by the customers (Kessler & Chakrabarti 1996).

During normal product development process team cohesion is needed, however it becomes more needful when the organizations have to respond faster. According to Schilling (2008), effective product development process requires cooperation and coordination across the team's divisional boundaries. The importance of coordination and effective team building is also argued by Brown and Eisenhardt (1995) that team building for NPD is an indispensable aspect of the team would be developing the idea and concept into a designed product. However, team coherence depends on many factors, eventually helping the product development. Reducing the development time, would increase the cohesion among team members resulting in few errors and mistakes after the product launch (Chen et al., 2005).

As explained by Cooper (2008), small development cycles for fast track developments based on customers are a need of the industry. Rapid product developmental projects are a common practice in the industry to create new sales items (Lohikoski et al. 2014), where accelerated product development takes place, but very little empirical research is present on this matter (Kaikkonen et al. 2015). Subsequently, rapid product development (RaDe) is a new concept developed at University of Oulu by researchers from the field of industrial engineering and management. Vigna et al. (2015) explained that RaDe is an incremental NPD process that is determined to develop new sales item by redesigning or updating the existing product in a more rapid and inexpensive way.

The focal point of RaDe is fast track product development, by keeping in mind agile methodology in for effective organizational management and smooth communication process (Vigna et al. 2015). In order to remain competitive, Van Echtelt et al. (2008) says

that the product development performance comprising of speed, cost and product performance have become more and more demanding. All organizations, whether small or large in their resources, faces an identical challenge to bring new products to the market in a rapid way (Ledwith et al., 2006). It becomes more important in RaDe projects to consider the information flow in an organization and coordination between different departments. When such factors are given importance to, these factors pave a way to address the issues which may hinder the development process, eventually resulting in rapid and fast project completion (Lohikoski et al. 2014). Subsequently, to make the product more penetrative in the target market, new product development managers require an innovative product and quick time to market, to fulfil these roles they often bring original equipment manufacturers (OEM) into their development process (Fang, 2008). Involvement of OEM into the development process, helps the managers identify the concerns of them, to maintain a quick time to market (Fang, 2008).

RaDe provides, guidelines and line of action to create strategic products that would fit company's portfolio (Vigna et al. 2015). Portfolio management of an organization is all about resource allocation, how they are allocated for R&D, engineering, operations and product development, when the resources are more extensively used (Roussel et al., 1991). The importance of team design and the building is taken well care of in RaDe as it focuses on modifying existing products, the product itself influences team design (Vigna et al., 2015). However, similar to NPD and other products, it is important to keep RaDe products strategic with the portfolio. Tolonen et al. (2014) explained the concept of product portfolio of a company, we can modify the image to incorporate RaDe products as a part of the portfolio, which can be seen below.

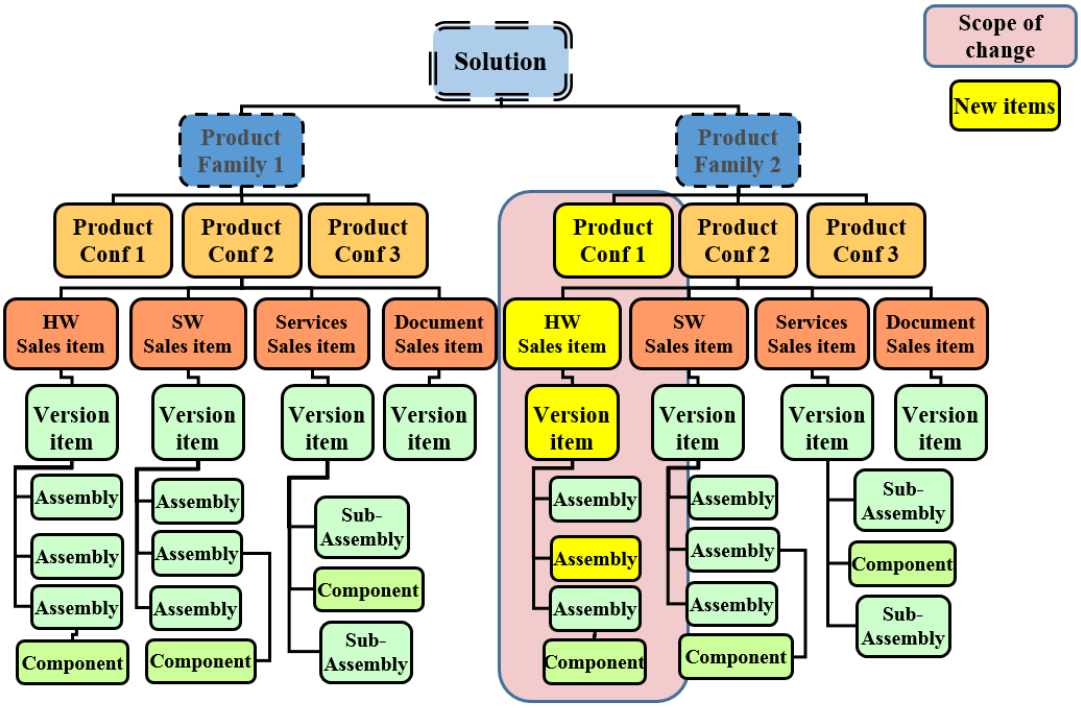

Figure 10: Scope of rapid product development on a product structure (modified from Tolonen et al. 2014).

Since RaDe is either an incremental NPD, which updates or redesigns existing products (Vigna et al., 2015), the picture modified from Tolonen et al. (2014) shows how new items are incorporated and a new sales item is visible in the portfolio. The need for a new sales item may arise internally or externally when customer requests modified version. Implementing such change and introduction of new sales item in the portfolio requires performance management on portfolio level to avoid risks like product cannibalism (Srinivasan et al., 2005) and to performance management on development level to keep a check on project quality, cost, time and its strategic nature (Hertenstein & Platt, 2000; Smith & Reinertsen, 1998).

2.4.2 RaDe related targets and KPIs

Verrollot et al. (2016) proposed strategic targets and key performance indicators, both as a challenge and a pre-condition for RaDe process. All the new and existing products of an organization, require a different type of target settings and performance indicators (O′Reilly & Tushman, 2004) to measure their performance and effectively manage them. RaDe specific targets and KPIs should be defined by the organizations, as the targets

should be connected with organization's portfolio in order to create a strategic RaDe products (Verrollot et al., 2016).

RaDe targets and metrics will be adopted similar to NPD targets. Time to market and customer participation are very crucial aspects of RaDe. NPD targets will deem fit for RaDe, with special importance to constraints of time to market and customer participation (Vigna et al., 2015). NPD targets, which would be suitable for RaDe to manage the product development activity with targeted cost, time and quality, targets are as follow (Hertenstein & Platt, 2000; Smith & Reinertsen, 1998; Dombrowski et al., 2013; Mahidhar, 2005 and Zheng et al..2009):

I. Strategic product
II. Cost bound
III. Quality
IV. Timeliness
V. Project performance

The targets of RaDe are similar to NPD targets as they cover the product development activity as well. However, performance indicators and KPIs relevant for RaDe considering they are adopted from NPD.

Most of the KPIs related to RaDe are explained in section 2.3 with KPIs of NPD, however few KPI's are only valid for RaDe and will be explained in more detail. After a thorough study from the different KPIs from Cooper et al. (2001), Ulrich & Epinger (2012), Taylor (2012), Dombrowski et al. (2013) and realizing the need of KPIs that would deem fit for the defined targets of RaDe can be found categorized in the picture below.

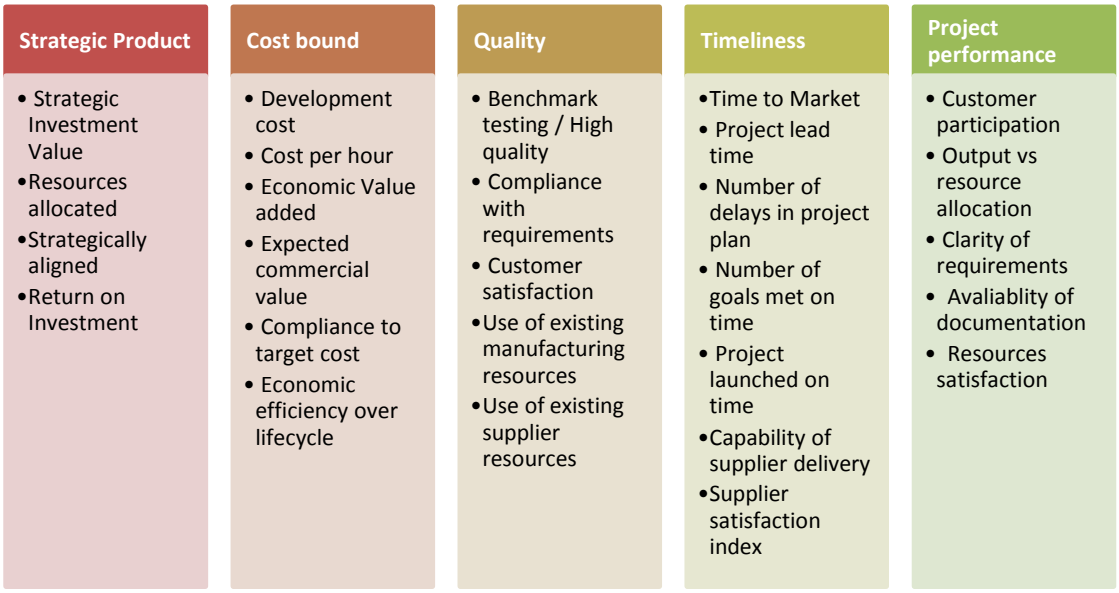

Figure 11: Targets and KPIs of NPD process

The KPIs for NPD and RaDe are very similar and have been explained earlier in section 2.3. However, as the RaDe project proceeds with the formation of collocated teams and for this reason, an additional KPI of resources satisfaction is pointed out in Project performance target of RaDe.

2.4.3 KPIs for project performance in RaDe

1. Resources satisfaction:

   RaDe team comprises of collocated and cross-functional teams, therefore the resources satisfaction is to be measured during and after the project to analyse the team cohesion in the process.

2.5 Theory synthesis

The literature review highlights the performance management in general and related to PPM, NPD and RaDe.. Strategy, CSF, targets, KPIs, coherence with strategy, information flow and organization culture are the enablers for effective performance management.

The literature review of PPM and its targets and KPIs highlight an important factor of strategy, which needs to be reflected in the portfolio (Cooper, 1999). However, the NPD and RaDe produces new sales items to the portfolio thus the related targets and KPIs need

to be strategically aligned (Hertenstein & Platt 2000, Müller et al. 2008) as well, which is a common target for PPM, NPD and RaDe related performance management. The NPD and RaDe related activities can be divided into two phases: 1) analysis and decision making and 2) product development implementation phase. According to literature, the targets and KPIs related to PPM and NPD have been studied earlier but more independently. There are less theoretical and empirical data available about RaDe related targets and KPIs. Verrollot et al. (2016) mentioned in the results that case companies have specific challenges to define RaDe targets and KPIs related to cost, project duration and development process.

In Phase 1 both NPD & RaDe processes, there should be analysis and decision making for developing new sales item. This analysis and decision making is very similar than with PPM related analysis and decision making. NPD and RaDe development decisions are made before the product concept and development phases. These decisions should be strategic in nature, aiming to maximize the value and maintain the balance in the portfolio. It can be synthesized that PPM targets and KPIs can be used for analysis and decision making criteria to start NPD or RaDe. In Phase 2 the NPD & RaDe related performance targets and KPIs are very similar.

3 EMPIRICAL CURRENT STATE ANALYSIS

3.1 Case Companies

This study was carried out on two case companies. Their practices related to performance management of PPM, NPD and RaDe were studied to validate the findings from the literature. Case company A is a medium sized, provider of locking solutions to a wide range of customers, based in Finland. Moreover, case company B is a global iron and steel manufacturer who develops tangible products in-house in their production facilities all over Scandinavia. A comprehensive extract of the case companies and the profile of the interviewee's profiles are described below.

Table 2: Summary of case companies and their interview details.

Case	Company type and size	Product type	No of interviews	No of interviewees	Role of the interviewees
A	Construction installation equipment. Medium	Tangible and intangible	1	1	• CTO
B	Iron and steel Large	Tangible	1	3	• Product Planning Manager • Product Development Manager • Product Manager

3.2 Research process for empirical current state analysis

The empirical study was carried out by designing a questionnaire (attached in Appendix A). The questions were designed very carefully based on the literature review to analyse the current practices in the case companies. The questionnaire was sent out to case companies. In addition further interviews were separately organised to analyse their PPM, NPD and RaDe related performance management targets and KPIs. The interviews turned out to be very informative and much information was gathered. The current state analysis study provided the needed practical insight and data about the case companies

performance management in the field of PPM, NPD and RaDe. Moreover the responses collected were analysed and compared with the practices from the literature, which aided in forming the results of this study.

3.3 A performance management process in case companies related to PPM, NPD and RaDe

The performance management process in case companies A and B was very clearly defined. The strategy translates the company's thoughts into the desired level of performance which is meant to be achieved through set targets, which the case companies have defined internally. These targets set the performance levels, which are measured quantitatively and qualitatively using the KPIs. This kind of holistic performance management model can analyse the performance gaps and fix the areas which need support.

3.4 Product portfolio management targets and KPIs

3.4.1 Case Company A

Case company A's product portfolio is a mixture of both tangible and intangible products, which are planned, budgeted and forecasted for a year and are reviewed monthly in the product management group (PMG) meeting. The profitability of different product lines is measured and studied. The decisions about the product lines and new products are strategic in nature as the best possible result for the company is chosen. When a new product is to be developed and accepted in the portfolio, there is often the acceptance of new products even with the less profitability for the company, due to difficulties to set price in the market or the new product will help the company secure more businesses. The strategic nature of the products are verified in the start of the new product development when the product planned is studied with the customer groups, market segments it will have. The PMG will review the new product ideas, evaluate them and will decide if it is a strategic fit for the company or not. Similarly the product lines at the case company A, are very strictly defined, so all the new products developed in the current business line is an incremental development project based on customer needs and is specific for that customers. The new product families or business lines are independent from the already existing business lines with their already defined customers. However, in the yearly planning, the balance of the high risk and low risk products in the

organization are studied as a part of a strategy review and risk assessment. So the targets which are fulfilled to maintain the product portfolio are *strategic fit* and *profitability*. Like any other organization, case company also measures the target fulfilment with the help of KPIs which are updated once a month and reviewed by the PMG in the monthly meetings to analyse the profitability of a product/product family. The KPIs which are currently used are:

Strategic Fit:

1. Strategic Investment Value: The targeted value of strategic investment for research and development activities of the organization which are budgeted and are measured in comparison with the actual spending, it is reviewed on a monthly basis. Strategic Investment Value = Target € / Actual €
2. Spending alignment: The indicator to highlight the expenditure of the allocated budget of the product and which resources are spent during the process. It is followed monthly in PMG meetings.
3. Strategically aligned: A KPI measured at the start of product development / product introduction, where the new strategy is updated yearly. An indicator to highlight whether the products are aligned with the business strategy or not.
4. Market Attractiveness: It is a part of strategic and budget planning, where the market sizes are evaluated where to go next, and which type of products to developed.
5. Market position and share: On a yearly basis the competitor analysis is done to see where does case company, stands in the market and has it achieved it last year goals and what will be the goals for coming year.

Profitability (Value Maximization):

1. Financial metrics: During monthly PMG meetings, financial metrics are checked such as sales turnover, gross margin, net margin, net profit, profitability in a month, and profitability over quarters. These financial metrics are measured and act as a KPI to see the progress of portfolio.
2. Financial yearly metrics: On the yearly basis internal rate of return (IRR), net present value (NPV) and expected commercial value (ECV) are evaluated to get an understanding of the cash flows and profitability.

3. Commercial prospect: Sales data is collected and reviewed by the sales director in PMG meetings on a monthly basis, where it is reviewed and compared to forecasted value. [Expected € / Actual €]
4. Development cost: it is measured on a monthly basis where the overall product development costs are monitored giving information about how much spending has been done in R&D and whether is it going with the budgeted value or not.

It can be said that PMG monthly meetings are very crucial to measure the performance of the business line. In these meetings, apart from the PPM practices, operational matters are discussed as well such as delivery times, delivery accuracy, and a quality matrix of a product / product line. Decisions of maintaining the portfolio, like product plan, launch, kill, maintain decisions are made in the PMG meeting as the meeting can be called upon when needed, it can be monthly, twice in a month or yearly as well. However, it was discovered that the targets of the PPM act as a decision maker for new product development and are discussed in more detail if new product family is to be developed.

3.4.2 Case Company B

Case company B's product portfolio is comprised of tangible products, which are planned, budgeted and forecasted for a period of three years, where the product management group makes the *product offer plan* (POP). The POP is composed of short term and long term products for the portfolio, discussed annually. However to measure the practices of PPM, the profitability of different product lines are measured and studied. The decisions about the product lines and new products are strategic in nature and must be in line with the company's overall strategy and bring maximum profit. The case company's portfolio focus is on one premium product group and its manufacturing and sales volume, which brings the most profitability.

When a new product is developed, its product development plan (PDP) is analysed carefully to fit into the product portfolio and its effect on the existing items in the portfolio are evaluated. However, there are no specific KPIs for maintaining the portfolio balance, apart from keeping the product volumes in a limited storage.

The product management team supervised by senior managers, are responsible for adding or taking out any sales item from the product portfolio. The decision to kill or initiate a product happens in an annual meeting, where POP helps to proceed with the development.

Whereas the removal of a product from a portfolio is based on the assessment of sales volume and storage capacity of the organization. However, the portfolio of the company is very responsive, where completely new products are not more than five in a year. The incremental development related to making a variant of an existing product is a common practice, which happens when a product variant can be made by changing the materials composition. If the product variant, is not just a change in the material composition, then the POP is created to decide whether it will proceed with a RaDe or NPD related activity.

Generally, KPIs are used to analyse the target fulfilment and performance measurement of the POP on a portfolio level, where sales and development of these products are analysed by the product management team over the lifecycle. KPIs are decided based on the strategy and are discussed yearly in annual plan of the case company. In the annual meeting, targets and KPIs are reviewed and are not changed during the year. The KPIs which are currently used are:

Strategic Fit:

1. Strategically aligned: A KPI measured at the start of product development / product introduction, where the new strategy is updated yearly. An indicator to highlight whether the products are aligned with the business strategy or not.

Profitability (Value Maximization):

1. Financial metrics: During annual product management team meetings, financial metrics are checked such as sales turnover, gross margin, net margin, net profit, profitability in a month, and profitability over quarters. These financial metrics are measured and act as a KPI to see the progress of products present in the portfolio.
2. Financial yearly metrics: On the yearly basis internal rate of return (IRR), net present value (NPV) and expected commercial value (ECV) are evaluated to get an understanding of the cash flows and profitability.
3. Sales Volume: Sales volume of the product sold in tons will highlight the revenue the product has brought to the organization.

These targets of the portfolio, actually formulate the POP of a product development activity, and the PDP is formulated to commence the development activity.

3.5 NPD targets and KPIs

3.5.1 Case Company A

In case company A, NPD project is backed by a team who will be developing the new product. Employing the collective responsibility of the NPD team for the performance, which is driven by the *program manager*. The decision to start the new product is taken in PGM meetings, where the product idea is verified to be strategic in nature and initial profitability is forecasted along with sales plan and cost plan before commencing the development activity.

During the product development activity, the most important target is to remain *cost effective* and follow the budgeted cost for the development activity. Apart from that *timeline* of the project is critical and reviewed monthly in PGM meetings to keep track of the progress and fulfil the goals on time. However, *quality* is considered important, but it is a target which is considered to be fulfilled by itself due to high R&D and development standards at company A. Monthly PGM meetings are crucial for NPD and performance management related to it, where company's pre-defined KPIs are monitored to highlight the performance in the product development activity. The KPIs used by Company A, is:

Cost effective:

1. Development cost: How much it has cost the organization to develop the product by utilizing the resources, and is it exceeding the expected development cost. As sales and cost planning needs to be considered here.
2. Economic Value added: It is an estimate of firm's economic profit, or the value the new sales item has created for the shareholders.
3. Expected commercial value: Expected commercial value, determines the value or commercial standing of each product to the organization. It is a calculation based decision-making tool to make a decision tree and analyse the projects based on the future earnings it can bring, probabilities of commercial and technical success (Cooper et al., 2002).
4. Compliance to target cost: The target cost, on which the organization planned to develop their new sales item, whether it is compliant with the target cost or not.

Project timeline:

1. A number of delays in project plan: The development process is divided into small phases and stages, just like a stage gate process, and delays in the plan are noted and fixed for effective product performance. In PGM meetings, actual plan is compared with the current project timeline and actions are taken if it is lagging.
2. Time to market: The development time is monitored, and if there are multiple delays in the project, more resources are allocated to follow the expected time to market.

Quality:

1. Testing: The products are thoroughly tested and the prototypes are shown to the customer before mass manufacturing.
2. Customer Participation: A pilot phase is designed to test the product, and to get customer acquainted with it. If there are concerns of the customer on the product, then the product is revised and suggestions are taken into consideration.
3. Customer Satisfaction: A yearly survey is done, which is not a part of the development process, but the results of the survey help the case company A, to understand the customer needs and requirements more.

3.5.2 Case Company B

In case company B, NPD project is backed by a team who develop the new product. Employing collective responsibility of the NPD team for the performance, which is driven by the project manager. The progress of NPD project is reviewed on a monthly basis, and if the NPD manager needs more resources or some key blocking issues, it is discussed then. The decision to start the new product is taken after a careful analysis of POP, which would see its effect on the portfolio and what is in it for the company to start the project and allocate resources for the purpose.

During the product development activity, there are project specific targets which are highlighted in PDP, such as mechanical properties, usability properties, which are reviewed in monthly meetings, but these project specific targets are set before the initiation of the PDP. The overall targets which remain same in all the NPD activities would be *profitability*, *strategic*, *quality rejection levels, time window, production efficiency* and *a cost estimation.*

The most important target is to remain cost effective and follow the time window that was allocated from the start of the project. It is reviewed monthly in meetings to keep track of the progress and fulfil the goals on time. Monthly product management team meetings are crucial for NPD and performance management related to it, where KPIs are monitored to highlight the performance in the product development activity. The KPIs used by Company B, are:

Cost effective:

1. Development cost: The cost to develop the product by utilizing the resources, and whether it is exceeding the expected development cost or not. In addition, sales and cost planning needs to be considered here.
2. Economic Value added: It is an estimate of firm's economic profit, or the value the new sales item has created for the shareholders.
3. Expected commercial value: Expected commercial value, determines the value or commercial standing of each product to the organization. It is a calculation based decision-making tool to make a decision tree and analyse the projects based on the future earnings it can bring, probabilities of commercial and technical success (Cooper et al., 2002).
4. Compliance to target cost: The target cost, on which the organization planned to develop their new sales item, whether it is compliant with the target cost or not.

Project timeline:

1. Number of delays in project plan: The development process is divided into small phases and stages, just like a stage gate process, and delays in the plan are noted and fixed for effective product performance. In PGM meetings, actual plan is compared with the current project timeline and actions are taken if it is lagging.
2. Time to market: The development time is monitored, and if there are multiple delays in the project, more resources are allocated to follow the expected time to market.

Quality:

1. Testing: The products are thoroughly tested and the prototypes are shown to the customer before mass manufacturing.

2. Customer Participation: A pilot phase is designed to test the product, and to get customer acquainted with it. If there are concerns of the customer on the product, then the product is revised and suggestions are taken into consideration.
3. Customer Satisfaction: A yearly survey is done, which is not a part of the development process, but the results of the survey help the case company A, to understand the customer needs and requirements more.

3.6 RaDe related targets and KPIs

3.6.1 Case Company A

In case company A, the decision to initiate a RaDe project, which is considered a small development activity in case company A, is discussed in the PGM meeting to consider its effect on the product portfolio. Since, the RaDe related activities in the case company A, are very small and targeted for a new market, so there is no or very insignificant possible impact on the existing product family.

After the project initiation decision to start a RaDe project, few members of the NPD team who are responsible for making a new variant of the existing sales item. D*esigner(s)* are given this task to run the development of a variant product, with a cross functional team. In the case of need, for example from marketing, sales or operations, headed by the technical R&D team leads like CTO of Mechanics CTO of Electronics. In monthly meetings, the performance is analysed and if more resources are needed in the RaDe activity, it is done so.

The targets of the RaDe are same as the NPD targets, which were identified to be cost, quality and time. The mentioned targets are measured using the KPIs which are same as NPD related KPIs, to measure its performance. In RaDe related activities, more emphasis is paid to financial matters, hence it can be said that *cost effectiveness* is considered the most important target for such activities. However the case company A, understands the importance of time in RaDe but the performance of project timeline is not worried upon. Therefore, to maintain the timeline the case company does not go forward to look for new suppliers and manufacturers, and will rely on their existing contractors.

3.6.2 Case Company B

In case company B, RaDe project, which is considered as an incremental development activity in case company B, cannot be made through changes in material composition. The major difference between NPD and RaDe related activity is the time duration of the project. A standard NPD project takes place over a period of 6 months, but RaDe projects are usually half the time, approximately 3 months.

The decision to initiate a RaDe project is taken in the monthly meetings, where the business plan and POP are made to analyse the effect of the new product on the existing product and its commercial benefits. Unlike NPD, the decision-making process is a lot quicker as a more simplistic product is developed with some incremental changes. Product manager, manager of product planning, manager of product development and manager of production are in charge of decision making to initiate a RaDe project after carefully analysing the POP, and drawing guidelines for the PDP. It is followed up by nominating a project manager for the specific RaDe project, who will build the team to work on the project. The project team for RaDe follows the guidelines of PDP and proceed with the activities of RaDe project.

The RaDe targets are same as the NPD ones which were identified to be cost, quality and time. The mentioned targets are measured using the same KPIs than NPD related KPIs. They are used to measure the performance of the ongoing RaDe project, the only difference is the critical amount of time. The targeted performance level is very similar to NPD, where the end result of the product matters the most. In case company B, more emphasis is paid on the timeline of RaDe project, and special resources are dedicated to achieving the project in the mentioned period.

3.7 Performance Management Culture

3.7.1 Case Company A

In Case Company A, the overall organizational culture is heading towards a performance measured system. The quality systems are being developed in the organization to measure the performance and KPIs are in practice to assess the performance of the processes and resources. The organization resources are impartial of these changes and it allows a proper information flow in the organization. As to achieve these performance levels,

organization culture supports the work of cross functional teams, which are currently evaluated informally but the resources are not hesitant of the performance measurement.

3.7.2 Case Company B

In Case company B, the overall organizational culture is very supportive of performance management in overall operations and their products. Such support, also allows the company to introduce the measures which ensure the performance of different areas of portfolio, product development activities and human resources. To achieve these performance levels, organization culture supports the work of cross functional teams, which allows the resources to share their expertise and develop a product, which helps the company to maintain their market leadership role.

3.8 Empirical synthesis

The case companies that were analysed during the research process were very different in their business lines but shared many common practices related to performance management, portfolio management and product development. There were not any contradictions in the operations of the both companies.

However, there were many instances when a clear difference between the theory and practice was observed. In PPM performance management was not fully employed by the case companies. The Portfolio balance was not mentioned formally by case companies as their targets but the case companies considered the effect of portfolio balance in some perspective. Therefore it is important to identify it as a target and bring into use for ideal PPM practices in the organizations. Similarly, the set of KPIs for PPM practices were very limited and would give the case companies a limited competitive edge to effectively manage the performance of their PPM.

However, it was discovered that the NPD and RaDe follow the same set of performance management indicators. They are very much aligned with the theory, however targets such as the strategic product are checked during the planning phase of the development activities. Internal meetings in the case companies cover the project performance target, where the issues are analysed in detail, however it's related KPIs are utilised to comply the targets of Quality, Cost and Time.

4 RESULTS

This chapter will highlight the results of the study and present the outcomes that were deduced from the literature review and empirical analysis.

4.1 Performance management framework and process

Pre-conditions for the portfolio management (Tolonen et al., 2014) will help an organization to set up the PPM. After the implementation, an effective portfolio management and strategy help identification of the success factors, which are deterministic from the nature of NPD and RaDe. The success factors such as cross functional teams, management support and a supportive organizational structure are important in defining the targets for the NPD and RaDe activities. The product development process starts with targets and the performance is measured with the help of indicators. PPM targets and KPIs should be seen as the criteria to start NPD and RaDe related product development activities.

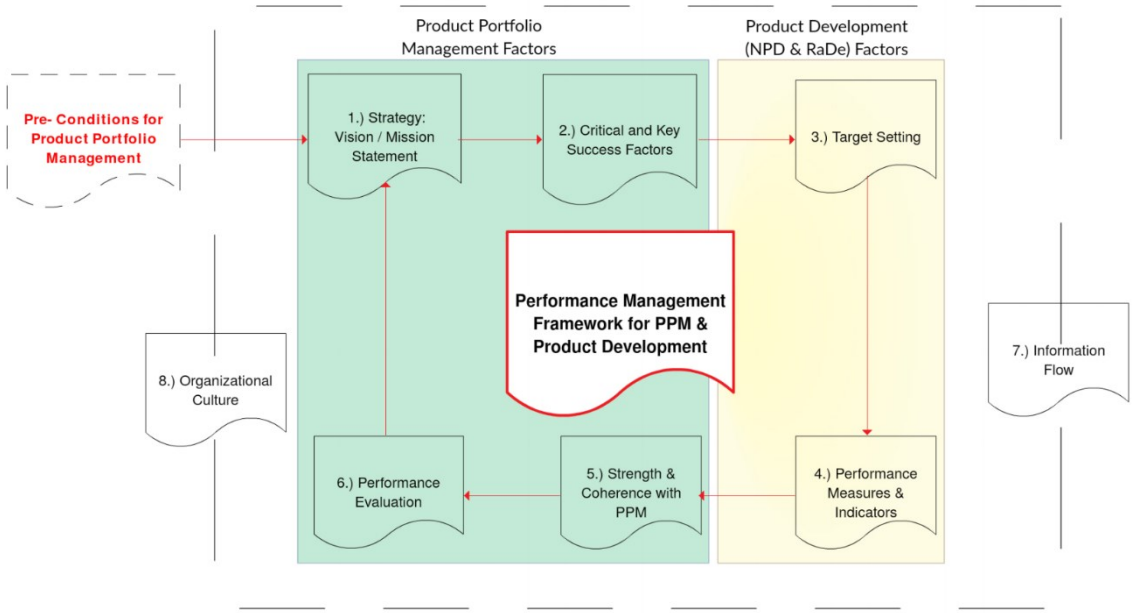

Figure 12: Performance Management framework for PPM, NPD and RaDe

This framework, will guide the organizations in implementing effective PPM practices as a trigger for the NPD and RaDe related product development activities.

The information flow in an organization along with the organizational systems and networks, are important for implementing any PMS. Information flow and organization culture, act as secondary drivers for the product development activities, and hence are included independently in the framework for effective performance management of the product development activities in the organization.

4.2 PPM targets and KPIs

The PPM performance management can be well divided over all the lifecycle of any product. PPM metrics do provide the related analysis and decision making for the product, which acts as an enabler for efficient NPD and RaDe processes. The targets and KPIs for the existing and new (new sales item) products in the portfolio are studied and analysed from different perspectives. The PPM targets valid over the lifecycle are as such, *Strategic Fit, Value Maximization* and *Portfolio Balance*. The KPIs which are valid for the each target for existing products in the portfolio are summarized as below:

Strategic Fit:

1. Strategically aligned:

   An indicator to highlight whether the products are aligned with the business strategy or not. Using techniques like Strategic Bucket and building strategic criteria using scoring models, can help to prioritize projects and products to be chosen for development (Cooper et al., 2001).
2. Strategic Investment Value:

   The targeted value of strategic investment for research and development activities of the organization is measured in comparison with the actual investment in R&D.
   Strategic Investment Value = Target € / Actual €
3. Spending alignment:

   The indicator to highlight the expenditure of the allocated budget of the product and how resources are spent during the process.
4. Resources availability:

   A number of available resources in the organization available for product development activities, both short and long term.

5. Resources Index (Resources in product development):

   The ratio of a number of resources in the organization which was intended to be utilized (target) to the number of resources which were actually available. Resources are used for different operations in product development from R&D, sales, operations and services.

Value Maximization:

1. Commercial prospect

   Solid commercial prospects of the products are analysed and financial opportunity is expected to get a quantifiable data about the product. It is a ratio or comparison between the expected value €, least expected value € and actual value €.
2. Economic value of the new product individually

   Economic value added (EVA) is the estimate of the financial profit the product is going to add for the organization. When a new sales item is to be developed, the study of EVA will predict the future capital the new sales item can bring for the organization. As an EVA links strategic planning with the operating divisions (Stern et al., 1995).
3. Economic value of the product portfolio

   EVA of the product portfolio level by adding a new product into product portfolio. This will analyse the effect of new sales item over the existing product items.
4. Time to market

   Time from product idea to its development and to its launch, this time is very critical for managers, to be the first in the market or at a reasonable time to maximize the profits.
5. Output vs resource allocation

   The output is the product, and the profit it brings to the organization needs to analyse in comparison with the resources spent on the product.
6. Development cost

   Cost beard by the organization to develop a product.
7. Cost per hour

   Cost beard by the organization, divided over per hour. Based on the calculations from total resources utilized.
8. Unit labour cost

It is the average cost of labour per unit output, and is calculated as a ratio of total labour costs to real output (product) in respect of the portfolio.

9. Reduced unit labour cost

   Reduction in the cost of labour per unit output, to the real output in respect of the portfolio.

10. ECV

    Expected commercial value, determines the value or commercial standing of each product to the organization. It is a calculation based decision-making tool to make a decision tree and analyse the projects based on the future earnings it can bring, probabilities of commercial and technical success (Cooper et al., 2002).

11. Market attractiveness

    This would highlight the target size of the market and what are the opportunities of this market to grow potentially in future. The market would provide customer base, so competition and competitive products in the market are studied to highlight the indication of maximizing value from the product.

12. Sales turnover

    The total amount of revenue generated by the organization during the calculation period, which is mostly a year without any tax calculation. It provides information about goods or services sold to the customers over calculation period.

13. Gross Margin

    It is a margin ratio to measure the efficiency in converting revenue dollars into profits over a given period of time. In simple words, it is the difference between the revenue and cost of products.

14. Net-margin

    It is calculated by finding the net profit as a percentage of revenue.

15. Profitability

    This measures the net profit of an organization over a reporting period.

16. Output vs resource allocation

    The output is the product, and the profit it brings to the organization needs to analyse in comparison with the resources spent on the product.

17. Number of high value and return projects

    A number of highly valued products in the portfolio, which brings maximized value to the organization.

18. IRR

The internal rate of return, on investment of the project is the effective compounded return rate. It is the rate of return in an organization, which sets the net present value of all the monetary cash flows from the investment to zero.

19. NPV

    By definition net present value, NPV is the difference between the present value of monetary inflows and the present value of monetary outflows. NPV is to be used with a bunch of other tools and KPIs to get an idea about other considerations such as strategy, constrained resources, using it alone will give false projections to run a business, which might be wrong (Cooper et al., 2002).

Portfolio Balance:

1. Size of portfolio

   Number of product families, sales items, components, common modules, are identified to keep a size of the portfolio realistic with organizational operations and to avoid risks like product cannibalism and portfolio explosion.

2. Long term / short terms products

   Outline the targeted long term and short term products, against the actual developed in both categories, to maintain the balance.

3. High risk / low risk products

   Outline the targeted high risk and low risk products, against the actual developed in both categories, to maintain the balance.

4. Technical feasibility

   Where technical gap, the familiarity of the technology, technical track record and proof of concept from technical results are analysed to keep the technology balanced in the portfolio.

5. Balance of markets

   Outline of the targeted vs actual markets that were planned, to analyse market penetration and impact of the portfolio.

6. Market position and share

   The products share in the market and how well they are performing against the other competitors.

7. Balance of technology

It is also an outline between the target and actual products of the technology that was planned and what was achieved.

8. Resource demand vs capacity

   A balance between demand by the development teams for resources against the capacity of the organization. If demand is increasing way too much, there is a risk of portfolio explosion.

9. Resource availability

   Resource availability from marketing, sales, R&D, technical, operational, services to develop and maintain the products over lifecycle which remain in the portfolio.

It is to be noted that the PPM remains active over the entire lifecycle. From R&D phase to the archive phase. Due to this reason PPM performance management provides metrics for all the stages of the portfolio. In any stage of the lifecycle when the data is not available, the forecasted values are to be used in order PPM acts as a decision-making tool.

4.3 NPD targets and KPIs

NPD targets can be divided into two phases:

1. Phase 1: Product Development Planning

   PPM related targets and metrics should be used in product development planning (PDP) phase of the NPD process. The new product decisions in an organization should include the decision to retain/kill the older or similar products, plan to maximize the profits and the new product should be aligned with the organization's overall strategy. PDP phase of NPD should include the targets of PPM practices for effective performance of the product. Including the targets of PPM in NPD explains the significance of PPM on the organization, that how the portfolio controls all the decision making processes in the organization.

2. Phase 2: Product Development Activity

   The product development activity (PDA) phase of NPD, is the phase in which the new product is actually being developed and will have the targets which were proposed to be Cost, Quality and Time. However, the other target, Project performance is excluded from being the exclusive targets of NPD in the phase 2,

as the purpose is filled by overall implementation of the performance management framework.

The proposed two phases of NPD have their own targets and KPIs which are used for effective performance measurement and the use of framework proposed in section 4.1 allows the effective performance management of the NPD in an organization. In the figure below, targets along with their KPIs are shown, and explained further below.

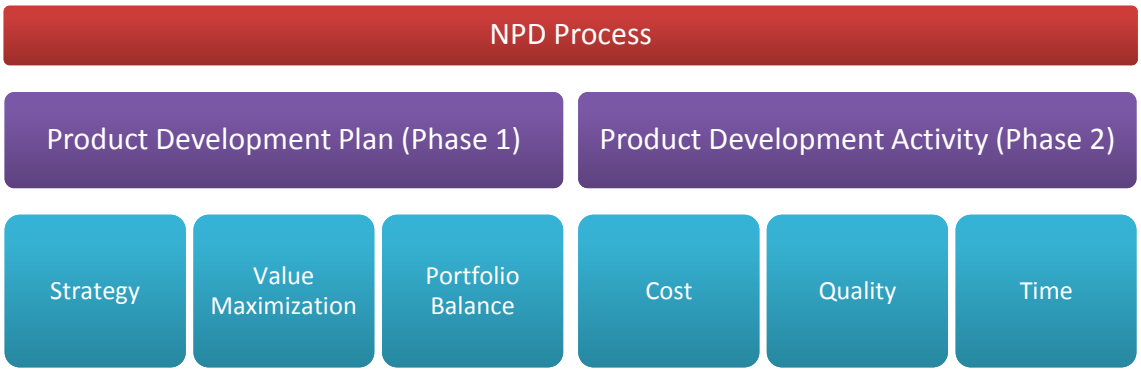

Figure 13: Targets of NPD process (Phase 1 & Phase 2)

The KPIs for the NPD process in an organization is subject to their respective targets. KPIs of NPD phase 1 is same as described in section 4.2. The KPIs for the PDA phase of NPD are explained as below:

1. Cost
    a. Development cost: How much it has cost the organization to develop the product by utilizing the resources, and is it exceeding the expected development cost. As sales and cost planning needs to be considered here.
    b. Cost per hour: Cost for an organization over the course of time, in unit hours on the development of the product.
    c. Compliance to target cost: The target cost, on which the organization planned to develop their new sales item, is it compliant with the target cost or not.
2. Quality
    a. Benchmark testing: The benchmark test, to measure the product performance and quality in compliance with existing benchmark of quality which is set by the organization.

b. Compliance with requirements: The new sales item which is made is it compliant with the requirements put forward by the customers or the marketing department.
c. Use of manufacturing resources: Whether the organization is relying on the existing manufacturing resources or looking for new options, then the error ratio of the manufacturer is also needed to be considered.
d. Use of supplier resources: Whether the organization is relying on the existing supplier resources or looking for new options, then the error ratio of the supplier is also needed to be considered.

3. Time
    a. Time to Market: After the product development, the organization needs to maintain their project timeline, when to ramp up the production and send the product to market, delay in time to market, decreases chances of product success.
    b. Project lead time: It measures is the project on time, or how much early/late it was completed then the actual schedule. It is the latency between the start and completion of the development activity.
    c. Number of delays in project plan: The development process is divided into small phases and stages, just like a stage gate process, and delays in the plan are noted and fixed for effective product performance.
    d. Number of goals met on time: Similarly to stage gate models, the number of project goals that were completed, and milestones which were completed as planned.
    e. The project launched on time: Similar to project lead time, but just an indicator to highlight the overall project timeliness.

4.4 RaDe targets and KPIs

Similar to NPD, RaDe targets and metrics should also be divided into two phases, for the planning phase and actual development.

1. Phase 1: PDP of RaDe
   PDP should be evaluated based on the PPM related targets and KPIs to analyse and decide if new RaDe project will be started.
2. Phase 2: PDA of RaDe

During the PDA phase of RaDe, product development activity is carried out to manage the product development implementation within targeted cost, time and quality. Apart from the traditional NPD phase 2 targets and KPIs, PDA of RaDe projects also have other important targets to differentiate it from a traditional NPD process such as customer involvement. Targets of NPD along with customer involvement acts as the four targets for RaDe's PDA phase.

The proposed two phases in RaDe related activity testifies that product development activities are similar in nature, where the effect of sales item has to be considered on the portfolio in the planning phase and the development activity is very similar in NPD and RaDe with their own set of quantitative measures.

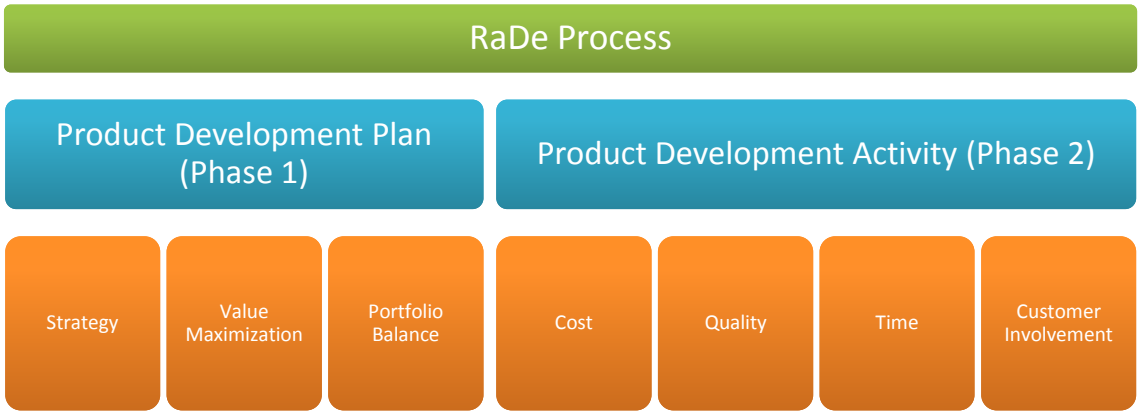

Figure 14: Targets of RaDe process (Phase 1 & Phase 2)

The KPIs for the RaDe process in an organization is similar to the KPIs used for compliance with NPD targets. KPIs for PDP of RaDe are explained in Section 4.2 and KPIs for PDA of cost, quality, and time is explained in Section 4.3. KPIs which would be valid for the fourth target of RaDe, i.e. Customer Involvement are explained below.

1. Customer Satisfaction: The lead users, customers find the final product compliant with their use, and is tested as a prototype. The KPI highlights the approval by customers on the prototype, which can be sent to manufacturing for the production ramp-up.
2. Customer Participation: A pilot phase is designed to test the product, and to get customer acquainted with it. If there are concerns of the customer on the product, then the product is revised and suggestions are taken into consideration.

3. Requirements Completion: This KPI highlights the number of completed requirements in the product against that were initially requested by the customer.

However, there are few enablers in the RaDe process which have been established by the research team of Industrial Engineering & Management of the University of Oulu. These enablers are essential for the RaDe project and are valid throughout the two phases of RaDe. They are as follows:

1. Formation of collocated teams.
2. RaDe project to be carried out by existing supply chain capabilities i.e no new manufacturer, supplier or distributor.
3. RaDe project to be carried with existing sales & marketing and care & service capabilities.

5 CONCLUSIONS

The reliability and validity of the results are important to be contemplated. The results are compared to earlier results and the differences are attempted to explain. Also the significance of the results is assessed.

5.1 Results of the study

The study proposes the results on three levels. The first level is related to analysing the existing PPM and developing more KPIs to implement PPM's performance management in case companies. On the second level, the study resulted in the formation of two phases of NPD and RaDe, each phase has its own targets and KPIs. Lastly, a performance management framework was developed to oversee the product development in organizations.

According to the analysis of the earlier research the PPM related target and metrics can be categorised as strategic fit, value maximization and the portfolio balance type of performance management areas. NPD and RaDe related performance management targets and KPIs are can be classified to categories as strategic product, cost bound, quality timeliness and project performance.

The empirical analysis highlights the strategic fit, sales and financial related KPIs as the most common PPM targets and KPIs in case companies. The balance of the portfolio was not included formally in performance management. The common KPIs for NPD and RaDe were found out to be cost, quality and time. Case companies highlighted that the product developed has to be strategic in nature which performs well.

The developed new performance management framework proposes two fundamental phases for the product development: a planning phase and development phase. During the planning phase the new product initiative to be analysed as an individual new product and as an impact to the product portfolio based on the PPM targets and KPIs. Indeed, PPM targets and metrics should be used for analysis and decision making to start NPD or RaDe type of product development activity. At second phase, development, the performance of the NPD and RaDe projects execution to be analysed and managed based

on based on cost, quality and time. Additionally, customer involvement as an additional target for the development phase is recommended for the execution of the RaDe projects.

5.2 Theoretical contribution

This study was carried out with a qualitative and an exploratory approach. The literature review and empirical current state analysis provided a solid base for results to be drawn from the study. The first theoretical contribution can be seen in the analysis and decision making of the new product initiative to analyse both an economic value of the new product individually and its impact to the economic value of the product portfolio. The second contribution relates to the idea to use PPM targets and KPIs to analysis and decision making to start any new NPD and RaDe product development projects and then use the specific targets and KPIs to the NPD and RaDe project execution phase.

5.3 Managerial contribution

For managers this study provides a new performance management framework manage NPD and RaDe in two phases as planning and development based on the phase specific KPIs. Furthermore, the developed KPIs are explained in detail. Managers can utilise the mentioned KPIs of PPM, NPD and RaDe for effective performance management.

5.4 Validation and reliability

The study was carried out in three stages and all stages had validation and reliability checks. Literature review was an intensive process, which constructed the base for this study by providing enough material for developing the questionnaire for the case companies.

The top management of the case companies contributed to this study by providing authentic and real information about their operations. The responses recorded from the current state analysis were compared with the literature, and a connection was established with the working style of case companies and theory. The findings were in line, with few practices of theory not being employed by the case companies to the fullest. With the results of this study, there are feasible improvement and recommendations for the case

companies who can employ the presented results of this study in their respective companies.

After analysing the empirical analysis and literature, the results were composed. A major portion of the result was related to NPD and RaDe targets and KPIs, which was presented in two phases. The basic need of dividing the process into two phases was established during the empirical study, where knowingly the importance of portfolio review before the induction of new sales item in it, is knowingly or unknowingly ignored by the case companies.

This study resulted in a framework, which presents how the PPM and companies strategy needs to be in line with their product development methodologies, how the product development targets and KPIs ensure the product remains strategic and in coherence with PPM for effective performance management. Considering the scope of the study, and its connection with other areas, a number of previous studies related to these concepts were limited due to newness of RaDe and its link with NPD and PPM for performance management. Therefore, the study can be seen to expand its scope further and justify the need for performance management in the areas of study.

5.5 Research Limitations

This thesis study was based on thorough research of the existing literature in the field of PPM, NPD, RaDe and overall performance management, where the author tried to bridge the performance measurement with operations of an organization. The study has been made with the superlative objectivity based on a clear research plan, multiple interviews, reliable journal articles and books. However, the findings depicted in section 4 of the study highlights the results, which are based on the author's understanding of the key areas and issues of product management from the academic background, literature review and interviewee responses from the case company. This has been a challenging task to grasp so many different areas with a very broad scope of one master thesis. With this broad amount of literature and information, there is a possibility that some relevant facts might have remain unnoticed that could be found in further studies.

Moreover, the concept of RaDe is in development and research is taking place right now with University of Oulu and case companies who are in a phase to adopt this practice in

their operations. It caused a clear challenge in defining the RaDe through existing literature. Additionally, only two case companies were analysed due to very tight research plan, which made it difficult to analyse the practices in multiple organizations and in more depth.

5.6 Recommendations for further research

Apart from improving the sample for empirical analysis, it is recommended to analyse the two phases of NPD & RaDe in more detail and effects of ignoring the performance measures in phase one of both product development activities. Another interesting area to build upon this research will be to compare the performance of NPD and RaDe related products, to analyse the product success factors. Lastly, further research can be carried out to design a strategic and performance management dashboard for the organizations, for this purpose literature was reviewed and Balanced Scorecard could be used as a tool, but due to a broad scope, it has been left out of results.

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7 APPENDIX

i. Product portfolio management related performance management (plan-do-check-act)

a. What factors are considered to develop the targets of PPM?
b. What are the currently defined PPM targets? (Compare with targets in Appendix 1)
c. How is the target fulfilment measured in the PPM?
d. What are the KPIs used for the PPM? (Compare with KPIs in Appendix 1)
e. Who is responsible for taking go/maintain/kill decisions of the products in the product portfolios over the lifecycle?
f. Are the decisions related to new sales items (NPD & RaDe activities) considered on product portfolio level?
g. How is the impact of new products analysed on product portfolio level targets and KPIs?
h. Do the targets of PPM, act as a decision maker for the product development?

ii. NPD and NPD project performance management

a. Is the NPD project manager solely responsible for the performance of NPD project?
b. Is the decision making to start new product (and related NPD project) development is compliant with product portfolio targets and KPIs?
c. What factors are considered to develop the targets of new product and related NPD project? Are they project specific?
d. What are the currently defined new product and related NPD project targets (compare with Appendix 2) and are they revised?
e. How is the target fulfilment measured in the NPD?
f. What are the KPIs used for the target fulfilment? (Compare with KPIs in Appendix 2)
g. Is there a targeted performance levels for new products and related NPD projects? What are them?

iii. RaDe and related performance management

a. Is the decision to start a RaDe related activity done after impact analysis on the product portfolio level over the lifecycle?
b. Who sets up a RaDe team and is responsible for the performance of RaDe?

c. What factors are considered to develop the targets of RaDe project? Are they project specific?
d. What are the currently defined RaDe project targets (compare with Appendix 3) and are they revised?
e. How is the target fulfilment measured in the RaDe?
f. What are the KPIs used for the target fulfilment? (Compare with KPIs in Appendix 3)
g. Is there a targeted performance levels for RaDe projects? What are them?
h. When measuring the performance, what areas are considered most in compliant to the team/person assessment?

iv. Organization Culture

a. Is the organization culture supportive of performance related measurement?
b. Is the information flow in the organization easy?