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A Path to Enriched Organizational Learning via Post-completion Auditing in R&D Investments

A Constructive Study

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Abstract

Research & development (R&D) investments are often complex and risky projects having a significant effect on company's financial success. Post-completion audit (PCA) is defined as quantitative and qualitative comparison of actual, *ex post* cash flows and figures with the forecasted *ex ante* figures and estimations of the capital budgeting project. Even though PCA has been widely recognized correlating positively with companies' success, it has gained less attention in academic research in comparison with other phases of capital budgeting process.

This thesis aims to create a construct for PCA system to enhance organizational learning (OL) in publicly listed Finnish high-technology manufacturing company that has high emphasis on R&D investments. Empirical material for the thesis were acquired from seven semi-structured interviews as well as by utilizing company's internal material to supplement the interview data. The construct was created by utilizing the constructive research method by Kasanen et al. (1993).

The main contribution of this thesis is the construct that was created for the case-company to steer and adjust its PCA process into a more OL-conducive direction, and to improve current situation considering R&D project estimates in company. Secondary contribution of this thesis arises from its R&D context which has been previously neglected as an investment type in PCA literature. However, due to characteristics of case company, the findings of this thesis may have only a limited applicability for other companies.

Keywords Post-completion audit, research & development, new product development, capital budgeting, organizational learning, constructive research approach

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Tiivistelmä

Tutkimus- ja tuotekehitysinvestoinnit voivat usein olla monimutkaisia ja riskipitoisia projekteja, ja niillä voi olla merkittävä vaikutus yrityksen taloudelliseen menestykseen. Investointien jälkiarvioinnilla (post-completion audit, PCA) tarkoitetaan määrällistä ja laadullista vertailua toteutuneen investoinnin valmistumisvaiheen ja sen alkuperäisen suunnitteluvaiheen välillä. Jälkiarviointi on jäänyt aiemmassa tutkimuksessa suhteellisen vähälle huomiolle verrattuna investointiprosessin aiempiin vaiheisiin, vaikka sen käytön on havaittu korreloivan positiivisesti yritysten menestyksen kanssa.

Tämän pro gradu -tutkielman tavoitteena oli luoda konstruktio kohdeyritykselle, joka parantaa organisatorista oppimista yrityksen jälkiarviointiprosessissa. Kohdeyrityksenä toimi suuri suomalainen pörssilistattu korkean teknologian tuotteita valmistava yritys, jolla on merkittävät tutkimus- ja tuotekehityspanostukset. Tutkimuksen empiirinen aineisto saatiin tekemällä seitsemän puolistrukturoitua haastattelua kohdeyrityksessä, minkä lisäksi haastattelumateriaalia tuki yrityksen sisäinen materiaali investointi- ja jälkiarviointiprosesseista. Tutkimusmetodi noudatti Kasanen et al. (1993) esittelemää konstruktiivista tutkimusotetta.

Tämän pro gradu -tutkielman ensisijainen kontribuutio syntyy sen kohdeyritykselle antamista teoriaan perustuvista käytännön ehdotuksista ja luodusta konstruktiosta. Toinen tutkielman kontribuutiolähde on sen tutkimus- ja tuotekehitysinvestointien konteksti, joka on aiemmassa PCA kirjallisuudessa jäänyt melko huomiotta. On huomioitava, että tämän tutkielman johtopäätökset ja yritykselle annetut ehdotukset ovat ainoastaan rajallisesti yleistettävissä muiden organisaatioiden käyttöön johtuen kohdeyrityksen erityispiirteistä.

Avainsanat investointien jälkiarviointi, tutkimus- ja tuotekehitys, investointiprosessi, organisatorinen oppiminen, konstruktiivinen tutkimusote

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ACRONYMS

BR: Business review (stage-gate process)

EVP: Executive vice president

KPI: Key performance indicator

NPD: New product development

NPV: Net present value

OL: Organizational learning

PCA: Post-completion audit

PIC: Profitability index calculation

R&D: Research and development

SME: Small and medium-sized enterprise

VP: Vice president

1 INTRODUCTION

As current business environment is so rapidly changing and dynamic, it often requires companies to put effort into their research and development (R&D) investments in order to stay competitive and innovative. However, the informed decisions considering R&D projects are not always easy tasks to make. Proper decisions require thorough evaluation and monitoring of the results and outcomes of the investments. As post-completion auditing (PCA) typically has a significant role being a valuable practice in providing insights into the investment decisions in general (see e.g.,Sandström et al., 2016, Lefley, 2019), it might be the case in R&D investment projects as well. However, the success of those R&D investments relies not only on the substance they deliver but also on firms' ability to learn from them, and thus the organizational learning (OL) also plays a crucial role in companies' success (see e.g., Kocoglu et al., 2012).

1.1 Background and motivation

Post-completion audit (PCA, also familiar as e.g., post-audit and post review) is a formal method that reviews the fulfilment of a completed investment after it has committed by comparing the pre-investment *ex ante* estimates of the project with its actual *ex post* figures (Huikku, 2007).

Motivation for the PCA research arises from the relevance of the topic and its relatively narrow consideration in the current management accounting academic literature in comparison of other aspects related to capital budgeting. Success of the investments is crucial for the companies, as capital budgeting processes often have far-reaching scope and link to company's strategic ambitions (Huikku, 2011b, p. 131). As companies typically suffer from scarcity of capital, it would be appropriate that the capital and resources would be allocated as efficiently as possible (Lumijärvi, 1991). Being able to enhance the capital budgeting by conducting more comprehensive and better post-completion audits could eventually save organizations' resources by mitigating the amount of

negative or low NPV projects. Eventually, the higher investment returns would increase the economic productivity, thus benefitting the society as well.

Post-completion audit in R&D investments has gained increasing attention in recent years due to the benefits arising from it in organizations. There is moreover a growing body of literature on the topic of the PCA in general, however still having at some level a lack of clarity and consensus on the best practices and methodologies for conducting the PCA. Even though in overall, there has been made research about capital budgeting rather comprehensively, the PCA part of the capital budgeting has experienced a slight lack of attention in relation to the other parts of the investment process despite its importance (Huikku and Lukka, 2016, Lefley, 2016).

Current PCA literature has mainly focused on investments in general and has not had emphasis on R&D investments *per se*. However, due to the fact that successful R&D investments have extensive impact on the financial growth and profitability of the company (Mohnen and Röller, 2005) as well as the overall benefits that the implementation of the PCA creates for the organization (see e.g., Gordon and Smith, 1992, Huikku, 2011a, Lefley, 2019) it would be important to focus on this particular segment in order to fill the current research gap about R&D investments. Thus, this thesis aims to fill the research gap where R&D investments are chosen as investment type when enhancing the organizational learning (OL) via post-completion auditing (PCA).

1.2 Research problem, objectives and method

Purpose of this study is to enhance the post-completion auditing (PCA) system in case company which is a large Finnish publicly listed manufacturing company with high emphasis on R&D activities. The company seeks to find improvement especially for the challenge that predictions made in the *ex ante* phase of the investment process are somewhat systematically over-optimistic compared to actual project figures. They see that enhanced PCA-system could have a major

role in solving the problem with estimations. This thesis is conducted by utilizing the constructive method (see Kasanen et al., 1993), and thus it aims to develop frameworks and guidelines by creating a construct to find several distinguishes occurring in case company. The objective in constructive method is to point out and solve organizational challenges by creating solutions and models to improve the current company's processes (Kasanen et al., 1993). Aim is to offer suggestions to case-company to enhance their PCA procedures from the OL perspective and to create a theory-based connections with the empirical findings and current processes of them.

Additionally, this thesis aims to increase the understanding about the post-completion auditing PCA in the R&D investments by addressing the possible distinguishes of those kinds of projects. Aim is to create academic contribution by filling the current research gap in the field of R&D investments as investment type in PCA. Along with practical approach, another research problem in this thesis is to address the issues and factors that affect on organizational learning (OL) in the PCA process. This thesis aims to address the problem by focusing on examining the role of post-completion audit in the path towards organizational learning.

1.3 Research structure

This thesis is structured in following way: after the introduction chapter in *chapter 2* at the literature review part, the relevant academic literature considering the PCA, R&D investments and theories related to organizational learning (OL) will be addressed. The purpose of the literature review is to provide a comprehensive overview of the existing research on the topic of post-completion audit in R&D investments, in order to identify the gaps in the current knowledge and inform the development of the research framework for this thesis.

This literature review will be structured in the following manner. First, it will provide a definition, benefits, and limitations of a post-completion audit. After which there will be review about PCAs general form and part as the last step in the capital budgeting process. The PCA part of the literature review also presents the OL-conducive PCA framework by Huikku (2011a). Second, in the literature review part there will be a review about the theoretical frameworks and models to explain organizational learning as well as the key concepts and variables that are commonly used in the literature. Third, in the literature review part, the research & development investments will be focused on by reviewing the relevant academic literature around the topic and defining the terminology. Lastly, there will be a part in the literature review that summarizes the three literature review parts in order to create a coherent structure.

In overall, the literature review part aims to provide a foundation for the research framework for this thesis and will help to ensure that the research is grounded in the existing knowledge in order to support the empirical findings of the thesis.

After the literature review, in *chapter 3* the research methodology will be examined by explaining the themes considering the constructive single-case method, data collection methods and used criteria for case selection. In this part of the thesis, the quality of the thesis, its theoretical contribution and such issues will be considered as well. I will gather empirical data for the thesis by conducting seven semi-structured interviews in the case company, in addition I have access to the company's internal material considering their R&D and PCA processes. The usage of multiple sources of information to gather the empirical data and integrating them with each other can help to create triangularity of the thesis (Pauwels and Matthyssens, 2004). As mentioned before, this thesis is conducted as single-case study with constructive approach (see Kasanen et al., 1993).

2 LITERATURE REVIEW

The first section of the literature review focuses on the PCAs general form, and what are the benefits and challenges that organizations may face while implementing the PCA process into their R&D investment projects. It also presents the OL-conducive PCA system by Huikku (2011a). The second section of the literature review delves into R&D investments by discussing about their distinguishes and complex nature. The third part of the literature review has emphasis in providing insight about the organizational learning (OL) and its theory. Lastly, there is a summary about the literature review present. By synthesizing the existing knowledge in these areas, theoretical framework can be established for the thesis, and the intended research gap considering R&D investments as investment type when enhancing organizational learning with the PCA is possible to fill.

2.1 Post-completion auditing

2.1.1 Definition and the general form of the PCA

Usage of the PCA methods for project monitoring after the capital budgeting process has perhaps documented first by Istvan (1961), whose field study about capital budgeting procedures among US large corporations included the PCA part which had previously been neglected. Despite being relatively old concept, Neale and Holmes (1990) argue that in the past, *ex post* analysis was conducted only rarely in the companies. Literature review by Haka (2006) points out that implementation of more sophisticated or systematic PCA procedures was a rather slow process in corporates. The post-completion auditing (PCA) can be described as a formal review process where after the execution of the capital budgeting project or the task the pre-investment estimates are compared to post-investment outcomes (Neale and Holmes, 1990, Huikku, 2007). Azzone and Maccarrone (2001) state that the objective of the PCA is to conduct comprehensive review of all the activities related to management of capital

investment proposal from its definition up to its execution and conclusion. Sandström et al. (2016) furtherly divide that into three main objectives that are (1) better-decision making, (2) providing better planning in organizations, and to (3) help the organization to create more realistic investment projects.

According to Huikku (2007), by definition the PCA process should meet following criteria:

- High formality in the process
- PCA process is conducted after the investment has been put into action and it has started to generate cash flows
- There is at least partial focus in comparing *ex ante* estimates with actual *ex post* figures
- Process is systematic, regular and includes instructions

In general, in capital budgeting (also known as capital investment) process (see e.g., Azzone and Maccarrone, 2001), there are three stages prior the PCA, which is the final and fourth stage of the process. The first stage involves identifying the business need and defining the investment project. The second stage involves developing and evaluating the proposal. The third stage involves selecting the proposal and obtaining final authorization to proceed. Koch et al. (2010) argue that the PCA process in the capital investment is typically considered being part of the implementation and control part in the capital budgeting.

The PCA additionally wraps up the project as it is not usually continued after that (Cooper, 1990). In the capital budgeting process chart presented by Azzone and Maccarrone (2001) the fourth capital budgeting phase (the PCA part) was furtherly divided into “early”, “intermediate” and “final” PCA parts, first of which was conducted at the project deployment stage, the second at the “operational phase” and the final one was conducted after the investment. Below in *Figure 1*

the life cycle of the investment is illustrated highlighting the PCA part of the process. There is some contradiction in PCAs definition among the researchers as the criteria for the PCA by Huikku (2007) suggests that the PCA would be conducted after the investment process is finished and has started generating cash flows. However, the capital budgeting literature does not provide an explicit definition of capital budgeting and the phases it contains, nor of the PCA (Jensen, 2022).

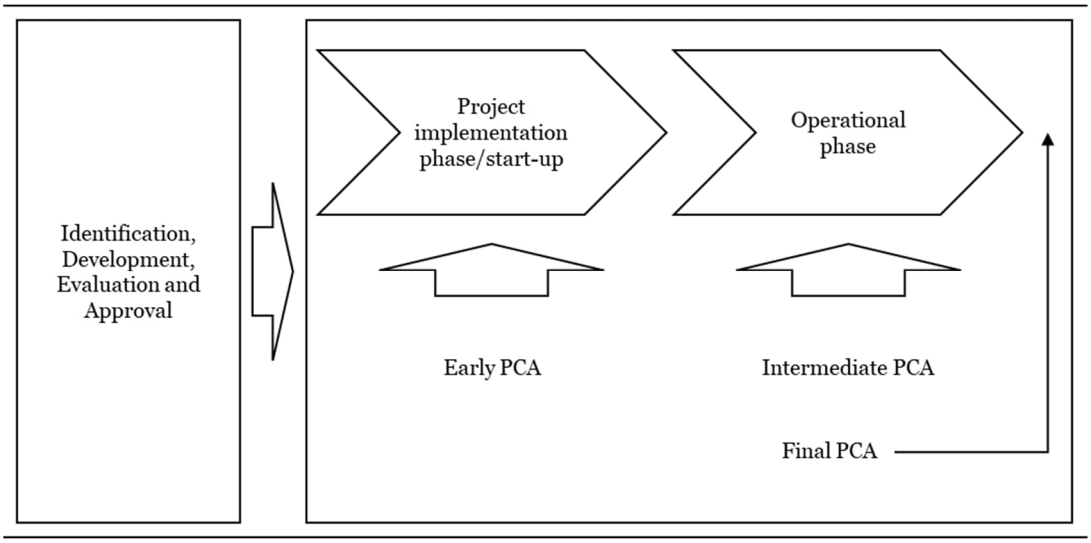

Figure 1: PCAs during investment project (modified from Azzone and Maccarrone, 2001)

In this section, post-completion audit (PCA) was presented as the final component within the comprehensive framework of capital budgeting. The exploration encompassed an examination of PCAs definitions and historical evolution. Additionally, the section delved into the distinctive features and criteria associated with PCA, drawing upon insights from prior literature.

2.1.2 Importance of the PCA

In the academic literature, post-completion audit (PCA) has not been put that high emphasis compared to steps in the capital budgeting process that precede the implementation of the investment (Huikku and Lukka, 2016, Lefley, 2016). The importance of the PCA seem to furthermore lack the attention in the firms' investment procedures, as according to Batra and Verma (2014), the PCA and the project review have not been explored that broadly in firms compared to steps that have occurred before implementation in the capital budgeting process. This section of the thesis focuses on highlighting PCAs benefits and the motives behind its adoption in the organizations.

Soares et al. (2007) argue that all possible benefits of implementing the PCA procedures have not been recognized comprehensively due to reasons that when investigated, firms tend to have deficient practices, and they usually keep the confidentiality of these practices protected. Successful investment projects can have a significant positive effect on the financial performance of the firm, however in the unfortunate scenario the investment may be troublesome for the company (Eng and Shackell, 2001). By conducting comprehensive PCA procedures, company is able to mitigate the risk of ineffective and careless investments (Udo, 1993). Additionally, PCA may help organizations to comprehensively and deeply understand not only the investment project but furthermore the whole life cycle of the product or service (Sandström et al., 2016).

The lack of attention is despite the findings that the usage of sophisticated PCA methods have been seen to correlate positively with firm's ability to create shareholder value (Gordon and Smith, 1992). In overall, numerous studies suggest that PCA acts as a significant instrument for enhancing decision-making and organizational learning within companies. This is true irrespective of the PCA method used. The PCA helps companies to understand the internal and the external aspects of the investment process, thus leading to more favourable

outcomes regarding the investment (see e.g., Neale and Holmes, 1990, Huikku, 2007, Lefley, 2019). PCA process is also seen to decrease the prejudicial "fund and forget" mindset in companies that conduct capital investments (Koch et al., 2010).

Organizational learning (OL) aspect is considered being one key benefit for organizations in adoption of the PCA processes. Even one of the first PCA research by Istvan (1961) found out that PCA was primarily used to enhance the learning among the investment proposal's originators. In modern capital budgeting and PCA research the organizational learning has additionally typically been seen as one of the key objectives – and even as a main motive for PCA in some cases – that companies are seeking to achieve when committing PCAs for their capital investments (Azzone and Maccarrone, 2001, Huikku, 2011a, Lefley, 2016). When viewed through the lens of the organizational learning, the PCA is often seen as a learning process and an enabler of a double-loop learning (Huikku, 2008). However, instead of using the PCA as a tool to enhance the organizational learning, some companies may have an inverse and more "judgemental mindset" when applying the PCA in their capital budgeting projects (Udo, 1993).

On top of the well-known PCAs learning enhancing attributes, the PCA has furthermore recognized being an effective control mechanism in organizations (see e.g., Huikku, 2008, Lefley, 2016). In investment projects, there may be certain biases among the people responsible and even an incentive to commit gameplaying by i.e., inflating the cash flow forecasts of the project (Cross and Brodt, 2001). There is, however, academic evidence that adoption of the PCA can reduce the gameplaying by the project owners when they are aware of the occurrence of the PCA, and in overall align the interests better (Smith, 1994, Lefley, 2016).

The academic literature about the PCA argue that the performance evaluation of the management can be recognized as a benefit of the PCA (Neale, 1991).

However, the performance evaluation aspect is somewhat controversial as it may be in conflict with the organizational learning objective as the performance evaluation may seem judgemental and negative towards the personnel under review, while the organizational learning as an objective has more emphasis being motivational and optimistic (Azzone and Maccarrone, 2001). Lefley (2016) concludes that PCAs may be used for management performance evaluation, yet PCAs are not comprehensive and rigorous enough being effective in reaching the objective of management performance evaluation, and that performance evaluation would require other criteria as well.

According to Lefley (2019), 60 % of the SMEs from the UK researched conducted PCAs and 40 % did not have adopted any kind of PCA procedures. However, only 21 % of the companies who conducted PCAs did them in formal, explicit, and written manner. 76 % had semiformal, implicit PCA methods, and 3 % of the companies committed their PCA reviews non-formally. There are rather similar findings among larger companies as well, as according to Huikku (2007) among 30 largest Finnish companies there were 20 PCA adopters (67 %) and 10 non-adopters (33 %). Survey by Azzone and Maccarrone (2001) finds that among large Italian organizations, the PCA adoption rate was around 70 % being analogous to previously mentioned findings.

Then, why not all companies adopt PCA procedures in their capital investments even though the benefits of the adoption are widely recognized? There can be several reasons. Azzone and Maccarrone (2001) suggested that the most typical reason for non-adoption was that PCA was considered ineffective due to high degree of environmental turbulence and the diverse nature of capital investment projects. However, the issues and uncertainties of this type can be often mitigated by conducting comprehensive, standardized PCA procedure and framework that takes into account both quantitative and qualitative aspects, and enables the comparison of diverse investment projects (Huikku, 2011a).

According to Neale (1991) the size of the investment project is one major reason for PCA adoption, thus the lack of projects large enough in the firm can be a typical and a fair reason in not conducting the PCA. This is in regular due to the fact that the benefits occurring from conducting the PCA are expected to exceed the costs arising from it. According to Huikku (2007) especially large companies may have other control mechanisms in their investment projects and thus they would not be willing to adopt the PCA in their company.

The main benefits and objectives of the PCA, which stands for post-completion auditing are outlined in the comprehensive presentation in *Table 1* below. This table points out four of the most crucial factors when considering the PCAs advantages according to the most relevant research papers from the field.

Table 1: Summary of PCAs main benefits and objectives

Benefits	Research findings	Papers
Improved decision-making	One major objective for companies to conduct PCA is to enable better decision-making	Neale and Holmes, 1990, Sandström et al., 2016, Lefley 2019
Control	PCA can serve as a control mechanism to verify that investment performance aligns with initial expectations	Huikku, 2008, Lefley, 2016
Organizational learning	PCA adoption enhances organizational learning and can be often recognized as key objective for the PCA	Istvan, 1961, Azzone and Maccarrone, 2001, Huikku, 2011, Lefley, 2016
Performance evaluation of managers	PCA can be utilized for evaluating management performance in relation to the project	Neale, 1991, Lefley 2019

2.1.3 Limitations of the PCA

Despite of PCAs numerous benefits that were outlined in the previous section, there are still challenges and limitations around. This section delivers the key issues from that area. One significant limitation of the PCA according to Sandström et al. (2016) is that the users or the people that managed the post-audited project do not benefit from the PCA from the organizational learning perspective as they do not learn that much from the historical data used in the PCA. In some companies the investment projects may as well have that high level of uniqueness and variation that adopting the PCA seems not appropriate due to scarce level of organizational learning to achieve (Neale, 1995).

As capital investments tend to have long life-cycles and the PCA process is often conducted way before the investment's termination, there are uncertainties in forecasts about issues such as future cash flows (Neale, 1991, Huikku, 2011a). Thus, it is not often possible to review the success of the investment exactly and comprehensively in the PCA report. Another requirement for successful PCA project is that the project costs would be allocated properly and that there were project management system in company to monitor the occurring project efficiently (Neale, 1995). The smallest companies may not have the comprehensive cost-tracking and project management systems available to conduct systematic and comprehensive PCA procedures and models.

Capital budgeting decisions and PCA procedures contain aspects that require subjective and qualitative review as well (Huikku and Lukka, 2016). Thus, when considering the appropriate person(s) to conduct the PCA procedure it is crucial to comprehensively understand the role of the PCA conductor and the interests the person is carrying in order to mitigate the risk of so-called self-assessment bias (see e.g., Segelod, 1997, Cheng et al., 2009, Huikku and Lukka, 2016). According to Cross and Brodt (2001), during the project selection phase in capital budgeting process the person that is holding the response of certain

project, may have an incentive to get the project accepted as he or she may overvalue the benefits of the project while undervaluing the risks occurring.

Research by Cheng et al. (2009) agrees with that view as the managers in charge of the PCA projects tend to avoid reporting and sharing the negative information that could be possibly harmful for them personally. These kinds of agency problems may arise in situations where the people involved in the investment are evaluating the success of their own work. Even though there are several reasons that self-assessment may not be the most optimal PCA method, according to the literature, the most typically PCAs are conducted in firms by the same individuals that have conducted the investment projects, in other words, the most common method of the PCA is self-assessment (Segelod, 1997, Huikku, 2011a, Huikku and Lukka, 2016).

Several researches argue that the self-assessment is suboptimal method for the PCA as the conductor may be biased, thus having an incentive to commit manipulation or gameplaying (see e.g., Huikku and Lukka, 2016). With the goal of achieve the highest performance in the investment process, it would be appropriate that the PCA process was conducted by people that did not have any role in the investment process before the PCA part (Farragher et al., 1999). However, according to Huikku (2011b) individuals who have been working on a certain project can typically have higher knowledge and expertise in that area compared to an external reviewer. Yet, according to Lefley (2019), the self-assessment in the PCA generates higher risk of gameplaying and self-assessment bias in large companies compared to SMEs due to their typically more complex organization and management structure. He states that this is resulting from the fact that in SMEs the senior management that typically act as PCA conductors, could have their incentives better aligned towards the shareholders of the company compared to their peers in more larger companies.

In their research, Koch et al. (2010) found that PCA adoption tend to increase managers' accountability, thus leading them to be more risk-averse than their

peer group that had not adopted the PCA. The extraordinary risk aversion may additionally be suboptimal for company's financial success and shareholder value if the managers were proposing lower return investment projects due to their personal bias towards excessive risk aversion. According to Neale and Holmes (1990) the main limitations and challenges in the PCA are its difficulties in identifying certain projects from the investment project portfolio, the pressure and additional work that PCA procedure puts into the organization and the costs that arise from the PCA action.

Despite the challenges and limitations that may occur due to PCA-adoption, it is appropriate to conclude that typically the PCAs benefits exceed its challenges (Lefley, 2016, Sandström et al., 2016). This section summarized the difficulties and issues causing the non-adoption of the PCA. In *Table 2* below, the four major factors affecting on this field are overviewed and the main academic papers of those areas are listed.

Table 2: Summary of PCAs main challenges and limitations

Challenges and limitations	Research findings	Paper(s)
Time-consuming and costly	The PCA procedure requires additional work and it can be costly	Neale and Holmes, 1990, Lefley 2019
Self-assesment bias	The project responsible individual may have incentive to commit gameplaying	Cross and Brodt, 2001, Koch et al., 2010, Huikku and Lukka, 2016
Bias for risk aversion	PCA adoption may increase risk aversion and managers' accountability in suboptimal way	Koch et al., 2010
Problems associated with data collection	There may not be enough sufficient and reliable information during project selection stage	Sandström et al., 2016, Neale and Holmes, 1990

2.2 Research & development investments

Research and development (R&D) can be described as systematic and experimental activities that organizations conduct with the intent of create new technologies, products, services or improving the existing ones (see e.g., Rogers, 1998). R&D or innovation procedures are moreover typically linked with creativity as the projects often require abilities regarding creating new (Taylor, 2017). R&D can be classified into public and private sectors based on funding sources, as public R&D aims to contribute to various dimensions like technology, economy and society, while private R&D is primarily profit-oriented focusing on developing new products (Coccia, 2004). Alongside with the term R&D, rather similar kind of action to innovate new in companies can be called as new product development (NPD), which is more managerial term (see e.g., Takeuchi and Nonaka, 1986, Godener and Söderquist, 2004) that can be defined being the process of turning market opportunity and suppositions made about technology available into a new product that can be sold (Krishnan and Ulrich, 2001). However, not all of the academic literature make distinction between those two terms (Godener and Söderquist, 2004). To clarify, in this thesis, the term R&D is used as general construct when discussed about innovation and/or new product development -related activities.

2.2.1 Characteristics of R&D investments

The significance and motivation about the R&D investments arise from the benefits that properly executed investment can establish in the firm. Academic literature about R&D investments suggests that investments toward innovations and R&D issues are in overall key components in economic growth and development (Werner and Souder, 1997, Shefer and Frenkel, 2005, Fagerberg et al., 2010). R&D investments tend to have positive impact on productivity growth and that the impact is more significant for firms in high-tech industries (Mohnen and Röller, 2005, García-Manjón and Romero-Merino, 2012). Jiménez-Jiménez and Sanz-Valle (2011) suggest that the positive correlation between R&D expenditures and firm performance is stronger among large,

entrenched companies working in manufacturing industry. Shefer and Frenkel (2005) further state that companies with large R&D expenditures tend to gain and to maintain the competitive edge over their peers.

R&D investments can typically be relatively large expenditures with long development times and uncertain success rates. Thus, it is recommended that they would be extensively and thoroughly planned in order to reach the desired outcomes (Cook and Rizzuto, 1989). In overall, R&D investments are often considered as rather risky investments that can have potential for great long-term success, but on the other hand, the risk of failure is significant (see e.g., Eng and Shackell, 2001). According to Lee et al. (2017), project delays and cost overruns are considered as a rather common risk in R&D investment projects.

Measurement of the performance of the R&D investments is often seen rather difficult or vague in terms of preciseness (Werner and Souder, 1997, Lazzarotti et al., 2011). According to Werner and Souder (1997) the *ex post* measurement for the effectiveness of the R&D investment is the most successful as there are integrated metrics having several objective and subjective methods altogether with qualitative and quantitative measures. Performance measurement of the R&D investments can be often tricky task due to certain characteristics of the investments. R&D investments typically have long time horizons with high relatively uncertainty and risk and outcomes of the projects are often intangible and not as concrete (Chiesa et al., 2009). In his research, Atkinson (1999) presented a relatively simple framework known as *the iron triangle,* also sometimes referred as *the triple constraint,* (Pollack et al., 2018) to illustrate three interconnected constraints when estimating the performance of investment project, that are *cost, quality* and *time*.

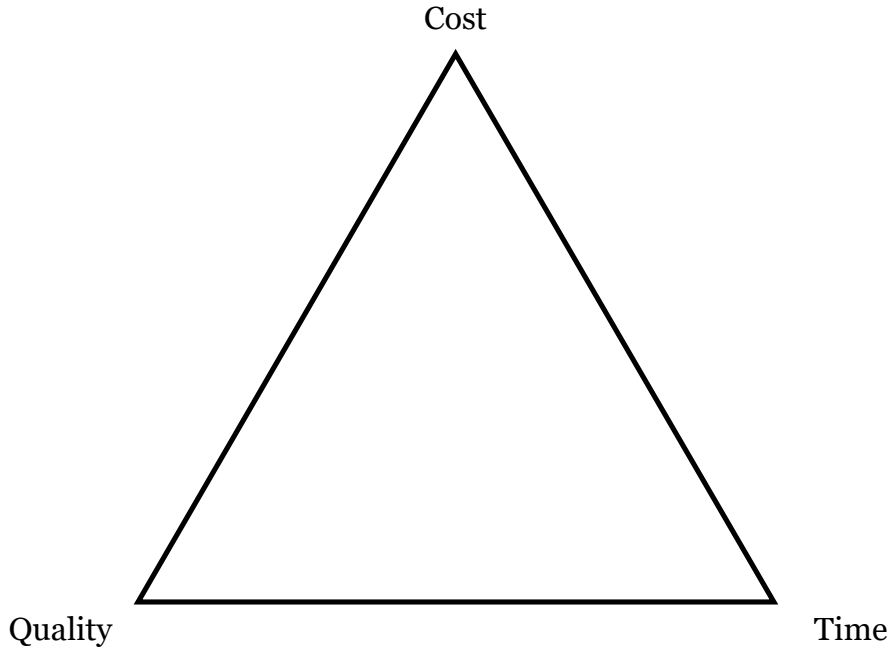

Figure 2: The Iron Triangle (Atkinson, 1999, p. 338)

In their research, Hertenstein and Platt (2000) found out that out of 75 companies that commit R&D investments, explicit performance measurement was used infrequently, however the companies that committed the measurement used both quantitative and qualitative measures to evaluate their project's success.

According to Godener and Söderquist (2004), the R&D performance measurement can be used as a tool to: (1) Use the performance measurement results as a basis to quantify and perhaps to justify the strategy; (2) Use the results to adjust the organization into right direction with diagnosis and control; (3) Use the results to allocate organization's resources efficiently in its R&D function and to manage the R&D portfolio properly; (4) Use the results as a basis of the personal performance evaluation of the R&D staff in the organization; (5) Use the results to enhance the organizational learning and continuous improvement in the organization.

2.2.2 Stage-gate model

R&D projects in high-technology are typically lengthy projects with remarkably high failure rate and risk (Chiesa et al., 2009). Notably, in high-technology companies the R&D project portfolio contains various different projects with varying level of complexities (Chandrasekaran et al., 2016). As high-technology companies are especially bound up with the success of the R&D projects when considering the financial growth of the business (Fagerberg et al., 2010), it is crucial for them to be able to effectively manage the complex and various R&D projects. As R&D projects tend to be complex and costly, it is crucial to enhance the predictability of operations and fostering synergies through resource sharing over all stages of R&D processes (Lee et al., 2017).

In order to make complex R&D processes more understandable, frameworks and process charts have been created (Lee and Lee, 2023). By nature, capital budgeting or R&D investment procedures are typically considered being linear processes having different phases occurring one after another (Coad et al., 2021). Investment processes can be divided into smaller pieces for clarity and easier organization of complex projects. To mention a widely adopted method, stage-gate system (Cooper, 1990) is a structured approach to investment process that is developed to help organizations to manage their R&D projects from idea to commercial market launch. The system divides innovation process into several stages or phases. In the linear stage-gate model, each stage is typically more expensive, and complex compared to its predecessors. Even though the stage-gate model originates from 1990s, it is still extensively used among companies as according to global survey by Markham and Lee (2013), 61.5 % of the companies had adopted formal stage-gate model for their R&D innovation function.

There are typically five stages in the stage-gate model (Cooper, 1990):

1. **Preliminary assessment** is an initial stage where a concept or idea for an innovation is created and estimated if the concept is worth executing, and if it has technical and commercial potential. It can involve for instance contacting with primary users, stakeholders of the project and a brief concept testing with possible users.

2. **Detailed investigation (business case) preparation** is a final stage planning stage prior the start of the actual product development. Its purpose is to evaluate and validate the potential of a new concept even further. One crucial aspect of this stage is market research to understand the needs and preferences of potential customers. Competitive analysis is often conducted during this stage as well to recognize the competitive landscape and potential challenges and opportunities for the new product. Further concept testing and appraisal of product's technical feasibility are implemented in this stage.

3. **Development** stage can be conducted once the concept is approved at the decision gate, and the project advance into detailed planning and design work. Prototype version of the product or an innovation is also created at this stage. Financial estimates are often updated at this point as well.

4. **Testing & validation** is conducted both internally and externally to the prototype or product to ensure that it is able to meet the technical requirements and specifications it has been assigned to. Feedback from the testing is utilized when refining the product to its final stage that is ready for full production and market ramp-up. Financial analysis is revised with current information and data. Customer's reaction to the product is further tested at this stage by committing market tests.

5. **Full production & market launch** is the last stage in the model that is conducted if the product concept has successfully passed each previous decision gates. In this stage, the final product is prepared for its market to commit commercial activities such as marketing, sales and distribution planning.

Between the stages, there are decision gates that act as quality control points for the process. Gates have their distinguish deliverables or inputs, and criteria for the inputs. The output in each gate are certain decisions by senior management considering the process such as decision to go on, halt the process, put on hold, or start the previous stage over again, and action plan for the future. The utilization the stage-gate model in investment process tracking is based on conducting an evaluation after each stage. In this evaluation, the progress of the investment up to that point is assessed, and the next-step plan is updated. This approach keeps the investment process continuously under control and monitoring, being regularly updated as well. Depending on the type of the investment, the model can be streamlined and applied to the stages that are relevant to certain project. (Cooper, 1990)

Implementing stage-gate system can be beneficial for organizations, as for instance, it can improve the success of the R&D projects (Schultz et al., 2019). However, Sethi and Iqbal (2008) have found that adopting stage-gate process may be potentially restricting factor towards organizational learning in R&D projects due to its strict review criteria in each stage of the process. It is moreover possible that being a linear framework by nature, the usage of stage-gate may cause firm to discard its valuable assets due to kill-decisions made in a decision gate, thus possibly repressing the innovation activity in organization (Garud et al., 2013).

Stage-gate model includes PCA part as its final component, which is known in the model as *Post-implementation review* (Cooper, 1990). PCA part holds crucial role in the success of R&D investment process. In research by Cooper et al. (2004) it was recognized being an activity that had the highest positive correlation with company's business performance.

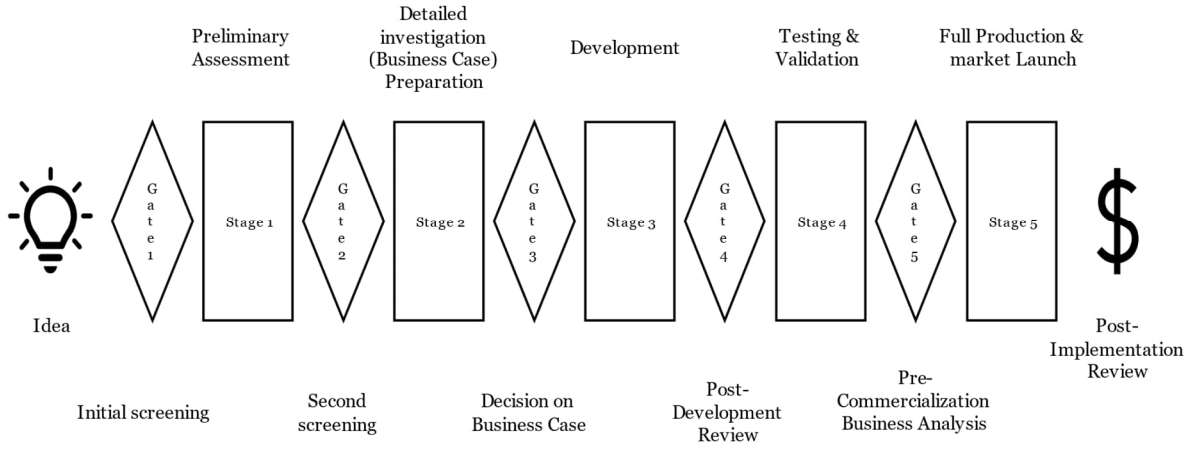

Figure 3: Stage-Gate Model (Cooper, 1990, p. 46)

2.3 Organizational learning

As current business landscape is characterized by constant change, including technological advancements, market dynamics, and competitive pressures organizations need to continuously learn and adapt to these changes to remain competitive and sustainable (Weldy, 2009). As an ancient Chinese proverb states: “learning is like rowing upstream: not to advance is to fall back”. Whitehill (1997) points out the benefits that organization can achieve by emphasizing the organizational learning (OL) that include: (1) ability to learn and change quicker, (2) cost savings, and (3) increase in competitive knowledge and ability. Today’s business landscape can be characterized by the necessity of gaining the knowledge and knowledge management in order to companies to gain and to retain the competitive advantage (Do and Mai, 2022). There are different definitions in the OL among different researchers, Argote and Miron-Spektor (2011) describe OL being the change in organization that arises when the organization gains experience. The creation of OL generally sprout when individuals recognize how their duties can be conducted better (Choo, 1996).

OL is also defined being a process to gain new information and knowledge that effect on both individual and organizational outcomes (Fiol, 1985, Huber, 1991). OL is considered as deeply rooted immaterial asset in organizations, that cannot be transferred or replaced (Alerasoul et al., 2022). According to Argyris (1977), the learning concept can be divided through two types of learning distinct from each other. Single-loop learning is a process in which the subject focuses on improving its effectiveness within the current paradigm without questioning the underlying assumptions, values, or goals. Whereas double-loop learning has more emphasis on finding the root causes and policies lying under and making proper reactive corrections based on the analysis. Huikku (2008) finds PCA as a proper tool for organizations to enhance the double-loop learning as it helps finding the underlying causes and policies for the flaws as well as successes of the project. Research conducted by Jiménez-Jiménez and Sanz-Valle (2011) shows positive correlation between OL and firm performance, recognizing the

positive correlation being stronger among SMEs and in “high turbulent” business environments.

In this section, the organizational learning (OL) is examined via framework by Huber (1991) which comprises four different constructs and processes associated with the OL that are: *knowledge acquisition, information distribution, information interpretation* and *organizational memory*. These constructs can be viewed as sequential steps in the organizational learning process.

2.3.1 Knowledge acquisition

Being the first step in the path towards organizational learning the knowledge acquisition is a fundamental process in the OL, involving the identification, creation, and assimilation of new knowledge (Huber, 1991). It is notable that knowledge can be distributed into explicit and implicit - or *tacit* - knowledge. While the explicit knowledge is often something that is stated clearly and in detail, the tacit knowledge is much more vague and it is typically difficult or impossible to verbalize (Davies, 2015). To summarize tacit knowledge, it can be described as “knowing how” as the explicit knowledge is more about “knowing that” (Lubit, 2001). While the knowledge can be divided into explicit and implicit knowledge, the knowledge acquisition can be divided further into intentional and unintentional acquisition as well (see e.g., Kuhn et al., 1995).

In his research, Huber (1991) lists five subprocesses via which companies are able to gain knowledge and information: *congenital learning, experiential learning, vicarious learning, grafting,* and *searching*. Congenital learning refers to the combination of knowledge and resources acquired before the company's foundation, coming from its founding instance and inherited knowledge at its conception. On the other hand, experimental learning occurs after the organization is already established, involving learning through direct experiences, which can result from systematic actions or unintended events and is based on learning by doing.

Vicarious learning involves borrowing best practices from competitors and other companies, where knowledge is acquired by observing others and the consequences of their actions. This type of learning can be facilitated through interactions with consultants, participating in professional meetings, and other means of peer knowledge exchange. Additionally, learning can also be gained externally by recruiting new personnel, acquiring entire organizations with the desired knowledge, or forming strategic alliances between other organizations, that is known as grafting. Searching refers to intentional information acquisition that can involve scanning broad and extensive observation of the organization's external environment, focused search towards more targeted and specific members or units among organization or performance monitoring serving as a means of assessing the organization's effectiveness in achieving its pre-determined goals. (Huber, 1991) Success of that kind of external knowledge acquisition is also dependent on the organization's ability to adopt those new concepts and to apply them into action commercially (Cohen and Levinthal, 1990).

In their research, Yli-Renko et al. (2001) argue that in industries that rely heavily on advanced technology, such as high-tech sectors, knowledge acquisition through relationships is particularly valuable for R&D procedures due to required specialized knowledge from various technological domains. They continue by proposing that there are three significant ways that knowledge acquisition contributes to R&D: (1) increasing the potential for innovation by acquiring larger pool of specific knowledge to generate ideas, (2) speeding up product development, and (3) boosting product development for key customers, as acquirement of external knowledge may increase firm's willingness to develop more tailored products to the needs of key customers.

2.3.2 Information distribution

Information distribution is considered being actions that persons, groups or larger units take in sharing information within their own group (Namada, 2018). Huber (1991) describes that it is the process where data from various sources is distributed in the organization, thus creating new understanding and knowledge. Information distribution is the second construct in linear framework of Huber (1991). He discusses about the importance of the information distribution in terms of its occurrence as well as its breadth. Information distribution has a crucial role in enabling organizational components in development of "new" knowledge by combining pieces of information gathered from different units within the organization. He argues that often organizations tend to lack having a comprehensive understanding of the knowledge they possess as they are not identifying where certain information exists within the organization.

Other common factors to hinder the generation of OL in information distribution construct typically include the lack of awareness to utilize the potentially synergistic information within the organization (Huber, 1991). Jiménez-Jiménez and Sanz-Valle (2011) suggest that organizations improved their information distribution by applying formal mechanisms to ensure the distribution of best practices. This can be made by for instance, improving communication among personnel, enhancing teamwork and by putting more emphasis on gathering and distributing personnel suggestions. Namada (2018) points out that the learning can occur in organizations if the knowledge is properly distributed, and it has several points of origin, not forgetting the importance of accessibility of the information.

Information distribution is typically divided into horizontal and vertical information distribution, horizontal taking place among units or functions at the same level in the organizational structure, whereas vertical distribution occurs between different levels of the organizational structure (see e.g., Sinkula et al., 1997, Ahmed et al., 2017).

2.3.3 Information interpretation

Information that is acquired and distributed is not helping the organization to enhance its OL optimally if it is not comprehensively interpretated and understood by its utilizers (Sinkula et al., 1997). Daft and Weick (1984) discusses about the process of interpretation that refers to giving a meaning to distributed information. They double define it as transformation of events into shared conceptual schemes as well as the translation of information into comprehensible understanding. Choo (1996) describes that knowledge generation occurs when it is acknowledged that there is synergistic connection between tacit and explicit knowledge within the organization and by structuring social mechanisms creating new knowledge by transforming tacit knowledge into explicit knowledge. According to Daft and Weick (1984) the primary purpose of organizations is to produce solid interpretations and models of vague data in order to organizations adapt flexibly to constantly changing business environment.

In modern business environment there is typically excessive amount of information available, thus giving effective information management even higher significance than it used to have. Thus, unlearning is a crucial ability in organizations, as it would be appropriate for the OL that outdated and misleading knowledge were discarded from the way of newer and more relevant information and practices (Namada, 2018).

2.3.4 Organizational memory

Organizational memory is considered as the process of storing the data and knowledge that can be utilized in the future (Jiménez-Jiménez and Sanz-Valle, 2011). If the organization is willing to learn from its past learnings, these learnings must be stored in accessible way into organizational memory (Huber, 1991). Namada (2018) argues that organizations' ability to learn depends on their organizational memory as modern business environment are so complex that without effective knowledge management companies would lose their

possible competitive advantage. Due to insufficient capabilities of human's memory, personnel turnover causing significant loss to an organization's memory, and such issues, it would be crucial for organizations to store its information and knowledge properly into computer based system (Huber, 1991). The knowledge and expertise that organizational memory consists of, can be passed to new employees via formal and informal methods such as mentoring and training (Namada, 2018).

2.4 Form of the OL-conducive PCA system

As mentioned before, the PCA methods can vary by their level of detail as some companies that commit the PCA, have structured, formal methods, while other companies conduct more implicit and informal PCA (see e.g. Lefley, 2019). In order to be effective, it would be appropriate that PCAs were conducted systematically and regularly, and not only in scenarios, when difficulties or unsuccessful investment has recognized (Farragher et al., 1999).

This thesis utilises the OL-conducive PCA framework by Huikku (2011a) that has been synthesized using four linearly occurring constructs of OL by Huber (1991) that are *knowledge acquisition, information distribution, information interpretation, and organizational memory*. Theory behind those four constructs was furtherly discoursed in *subchapter 2.3*. In this section, the different subparts of the OL-conducive PCA framework by Huikku (2011a) are described. In addition to the framework by Huikku (2011a), proper composition of the PCA board from OL-perspective is furthermore discussed in *Presentation forum for PCA reports* part.

The previously mentioned four different OL constructs by Huber (1991) are linear by nature. Framework by Huikku (2011a) utilizes that linearity by tying the *Selection of projects for PCA, Timing of PCA, Responsibility for PCA* and *PCA auditor* parts into the first construct known as *knowledge acquisition*. He

combines *information distribution and interpretation* together in the framework, which include *Content of PCA report, Presentation forum for PCA reports* and *Dissemination of final PCA reports*. The last construct *organizational memory* includes *Archiving and filing of PCA reports*. The complete framework can be seen in a *Table 3* below.

Table 3: OL-conducive PCA framework (Huikku, 2011, p. 14)

OL phases/design properties	**Proposed criteria**
Knowledge acquisition:	
Selection of projects for PCA	- repetitive investments - pilot investments - complex investments
Timing of PCA	after, but not long after, an investment is stabilized
Responsibility for PCA	- head office level (division or corporation), not investing unit
PCA auditor	- can be from investing unit or outside (both expected to be involved in making PCA reports)
Information distribution and interpretation:	
Content of PCA report	- the same capital budgeting calculation methods used ex ante and ex post - detailed comparisons of ex-ante and ex-post calculations - comments on the achievement of objectives - common corporate language - standard format - proposals for future investing
Presentation forum for PCA reports	at least one formal forum for interactive discussion and presentation of the reports
Dissemination of final PCA reports	extensive dissemination: at least to all people involved in the project (planning, approval, implementation, PCA)
Organizational memory:	
Archiving and filing of PCA reports	widely known archives or databases exist relevant persons have convenient access to reports

Selection of projects for PCA

In order to PCA being effective, it would be appropriate to pick the projects PCA is conducted to carefully. Neale (1991) suggested that targeted and strategic selection of PCA projects lead to more valuable outcomes as PCAs benefits were considered higher when resources were focused on carefully chosen projects compared to random selection of the projects that PCA was conducted to.

Huikku (2011a) argues that choosing recurring investments, pilot investments and investment projects with high complexity for the PCA review, the OL can be potentially reached thoroughly.

There is academic proof that the size of the investment project is typically the most important factor when picking the projects for the PCA review (e.g., Neale and Holmes, 1990, Lefley, 2019). Azzone and Maccarrone (2001) found out that other significant criteria used to select projects for PCA were the complexity of the investment and its strategic substance.

Timing of PCA

Conducting a PCA requires a balance between having adequate time to address initial problems that might have emerged since the completion of the project. However, it would be appropriate that the PCA is started early enough in the project's lifecycle to ensure that any necessary changes or modifications to the project can be made (Neale, 1991). Neale (1995) discusses that PCA is typically conducted around one year after the investment, still emphasizing the fact that optimal timing of the PCA is highly project specific. When considering timing of the PCA from a OL-conducive perspective, it is recommended that there is a relatively long timespan between the completion of the project and the conduction of the PCA part to gather more thorough and accurate information about the success of the project, however if the timespan is too long the learning possibilities may likewise diminish (Huikku, 2011a).

Huikku (2011a) furtherly suggests that PCA would be conducted once the investment has achieved its stability, but not long after it. He states that the optimal timing of the PCA is strongly dependent on the characteristics of each project, and thus an explicit guideline cannot be granted.

Responsibility for PCA

Huikku (2011a) suggests that it would be appropriate that within the organization, the corporate level or the business division level is responsible for the PCA. He implies that a centralized PCA responsibility outside of the investing unit would be more effective to standardize the PCA processes and facilitate the sharing of investment insights and knowledge within the corporation or the business division. According to Azzone and Maccarrone (2001) responsibility for the PCA includes managing resources related to PCA process, controlling the proper utilization of the process, overseeing different factors that may affect the quality of the PCA review, selecting projects that PCA is conducted, pointing out the PCA personnel and coordinating the development of the PCA system. When considering the most appropriate location of the PCA responsibility in the organization, Azzone and Maccarrone (2001) argue that centralized responsibility has ability to enhance the OL better due to larger resources that are often used in corporate or divisional level to find solutions to certain issues. They further argue that if the PCA was used for performance control activities instead of OL, more decentralized responsibility may have been better as it could improve the agility of the organization.

PCA conductor

When considering the suitable person to act as conductor of the PCA, it is crucial to understand their role and interests in order to minimize the risk of self-assessment bias. Self-assessment bias occurs when the person assessing their own work is influenced by personal incentives or motives. For instance, they might overestimate the project's benefits while underestimating the associated

risks. (see e.g., Segelod, 1997, Cheng et al., 2009, Huikku and Lukka, 2016) Some researchers argue that in order to achieve the best performance and to reduce the gameplaying in the investment process, it would be appropriate that the PCA would be conducted by individuals who were not participating in the investment process (e.g., Farragher et al., 1999).

Despite its flaws, self-assessment is the most common way to conduct the PCA in organizations (Segelod, 1997, Huikku, 2011a, Lefley, 2019). Actually, only very few companies have an external PCA conductor despite its advantages (Azzone and Maccarrone, 2001). The self-assessment is often explicated by organizations using arguments such as that it is not possible for external reviewer to gain necessary expertise on the subject, thus the self-assessment being the only acceptable way to conduct the PCA (Gordon and Smith, 1992). When considering the issue whether PCA conductor's expertise on the project or his/her objectivity towards it is more important, the PCA literature does not have an explicit answer to that (Huikku and Lukka, 2016).

Nevertheless, the consideration about choosing a person having a role in an investment project or embracing the external person to commit audit is rather ad hoc procedure that depends on the current scenario and environment. Whether the PCA is conducted in a self-assessment manner or the conductor is external reviewer, it is appropriate that the PCA report is executed in both occasions and in similar manner (Huikku, 2011a).

Content of PCA report

PCA report is often conducted as conventional and formalized output of the PCA process (Huikku and Lukka, 2016). The relevant PCA literature agree that the PCA report consists of four different components: (1) description of the capital budgeting proposal, (2) monitoring the advancement of cost budget, scheduling the project, and technical aspects in order to ensure the appropriate progress,

(3) comparison of the pre-investment *ex ante* calculations into actual *ex post* calculations, (4) qualitative analysis and comments about the project and its achievements, proposals for future R&D projects, formal proposal for next steps and such matters that have been acknowledged during the process and that may become beneficial in the future projects (Neale and Holmes, 1990, Azzone and Maccarrone, 2001, Huikku and Lukka, 2016). From OL perspective, the proposal for next steps and implementation of them in action are crucial factors in double loop learning (Azzone and Maccarrone, 2001). Even though companies do not always utilize standard methods in their PCA (Farragher et al., 1999), the standardized content of the PCA report enables company to conduct the required *ex ante* to *ex post* comparison better (Huikku, 2011a).

It would be likewise appropriate to utilize the common corporate language in PCA reporting (Huikku, 2011a). The primary rationale for introducing a common corporate language is to enhance smooth daily communication within the corporation and its often globally spread subsidiary units. Given the prominence of English in international business, many companies adopt English as their common corporate language to standardize internal communication. (Fredriksson et al., 2006) According to Huikku (2011a) alongside with the standard corporate language, it would be appropriate for PCA report to contain other standardized features to enhance the knowledge as well to enhance the OL.

Presentation forum for PCA reports

The significance of a forum for presenting PCA reports in contributing to OL has been largely overlooked by researchers in comparison to other OL-conducting factors. However, Azzone and Maccarrone (2001) highlight the common practice of holding meetings involving PCA conductors and other personnel engaged in the investment process, in which PCA outcomes and potential next-steps are discussed about and implemented. Huikku (2011a) implies that a shared forum offers three advantages: (1) it disseminates knowledge among participants, (2)

aids in interpreting results, and (3) facilitates the development of collective comprehension. He further argues that such a forum ensures that the findings and recommendations presented in a PCA report are embraced as a shared organizational understanding. The lack of such a platform could raise questions among report readers about the dependability and extensive acceptance of the findings, potentially resulting in the exclusion of proper recommendations.

Neale and Holmes (1990) highlighted the importance of that the PCA conductor can receive feedback on his/her work and is able to discuss about the difficulties that was faced during the process in a constructive manner recognizing possible pitfalls and challenges. Thus, to increase the OL within the organization, it would be appropriate to have a forum where interactive discussions and PCA presentations are held (Huikku, 2011a). Besides the importance of communicational skills among the PCA board, technical expertise considering investment projects, problem-solving skills and proper mix between managerial and operational capabilities are required when creating an OL-conducive composition for the PCA board (Azzone and Maccarrone, 2001).

Dissemination of final PCA reports

From the OL perspective, the dissemination of the results of the PCA to the organization is one of the most important duties (Neale and Holmes, 1990). According to Azzone and Maccarrone (2001) it would be appropriate that the PCA reports were shared with the people involved with the investment project regardless that they found out in their research that companies did not find dissemination of PCA reports that crucial despite that it is recognized as a critical factor in the OL context. Huikku (2011a) suggests that to ensure feedback for future projects, it is recommended that companies distribute PCA reports to all individuals engaged in the planning, approval, implementation, and PCA part of an investment project.

Archiving and filing of PCA reports

To foster organizational learning, it is important to systematically archive PCA reports in a manner that allows the members of the organization to retrieve them from internal archives or databases when needed. Huikku (2011a) recommends that it would be appropriate that these databases or archives maintained a comprehensive record of their contents, and relevant persons were informed about the location and granted access to these archives. As these criteria are met, he further suggests that a suitable foundation for OL is established. Archived and filed PCA reports are the collective knowledge of the company, the effective management of which is a crucial factor in the organization's success (Namada, 2018).

2.5 Summary of literature review

Literature review was formed in a manner where post-completion audit (PCA) was introduced as a part of the capital budgeting process. PCA plays a crucial role in evaluating the outcomes of capital budgeting projects, and its definitions and criteria used in this thesis were mainly formed around PCA research by Azzone and Maccarrone (2001) and Huikku (2007). Literature review clarified the motives behind PCA adoption, most relevant being organizational learning (OL) (see e.g., Azzone and Maccarrone, 2001, Huikku, 2011a, Lefley, 2016). Beside the OL, that is in the scope of this thesis other significant objectives and benefits of PCA adoption were its positive effect on decision-making (Sandström et al., 2016, Lefley, 2019), its ability to act as control mechanism (Huikku, 2008, Lefley, 2016), and a possibility to use PCA to evaluate the performance of managers in the investment project (Neale, 1991, Lefley, 2019).

Even though PCA is widely recognized being beneficial for companies, it may still have its challenges and limitations: when conducted carefully and thoroughly, PCA requires time and money that may hindrance PCA adoption especially in smaller companies (Neale and Holmes, 1990, Lefley, 2019). PCA conductor's position regarding the project and a lack of control may also increase a risk of gameplaying and cause self-assessment bias (Cross and Brodt, 2001, Huikku and Lukka, 2016). Koch et al. (2010) also pointed out the possibility that PCA adoption may increase suboptimal risk aversion in organizations. Another challenge in PCAs may be associated with difficulties in project selection stage due to insufficient or vague information available (Neale and Holmes, 1990, Sandström et al., 2016).

OL-conducive PCA system by Huikku (2011a), and its different components were covered in *subchapter 2.4*. The system was created to utilize the four constructs of organizational learning by Huber (1991): *knowledge acquisition, information distribution, information interpretation and organizational memory*. Theory about the OL, and its four constructs were discussed thoroughly in *subchapter*

2.3. by covering different OLs dimensions and their implications for business success. Knowledge acquisition is a fundamental process including the identification, creation and assimilation of new knowledge (Huber, 1991). Knowledge can be defined as explicit knowledge or as tacit knowledge, where explicit knowledge can often be tangible, written, formal and somewhat more recognizable. Tacit knowledge, on the other hand, is more subjective, vague, and based on insights difficult to verbalize. (Davies, 2015) Namada (2018) describes information distribution as actions that individuals, groups or even larger units take to share knowledge. It has a crucial role in creating new understanding within an organization (Huber, 1991).

Sinkula et al. (1997) point out the importance of information interpretation in organizations as learning could not be properly achieved if acquired information is not understood by its utilizers. However, due to information overload typically occurring in companies, unlearning is a crucial ability for organizations to get rid of outdated and misleading information (Namada, 2018). Organizational memory is a process of storing data and knowledge for future use (Jiménez-Jiménez and Sanz-Valle, 2011). Namada (2018) argues that organization's learning ability is highly dependent on its organizational memory, especially in a complex business environment. Due to aspects such as human limitations in memory and personnel turnover it would be appropriate to store the information in accessible computer-based systems (Huber, 1991).

Research & development (R&D) investments can be defined as systematic and experimental activities aimed at creating new technologies, products, services or improving existing ones (e.g., Rogers, 1998). R&D activity has been seen having a positive impact on productivity growth, especially in high-tech industries (Mohnen and Röller, 2005, García-Manjón and Romero-Merino, 2012). Due to often complex and risky nature of R&D investment projects (see e.g., Eng and Shackell, 2001), tools and frameworks such as stage-gate model (Cooper, 1990) have been developed to make complex processes more understandable. Stage-gate model is a linearly running and structured approach to manage R&D

projects from idea to market launch. In the model, decision gates act as quality control points where decision board decides about follow-ups for the project. Stage-gate model includes PCA part as a final component of it. Cooper et al. (2004) see PCA as an activity with the highest positive correlation with a company's business performance.

Purpose of the study is to enhance the PCA system in case company which is a large Finnish publicly listed manufacturing company with strong emphasis on R&D activities. The company has identified a specific challenge in its investment process: predictions made during the *ex ante* phase tend to be overly optimistic compared to the actual project outcomes, and enhanced PCA system could have a crucial role as a solution to this problem. In *chapter 3* the chosen constructive research approach is presented after which in *chapter 4* the gathered interview material is presented. The actual construct synthesizes the prior literature with gathered empirical evidence and is presented in *chapter 5*.

3 METHODOLOGY

This section outlines the research design and methodology used in this thesis and the benefits and limitations that occur in the case study format. This thesis will be conducted as qualitative empirical study focusing on the context of single organization. In this chapter of the thesis, the used research method will be presented and justified after which there will be discussion about the possible pitfalls and limitations that may occur among which the generalization, reliability, validity, contribution to theory and triangulation of the thesis.

Kasanen et al. (1993) highlight that the notable portion of management accounting master's theses were at least at the time conducted in so-called problem-solving focused methodology, which is often structured by (1) pointing out a problem statement, (2) theory review, (3) the resolution of an actual business challenge or *managerial construction* and ending with subsequent (4) discussion. This thesis is structured rather similarly, as the chosen research method for this thesis is single-case study with constructive approach, where large publicly listed Finnish high-technology manufacturing company's PCA system in R&D investments is presented in the theoretical context of enhancing the organizational learning in it by utilizing the OL-conducive PCA framework by Huikku (2011a). The aim is to achieve a comprehensive and holistic view considering the PCA procedures in the R&D investments in the case company. The in-depth information was captured via interviews that were conducted in the organization in order to reach the desired outcome. To enhance triangulation, there were supplementary materials about the company's PCA and R&D processes available as well.

3.1 Single case study with constructive approach

Single case study was selected as research method for this thesis. The single case study research method is a qualitative research approach that focuses on the analysis of a single unit of analysis, such as an individual, group, organization, or

community (Eisenhardt, 1989). Case study approach is particularly suitable method for exploring complex phenomena (Cooper and Morgan, 2008). As a research method, single case study aims to create comprehensive understanding of the certain area of interest by conducting remarkably detailed and multi-dimensional analysis and research about the case organization (Vaivio, 2008), thus the single benefit of the method is that it allows researcher to have more in-depth focus on certain organization and emphasis (Ahrens and Dent, 1998). Case study is considered being rather demanding research method due to its nature, relevance of which arises from its ability to establish credibility by linking relevant former accounting knowledge with current research problem and the empirical results in meaningful way (Lukka and Kasanen, 1995). Ahrens and Dent (1998) point out the choice between profoundness and breadth in qualitative research regarding the sample size. Being a single case study, this thesis has sample size of one. Thus, it aims to dig deep into the company's procedures and to understand comprehensively its problems and atmosphere with the aim of creating solutions.

This thesis is formed using constructive approach (see e.g., Kasanen et al., 1993) to enhance the organizational learning in the context of case company's R&D investments. The aim for constructive approach is to build a construct that is theoretically solid as well as helpful towards the case organization and its management by participating into the change management and development in the organization (Malmi, 2016). Constructive researcher seeks for practical problem in case organization that has research potential and works in co-operation with it to gather the applicable data and information from the organization. After which the researcher constructs theory-based solution to the problem (Labro and Tuomela, 2003). One of the key objectives in the constructive approach is that these solutions and new constructions created were implemented into organization's procedures thus tested in action (Kasanen et al., 1993).

Interviews are considered being the most frequently used method for qualitative research (Puusa and Juuti, 2020). In this thesis, semi-structured interviews act as the primary source of the empirical data. According to Horton et al. (2004) using semi-structured interviews mitigate the risk to ask irrelevant questions from the interviewee. The key factor in such interviewing method is the selection of the interviewees. A skilled interviewee can provide extensive information on the themes, increasing the validity of the interview data gathered. Even though Vaivio (2008) argues that despite that interviews are typically the primary sources of the information that is gathered from the case organization, he states that in order to increase the reliability of the research, other material supplementing the interviews would be advantageous.

According to Kasanen et al. (1993), market test that examines construction's functionality in action is the main relevance test in constructive research method. When organization that the construction is created for adopts the construction *weak market test* can be passed. *Semi-strong market test* would require that multiple organizations used and proved the construction effective. The highest level of testing *strong market test* means that the financial benefits of using the construct apply to multiple businesses. It indicates a broad and substantial impact, showing that the construct is not only effective in different organizations but also brings about tangible economic advantages. (Rautiainen et al., 2017) In the scope of this thesis, it is not appropriate to presume passage greater than *weak market test* due to restrictions in time and resources available.

3.2 Generalization

Due to small sample size, generalization is seen perhaps as the single biggest limitation in case studies (Yin, 2003). If argued that case studies should be evaluated with similar requirements of statistical significance than quantitative studies, the generalization would not be possible to achieve (Lukka and Kasanen, 1995). However, according to Vaivio (2008), it is not appropriate to judge single

case study with similar criteria compared to for instance statistical study. Instead, in the field of case studies in accounting research, the generalization is rather “theoretical generalization" (see e.g., Eisenhardt, 1991, Parker and Northcott, 2016). Theoretical generalization is about the process when researcher applies theory into certain phenomena by broadening the qualitative empirical findings into general theoretical ideas about the phenomena rather than trying to enhance the statistical coverage of the research (Parker and Northcott, 2016).

However, according to Vaivio (2008) one possible pitfall for management accounting researchers is “over-generalization” of their work and findings. Lukka and Kasanen (1995) argue that even though majority of the accounting researchers have been aware of the problems considering the generalization, there may still be emphasis on trying to create results that are as generalizable as possible. Parker and Northcott (2016) point out that the desire to establish generalizability for research findings arises typically from two reasons. Firstly, the ability to generalize allows researchers to find connections between their research findings and other phenomena that might not be immediately apparent, creating more comprehensive understanding. Secondly, they argue that achieving generalizability helps researchers to communicate about their findings beyond their imminent research context, creating broader relevance in their findings among other studies’ researchers as well.

Lukka and Kasanen (1995) point that with the intent of creating generalizable accounting research, it would be appropriate that there are three components included: sufficient theoretical knowledge about the subject area, prior empirical results and empirical results that are provided by the research that is discussed about.

3.3 Reliability and validity

Reliability in the context of qualitative case study arises from the replicability and repeatability of the research. It implies that the information acquired via the research is considered being dependable and trustworthy. (McKinnon, 1988) However, Ahrens and Chapman (2006) argue that it is not appropriate to assume that qualitative research in accounting would establish replicable research studies. They point out that reliability has been originally introduced in social sciences, and mainly in positivistic studies utilizing questionnaires as research instruments. Thus Ahrens and Chapman (2006) see that kind of standard for reliability inappropriate for qualitative research in accounting as in this research area studies do not rely that heavily on such research instruments, and have to deal more with a mix of structured and unstructured data. By definition, validity refers to what extent the study's findings, analysis and conclusions represent the phenomena research is conducted about (see e.g., McKinnon, 1988). In qualitative studies, validity is a debated topic within research community, and is considered being often interconnected with reliability (Hayashi et al., 2019).

McKinnon (1988) lists four different types of major risks towards reliability and validity in case studies: effects caused by observer, observer bias, limitations in access to data and limitations of the human mind. In order to mitigate the risks and threats considering reliability and validity McKinnon (1988) suggests three different issues to focus on: it would be appropriate that the researcher would allocate significant share of his/her resources available in the case company gathering empirical data, the usage of several methods and ways to gather the data and being aware of the personal behaviour of the researcher. When conducting interviews, the possibility of the observer bias is around as the interview event is typically led and steered by the researcher (Puusa and Juuti, 2020).

To bring up reliability and validity in this current thesis process, the research design and method was thoroughly planned in order to have high potential for holistic results that are as valid and reliable as possible. Constructive research method seemed appropriate way to map current procedures and challenges occurring in the case company and eventually to seek methods to help it to improve its processes. Another significant tool to improve the value of the thesis was the usage of multiple data methods. Company's internal material and presentations about their PCA and R&D processes had crucial supporting and supplemental role regarding the main empirical data that was gathered via semi-structured expert interviews in the company. Conducting interviews by utilizing the semi-structured method allowed to gain more holistic and comprehensive view from the experts to improve reliability and validity of the research. Significant time and resources were also allocated into the project and especially to thorough analysis considering the gathered interview material and transcriptions. Another method to increase the reliability and validity of the thesis was the decision to tailor the interview themes and questions depending on interviewees role and gathered output on prior interviews. For example, the first interview was more broader focusing on gaining understanding on the entire R&D process, company's industry, organization and such issues. This practice helped to focus asking relevant questions from other interviewees and allowed interviewer to gain better knowledge on the subject.

3.4 Contribution to theory

In management accounting research, contribution to theory can refer to the impact of the study on creating or developing existing theoretical frameworks (see e.g., Keating, 1995). Creating theoretical contributions is considered as major concern in management accounting research as distinctive complexity of research phenomena may hinder the contribution to theory (Ahrens and Dent, 1998). Parker (2012) suggests that qualitative research in the context of management accounting has made important contributions to the overall knowledge and theory also having the potential to offer stand-alone research as

well as complementing research to quantitative papers. This is despite the critique that Ferreira and Merchant (1992) pointed out considering theoretical contributions in management accounting qualitative research. In their review, they noted that majority of management accounting research did not sufficiently tie the empirical findings into the literature.

Given the fact that vague or deficient theoretical contributions can be a major pitfall in this kind of qualitative management accounting research. Thus, to enhance the value of this thesis it is appropriate to recognize that possible flaw and commit actions to reduce the unscholarliness.

This thesis is conducted by using constructive research method that has emphasis on creating managerial contribution by giving suggestions to solve practical problems in the company. However, this thesis has also academic dimensions as it was able to contribute theoretically by filling the existing research gap in PCA by focusing on R&D investments and utilizing OL-conducive PCA model by Huikku (2011a).

3.5 Triangulation

In this thesis, most of the empirical data was gathered through semi-structured interviews conducted in the case-company. In addition to the interview data, the company provided internal material about their PCA and R&D investment processes. The possibility for using internal company material about the R&D and PCA processes decreases the risk considering an insufficient empirical material, and would enhance triangulation between those different data sources, thus enhancing the reliability of the research. Triangulation is a method of integrating several sources of data to find the interrelationship between the various sources in order to enhance the reliability and validity of the research (Pauwels and Matthyssens, 2004). It is considered as one of the most well-known validity criterion in qualitative research (Hayashi et al., 2019). This kind of triangulation is specifically known as data triangulation where several

different sources of data are utilized to supplement each other (Puusa and Juuti, 2020).

3.6 Data collection

Seven semi-structured interviews lasting 60 minutes in average were held between June and September 2023 to gather the empirical data for the thesis. The interviews were held in MS Teams and interview themes were sent to interviewees via e-mail prior each interview. However, actual interview structures and questions asked varied among the interviews as each conversation and interviewee were different. The interviews were recorded and transcribed to make the actual analysis work more convenient for the researcher. A relatively long timespan between the first and the last interview was an intentional choice. The aimed plan in that was to ensure that the interview structures and questions were effective and that I had time to gain as much knowledge about the case organization as necessary to hold proper, interactive interviews. Another challenge in the data collection was that prior each interview I was not aware of current interviewee's actual position and background in relation to the topic and the PCA. This increased the demand for interviewer as well. This approach, where enough time was taken between interviews allowed me to gain a deep understanding and thoroughly analyse the complex processes within the case company. Thus equipping me with the ability to ask appropriate questions of the interviewees and gave me new insights considering the phenomenon, that is also seen as one of the key benefits of semi-structured interviews (Wrona and Gunnesch, 2016).

Composition of interviewees is rather diverse having people with different backgrounds and working on different positions in relation to the PCA and R&D processes in the company. List of interviews include people that currently have or previously have had a conducting role in the PCA. It also includes people who act in PCA board in decision-making and sparring role. Beside that PCA conductor – PCA reviewer/board member dimension, the variance between the

technological and financial expertise is around as well. Persons responsible for the development of the PCA process and more broadly the R&D processes in the company are also involved in the interviewee list. When the possible interviewees were mapped in the case organization, high level of experience and knowledge was emphasized. This was made to improve the potential for high quality responses and an insight about the possible changes that may have occurred in the organization's processes within the past years in relation to the issues under investigation. The list of interviews conducted can be found below in *Table 4*.

Role of Interviewee	Date	Duration
Head of Portfolio	26.6.2023	80 min
Process Development Manager	13.7.2023	60 min
Senior Business Controller	14.7.2023	55 min
R&D and Engineering Portfolio Manager	14.7.2023	60 min
Senior Product Manager	31.7.2023	62 min
R&D Portfolio Manager 1	15.9.2023	50 min
R&D Portfolio Manager 2	25.9.2023	50 min

Table 4: List of interviews

4 EMPIRICAL FINDINGS

This chapter delves into the case company and empirical results gained from the interviews conducted as well as from supplementing material. First, the case company will be presented and its distinguishes, organization and industry are discussed about. After that, this chapter focuses on its primary contribution, delving into the presentation of empirical material. It is structured by implementing it into the OL-conducive PCA framework by (Huikku, 2011a) and the PCA components or phases presented in it. Prior to that there is also a part where the case company's overall attitude towards the PCA is presented and discussed about by pointing out the objectives and benefits of the PCA as well as challenges and limitations that consider being related to their PCA activities.

4.1 R&D process in case company

The case company of this thesis is a large publicly listed Finnish high-technology manufacturing company that has strong emphasis on R&D commitments in its activities and it has established strong reputation with its innovative products and solutions. The company is a global player, with subsidiaries and distribution channels all over the world. The company conducts several different R&D projects yearly. There is also a rather high variance in the sizes of the projects in the company as the smallest R&D projects are around 100 to 200 thousand euros with project length less than year. However, larger projects last around 5 to 7 years costing several million euros. The company offers a wide range of products, with prices ranging from a few thousand euros to hundreds of thousands of euros per unit.

The company allocates a significant share of its resources into R&D investments to maintain its competitive edge in the market. Thus, the importance of the R&D procedures acts as crucial factor to motivate the research and to comprehensively understand the PCA procedures in the company. The case

company's large size, high-technology focus and high number of R&D projects make it a suitable target company for the research. The overall context of the company enables us to provide valuable insights associated with PCA in the field of R&D investments in a technologically advanced industry.

As case company's R&D project portfolio contains lengthy and complex projects, the company is using their application about Stage-gate model by Cooper (1990). The company has adopted the Stage-gate model in order to make the R&D processes easier to manage. The company is calling its Stage-gate application in product development process Business Review or "BR" process, where there are BR gates as decision points. The purpose of the BR in case company is to evaluate and approve whether the proposed business idea is in line with the company's strategies, has necessary business justification and acceptable business and execution risks in order to proceed with it.

The PCA part of the Business Review or BR process is called BR3, where ramp-up business analysis is conducted. The BR3 is typically conducted two to three years after the product launch, however there is variation between different types of R&D projects. Despite BR3 being nominally a BR gate, decisions to advance in the project, to redo the phase or to kill the project are not made by the board. The PCA report is conducted and presented by the Product Manager to the BR board consisting of pre-determined list of participants such as Business Area's EVP, Business Unit's VPs and Business Controller. In the PCA report, the current situation is compared to estimations that were made during the previous BR gates. The PCA report is structured, and it includes comparison of quantitative *ex ante* project estimations to actual *ex post* figures. Besides the quantitative analysis, the PCA includes qualitative appraisal of the project as well. The quantitative analysis consists of comparison of KPIs such as sales, R&D budget, schedule, profitability index calculation (PIC) margin and discounted payback time. Net present value (NPV) is not included in the PCA report, yet projects' NPVs are calculated and reviewed in the portfolio level. The qualitative evaluation in the PCA report consists of subjective matters such as which was

good in the project, which were the challenges, what the organization learned during the project and what actions should be taken, and when the follow-up for those actions would be held.

To sum up, this section presented features of the case company which is a large publicly listed Finnish high-tech manufacturing company with high emphasis on R&D activities. Utilizing stage-gate model as the Business Review (BR) process, the company employes BR3 gate for PCA activities. The following *subchapters 4.1.1* and *4.1.2* about the PCAs objectives and challenges are providing supplementing and supporting material about the current PCA procedures and R&D processes in the case company. The actual OL-related aspects of the PCA are discoursed more thoroughly in the *subchapter 4.2*.

4.1.1 Objectives and benefits of the PCA

Process Development Manager with extensive experience in the company points out that the PCA has been around in its current BR3 form since 2016. Before that the company had also conducted less structured project end reports with less emphasis on the business performance review compared to the current BR3:

> *"Current form for the PCA has been around since 2016 when we started to conduct BR3s. But even before that we have conducted project end reports, that had higher focus on other issues, yet it also had some business performance review as well." – Process Development Manager*

Company has written purpose for the BR3 phase being the PCA part. Proper PCA report would answer to questions about whether the project was justified, did the project go according to plans, and how the organization was able to learn from the project. The purpose also addresses the market aspects, and plans for future actions. The objective or purpose of the PCA in case company's internal PCA instructions is phrased in following manner:

> *"The purpose of BR3 is to follow up the original business case. Did we do the right decision when we initiated the project? How did the development go compared to the plans, and what did we learn from it?*

What was our go-to-market plan, and how well did we execute it? What is our way forward with this product?"

The Head of Portfolio argues that even though the above presented purpose of the PCA may seem rather brief, it actually is somewhat comprehensive and has several different aspects and dimensions in it. He also thinks that even though the PCA already has rather high emphasis on organizational learning in company, it could be emphasized even more by conducting thorough analysis on the successful R&D projects as well. According to the interviewee, nowadays the company seem to learn from the mistakes perhaps mainly but not from the successes, at least not in same scope:

"Even though it seems that there are not that many in it, but actually there are major ones, of course." – Head of Portfolio

"Yes, issues such as control of the project and its outcomes. And also, that organizational learning aspect comes up clearly, am I right?" – Interviewer

"Yes, yes. And I think we should somehow improve the learning even more by making it more systematic. Even though we have discussed learning from mistakes and analyzing unsuccessful projects or projects that have gone south cost-wise, and I find that important thing to do. But sometimes I have thought that if we should put more emphasis on learning about those successful projects as well. Because often we just have been happy for the success and not analyzing the root causes. So, that would be also interesting aspect to think if we should learn more from the good cases as well." – Head of Portfolio

Despite the acknowledged need for improved learning in the PCA, the Head of Portfolio further believes that the OL has improved compared to the past. He sees that the BR3 PCA phase has developed into a more sparring direction. He provides an explicit illustration of that by pointing out that there have been increasingly number of attentions and action plans in the BR3 gate:

"It has been developed in a direction where it (BR3) has become a more sparring situation. Thus, it has led to more "conditional go" decisions in the log and other remarks as well. Like there are more of those tasks

currently compared to past when there were more unconditional passes. – Head of Portfolio

Another aspect that is considered as benefit according to the Head of Portfolio is the improved decision-making. He sees that the PCA decision-making board has been able to ask better questions and to steer the product team into right direction:

> *"I think it (decision-making) has improved. Product and project managers have given feedback that the board has been able to ask questions that help the product manager to understand and analyze the situation, as if it's more like a coaching session than before. – Head of Portfolio*

4.1.2 Challenges and limitation of the PCA

Even though not explicitly related to just PCA process, the significant challenge that the case company is facing is related to over-optimistic predictions made in the *ex ante* phase of the investment process. Thus, the PCAs systematically conclude that cost budgets and predicted time schedules for the projects were not reached. Head of portfolio considers that as major challenge and underlines that especially the project costs could be estimated better:

> *"It is still a struggle for us. Like how we would be able to estimate and manage the project costs and why we still have loads of projects where costs grow that significantly during the project compared to estimates during the BRO concept phase. I am not saying that we should cut the costs during the project, but the question is why our estimates were not accurate in the planning phase. The costs are more related to uncertainty in development of new technologies. Could we manage that better? As I think that we are not able to manage the market performance that well." – Head of Portfolio*

Senior Business Controller agrees with the cost overruns and underlines that especially the market performance is difficult to estimate due to several uncertainties. He points out that the estimated market possibility and size for new product and its valuation are difficult to estimate and those can have a

major impact to the investment calculations and financial success of the projects:

> *"It (market size) is one of the most difficult things to estimate. From the point of view of project manager as he estimates it. And also, the possibility to challenge the assumptions by others. Because often it can be a certain new market that does not yet exist. I think that is the most difficult aspect of estimations." – Senior Business Controller*

When considering the method to improve the quality of market size estimates, the Senior Business Controller points out that conducting a new study for market size would not be resource-wise appropriate. Despite, he emphasizes the possibility to increase the challenging of those market size and value assumptions PCA conductors have made. It would be important to recognize the suitable personnel to question those assumptions:

> *"Well, I think that it would be best if we were not conducting a new competitive market study about the same subject due to resource issues. But it would be good if we were able to challenge the assumptions and logic behind the estimates on market size or its growth. I think that it would be the best method and that we have correct personnel in there to challenge in BRs." – Senior Business Controller*

Development Manager also recognizes the problem considering the cost overruns and mentions corporate cultural aspects as single possible reason behind it. He suggests that there may be behavior around that the BR board is eager to have the estimated costs unconvincingly low:

> *"That is perhaps somewhat related to our corporate culture. I have even made research long ago about these project costs that stated that the actual costs were systematically let's say 30 % above the predicted. I think that people in charge are not willing to hear the truth, like if project manager says that the project will last 18 months the executives may state that "no, it should be 12 month project", so we would stick with the 12 months and be surprised why time schedule and costs exceeded the estimations." – Development Manager*

The Head of the Portfolio believes that project delays are primarily caused by the organization's decision to shift its focus from one area to another. He points out that it is somewhat common practice to prioritize one project over another:

> *"We have decided to prioritize one project over another, and this project has been intentionally delayed and put into hold or its resources have been decreased. So those delays are also due to our own decisions and actions. But as we delay the projects, it can usually be seen as cost overrun as well. – Head of Portfolio*

R&D and Engineering Portfolio Manager believes that project delays and cost overruns may be a result of insufficient resources, which in turn stems from underestimating budgets. Thus, this situation may necessitate a reevaluation of project priorities, as it may not be feasible to execute every project as initially planned:

> *"So, if we now show, let's say, too low costs for 10 projects. That's why we start a couple of 3 new projects alongside them. Then we see that they should progress, but when the costs are already so high for those ongoing projects, these new ones can never really get going. They try to inch forward, so what happens is that we have too many projects then in the portfolio. – R&D and Engineering Portfolio Manager*

When asked about how organization would be able to learn from those occurring project cost overruns, Senior Product Manager stated that it would be appropriate if the PCA board had a clearer picture of the entire R&D portfolio and not only of single projects that they review during the BR process. Thus, it would possibly help to increase the understanding about the root causes of systematic project cost overruns:

> *"There should be those, kind of reviews about the entire portfolio. That could help the BR board to understand how the projects perform on average." – Senior Product Manger*

There are certain difficulties considering learning as case company's R&D projects tend to last several years, thus the frequency for PCA, at least for the PCA conductors and the project team is remarkably low. R&D Portfolio Manager 2 points out this issue:

"So, it's a rather rare moment because this stems from the fact that our product development projects are typically incredibly long. At least, easily spanning several years, and in addition, after that, there is a desired length of production ramp-up period, where we then see whether we got what we wanted, right?" – R&D Portfolio Manager 2

4.2 PCA process from OL framework perspective

This subchapter walks through the different criteria for learning-wise effective PCA system based on an OL-conducive PCA framework by Huikku (2011a). It aims to create a comprehensive picture of the case company's PCA procedures by utilizing the gathered interview material from case company's personnel as well as supplementing empirical material.

4.2.1 Project selection for the PCA

In case company, the BR3 (PCA) is conducted to every new product development R&D project systematically and in similar manner. R&D Portfolio Manager 2 states that there are certain software projects that have separate control and review mechanisms with higher frequency due to the continuous development nature of those projects:

"All of the new products under development go through BR pipeline. It (BR) is basically our funding mechanism where business case is analysed and certain mandate to operate is given. This mandate can also be adjusted during the BR process, and eventually it will be shut down. Beside the BR process, in some system software products we have other process as well without the Business Review gates. But that has its own control mechanisms, and the feedback loop is shorter (compared to BR). – R&D Portfolio Manager 2

When asked about number of projects beside the BR pipeline, R&D Portfolio Manager 2 did not provide an explicit answer but stating that there are not many of them:

"There are not many of them. Currently in my portfolio I have only one that kind of project. Let's say that in total those consist minor share of all projects. – R&D Portfolio Manager 2

Currently all of the new products under development are handled basically in a similar way. Yet, R&D and Engineering Portfolio Manager recognizes the distinctiveness of the products that contain software needing continuous development and updating. He wonders if those software projects would benefit from more frequent agile review cycle compared to hardware products.

> *"Perhaps another thing would be that for something where agile software is developed with a faster cycle for selling features and offerings, there should also be a culture where they would look at it at the BR (Business Review) level. If there were this BR3 or maybe a lighter, more frequent agile kind of review. To see what was planned and what was accomplished." – R&D and Engineering Portfolio Manager*

4.2.2 Timing of the PCA

Process development manager who has been developing current processes including the BR process and the BR3 (PCA) states that for the timing of the PCA the company has aimed to conduct it six months after the market release of the product. The six months seemed like a decent compromise as thus the R&D project would still be reasonably well in minds of the personnel, but still the financial performance in the markets would become observable in most cases. Another motive for the reasonably short timespan after the release and the BR3 is the possibility to increase the market performance with the BR board sparring the project and product responsible personnel:

> *"Another objective for the BR3 (PCA) is that the gate meeting would be held approximately six months after the product release. And if we have also previously had some (ex ante) business presumptions, it would be reasonable to ask for example why these presumptions did not realise and if we are still able do something to improve the current situation. For example, if there was a potential customer segment that we believed to sell the product to. So, was the non-success due to insufficient marketing or is our product lacking a feature that these customers want, or what was the issue. So, it is a place to find ways to improve the business if possible." – Process Development Manager*

However, the aim that the BR3 gate meetings were conducted six months after the market release of the product has become more or less utopia. The fact that Head of Portfolio remembers the aim timing being twelve months could refer that it is not emphasized or taken as an order among the organization. In reality, the timespan between the product's market release and the BR3 may stretch to even several years long. There are numerous practical reasons behind that that arise from the features of the company's business model and its R&D portfolio's high product mix:

> *"BR3 (PCA) is held after the product is launched and when its market performance has been realised. And there can be high time variation at which point the meeting should be held. We have some instructions that say one year after the launch but that is not often the most practical way. For example, in a case of product x (more simple bulk product) the shorter timespan may even tell us something and can work pretty well. But if we think about product y, the product y is so large, complex, and expensive that it becomes more or less fortune if there are many or even any units sold one year after its market launch. Thus, we cannot have a proper view about the business performance and even about the technical performance in action. So, in these kinds of products, it would be appropriate to hold the BR3 three to five years after the launch due to minimal volume of certain complex products." – Head of Portfolio*

R&D Portfolio Manager 2 has similar opinions about the timing of the PCA than previous interviewees. He argues that strict guidelines for i.e., six months after the product release cannot be set as the sales volumes and projects have significant variety:

> *"No. It needs to be tied to that. The products are so different. The volumes are very different, so how much data we need, and what we need to learn can vary. And then, when sales cases can go in a way that, for example, we had a project a few years ago that was done for a specific customer. Nevertheless, it was a normal new product project and not some kind of custom tailoring. And it couldn't have been measured six months later as it hadn't been sold at all yet at that point." – R&D Portfolio Manager 2*

He further suggests that PCA timing could have a guideline to have checkpoints to briefly evaluate if the project has yet gained the necessary market information

to conduct the PCA. This would help to ensure that PCAs were conducted at the earliest possible moment the evidence about business performance can be recognized.

> *"Perhaps there could be some sort of guideline for that. And perhaps, or rather, we could schedule it firmly with checkpoints to see if we are ready. Perhaps that's the concrete thing that could be useful, and currently, we don't have such a thing." – R&D Portfolio Manager 2*

R&D and Engineering Portfolio Manager sees that the timing of the PCA tends to lengthen due to difficulties in appointing suitable meeting time. With relatively large attendant list required in PCA presentation forum, it can be often a case that suitable time can be difficult to find.

> *"The calendar issues are also usually around as it is often difficult to find time from those people. We even listed a business ramp-up (BR3, PCA) of a crucial product to be held this year as an objective. But we were not able to do that as the people (PCA attendants) thought that the timeframe is not possible. In overall, we should emphasize it (PCA) more." – R&D and Engineering Portfolio Manager*

4.2.3 Responsibility for the PCA

Case company consists of two main business areas focusing on different types of industries and products. Company's R&D and NPD processes as well as its PCA procedures are alike in both business areas. Responsibility for the PCA is centralized in both business areas its leader acting as chairman of the BR board. When discussed whether PCA activities should be organized centrally or among an investment unit subordinated to the business area, the R&D Portfolio Manager 1 has an explicit opinion. He believes that centralized way is superior due to its more transparent process, and ability for top-down communication and control. He also states that PCA centralized at higher level may improve the performance of R&D portfolios as more centralized PCA crew may be able to manage the big picture better:

"Well, I think that the higher level the better as then the transparency and visibility around the organization about what is working and what is not can be distributed top-down. Of course, there is a dialogue downwards, but as our projects should have as good business impact and execution as possible, it would not be sufficient to conduct wrong projects. Thus, it is important that we are doing right things and that is why I see that these (PCAs) should be managed from the top." – R&D Portfolio Manager 1

When asked R&D Portfolio Manager 1 more about possible organizational learning outcomes that centralized PCA responsibility may generate he emphasizes the experience of the PCA board, and the board's ability to coach and challenge the assumptions made in the PCA report. He believes that these actions can enhance the organizational learning and manage the company into right direction:

"There is that kind of crew (in the PCA board) that has been involved in plenty of those business reviews. Thus, I would think that they can challenge the estimates for instance about the sales growth and the assumptions behind the figures. And similarly, if the projects are systematically behind the schedule due to their execution they can challenge and for instance recognize if the projects were under-resourced and we have too much on the table. Thus, we could learn better to allocate that money top-down. So, I would say that there are a lot of possibilities to steer the organization to do the right things." – R&D Portfolio Manager 1

R&D Portfolio Manager 2 sees the optimal place for the PCA responsibility in organization as multi-dimensional issue. On the other hand, he suggests that if the PCA responsibility would be on the operating level, it could be better as that level has the technical knowledge and experience. Yet, he finds the information and knowledge distribution within the organization as crucial aspect that could devolve if the responsibility was more local. He thinks that the analysis work itself should be made in lower level and that the results were communicated and disseminated properly within the organization:

""Yeah, this is indeed an interesting question that I haven't thought about before. I might think of it in a way that the right place to do it is where the knowledge of the work is. And in our organization, that's at

the product area level. Because at the product areas, we have all the resources. So, in my opinion, that's the right place to do it. But then, some cross-pollination would also be good so that product areas can also share what they have found." – R&D Portfolio Manager 2

Senior Product Manager believes that currently the organizational learning is not as satisfactory as it could be. He states that the company frequently repeats the same mistakes in the PCA and BR processes. A significant reason behind that could be internal biases among different stakeholders in relation to the project. He continues that personnel definitely are able to make analysis and estimations but that varying ambitions affect on the lack of optimal learning:

"If I should consider what is the proper learning aspect in that when we have conducted these (PCAs). Well, I could be a bit more sceptical about if anything has changed anywhere. In some recent projects where we have executed retrospective reviews, we have recognized that similar (negative) phenomena are around compared to some previous cases. So, still every year there are those, internal kind of biases around. That may arise from the varying objectives of different stakeholders and other such issues. It is not that we are not able to make estimates." – Senior Product Manager

4.2.4 PCA conductor

In case company, PCA is formed and presented by Product Manager who acts as product owner for the new product under development and is responsible for the product-related issues such as creating a vision of the product, defining its technical requirements, and focusing on planning user-centric product. In every R&D project there is also Project Manager who is in charge of the execution and successful delivery of the project and considers issues such as resource allocation and progress tracking of the project:

"Yes, we have Project Manager who is responsible for executing the project. Yet we also have Product Manager acting as an owner of the product under development. They are working in cooperation with each other." – Head of Portfolio

Knowledge and expertise considering the high-technology R&D products and projects are considered as beneficial and necessary attributes for the individual in charge of conducting the PCA report. Head of Portfolio underlines the need for expertise due to products' complexity and their high variation:

> *"I think that it is very difficult to find an external conductor to the (PCA) process. Product managers have that high expertise in the products they are in charge, and they also have that market knowledge. So, I think it would be very difficult. Even though we have extensive R&D portfolio and capabilities, but in product level the R&D teams are actually quite thin. There are not many experts available (even globally) in some of our niche areas." – Head of Portfolio*

However, Head of Portfolio agrees with the risk for possible self-assessment biases and the PCA conductors' possible ambitions to present those results and reasons behind them from an angle that is beneficial for themselves. He believes that this can be especially problem at the scenarios that the project has not met its objectives.

> *"Of course, especially if performance of the product is worse than expected. Of course, it can increase the tension, hard to say if there can be a bias, it may be possible. Definitely it can at least alter the angle that the PCA is presented." – Head of Portfolio*

Senior Product Manager has rather similar views. He underlines the importance of technical expertise and experience of the PCA conductor, still recognizing the possible risks that self-assessment situation can raise. He also points out that as the technical aspects in R&D projects are often significantly complex, it would take unnecessary amount of resources if purely external person would conduct the PCA:

> *"Perhaps it can seem like a situation where there is a fox in a henhouse, in a manner. But on the other hand, the Product Manager is a person who has deep knowledge about the product and the successes and difficulties that occurred during the project. I think it (self-assessment) has altogether more pros than cons. It would take an extensive time and resources for external person to gain that necessary knowledge." – Senior Product Manager*

R&D Portfolio Manager 2 sees the PCA conductor's position being a rather sensitive question when considering the objectivity of the PCA process, and recognizes the possibility for the self-assessment bias:

> *"Now, this is a sensitive question. Because one should also be able to ask whether the Product Manager is acting in the best possible way when making decisions regarding the business case and the project. It's kind of like whether he can objectively see this matter well enough." – R&D Portfolio Manager 2*

He continues by admitting that the Product Manager is definitely the most appropriate person to conduct the PCA, however according to him there should be certain control mechanisms to ensure the objectivity of the PCA output. He believes that for instance, the supervisors could have a higher role to play in that issue as they typically have sufficient technical and business knowledge, and are rather independent in relation to the certain single product under development:

> *"Well, in a way, the fact that the product manager is responsible for it, it's correct in the sense that then the learning goes directly to the right place. So, in the next project, the product manager can get the best possible lesson from the previous one. I feel that I also have a role in that (as manager). I do participate in these projects, and I participate in all the steering groups, but I'm not responsibility of the business case or steering group. So, I sort of feel like I'm maybe, of course, being a bit more independent. And an outsider in the sense that I see things from a different perspective at least." – R&D Portfolio Manager 2*

When asked about possible control mechanisms and other actions to decrease the possible agency problems and biases, Senior Product Manager highlights the traceability of the entire BR process, and the required content of the PCA report. He points out that at least the quantitative data side is rather traceable as the previous BR stages contain the evidence about the past estimates and assumptions behind those:

> *"That is an interesting aspect. I think that data side is rather well structured and clear. We can see how the estimated figures have*

developed in each BR stage and how it actualized. It is quite ruthless as the facts are not easy to hide." – Senior Product Manager

R&D and Engineering Portfolio Manager points out that even though in the organization there are several aspects that contain peer review, the PCA phase does not include peer review aspects. He also states that increase in the peer review could be useful:

> *"So why isn't there this kind of peer review, colleague assessment – there's a lot of it in planning, and it's mandatory, but in this field, there isn't. I don't know if you've ever come across it. But it would be quite healthy." – R&D and Engineering Portfolio Manager*

However, Senior Product Manager further states that even though the project cost figures cannot be easily manipulated, the business performance review part of the product includes more risks as it is at least partially based on estimates about future sales and sometimes vague market valuations. Also, he points out the fact that as the sales personnel does not attend the PCA forum, there is a possibility that their viewpoints were presented by PCA conductor from and angle desirable to the presenter, thus increasing the negative effects of the self-assessment bias:

> *"There may be higher uncertainty in sales estimation. It would be perhaps appropriate that we could enhance the viewpoint of the sales crew. As in current system the sales crew's voice is filtered through Product Manager and his/her personal view about the actualised sales and future sales potential." – Senior Product Manager*

4.2.5 Content of the PCA report

Currently, the PCA template is rather simple and contains only couple slides. In the PCA report, the current situation is assessed by comparing it to the estimations made during the previous BR gates. Report template is well-structured, encompassing a comparison of quantitative *ex ante* project estimations with actual *ex post* figures. The *ex ante* estimations compared with the most recent figures in the PCA report are from BR0 (business concept) gate.

Additionally, BR1 (project business case) estimated figures are also included in the report. PCA report often contains a brief illustration of the product and its technical functioning. There is also a quantitative analysis that involves comparing key performance indicators (KPIs) such as sales, R&D budget, schedule adherence, profitability index calculation (PIC) margin, and discounted payback time, which are expounded with verbal analysis.

In addition to quantitative analysis, the PCA also incorporates a qualitative appraisal of the project with headlines such as *Good, Bad, Lessons learned, Actions*. Even though PCA report template has not more than 3 slides in it, the finished BR3 presentation can contain anything between 5 to 30 PowerPoint slides depending on complexity of the project and personal preferences and ambitions of the Product Manager acting as PCA conductor. PCA report is conducted in English, which is the common corporate language used in globally operating case company.

Senior Product Manager sees the relative simplicity of the PCA template as an advantage due to high mix of different products in case company. If the template would be more complex, it could not possibly be suitable for certain product:

> *"In principle, it is because there are variety of different projects and products. So it cannot go that deep into detail level as it would not be suitable for each different case." – Senior Product Manager*

Head of Portfolio sees that the lack of complexity and guidance in BR3 or PCA template increases the responsibility of the Product Managers in putting the right things on paper and conducting necessary analysis to create an effective PCA report. He also thinks that there is currently relatively little instruction for PCA conductor:

> *"So, our product managers, who are essentially responsible for this BR3, have to do quite a bit of analysis to distill these things out. Even though this is somewhat lightly guided, they still have to put in a lot of effort to genuinely address these issues." – Head of Portfolio*

R&D and Engineering Portfolio Manager has similar impressions about the content of the PCA report. The versatility and lightness of current PCA form is an advantage as the PCA conductor can tailor the PCA report to suit each product in development. However, he thinks that there could be more instructions available for the PCA conductor, and more systematic form for the PCA report could improve the PCA phase. As an example, R&D and Engineering Portfolio Manager points out certain software projects, that require continuous development and updates, and has several releases for new features. He sees those software projects having that unique attributes that it would be appropriate to have somewhat different PCA process for them with perhaps more PCA review phases.

> *"In our process, there is not that much structuration on which should be considered (in the PCA). Certainly, it is good that the process is not too heavy that we could tailor it better for different projects. But if we have for example a software project with continuous development with plenty of releases. It would be appropriate that those (updates and new features) were also reviewed. It could be probably made with relatively low effort." – R&D and Engineering Portfolio Manager*

Senior Product Manager also points out the software projects and their unique aspects and need for continuous review. He also states that these challenges concern hardware projects as well as they include increasingly amount of software and technology with the need of continuous development.

> *"Recently we have had increasingly software projects that actually do not ever end and have a continuous development mode at them. I think there could be something to improve. Maybe one-shot review is not the most optimal way in these cases. Actually, this spreads to concern hardware platform as well as if there is for example some Linux box integrated, the maintaining and developing cannot be halted due to security problems." – Senior Product Manager*

Senior Business Controller would appreciate better documentation and traceability concerning assumptions made to commit financial estimates and analysis for the PCA phase as well as for other phases of the project. He suggests

that PCA report would contain a summary about the main assumptions behind the financial calculations and analysis.

> *"Bit a cliché, but the documentation (could be better). There may have been cases where at the report there was only an Excel screenshot from cashflow analysis without documentation about the main assumptions behind it. For example, like selling price is this much, volume increases that much and that assumption is because Asian market's predicted 5% annual growth, or something like that. So, generally better documentation about the assumptions that we could understand and develop the current process better. -- Assumptions could be summarised (to report) by having a brief table about them in it. That would be a good point to develop." – Senior Business Controller*

R&D Portfolio Manager 2 believes that it would be appropriate if PCA reports contained more analysis to describe the uniqueness of each project and motive behind them. He sees that PCAs purpose is not solely to find out if things have been done right, but as well to recognize if the right things were done. He also emphasises that those different assumptions made during previous phases would be reviewed properly:

> *"What it (report template) is currently missing is the description about what made this project distinctive. Because, really all of our projects are so different from another. So, which factors made this unique? How did we tackle it (challenges considering uncertainties)? And I believe that when we would have sufficient amount of these analysis' we would be able to gain statistics out of them. So, perhaps somewhat getting rid of that "project is project" state of mind and recognizing truly the variety of our products and projects. For instance, reviewing if the assumed dream team was that good in reality, and did projects get the resources it requested. So, did all go as planned or was that all an illusion? – R&D Portfolio Manager 2*

When considering the language used in the PCA report template and the learning from broader view Head of Portfolio wonders if the bullet point *Bad* could be instead phrased in a manner that did not contain that negative attitude:

> *"It is a corporate cultural aspect. I think the challenge is at the moment that when even considering the title "bad", I don't know if it could be something else, but it is a charged term in a manner. Like how we could*

emphasize the receptive atmosphere. And would dare to present the failures more openly." – Head of Portfolio

4.2.6 Presentation forum for the report

PCA is presented by product manager at BR3 gate to decision board. The board consists of the management of the business area, business units', R&D management, and controller. There are also marketing people around in the presentation forum.

> *"It is determined that in the BR3 (PCA) -gate the product manager conducts the presentation and is in charge of the PCA report. Yet the attendants in a decision board has business area's EVP as chairman, then there are VPs of the business units, business area's R&D VP, product area manager and business controller as board members. Marketing managers are also present supporting the product manager." – Head of Portfolio*

When evaluating the composition of the BR3 or PCA meeting, R&D Portfolio Manager 1 recognizes the current business-oriented emphasis in there and perhaps a lack of technical expertise. He also thinks about the absence of manufacturing representatives, but concludes that it is not perhaps significant:

> *"There is EVP, product line lead, people from marketing, a controller, business unit lead, product manager and so on. So, it is remarkably business-oriented on the whole while the R&D or portfolio view is lacking behind, like how we have been able to execute the project and why we are late and so on. But I don't see that we should add more people there. The current situation is comprehensive. Also, there is not presentation from the manufacturing but as long as we have the delivery capability everything is fine." – R&D Portfolio Manager 1*

Process Development Manager argues that currently, the PCA presentation meeting and its arrangement is described being similar to "Shark Tank", referring to popular tv-show. As the product and project managers step into the meeting to present their product and its performance, they can be nervous as the board tends to have tough questions and high expectations. He says that the personal traits such as charisma and presentation skills of the product manager

have a remarkably high effect on how the success of the product and the project is evaluated. Even though in overall, project managers are experienced presenters with loads of technical knowledge about the product, it is still considered being highly influenced by project manager's ability to confidently present and to answer the tricky questions by the board.

> *"It is more about competency of the presenter, and how he is able to present the business case. It depends on the presenter and his/her charisma and such like how he can really present those difficult issues. I really cannot see that we are able to change that with process, it is more corporate cultural issue. No process is helping if presenter is afraid to say the truth, and there is a Shark Tank atmosphere around." – Process Development Manager*

Senior Product Manager continues with similar experiences stating that the PCA presentation forum and meeting is often quite single sided, PCA conductor having defensive position. He suggests that there should be a higher level of dialogue between the presenter and the board. This configuration is according to him highly dependent on personality of the board members:

> *"In worst case it (the board's response) can be convicting. The PCA conductor leaving room thinking that: "you (the board) accepted that plan and sales estimates and now it is my fault that we did not reach the goals". I mean like the BR board could also sometimes look in the mirror as these are, at least in principle, common projects. There should be a proper dialogue between the board and presenter. But that also depends on the personal ambitions and traits of the board members. Some are not willing to discuss that much while some people prefer more dialogistic approach." – Senior Product Manager*

4.2.7 Dissemination of final PCA reports

In case company, the final PCA report are not consistently shared to personnel related to the project. Yet, the relevant people have access to the archive where the final reports are eventually stored. Beside the formal dissemination of the PCA reports in each R&D project, Product Managers who conduct the PCA reports have a peer discussion and feedback forum where they can exchange

ideas, provide constructive feedback, and solve problems collectively. This non-structured forum may enhance the culture of continuous improvement, information dissemination and employee engagement.

> *"Product Managers have that kind of forum where they share information. For example, considering the BR3 (PCA) they could have certain topics on agenda about which they discuss. During the spring there was a goal to improve the BR templates, and thus we asked feedback from Product Managers. The feedback forum helped on that." – Process Development Manager*

Senior Product Manager highlights the discussion forum for Product Managers further. He points out that it is an interest group that focuses on varying topics considering Product Managers' interests and work. The group has a meeting once a month.

> *"We (Product Managers) have that interest group in which there are varying topics in agenda related to Product Managers' work. It is held once a month and has around 50 people in it." – Senior Product Manager*

Besides the peer feedback forum for Product Managers, it seems that distribution of the final PCA reports, and knowledge sharing could be more comprehensive in the case company. R&D Portfolio Manager 2 states that he is not aware about dissemination of those reports, and continues that if there was any notable dissemination, he should have been recognizing that.

> *"Really, I must say that I have no idea (about PCA report dissemination). It is not at least conducted actively as I would be aware of that if that was the case." – R&D Portfolio Manager 2*

R&D and Engineering Portfolio Manager believes that the distribution of the learnings and the PCA reports are not sufficient. He argues that the knowledge distribution is mainly limited to review of the actual business figures of one's own business area and that the successful projects are presented in several info meetings:

"No, no, the information doesn't really flow much. It's that small group that has the information. Why some businesses succeed and others don't. Usually, it's not very widely shared. So, we just look at the business numbers for a particular product. Of course, you can always see the figures for your own area, but I don't know. One possibility is that you should also be able to tell about these failed projects and what was learned from them. You probably hear about the ones that go smoothly, and had a good boost that somehow worked for that business. – R&D and Engineering Portfolio Manager

Senior Product Manager sees a procedure where BR3 and other BR presentations are presented to the product team prior to the actual presentation as very good practice. He thinks that this can create feedback to enhance the actual presentation and to increase the knowledge distribution.

"The practice we have here in different product areas is that we have these, like, previews, so before you hold the BR 3 or any other BR session, it's presented to the whole team. Feedback on the presentation methods and other aspects can be provided during that. In my opinion, this is a very good approach that is in use." – Senior Product Manager

4.2.8 Archiving and filing of PCA reports

Finished PCA reports as well as minutes from the BR3 meetings are saved into the company's intranet, where they are available to appropriate personnel. However, as the PCA reports usually have crucial and strategic information in them, access is naturally restricted to only necessary personnel.

"Yes, the archiving locates at intranet. Available, but on a site that has quite restricted access. Only certain people are able to look at them as they are pretty strategic business decisions. But those whose access is granted have access to all the reports. So yeah, the reports are archived. I think it is handled quite well." – Senior Product Manager

"Those (finished reports) are saved into Sharepoint, where we have reports on all of the BR gates. There is kind of library where every decision is filed with all its attachments, project's budgets and so on. There is restricted access in it so not everyone can see them. Actually, I am not certain who have access and who does not but of course at least

people involved in the BRs have access to the files." - R&D Portfolio Manager 1

Process Development Manager believes that the current archiving system is at least in principle accessible to the relevant personnel. However, he admits that it cannot be confirmed if personnel in reality utilizes the archived material:

> *"I would say that it is accessible to everyone in need. But whether they are looking for the material afterwards, it cannot be confirmed. Of course it could be checked from the log if needed." – Process Development Manager*

Even though the finished PCA reports are archived and accessible to required persons, there has been some criticism towards search features of Sharepoint as well as incoherent project and folder naming. R&D Portfolio Manager 2 sees that there could be room for improvement in PCA report archiving so it could have a possibility to reach the goal of being a knowledge distributing factor:

> *"Those are at Sharepoint which has miserable search features. Folder structure is remarkably incoherent, and project naming is not consistent. Some projects can be named with their internal project code name, and some with the brand name of that new product, thus it is difficult to know the right search entry. I would say that currently it is more data vault than knowledge distribution platform." – R&D Portfolio Manager 2*

In overall it seems that there is a room for improvement in archiving of the PCA material and the distributing those results and findings as according to interviews, many people close to R&D projects did not have comprehensive understanding about where those PCA reports, and other materials were saved.

Taken together, this section provided empirical evidence gathered from interviewees about PCA activities in the case company. Material was formed to follow the criteria of an OL-conducive PCA framework by Huikku (2011a). Next chapter will provide constructive suggestions based on literature and empirical material.

5 SUGGESTIONS FOR OL-CONDUCIVE PCA

This part aims to give suggestions for the case company about the different parts of the post-completion audit (PCA) from the point of view of organizational learning (OL). This construct follows the framework of Huikku (2011a) about OL-conducive PCA alignment, and is influenced by the academic PCA and OL literature as well as by the interviewees from the case company who gave valuable insights concerning the subject. From project selection to the dissemination of final reports, each recommendation is tailored to foster a culture of learning, transparency, and efficiency within the organization. Through the thoughtful implementation of these implications, the company can strengthen its ability to learn from past R&D projects, improve decision-making processes, and ultimately enhance its overall performance. This created construct is optimal for case company as it enables it to comprehensively review its current approaches towards PCA from several points of view. It is also potentially able to help the company in its current problem considering often inaccurate estimates made in project selection phase.

Project selection for the PCA

Currently, every R&D project going through the Business Review pipeline for new R&D products are systematically selected for the PCA procedures. The company's high technology R&D portfolio has a remarkably high product mix with typically low volumes. On the basis of this kind of complex R&D business, it would be recommended that every single project should be chosen for the PCA review in the future as well.

Due to their nature, software projects may often have an extensive need for continuous development and maintenance even after the product launch and after the primary PCA has been conducted. Software environment's dynamic nature, changing requirements, technological advancements and user feedback may create a need for more frequent review loop for the software projects. It is

suggested that the possibility of an additional and agile review method for software projects would be considered.

Timing of the PCA

As mentioned before, case company's R&D portfolio mix contains various different projects, thus the timing to gain sufficient data about the product's business performance and its technical performance can vary substantially. If the product is a relatively simple replacement product that already has its market and customers, it can start generating revenue immediately, and the PCA may be reasonable to be held within a short timespan after a product launch. However, there are products that require more attention, for example, due to their complexity, large size, new market, or other factors that cause them to generate sales later than other products. It would not be sufficient to hold the PCA if the business or technical performance was not clear. Thus, the exact and appropriate timespan for PCA is not possible to choose.

However, it would be most appropriate to conduct the PCA shortly after the project has stabilized, and its performance is recognized. Therefore, the suggested timing for the PCA would be shortly after both the product's business performance and its technical performance have been acknowledged. It is also crucial to ensure that PCA meetings are not postponed due to scheduling conflicts of the participants or other issues. A practical way to determine the optimal timing for the PCA is to establish a checkpoint tool that assesses whether the project is ready for the PCA review. This assessment could be based on criteria such as sufficient sales, user feedback, or other relevant data.

Responsibility for the PCA

It is suggested that the responsibility for the PCA remains at the business area level. This centralized way to conduct the PCA ensures that the PCA reports and their presentation are similar to each other and that they are comparable. As the

PCA process is led by business area's management, there is higher potential for organizational learning due to BR board's experience on numerous PCA reports and presentations and the higher ability to spread the knowledge top-down manner. Despite the centralized responsibility and standard procedures, it is important to note that the actual PCA work is suggested to be conducted in the R&D project teams similarly to the past.

PCA conductor

Recommendation for the PCA conductor in the case company is that Product Manager continues to form the PCA report and the presentation. Deep technical expertise and experience in the field of the product under development is required to ensure the quality of the PCA report, thus an external auditor does not necessarily come in question. Yet, possible self-assessment biases should be recognized and mitigated to enhance the overall quality of the PCA.

It is recommended that the PCA process should offer greater control and support to PCA conductors, particularly from their management. The personnel in these supervisory roles should possess a deep understanding of both technical and business aspects, along with independence towards the project. This approach could have several benefits: (1) quality of the PCA reports could enhance, (2) self-assessment biases may be reduced, and (3) PCA learning could be spread better. Another approach to potentially reduce harmful biases is to enhance peer review among product managers during the PCA phase. These could be two efficient control tools in self-assessment bias reducing.

Content of the PCA report

The current 'fit-for-all' PCA report template has numerous benefits. The current PCA report includes necessary elements such as detailed comparison with *ex ante* BRO calculations, qualitative review about the project and proposals for future actions. Due to case company's high product mix it would be impractical

to excessively complex the report. Yet, there is a room for improvement in making assumptions more recognizable by reporting the trail behind those assumptions more thoroughly. It is recommended that the rationale behind those assumptions were documented in a standard manner, and that the calculations were stored systematically. Also, there could be a brief explanation for reasoning behind each assumption made.

Another recommendation for the content of the PCA report is to introduce a tool for conducting a root cause analysis of the three universal project constraints: *time*, *quality*, and *cost*. This approach would provide a comprehensive framework for product and project evaluation and could lead to significant improvements in organizational learning and continuous enhancement. However, it is crucial to ensure that this tool does not overly burden Product Managers and remains relatively straightforward. The results of the root cause analysis should be stored in a manner similar to the PCA reports.

Presentation forum for the report

The overall benefit for the current presentation forum is that the composition of the PCA board is basically the same compared to the preceding BR gates. That enhances the potential for learning in the organization as the project is familiar to the board from the previous meetings. The current forum for the presentation is rather well structured and the board has a comprehensive composition. As a general suggestion, it would be appropriate to ensure that there are relevant personnel around in forum in relation to each project, yet the number of personnel should not be excessive to keep the forum conversational. Another important issue for enhanced learning is the culture and atmosphere that should be interactive and not judging. Both PCA conductor and the board have a role in that: board should emphasize the solution-oriented atmosphere in the meeting instead judgmental whereas PCA conductor is responsible for delivering a well-prepared report and presentation.

Dissemination of final PCA reports

In overall, it seems that the dissemination of final PCA reports could be improved. However, it is crucial to acknowledge the necessary restrictions on individuals who have access to confidential PCA material. This naturally has a constraining impact on potential knowledge sharing. It is recommended that the PCA report dissemination would be emphasized more in the organization due to its benefits. This could be executed by sharing the final PCA report with the relevant personnel in the project. Thus, the learning could be enhanced by ensuring that the personnel actually read the final report. Another beneficial practice for enhancing the PCA report and knowledge dissemination would be a preliminary presentation of the PCA report to the project team. This approach can improve the reports' quality by incorporating diverse opinions and addressing questions from team members, ultimately leading to more effective dissemination of PCA reports.

Archiving and filing of PCA reports

In order to utilize and enhance the organizational memory, the proper archiving and filing of PCA reports is required. It is suggested that the current PCA archiving format was improved by creating more coherent folder structures and a consistent manner in project naming. Well-organized folder structures and consistent naming make it easier for employees to find and retrieve project-related information. This efficiency can save time and resources.

MANAGERIAL IMPLICATIONS

This part of the thesis summarizes the created construct that was presented in *chapter 5* and presents key managerial implications aimed at enhancing organizational learning for a case company. These implications are grounded in the framework of Huikku (2011a) and influenced by academic literature on PCA

and OL as well as insights from interviews within the case company, these suggestions encompass various aspects of the PCA process. Even though these implications are based on the created construct for the case company, other companies conducting PCAs in their R&D investment projects could find these findings relevant for them as well. However, it must be noted that created construct is most likely not suitable to adopt for other companies in its entirety and must be tailored to fit each company's characteristics.

Project selection for PCA:

- Consider continuing to conduct PCA review for every R&D project in the BR process due to the complex nature of the high-technology R&D portfolio.
- Consider whether software projects require agile and more frequent review methods to address their continuous development needs.

Timing of PCA

- Emphasize conducting PCA shortly after the project has stabilized and its business and technical performance has been recognized.
- It could be appropriate to implement a checkpoint tool based on criteria such as sales and user feedback to determine whether the project is ready to evaluate.

Responsibility for PCA

- It would be appropriate to maintain centralized responsibility at the business area level to ensure that PCA reports and presentations were consistent.
- Despite the centralized responsibility and standard practices, the actual PCA work is suggested to be conducted in R&D project teams similarly to the past.

PCA conductor

- It is suggested that product managers continue to conduct PCA reports to leverage their technical expertise.
- Greater control and support could be provided to PCA conductors by appointing a supervisor for PCA conductor, emphasizing the supervisor's independence and understanding of both technical and business aspects. This could mitigate potential bias that PCA self-assessment may create.

Content of the PCA report

- It is suggested that current PCA report template is maintained. However, the recognition of assumptions could be improved by documenting rationale and made calculations systematically.
- It would be appropriate to introduce a tool of root cause analysis of the most common project constraints *cost, time* and *quality*. Adoption of such practice could help to recognize possible underlying problems better, and to enhance organizational learning.

Presentation forum for the report

- Current PCA board composition is suggested to keep maintained for organizational learning. It is beneficial for OL that BR board members are mostly same in each BR gates.
- Interactive and solution-oriented atmosphere in the presentation forum should be enhanced.

Dissemination of final PCA reports

- Dissemination of final PCA reports with relevant personnel should be emphasized within the organization for enhanced organizational sharing.
- It would be appropriate to adopt preliminary PCA presentation within project teams. This practice could improve quality of the PCA reports and enhance the knowledge sharing.

Archiving and filing of PCA reports

- Current PCA archiving format should be improved with coherent folder structures and consistent project naming to enhance organizational memory.
- Well-organized archives allow easy retrieval of project-related information, saving time and resources.
- Ensure that the appropriate personnel have access to the PCA report archives, while maintaining the confidentiality.

6 DISCUSSION

This chapter delves into the main findings of this thesis and ties it with the literature that was discussed in *chapter 2* in order to interpret the findings and discuss relationships between the literature and empirical evidence. There will be a brief recap of the research problem, and the objectives of the study, summary of key findings and their comparison with the literature. Firstly, in actual discussion part the benefits and objectives as well as the challenges of the PCA in case company are reflected in alignment with prior PCA literature. Secondly, the current PCA system of the case company is analysed by comparing empirical evidence with existing literature. This analysis utilizes the OL-conducive PCA framework proposed by Huikku (2011a).

As previously mentioned, purpose of this study was to enhance the post-completion auditing (PCA) system in case company which is a large Finnish publicly listed manufacturing company with high emphasis on R&D activities. The company seeks to find improvement especially for the challenge that predictions made in the *ex ante* phase of the investment process are somewhat systematically over-optimistic compared to actual project figures. This thesis utilised the constructive research method (Kasanen et al., 1993), and aimed to create a construct that could give suggestions and find remarks considering current procedures in the case company. Other purpose for the thesis was to broaden the understanding about the post-completion auditing (PCA) in R&D investments in relation to the organizational learning (OL), and to fill the current research gap considering the PCA research in the R&D investments.

PCA BENEFITS AND CHALLENGES

Being in line with previous literature (e.g., Azzone and Maccarrone, 2001, Huikku, 2011a, Lefley, 2016) about the benefits and objectives of the PCA, organizational learning was considered as the most important objective of the PCA in case company. Beside the learning that is the most intrinsic benefit in the

scope of this thesis, there were some other factors in the empirical material that were considered as PCAs benefits such as improvement in decision-making that was discussed by for instance, Neale and Holmes (1990), Sandström et al. (2016) and Lefley (2019). Even though PCAs ability to enhance the decision-making was not directly put in the scope of this thesis, it was interesting to find out from the empirical material that the decision-making had improved due to PCA board's ability to ask better questions and to steer the R&D teams into the right direction. This is also partially correlated with the OL as the board's decision-making can be seen to improved due to their learning. PCA was also used as a control mechanism to evaluate whether the actual investment performance reviewed in the BR3 phase aligned with the initial expectations provided in the BR0 phase in the case company. For instance, Huikku (2008) and Lefley (2016) see control as a single crucial objective for the PCA.

According to previous literature, the downside of the PCA is typically that it requires additional work and can be costly (Neale and Holmes, 1990, Lefley, 2019). While this was recognized in the empirical evidence as well, the benefits of PCAs were unanimously found to significantly outweigh their costs. Prior PCA literature addresses self-assessment bias being frequently recognized challenge in the PCAs (Cross and Brodt, 2001, Koch et al., 2010, Huikku and Lukka, 2016). The significance of this challenge amplifies due to the fact that self-assessment is the most typical manner to conduct the PCA in companies (e.g., Segelod, 1997, Huikku, 2011a, Lefley, 2019). Based on empirical evidence, the self-assessment bias emerges as a relevant issue for the case company. This concern will be examined more thoroughly in the subsequent section on PCA conductors in this chapter.

R&D projects are typically many years long processes in case company. Empirical evidence highlighted this feature, and its impact on the PCA system. Thus, all PCA conductors do not necessarily have high experience on conducting PCAs, at least in the current role in case company. This can be seen as an issue that amplifies the importance of the OL and increases the need for an effective

PCA system. This empirical evidence is in line with Sandström et al. (2016) who see that due to often infrequent PCA processes, the conductors of those may not be able to learn from those projects. However, despite the PCA conducting project managers' sometimes relative inexperience on PCA reports, the decision-making BR board in case company attend in PCA meetings in BR3s on a regular basis thus having the ability to also responsibility to steer the projects into a right direction by challenging and supporting the PCA conductors.

PCA PROCESS FROM OL PERSPECTIVE

Project selection for the PCA

According to literature considering project selection for PCA, a targeted and careful consideration when choosing PCA projects yields more valuable outcomes than random selection (Neale, 1991). Investment project's complexity and strategic substance are frequently seen as an important criteria for the PCA adoption in literature (see e.g., Azzone and Maccarrone, 2001) along with the project size (Neale and Holmes, 1990, Lefley, 2019). According to empirical evidence the R&D projects have a crucial role in the company's success, the project portfolio has high variation in its projects, and the projects are often complex. Thus, case company's method to commit PCA to every R&D project in BR pipeline is well in line with the PCA literature and the suggestions and criteria that for instance, Huikku (2011a) gave considering the OL-conducive project selection for the PCA.

Timing of the PCA

Prior PCA literature does not provide an explicit suggestion to optimal timing of the PCA. The early timing could ensure that there is time to make any necessary changes or modifications to the project (Neale, 1991). However, longer timespan between project's completion and the PCA conduction may provide more accurate information considering success of the project (Huikku, 2011a). As per Neale (1995), typical timing for the PCA is one year after the completion of the project, yet highlighting the distinctive features and varying demands for

different projects. Empirical evidence is in line with the literature by highlighting the high variation between projects and their uniqueness. Even though currently case company has a suggestive advice to conduct PCA six months after the product launch, the real practice is that the timing is purely dependant on each project. Interviewees unanimously agreed that the exact binding timeframe cannot be pointed for the PCA. Empirical evidence suggests that appropriate timing for the PCA is as soon as the project has gained sufficient amount of information about its performance regarding financial and technical aspects.

Responsibility for the PCA

Prior literature considering the responsibility of the PCA has mainly focused on discussing about centralized vs. decentralized responsibility and their characteristics. Literature suggests that centralized responsibility, often found at the corporate or divisional level, is more effective in improving Organizational Learning (OL) because centralized manner typically has access to larger resources to solve the corporate level problems (Azzone and Maccarrone, 2001). Another significant benefit of centralized responsibility is the standard PCA processes enhancing sharing of investment insights and knowledge within the corporation or the business division (Huikku, 2011a). However, literature sees decentralized responsibility advantageous by increasing organization's agility in cases when PCA is primarily used for performance control activities instead of enhancing OL (Azzone and Maccarrone, 2001).

Similarly, to the literature, empirical evidence sees centralized PCA responsibility as OL-conducive practice. It was seen as a more transparent process that was able to increase the top-down communication and control within the organization compared to decentralized method. However, empirical evidence saw possible benefits in decentralized manner as well due to the fact that the technical capabilities and practical experience are located on that level in organization, thus improving agility of the organization. Currently, the

practice in case company considering PCA responsibility is centralized in Business area level PCA and BR processes being similar with each other.

PCA conductor

When considering the suitable personnel to conduct the PCA report, current PCA literature mostly see the issue of selecting the conductor from the lenses of self-assessment bias. Self-assessment bias occurs when the individual conducting the assessment is influenced by personal incentives or motives, leading to potentially inaccurate assessments. For example, they might exaggerate the project's benefits while downplaying associated risks. (see e.g., Segelod, 1997, Cheng et al., 2009, Huikku and Lukka, 2016) It is argued that to achieve the best performance and reduce any potential biases in the investment process, it might be more suitable to have the PCA conducted by external reviewers (Farragher et al., 1999).

However, the self-assessment is often justified with arguments that external reviewers may not have the necessary expertise in the subject matter, making self-assessment the only acceptable method (Gordon and Smith, 1992). The self-assessment method is the most common way to conduct the PCA (Segelod, 1997, Huikku, 2011a, Lefley, 2019) and it is used in the case company as well. Empirical evidence suggests that as PCA conductor is required to have expertise in high-technology R&D products there is no practical alternative for self-assessment. Yet the interviewees recognize the possibility for self-assessment biases and see that as an important issue to mitigate. Even though it would not be practical to use purely external PCA conductor, single suggestion to mitigate the self-assessment bias is to have supervisor overseeing and monitoring the PCA process. They have sufficient technical and business knowledge and are independent towards the certain project. According to Farragher et al. (1999) the independent and external personnel around the PCA project may mitigate the bias. Huikku (2011a) suggests that OL-conducive PCA system should include personnel from investing unit as well as outside staff.

Content of the PCA report

According to PCA literature, it would be appropriate that PCA report had four key components in it: (1) description of the investment proposal, (2) monitoring of its progress, (3) comparison of *ex ante* and *ex post* calculations, and (4) qualitative analysis and recommendations (Neale and Holmes, 1990, Azzone and Maccarrone, 2001, Huikku and Lukka, 2016). In accordance with empirical evidence, despite the current PCA template being relatively simple, it contains those four key components remarkably well: it assesses the current situation by comparing it to the estimations made during previous BR gates, it contains brief description and illustration about the product in development and its technical functioning, it includes quantitative analysis with predestined KPIs such as sales, R&D budget, project timing, profitability index calculation (PIC) and discounted payback time. In addition to that, the report template has qualitative appraisal about the project as well as recommendations for the future. These four components of the report are the standardized and necessary parts it. Thus, despite the high-mix in R&D portfolio and significant variation in products and projects in case company the core of their PCA report is rather standardized. Huikku (2011a) sees that standardization and consistency of PCA reports could amplify the knowledge transfer, and thus the OL.

Interviewees see the current versatility and simplicity of the PCA report template as an advantage. It is seen that due to high product mix in company's R&D portfolio, stricter criteria in the template could not be used as it would not be universally suitable. Empirical evidence suggests that the current simple format for PCA report increases the PCA conductor's responsibility to conduct proper analysis for an effective PCA report and presentation. The language of the PCA report is English, which is the common corporate language used in the globally operating case company. Huikku (2011a) suggests that it would be appropriate that PCA report was conducted in common corporate language.

Presentation forum for the PCA report

According to Huikku (2011a) holding meetings for presenting the PCA results has a significant effect on information dissemination in organizations. Neale and Holmes (1990) emphasize that the forum also allows the PCA conductor to receive feedback on their work. It provides a platform to discuss the difficulties faced during the PCA process in a constructive manner, recognizing possible pitfalls and challenges. According to empirical evidence, in case company the PCA conductor receives feedback from the BR board in presentation meeting. However, interviewees suggest that level of interaction and dialogue between the board and the presenter is highly influenced by the PCA board. Thus, in this part the information dissemination's potential is somewhat dependant on personal traits of the people around in the presentation forum.

When considering the composition of the PCA board, Azzone and Maccarrone (2001) argue that it would be appropriate that the board had diverse composition with technical expertise, problem-solving skills, managerial and operational capabilities. Empirical evidence about the current composition of the board shows that currently there are business unit's lead, business unit lead, business area's R&D lead, product area manager and business controller as members of the board. Beside that, there are marketing managers also present supporting the product manager in the PCA presentation. Some interviewees see the current composition being rather business-oriented and relatively lacking technical experience. The PCA board composition remains mostly the same in each of the BR decision gates, which can be considered advantageous from OL-perspective by increasing their collective comprehension.

Dissemination of final PCA reports

Prior literature emphasizes that the dissemination of PCA results is considered one of the crucial duties of the PCA process from OL perspective (Neale and Holmes, 1990). It is suggested by Huikku (2011a) that the final PCA reports would be shared to relevant personnel related to the investment project. However, empirical evidence suggests that proactive sharing of reports does not

take place currently in the organization. Yet, relevant personnel need to actively search for these reports from the archive where they are stored and accessible. Thus, it is possible, and probable that in practice the dissemination of the knowledge is not optimal due to insufficient PCA report sharing. Jiménez-Jiménez and Sanz-Valle (2011) suggested that it would be appropriate for organizations to adopt the formal mechanisms of information dissemination. Thus, the final PCA report sharing for relevant personnel could be efficient to ensure the proper information flow in organization.

Yet, empirical findings show that there are some other beneficial knowledge sharing practices around: Product managers who act as PCA conductors have a monthly non-structured forum where they are able to provide feedback to each other, exchange ideas and solve problems collectively. Topics in this meeting vary, for instance there has been discussion about the form of the PCA report. The peer discussion forum is an important platform for horizontal information distribution where learning takes place between personnel at the same level in the organization (see e.g., Sinkula et al., 1997, Ahmed et al., 2017). Another good practice that has been implemented at least in some parts of the organization is the preliminary BR3 (PCA) presentations. In these, prior to the actual presentation to the board, product manager presents the findings and results to their own project team in order to gain feedback to enhance the actual presentation. This is seen as good practice that could be beneficial for the entire organization if implemented into action more widely. Beside the improvements for the presentation and the report that preliminary feedback could create, the PCA results were also disseminated with the project team more comprehensively.

Archiving and filing of PCA reports

According to Namada (2018), the accessibility of the information is a crucial aspect in the OL. PCA literature suggests that the information should be available for the relevant personnel in relation of the investment project and that the reports and other material was stored properly (Huikku, 2011a). According

to empirical evidence, the final PCA reports and the minutes for PCA meetings are stored to the company's intranet. As PCA reports often contain strategic and confidential information the access in restricted to necessary personnel only. The current archiving system is seen somewhat accessible, yet some interviewees disagreed with that by arguing that due to poor folder structures, insufficient search features and inconsistent project and folder naming it is inconvenient to search anything from the archive. Due to these flaws, current system is described as data vault rather than knowledge distribution platform. It seems that there is a room for slight improvements in current PCA report archiving system to ensure that the company's stored knowledge can be distributed more effectively.

To conclude the empirical evidence, it appears that the current areas for improvement in the case company present a dual aspect. While the quality of OL and PCA could be enhanced by improving processes and establishing best practices to address difficulties, the corporate cultural aspects and soft skills, such as communication, play a crucial role as well in a path to an OL-conducive PCA system. When contemplating the concepts of process and culture, it is advisable to bear in mind the distinct yet interconnected nature of these two aspects when enhancing the PCA system.

7 CONCLUSIONS

Capital budgeting is often crucial activity for the companies due to its typically strong relation to company's strategy and overall financial success (Huikku, 2011b). Post-completion audit has received increasing attention in recent years due to its various benefits for organizations, yet being still relatively outlooked by the researchers compared to other phases of the capital budgeting process (Huikku and Lukka, 2016, Lefley, 2016). Despite the complexity, uncertainty and strategic importance that R&D activities typically have, without better knowledge the PCA research considering R&D investments' distinctive features does not occur. Enhanced organizational learning (OL) has often considered as the most common PCAs benefit and typical motive for it in organizations (see e.g., Azzone and Maccarrone, 2001, Huikku, 2011a, Lefley, 2016).

This thesis aimed to create a learning enabling construct for PCA for case company to improve the typically over-optimistic estimates made in *ex ante* phase in the R&D investment process. OL-conducive PCA system could have a major impact on solving that problem with estimations.

7.1 Thesis' contributions

As previously mentioned, the research approach in this thesis is constructive, thus its main contribution was the created construct for case company's PCA system to eventually improve the *ex ante* predictions made for R&D investment projects. Currently, the predictions are rather over-optimistic compared to the actuals, and learning from those has been limited. The practical or managerialist contribution of this thesis was its ability to give theory-based practical suggestions for the company to steer and adjust its PCA process into a more OL-conducive direction. The created construct was presented in case company for its personnel and the company was willing to adopt it into action to further enhance its PCA and R&D processes. This can be recognized as *weak market test* (Kasanen et al., 1993).

"We will definitely take this construction and its valuable observations and ideas into use. A good reminder of the importance of the topic." – VP, Products and Technologies

The academic contribution of this thesis arises from its R&D context. Prior PCA literature has mainly focused on investigating investment projects in general having neglected the R&D investments as investment type. This thesis is contributing to theory by extending the OL-conducive PCA framework by Huikku (2011a) into the context of R&D investments, thus filling the current research gap in the R&D field. Case company in this thesis is a large publicly listed Finnish high-technology manufacturing company that puts significant efforts into its R&D and innovating capabilities. The success of the R&D investments plays crucial role in company's success and thus there is a high motivation for PCAs enhancement. R&D investments can often be rather complex, costly and risky projects thus having an increased need for proper PCA system to review projects' outcomes and successes thoroughly.

7.2 Limitations of the thesis

As mentioned before, this thesis is a study that utilizes constructive research method by Kasanen et al. (1993). They point out six different steps to accomplish when conducting proper research in constructive method:

1. Identifying a problem of practical significance with potential to research
2. Obtaining a holistic understanding of the phenomena
3. Constructing a conceptional solution approach
4. Demonstrating the practical applicability of the solution
5. Showing theoretical links and research contribution
6. Explore the scope of solution's applicability

Unfortunately, there is limited room to demonstrate and evaluate the success of the solution and its applications in action (phase 4) within the timeframe and scope of this thesis. Due to similar restrictions, it is not possible to properly

examine the scope of potential applicability of the construct (phase 6). Thus, the practical operating cannot be shown in action even though the practical relevance of the subject and the construct is visible. However, as the created construct was presented in the case company, and the company was willing to adopt the construct into action, *weak market test* was at least partially reached (Kasanen et al., 1993). Despite the limitations considering practical demonstration, this thesis is able to create a construct that has different aspects about phases 1-3 and 5 rather comprehensively present. However, as Ahrens and Dent (1998) have presented, the lack of proper theoretical contributions is typically seen as major pitfall in qualitative management accounting research. Thus, it enhances the importance of phase 5 when considering the academic contribution of this thesis.

In qualitative research, there are risks and pitfalls in conducting interviews. In order to achieve the best possible output, the interviewees should be chosen carefully. Interviewees were chosen by contact person in case company, and the aim was to get experienced group of interviewees. Interviewees' roles were probably slightly more engineering types compared to business. However, the advantage considering a composition of the interviewees was their diverse roles in relation to the PCA process: there were personnel developing the process, supervising it, conducting actual PCA reports, and providing calculations for the report. Still, it would be appropriate to consider possible biases of the interviewees. Even though the interviewees had somewhat diverse roles, it must be taken into account that their opinions are subjective and the possibility for certain interviewee biases is still there.

As this thesis was conducted as a single-case study and the construct was created purely for case company's needs, same suggestions might not be applicable for other companies that e.g., work in different industries, are smaller/larger by size or are geographically different located. Case company was a Finnish large publicly listed manufacturing company with high emphasis on R&D activities.

7.3 Suggestions for further research

As previously mentioned, there has not been previously too much focus on R&D investments in PCA research. R&D investments' nature as complex, risky and usually strategic investments could raise the interest for researching R&D investments more thoroughly. For instance, further research could include multiple high-technology companies comparing their approaches to PCAs in R&D investments.

Another possibility for further research would be a longitudinal analysis for the construct made in this thesis and its adoption in the case company. It would be interesting to track the impact of proposed adjustments in the PCA system in case company and their effect on OL. This could involve analyzing how learning evolves, whether changes are sustained, and the long-term effects on innovation and financial success in the case company.

Self-assessment bias has been seen as an area in PCA literature that has raised concerns (e.g., Koch et al., 2010, Huikku and Lukka, 2016). The key consideration is whether PCA was conducted by personnel within the investment unit or by purely external reviewer or auditor. According to empirical evidence presented in this thesis, the possibility for the bias was well-recognized. However, uncertainties arose regarding whether an external reviewer could possess the necessary expertise and knowledge to evaluate those unique and complex high technology projects and products. Therefore, exploring the potential for external PCA conductors in high technology R&D or NPD projects could be an intriguing topic for future research.

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APPENDICES

Appendix 1. Interview structure 1

Background questions:

1. Describe your role in company and your work experience.
2. What is your role in relation to R&D process?
3. What is your role in relation to PCA process?

R&D:

1. Describe the R&D investment process in company.
2. Who is in charge of each R&D investment?
3. Is there different classification among R&D investments, i.e., monetary size, strategic significance?
    a. Does the handling of investments differ in any way between different classes?
4. How R&D investment performance is measured?
    a. Does performance measurement consider both quantitative and qualitative aspects and what is the relation and ratio between them?
    b. What kinds of challenges performance measurement may include?
5. Tell me about typical risks considering R&D investments.
    a. How to mitigate the risks in R&D investments?
        i. During the investment process.
        ii. After the investment process.

PCA:

1. Tell me about the PCA process in company.
    a. How systematic and structured the process is?
    b. What stages or components is in the PCA process in the company?
2. How long the company has made systematic PCA analysis?
    a. How implementation of the PCA has worked out? Has there been any difficulties?
3. How long is typical PCA process?
4. Is there a standard PCA report that is used?
5. What are the possible unique attributes in R&D investments when considering the PCA?

    a. Is PCA conducted for other types of investments than R&D as well?
6. Who is responsible for the PCA process?
    a. Do you feel that the right person in the organization is responsible for PCA?
7. Is there any additional evaluation during R&D investment process?
    a. Is that possible additional evaluation part of the PCA report?
8. How are the investment project selected for which PCA is conducted?
9. Is the PCA conducted similarly for every R&D project?
10. Are there certain objectives for the PCA process?
11. What benefits do you see in the PCA?
    a. Has the implementation of PCA brought any concrete benefits to the R&D investment process?
    b. Do you see that PCA could act as risk management tool?
    c. Do you believe that PCA adoption may enhance organizational learning?
    d. Do you think that the benefits may differ in different stages of investment process?
12. What challenges there may be in current PCA process?
    a. Has there possibly been any restrictive issues in the PCA applying in certain circumstances or projects?
    b. Do you think that the challenges may differ in different stages of investment process?
13. Do you have anything else to say about the subject?

Appendix 2. Interview structure 2

Background questions:

1. Describe your role in company and your work experience.
2. What is your role in relation to R&D process?
3. What is your role in relation to PCA process?

PCA

1. Tell me about the PCA process in company.
    a. How systematic and structured the process is?
    b. What stages or components is in the PCA process in the company?
2. How long the company has made systematic PCA analysis?
3. Are there specific goals set for PCA in the company?

4. What benefits do you see in the implementation of the PCA process?
    a. Has the adoption of PCA brought tangible benefits to the R&D investment process?
    b. Do you think PCA can enhance organizational learning?
    c. How do you think learning could be increased?
    d. Do you believe the benefits vary at different stages of the investment process?
5. Do you perceive any weaknesses or challenges in the current PCA process?
    a. Have there been limitations in applying PCA in certain situations/investments?
    b. Do weaknesses vary in different stages of the investment process?
6. In your opinion, how can one best learn from project cost overruns?
    a. Is it difficult to present accurate cost estimates to the board in the BRO phase?

Project Selection

7. How are projects selected for PCA?
    a. Is PCA conducted in the same way for all projects?
8. Are there any specific features of R&D investments from the perspective of PCA?
    a. Is PCA conducted for investments other than R&D?
9. Is the current approach, in your opinion, the right one?

Timing of PCA

10. At what stage of the product development process is PCA conducted?
    a. Is there a target schedule?
    b. Do you find the current method effective?

Responsibility for PCA

11. Who is responsible for PCA in the organization?
    a. Is the current approach good?

PCA Conductor

12. Who conducts PCA?
    a. Do you feel that the right person/people in the organization perform PCA?
    b. Do you see risks in having the same person conduct PCA and be responsible for the investment?

Content of the Report

13. Is the current PCA form, in your opinion, good?
    a. The PCA model is quite simple; do you think it should be expanded or adapted differently?

Presentation Forum

14. What are the presentation forums and formats for PCA?

a. Are the current methods and composition effective for learning?

Dissemination of PCA Reports

15. How are PCA results distributed within the organization?

Archiving and Filing of PCA Reports

16. How are PCA results archived in the company, and are they accessible?

17. Do you have anything else to say?