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DEVELOPING PROACTIVE QUALITY PERFORMANCE MEASUREMENT IN THE PAPER MACHINERY INDUSTRY

Master of Science Thesis
Faculty of Management and Business
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ABSTRACT

Eetu Hietanen: Developing proactive quality performance measurement in the paper machinery industry
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Companies must improve continuously to sustain competitive advantage. In modern business, data is an essential tool to be utilized in decision-making and driving organizational performance. At the same time, businesses must strive for excellent quality, to satisfy their customers and retain their competitiveness. Improving quality is crucial, as it affects the overall performance of a company.

This study aimed to harness the valuable data by developing a performance measurement system in quality management context. The study was conducted as a multi-method case study in a quality function of an organization in paper machinery industry. The organization was facing issues regarding the implications of its quality performance measurement practices. The current measurement system offered a lagging, and narrow view into the overall quality performance of the organization, which did not support quality improvement and management effectively. On a practical level, this study aims to address the mentioned issues by developing a balanced, more comprehensive and proactive quality performance measurement system. On a theoretical level, this study aims to apply and refine the established research on quality and performance measurement onto the case organization's setting. Furthermore, the study aims to explore the precise nature of the issue in the organization context.

The data for this study was gathered from 19 semi-structured interviews, internal company documents, group meetings with the quality function, and informal discussions. The theoretical background for the study was developed abductively, by incorporating findings from the literature to the quality management setting. This was done to build new, or modify existing theory on proactivity and development of performance measurement in quality context.

The findings highlight significant gaps in the current state of data gathering, measurement, and reporting. Overreliance on financial measures, fragmented organization structures, deficient measure alignment with management, and insufficient data availability hinder the effectiveness of the current measurement system. In addition to these internal challenges, external pressures, such as the ISO 9001:2015 quality management system standard revision motivates the development process. The findings show that the proactivity of the quality performance measurement system can be developed by incorporating risks, preventive quality costs, a balanced set of leading and lagging measures, and predictive analytics to the measurement system. The study found that adopting strategic alignment through tools like strategy maps and the Balanced Scorecard can enable organizations to incorporate proactive elements into quality performance measurement. Finally, a two-level framework approach used in this study can aid in setting clear goals for the target state of the measurement framework, and with a specific design process, effectively guide the development of a quality performance measurement system.

Future research could focus on generalizing this study's results across other case settings, industries, and organizational types. Furthermore, research could be continued on implementing quality costs models into performance measurement systems and exploring the opportunities of emerging technologies to quality performance measurement.

Keywords: quality, measurement, performance, proactive, continuous improvement, balanced scorecard

TIIVISTELMÄ

Eetu Hietanen: Proaktiivisen laadun mittauksen kehittäminen paperikoneteollisuudessa
Diplomityö
Tampereen yliopisto
Tuotantotalouden DI-ohjelma
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Yritysten on kehityttävä jatkuvasti pysyäkseen kilpailukykyisinä. Nykyajan liiketoiminnassa data on olennainen työkalu, jota tulee hyödyntää päätöksenteossa ja organisaation suorituskyvyn edistämisessä. Samalla yritysten on pyrittävä erinomaiseen laatuun, jotta ne voivat tyydyttää asiakkaansa ja säilyttää kilpailukykynsä. Laadun parantaminen on ratkaisevan tärkeää, koska se vaikuttaa yrityksen kokonaisvaltaiseen suorituskykyyn.

Tämän tutkimuksen tavoitteena oli hyödyntää tätä arvokasta dataa kehittämällä suorituskyvyn mittausjärjestelmä laadunhallinnan kontekstissa. Tutkimus toteutettiin monimenetelmällisenä tapaustutkimuksena paperikoneteollisuudessa toimivan organisaation laadunhallintafunktiossa. Organisaatio kohtasi ongelmia, jotka liittyivät sen laadun suorituskyvyn mittauskäytäntöjen vaikutuksiin. Nykyinen mittausjärjestelmä tarjosi jälkijättöisen ja kapean näkymän organisaation kokonaislaadun suorituskyvystä, eikä se tukenut laadun parantamista ja hallintaa tehokkaasti. Käytännön tasolla tämän tutkimuksen tavoitteena oli ratkaista edellä mainitut ongelmat kehittämällä tasapainoinen, kattavampi ja ennakoivampi laadun suorituskyvyn mittausjärjestelmä. Teoreettisella tasolla tutkimuksen tavoitteena oli soveltaa ja tarkentaa vakiintunutta tutkimusta laadun ja suorituskyvyn mittaamisesta organisaation tilanteeseen. Lisäksi tutkimus pyrki selvittämään ongelman tarkkaa luonnetta organisaation kontekstissa.

Tutkimuksen data kerättiin 19 puolistrukturoidun haastattelun, yrityksen sisäisten dokumenttien, laadunhallintafunktion kanssa järjestettyjen ryhmäkokouksien ja epämuodollisten keskustelujen avulla. Tutkimuksen teoreettinen tausta kehitettiin abduktiivisesti, liittämällä kirjallisuuden löydöksiä laadunhallinnan kontekstiin. Tavoitteena oli rakentaa uutta tai muokata olemassa olevaa teoriaa ennakoivuudesta ja suorituskyvyn mittauksen kehittämisestä laadun kontekstissa.

Tutkimustulokset korostavat merkittäviä aukkoja nykyisessä datan keruun, mittaamisen ja raportoinnin tilassa. Ylikorostunut luottamus taloudellisiin mittareihin, sirpaleiset organisaatiorakenteet, mittareiden huono yhteensopivuus johtamisen kanssa ja riittämätön datan saatavuus estävät nykyisen mittausjärjestelmän tehokkuutta. Näiden sisäisten haasteiden lisäksi ulkoiset paineet, kuten ISO 9001:2015 laatujohtamisjärjestelmän standardin päivitys, motivoivat kehitysprosessia. Tutkimustulokset osoittavat, että laadun suorituskyvyn mittausjärjestelmän ennakoivuutta voidaan kehittää sisällyttämällä riskit, ennaltaehkäisevät laatukustannukset, tasapainotettu joukko ennakoivia ja jälkijättöisiä mittareita sekä ennustavaa analytiikkaa mittausjärjestelmään. Tutkimuksessa havaittiin, että strateginen linjaus työkalujen, kuten strategiakarttojen ja Balanced Scorecardin avulla, voi mahdollistaa ennakoivien elementtien sisällyttämisen laadun suorituskyvyn mittaukseen. Lopuksi, tutkimuksessa käytetty kaksitasoinen lähestymistapa voi auttaa asettamaan selkeät tavoitteet mittauskehyksen tavoitetilalle ja tarkalla suunnitteluprosessilla ohjaamaan tehokkaasti laadun suorituskyvyn mittausjärjestelmän kehittämistä.

Tulevassa tutkimuksessa voitaisiin keskittyä tämän tutkimuksen tulosten yleistettävyyteen muihin tapaustilanteisiin, teollisuudenaloihin ja organisaatiotyyppeihin. Lisäksi tutkimusta voitaisiin jatkaa laatukustannusmallien toteuttamisessa suorituskyvyn mittausjärjestelmiin ja tutkia uusien teknologioiden mahdollisuuksia laadun suorituskyvyn mittauksessa.

Avainsanat: laatu, mittaaminen, suorituskyky, proaktiivinen, jatkuva parantaminen, tasapainoinen tuloskortti

USE OF AI IN THESIS

I have utilized AI tools in my thesis:

☐ No

☒ Yes

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Names and versions of AI tools: ChatGPT using GPT-4o mini

Purpose of using AI tools: Used for language revision to produce structurally and grammatically fluent text.

Sections where AI tools were used: Chapters 5, and 6.

I acknowledge that I am fully responsible for the entire content of my thesis, including the parts generated by AI, and accept accountability for any violations of ethical standards in publications.

PREFACE

“Don't cry because it's over. Smile because it happened.”
Fortunately, I am smiling either way.

I want to thank the case company for trusting me with this challenging and rewarding thesis topic. Special thanks to Tiina Sarkkinen, my supervisor from the case organization. Thank you for your continued support and encouragement during the project. Thanks also to Juha Rajala for your mentoring, and for the enlightening discussions along the way. Lessons learned from this project will last a lifetime.

I am deeply grateful to my significant other Laura, my friends, and to my family for your unwavering support, patience and encouragement throughout the project. Without your support, this thesis would not have been finished.

From Tampere University, I am thankful to Professor Aki Jääskeläinen for guiding my work, by offering me valuable feedback with a few words of wisdom. I also wish to thank Professor Teemu Laine for serving as the second examiner.

This thesis marks the conclusion of my studies and the wonderful experiences I have had at the university. Now it is time for me to head towards new adventures.

Tampere, 8th December 2024

Eetu Hietanen

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LIST OF SYMBOLS AND ABBREVIATIONS

ABC	Activity-based costing
BAM	Business Analytics Module
BSC	Balanced Scorecard
CI	Continuous improvement
COGQ	Cost of good quality
COPQ	Cost of poor quality
COQ	Cost of quality
CSF	Critical success factor
DMAIC	Define-measure-analyze-improve-control
EBITA	Earnings before interest, taxes, and amortization
ERP	Enterprise resource planning
HR	Human resources
HSE	Health, safety, and environment
IT	Information technology
KBEM	Kanji Business Excellence model
KPI	Key performance indicator
KRI	Key result indicator
OTD	On-time delivery
PAF	Prevention appraisal failure
PDCA	Plan-Do-Check-Act
PDSA	Plan-Do-Study-Act
PEM	Project execution model
PM	Performance measurement
PMM	Performance measurement and management
PMS	Performance measurement system
PQC	Poor quality cost
QA	Quality assurance
QC	Quality control
QM	Quality management
QMS	Quality management system
QSC	Quality Scorecard
R12	Rolling twelve
RMS	Risk management system
SQM	Strategic quality management
TQC	Total quality control
TQM	Total quality management

1. INTRODUCTION

Change is the only constant in business, and companies must continuously evolve to stay ahead. The modern business landscape is going through the Fourth Industrial Revolution, where the ever-growing volume of data is being harnessed as tools to support decision-making (Schniederjans et al., 2020), and thus drive organizational performance. For decisions to be made successfully, however, the appropriate tools need to be well-equipped and functional. At the same time, growing global competition and more demanding customers drive companies to enhance their quality and seek continuous improvement (Hietschold et al., 2014). This focus on quality is crucial, as the companies' quality performance has been shown to have a positive impact on overall business performance (Patyal and Koilakuntla, 2017).

This report presents a master's thesis on developing proactive quality performance measurement. In quality management context, performance measurement is a tool to converse quality targets into results (De Feo, 2017, chap. 7.7.8), and is used as an input to decision-making in quality management processes (Sower, 2010, p. 108; Arter, 2002, p. 18). Performance measurement can, however, be carried out in many ways, and companies continuously face issues stemming from poor measurement practices (Parmenter, 2019, pp. 150–152; Kerzner, 2017, p. 154; Gray et al., 2015, pp. 11–12). This study seeks to address this problem from the perspective of a quality organization in a large manufacturing company.

1.1 Background

Quality is a concept familiar to many, but it lacks a single, unambiguous definition, even though it can be essential for manufacturing companies, as it can have a significant impact on their revenue (Plewa et al., 2016; Tye et al., 2011). Since this thesis is being carried out for a company in the manufacturing industry, this should be considered when examining the definition. In chapter 2 of this study, quality is defined as the conformance to requirements in the operations of the organization, which leads to meeting customer expectations. According to this definition, better quality is expected to result in lower costs. In the study on 286 German manufacturing companies (Plewa et al., 2016), the average cost of quality was 2.7 percent of net sales. In another study (Tye et al., 2011),

which included a sample of 63 Malaysian manufacturing companies, 48.1 percent of respondents estimated their cost of quality to be 6 percent or more of net sales, while 19.3 percent assessed it to be 11 percent or more. Quality is thus an essential concept for companies, even solely because of its cost impact.

Traditionally, organizations favor financial indicators in their performance measurement. This is the case both in general performance measurement research (Neely et al., 2007, p. 12; Bourne et al., 2000; Wisner and Fawcett, 1991), as it is in quality literature (Williams et al., 1999). These traditional indicators come from accounting and costing systems, with a heavy emphasis on financial measurement (Neely et al., 2007, p. 12; Bourne et al., 2000; Wisner and Fawcett, 1991). Similarly, quality costs, such as costs due to rework, have been a popular measurement for quality in organizations, because firstly, they have been high in organizations, and secondly, reducing quality costs lead to improved sales and return on investment (Williams et al., 1999). Financial indicators can offer a clear view of the organization to its stakeholders, but over-reliance on only these types of indicators can pose problems (Parmenter, 2019, pp. 150–152), since they only offer results, instead of an indication on how to improve them.

The literature on performance measurement has extensively studied various measurement systems, as well as their design and implementation in general (Taticchi et al., 2012; Neely et al., 2007; Kennerley and Neely, 2002; Kaplan and Norton, 1992). Measurement systems that include metrics beyond a purely financial perspective—which is often perceived as providing a lagging, result-oriented view of performance—can offer managers a more balanced, accurate, and timely dataset for decision-making (Kaplan and Norton, 2004; Kennerley and Neely, 2002; Neely et al., 2000). These systems often incorporate forward-looking driver metrics alongside other indicators, forming the measurement system to be more proactive. Although such measurement systems have been studied to some extent in the context of quality management, Pimentel and Major (2014), for instance, point out that more case studies should be conducted in this area. Proper performance measurement can benefit operational development, making it worth exploring as a tool for improving quality, as well. This thesis addresses this research gap, and focuses on developing a quality performance measurement system that is both balanced, as well as more proactive in nature, to foster better decisions and to improve quality performance in the case organization.

1.2 Premise of the case organization

The case corporation develops and supplies process technologies, services, and automation for paper, pulp, and energy industries. It has over 19 000 employees working in

five business lines, one of which is the Paper Business Line. The Paper Business Line consists of five business units. The paper machinery industry is characterized by long-lasting and large-scale customer delivery projects. The projects are capital heavy and can take several years to complete. The industry poses challenges to quality, because the paper machinery has small tolerances, but at the same time, a small product repeatability, and complex production and assembly. Furthermore, customers expect exceptional quality from their capital-intensive orders.

The corporation follows a matrix organization structure. In a matrix organization, the teams have a dual reporting relationship (Rees and Porter, 2004), where the teams report to both a functional manager, and to a line or project manager. In the case of this study, the Paper Business Line quality function reports to the business line Operational Excellence organization, as well as to the corporation-level quality function, and covers the five business units under the Paper Business Line. The reporting structure is depicted more clearly in figure 16. The roles of the case quality function include supporting the Paper organization in fulfilling the requirements of its stakeholders, as well as managing and continuously improving quality performance in the organization. That is, the role of the quality function is to assess the organization's ability to produce quality and strive to improve it.

The quality function is facing issues regarding the implications of its performance measurement practices. The current quality measurement system in the case organization has a limited impact due to its heavy reliance on COPQ (Cost of Poor Quality) measurement, which offers a lagging, result-based view of quality. This type of measurement does not provide enough data for the quality department to drive improvements effectively. Additionally, due to the long timelines of business line projects, quality costs may not materialize for months or even years, resulting in outdated measurement data. With a primary focus on financial, lagging indicators, it becomes difficult to assess the success of improvement initiatives, and correlations between actions and outcomes are unclear. As a result, the organization’s view of its quality performance is narrow, and the overall control and influence over effective quality improvements remain limited.

At the time this thesis was being conducted, the organization was in the process of developing a new enterprise data storage system, known as the Business Analytics Module (BAM). This system is designed to integrate data from various sources and provide a comprehensive solution for all analytics and business reporting needs within the organization. The development of this data warehousing solution will offer enhanced measurement capabilities and opportunities for quality function in the future. Thus, it also provides a solid foundation for new measurement practices carried out in this thesis.

On a practical level, this thesis project aims to address the mentioned issues by developing a balanced, more comprehensive and proactive quality performance measurement system. Ideally, the benefits of the development include saving time in reporting through reduced manual effort, providing more data-driven decision-making with relevant and up-to-date measurement data, and improving the identification of development needs. With a more accurate picture of the organization's quality performance generated by the improved measurement system, resource allocation for development becomes more precise. Additionally, by utilizing more proactive indicators, the quality function's influence over the organization's quality improvement efforts will be strengthened. Overall, the development should result in more efficient and informed decision-making, leading to improved quality in the corporation.

1.3 Research objectives and scope

Based on the premise of the organization and it's development needs, and on the lack of research surrounding balanced quality measurement system development, the main research question for this study is formulated as:

RQ1: How to develop a balanced quality performance measurement system in a manufacturing company's business line operating in the paper machinery industry?

The main research question is supported by three additional sub-questions, which function as steps towards answering the main question. The first sub-question is:

SQ1: What is the current state of data gathering, measurement, and reporting regarding quality? What numeric data is available?

Answering this question helps in understanding the case organization context, and the problem setting. The current state description can also enable a comparison between the current state and the developed measurement system, thus allowing for evaluation of this study. The second sub-question is:

SQ2: What quality performance measures are needed, and why?

This question is intended to clarify the development needs in the organization and explore the reasons for measurement development. The third sub-question is:

SQ3: How to increase proactivity in quality performance measurement?

The meaning of this question is to further emphasize the proactivity aspect in quality performance measurement development, and besides practical value, offer theoretical contribution.

Defining the boundaries of a case study is essential (Saunders et al., 2019, p. 196). It is necessary to narrow the scope of the thesis due to available resources and time. In this thesis, the scope is affected by the assignment from the case organization, which is a quality function in a business line operating in the paper machinery industry. The performance measurement system developed is intended for the business line level and does not primarily focus on corporate or operational-level measurement. The case organization's quality management framework categorizes responsibilities into Quality Management (QM), Quality Assurance (QA), and Quality Control (QC). The business line level quality function operates within the QM area, focusing on overall organizational quality, while QA and QC are more process specific. Furthermore, the definition of quality in this study has a focus on the operations of the organization, and quality is not regarded as an all-encompassing characteristic.

The Business Analytics Module is not implemented in the organization during the thesis project, and this limits the implementation of the developed quality performance measurement system, since not all intended data sources are yet available. Therefore, the focus of this study is on the design of the quality performance measurement system, and complete implementation of the system is not reached. If the implementation of developed measures demands completely new data sources, they are mentioned in chapter 4.4.2, when describing the proposed quality performance measurement system, and discussed in the development proposals for the case organization in chapter 5.5. The design phase of the development process utilizes four literature-derived frameworks: the quality strategy map, the table of proactive measurement elements, the quality-based performance measurement system design process, and the quality performance measurement record sheet. These tools scope the creation of the PM system while aligning with the organization's quality context. As a final boundary, predictive analytics were mentioned as a source for more proactive performance measurement data. Further examination of these measures was excluded from this thesis, because this maintained the qualitative focus of the research.

1.4 Structure of the research

The following thesis is structured into five chapters. Chapter 2 incorporates the theoretical background for this thesis, based on the results of the literature review. The literature review was conducted by following a pragmatic approach in the literature searches. When searching and evaluating articles, efforts were made to focus on the fact that the selected articles serve to advance the work, and that the literature searches based on

keywords related to the research questions. Pearl growth technique and the Finnish Publication Forum portal were utilized to improve the fitness of the search results. In the theoretical background, key concepts used in this study are presented, including quality, quality costs, performance measurement, proactivity, and quality performance measurement systems.

Chapter 3 presents the methodological choices made in this study, including the research design, research process, and data collection and analysis. This chapter presents how the results of this research were reached. Chapter 4 includes the findings of this study, and its' structure reflects the research questions: in chapter 4.4, the designed quality performance measurement system is presented. The empirical findings are discussed in chapter 5, and the discussion focuses on reflecting the findings on the literature and presenting development proposals for the case organization. Finally, in chapter 6, the research is concluded by presenting key findings, and managerial and scientific contributions. Evaluation and limitations of the research are also discussed, and future research opportunities are proposed.

2. THEORETICAL BACKGROUND

The purpose of this literature review is to aid in answering the research questions, which form the core of this thesis. To answer these questions, it is essential to understand the concepts presented in them. Therefore, the concepts relevant to this thesis are defined in the following chapters based on research literature. The literature review also supports the empirical part of the work; once the concepts are defined and understood, interviewing based on these concepts and interpreting the research results becomes more meaningful. This approach also aims to increase the repeatability of the research. Thus, the task of the literature review in this thesis is to place the work in the context of the subject area's literature and facilitate the implementation of the next stages of the work.

Discussion based on the literature begins with the concept of quality and the quality costs that are strongly related to it in the context of this thesis. Next, the concept of performance measurement is introduced, and its purpose is discussed in the context of quality management. Thirdly, performance measurement is discussed from the viewpoints of individual performance measures, performance measurement systems, and their development. Then, the concepts of performance measurement are connected to quality perspective. The final topic discusses the proactivity aspect of quality performance measurement. At the end of the literature review, there is a synthesis of the main takeaways from the theoretical section of the study.

2.1 Quality

The research questions in this study include the concepts of quality as well as measurement. To develop measurement, the variable to be measured must be understood. Defining the concept of quality is therefore paramount. However, quality is a broad concept, and an entity understandable in many ways, which makes its unambiguous definition challenging. Next, quality in the context of this study is defined.

Interpretation and debate over the definition of quality dates back to Greek philosophers Plato and Socrates (Sower, 2010, p. 5). Modern definitions began forming during the 1920s, and in the following decades, writers such as W. Edwards Deming, Joseph Juran, Armand Feigenbaum, and Phillip Crosby shaped the definition and implementation of quality (Sower, 2010, p. 5). To this list of contributors to modern quality, Beckford (2016, p. 54) adds Kaoru Ishikawa, John Oakland, Taiichi Ohno, Shigeo Shingo and Genichi Taguchi, and calls them 'quality gurus'. Even though the field of quality is vastly studied,

a single authoritative source does not exist. However, when new quality systems and approaches are developed, the work derives from the fundamentals established (Beckford, 2016, p. 53). Thus, quality should be defined by interpreting the renowned literature.

2.1.1 Definition of quality

Drawing from the ambiguous quality literature, a list of five approaches to quality definition was introduced by David Garvin (1984). The approaches and their apparent connection to the quality definitions of the quality gurus are visualized in figure 1. These connections are made to organize the group of quality definitions, and thus help in giving a concise definition relevant to this study.

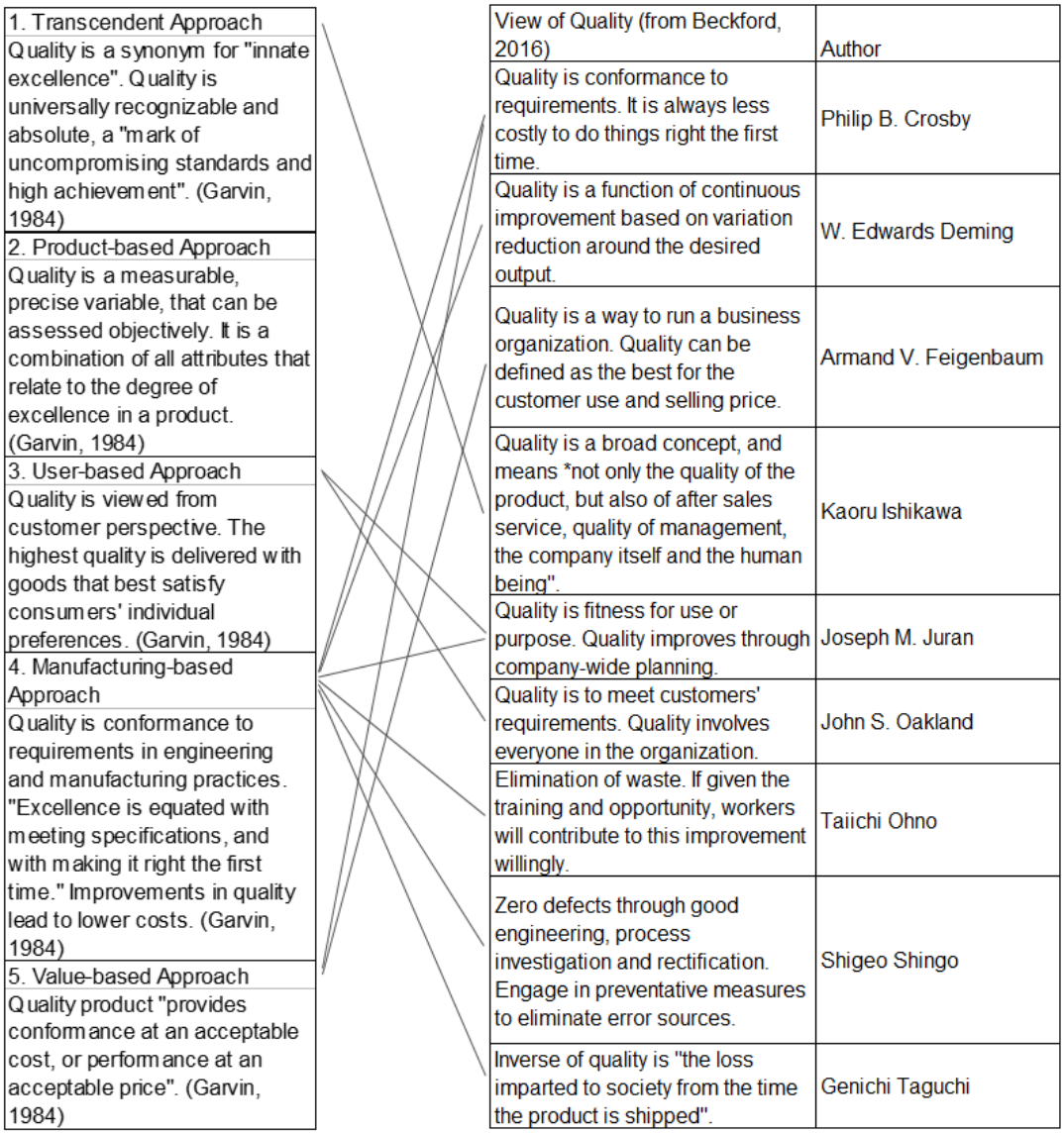


Figure 1. *Garvin's five approaches to quality and their connection to the philosophies of quality gurus. Deduced from (Beckford, 2016, pp. 55–143; Garvin, 1984; Sower, 2010, pp. 10–11)*

The five approaches can still be seen as a relevant framework: most of the gurus' individual views to quality seen in figure 1 can be recognized to belong under one or two of the five approaches, even when some views have formed after the publication of Garvin's 1984 model. According to Garvin (1984), the different approaches stem from philosophy, marketing, economics, and operations management fields of study. In the 1984 article title, Garvin emphasizes quality from the product standpoint, but the approaches themselves seem not to be limited only on product quality (Sower, 2010, p. 10). Instead, they aim to be more comprehensive approaches. Thus, the gurus' views can be categorized, since, by definition, they are not limited to defining only product quality.

Two of Garvin's approaches resonate less with the concise summaries of the gurus' views. The transcendent approach can be seen as hard to implement to practice, and in the context of this work, it can be seen as a difficult concept to measure. Kaoru Ishikawa highlights the broad nature of quality (Beckford, 2016, p. 98), and his definition has a clear connection to the transcendent approach. The product-based approach does not resonate with the gurus' views either, at least not directly. In this approach, quality can be seen as the quantity of desired attributes in a product, and thus, higher quality can be achieved only by higher cost (Garvin, 1984). This approach seems specific in nature, and as the name suggests, more product focused. Although the transcendent and product-based approaches do not seem to be directly in line with most of the gurus' views, it does not deem them irrelevant, nor their content truly separate from the other approaches.

The user-based, manufacturing-based and value-based approaches (Garvin, 1984) seem to draw most connection to quality gurus' views: all three approaches have a minimum of two connections. Between these approaches it can be also noticed that some of the gurus' definitions can be linked to multiple approaches. Joseph Juran and John Oakland emphasize quality from the customer's perspective (Beckford, 2016). When the product or service offered by the company meets customer's expectations, that is it fits to the purpose or use of the customer, quality is achieved. (Beckford, 2016) This definition is well in line with the user-based approach (Garvin, 1984). Furthermore, if Juran's view of fitness for use is determined in the manufacturing process, it can be thought of falling under Garvin's manufacturing-based approach as well.

Taguchi, Shingo, Ohno and Deming approach quality clearly from the manufacturing viewpoint. Quality can be defined as conformance to requirements (Beckford, 2016). Not doing things according to the company processes, doing work that does not add value and failure in doing things right the first time are seen as inverse to quality. Philip Crosby also views quality as conformance to requirements. However, Crosby's view can also be

linked to Garvin's value-based approach, because of Crosby's distinct linkage between quality and costs. Armand Feigenbaum also views quality from the value perspective: performance and usefulness has a price to the customer. (Beckford, 2016) At the same time, in the manufacturing-based view, non-conformance creates costs to the manufacturer.

It is clear, that the definition of quality has divided researchers, and one, universal definition seems to be missing from the renowned literature. More recent literature seem to contain similar division. According to Sower (2010, p. 19), the best modern and universal quality definition might be that quality is to meet or exceed customer expectations. De Feo (2017, chap. 1.3) adds to this by stating, that in meeting customer needs for a service or good, usually higher quality costs more. Furthermore, De Feo (2017, chap. 1.3) makes the argument that quality can also be defined as freedom from failures. This approach orients itself to costs and here, higher quality costs less (De Feo, 2017, chap. 1.3). On top of fulfilling requirements and absence of errors, Hietschold (et al., 2014) also links improved organizational performance, and the focus on specific processes, products, or services to the quality definition.

Krishnan (2006) again defines quality from the value-based approach: provided that a product or service delivers value for the money paid by a customer, they will be satisfied. Then again, Krishnan (2006) states that the price is determined by the level of desired attributes, which links this definition to the product-based approach presented by Garvin (1984). In conclusion it is visible, that in the more recent literature, the definition of quality is heavily build upon the ambiguity of the established research.

After reviewing the quality literature, quality should be defined in the context of this study, basing on the literature. The case organization's quality function supports the operations within the business line, and thus, the viewpoint to quality is internal: this links the quality definition to the manufacturing-based approach. Quality is seen as conformance to requirements (Beckford, 2016): manufacturing products and executing things according to the company processes, and doing them right the first time. Here, improvements in quality lead to lower costs (Garvin, 1984). According to Garvin (1984), different functions can see quality differently, and thus, multiple definitions to quality can exist inside one organization. For example, marketing typically sees quality from the product-based or user-based views, where the key is to meet or exceed customer's requirements, and manufacturing sees quality as conformance to engineering and manufacturing requirements. (Garvin, 1984) To avoid this conflict, and with the aim to define quality holistically in this study, let's assume that customer expectations and requirements are communicated and

already established in the engineering and manufacturing phases, and thus, conformance to requirements also fulfills customer expectations. As a summary, in this study's context:

Quality is conformance to requirements in the operations of the organization, which leads to meeting customer expectations.

By this definition, improvements in quality are expected to lead to lower costs.

This definition aims to define quality holistically, and bases the definition on the approaches presented by Garvin (1984). However, according to Cameron and Sine (1999), the five approaches presented focus on quality as an attribute of a product or service, or alternatively, on specific techniques, activities or tools in an organization. One of the quality gurus, Joseph Juran, calls this the "little q" approach to quality. Adding on the five approaches, Cameron and Sine (1999) present two additional definitions, that focus on quality as the overall functioning of the organization, or as an ultimate outcome. According to Juran, this is the "Big Q" approach to quality. (Cameron and Sine, 1999) Following the "Big Q" definition, the importance of quality to organizations is clearly visible. According to (Garvin, 1984), quality is an important concept and a competitive factor in several parts of business, and (Krishnan, 2006) states that quality must be a part of everything that is done. Hietschold et al. (2014) view increasing global competition and more demanding customers as a compulsion for companies to enhance quality and seek continuous improvement. If an organization were to neglect quality as it is defined in this research, it is apparent that it would endanger the operations and competitiveness of the business. Consequently, organizations must seek to sustain and enhance their quality.

Regarding quality as an ultimate outcome clarifies the use of the term *quality* in this study. This way, the formed quality definition aligns with the concept of zero defects, popularized by Crosby (Sower, 2010, p. 11). In this approach, the ultimate target is error free production, and complete conformance in products and processes, and the only true measurement of performance is the cost of quality. Here, quality costs are seen as a measure of outcome. Zero defects is a philosophy (Beckford, 2016), with which the profits in an organization can be increased through elimination of failure costs, and at the same time, revenues can be increased, because customer satisfaction improves through compliance. This is the ultimate outcome, to which the organization strives towards, and is used as the target in this study. However, defining the outcome does not automatically lead the organization to it. As an example, although managers in organizations estimate the cost of quality, they fail in reducing it (Neely et al., 2005). This is why it is also important to understand how to make quality happen.

2.1.2 Quality management

Now, the concept of quality is defined, and it is a concept that organizations strive towards. The totality of functions that are involved in determining and achieving quality, is called quality management (Sower, 2010, p. 20). Understanding quality management concepts is relevant to this study, because quality measurement is integral to quality management practices (De Feo, 2017, chap. 7.2, 20.4). According to ISO 9000 (2015), which is a standard that has had a big impact on quality systems implementation and international trade by organizations globally (De Feo, 2017, chap. 11.2.1.), quality management can include establishing quality policies and objectives, as well as processes to achieve said quality objectives through **quality planning**, **quality assurance**, **quality control** and **quality improvement**. Quality planning focuses on setting quality objectives and specifies needed operational processes and resources in order to achieve quality objectives. Quality assurance (QA) focuses to provide confidence that quality requirements, such as effectiveness or efficiency, are fulfilled. Quality control (QC) focuses on fulfilling these requirements. The fourth activity, quality improvement, focuses on increasing the competence to fulfill the quality requirements. (ISO 9000, 2015) Two other common quality management concepts (Sower, 2010, p. 20) are strategic quality management (SQM) and total quality management (TQM). SQM is a systematic approach to set and meet quality goals company-wide, and it involves the upper management and the integration of quality to the strategic management process. Total quality management is a quality management approach, which is based on the participation of the whole personnel in the company to improving processes, services, products, and the whole culture that they are working in. (Sower, 2010, p. 20) According to Cameron and Sine (1999), TQM is generally used synonymously with the “Big Q” approach to quality.

Before discussing the concepts of performance measurement and its use in making quality happen through quality management activities, the quality costs should be acknowledged. Quality costs are relevant to this study because they are tied to the quality definition as an integral measurement of outcome, and thus, as a relevant target of the measurement and management activities studied in this thesis. What’s more, quantification of quality issues in the language of quality costs, can improve the communication between middle and upper managers (De Feo, 2017, chap. 25.5.), and thus also be of use in making quality happen.

2.2 Quality costs as an outcome of quality

To control something, the first thing is to measure it (Krishnan, 2006). Because quality has a big effect on costs (De Feo, 2017, chap. D.2.3; Sower, 2010, p. 311), and because

quality costs have been closely linked with measurement of quality in the literature (Shin et al., 2018; De Feo, 2017, chap. 1.3; Beckford, 2016, p. 56; Sower, 2010, p. 311; Krishnan, 2006; Merino, 1990; Garvin, 1984), the concepts of quality costs should be defined in this study. Furthermore, Merino (1990) and Williams (et al., 1999) emphasize the importance of the quality costs concept simply because these costs are high in organizations. Secondly, most of quality expenditures add little value to the organizations. Reducing quality costs thus lead to improved return on investment and sales. (Williams et al., 1999)

There seems to be no single, unambiguous definition to quality costs, but the established literature often divides the cost of quality to conformance and non-conformance costs. According to Cheah (et al., 2011), quality costs, or the cost of quality refers to the total expenses that an organization incurs for its quality overall. The cost of quality (COQ) comprises of two elements: the cost of conformance, and the cost of non-conformance (Cheah et al., 2011; Schiffauerova and Thomson, 2006; Gupta and Campbell, 1995). This categorization is also called Crosby's model, because Crosby based this model on his "conformance to requirements" definition of quality (Schiffauerova and Thomson, 2006). Cost of conformance is the price that is paid for prevention of poor quality, such as inspection and quality appraisal. Cost of non-conformance is poor quality cost that is caused by product or service failure, such as returns and rework. (Schiffauerova and Thomson, 2006) According to Dale and Plunkett (1995, via Schiffauerova and Thomson, 2006), quality costs also include cost of resources allocated to continuous improvement, and the costs that incur in the design, implementation, operations and maintenance of a quality management system. Thus, in this study, quality costs can be defined as:

Cost of quality (COQ) is the total of expenses that result from activities that are required to achieve quality. COQ comprises of the cost of conformance and the cost of non-conformance.

COQ can, however, be divided into more specific components. In 1943, Feigenbaum (via Harrington, 1999) divided cost of quality into four categories: prevention cost, appraisal cost, internal defect cost, and external defect cost. In more recent research, the defect costs are translated into failure costs (Cheah et al., 2011; Harrington, 1999; Tsai, 1998). This is the categorization on which most COQ models are based on (Cheah et al., 2011; Schiffauerova and Thomson, 2006), and it is called the PAF model. The model has been adopted by the American Society for Quality Control, as well as by the British Standard Institute. Furthermore, the PAF model is employed in most of companies that use quality costing (Schiffauerova and Thomson, 2006). The components of the PAF model can be described as follows:

Prevention costs are expenses that go into prevention of defects and non-conformities (Cheah et al., 2011). These expenses are planned, they incur before actual operation (Tsai, 1998), and thus ensure that quality products and services are provided by a process (Schiffauerova and Thomson, 2006). According to Tsai (1998), prevention costs are associated with design, implementation, and maintenance of the total quality management system. Prevention cost elements are, for example, product development and customer surveys (Sower, 2010, p. 313)

Appraisal costs are the costs of evaluating and measuring the level of quality which is attained by the process (Schiffauerova and Thomson, 2006), and thus ensuring that products and services meet customers' requirements (Cheah et al., 2011). Appraisal costs can be associated with the quality of processes, purchased materials, intermediates, on top of the quality of products and services (Tsai, 1998). Appraisal cost elements are, for example, quality audits and outside certifications (Sower, 2010, p. 313).

Internal failure costs occur when the work results fail to reach planned quality standards, and are corrected, but are also detected before delivery to a customer (Cheah et al., 2011; Schiffauerova and Thomson, 2006; Tsai, 1998). Internal failure cost elements are, for example, internal design failure and rework (Sower, 2010, p. 313).

External failure costs occur when products or services fail to meet design quality standards, and are not detected and thus corrected until after the delivery to the customer (Cheah et al., 2011; Schiffauerova and Thomson, 2006; Tsai, 1998). External failure cost elements are, for example, loss of customer goodwill and returned goods (Sower, 2010, p. 313).

The term cost of poor quality (COPQ) is gaining popularity (Sower, 2010, p. 311). Secondly, there is some confusion and misunderstanding between the terms COQ, COPQ, and poor quality cost (PQC) (Krishnan, 2006). For example, Sower (2010, p. 311) considers COQ and COPQ as synonymous, when Sörqvist (1997) defines COPQ as "the costs which would be eliminated if a company's products and the processes in its business were perfect". Sörqvist (1997) adds, that COPQ is divided into internal and external failure costs, and appraisal costs. This would indicate that all except prevention costs of the PAF model are thought of as being COPQ. Krishnan (2006) makes a distinction between COQ and COPQ: COQ considers all the categories in the PAF model, but COPQ or PQC only the internal and external failure costs. In conclusion, in this study, COQ and COPQ are seen as different concepts. COPQ and PQC are considered as synonymous, and the term cost of poor quality is preferred for its' popularity.

One other categorization of COPQ is presented by De Feo (2017, chap. 25.5). This categorization divides COPQ into three components, visualized in figure 2.

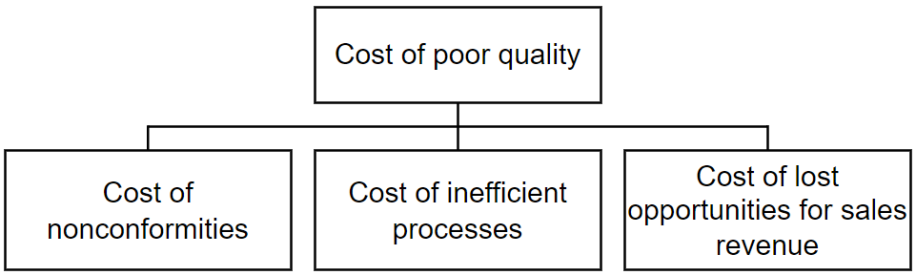


Figure 2. *Main components of COPQ (De Feo, 2017, chap. 25.5).*

Here, COPQ is not based on the components of the PAF model per se, but it does not seem to conflict with that categorization, either. The elements: cost of nonconformities, cost of inefficient processes and the cost of lost opportunities for sales revenue are costs that can be thought to disappear, if internal and external failure costs as they are defined in this study, would also disappear. In conclusion, in this study:

Cost of Poor Quality (COPQ) is the set of costs that would disappear, if there were no internal or external failures. Costs of poor quality can realize due to nonconformities and inefficient processes, and from lost opportunities for sales revenue.

The PAF model makes two fundamental assumptions on cost of quality. First, investing in prevention as well as appraisal activities will mitigate failure costs (Schiffauerova and Thomson, 2006), and secondly, further investment in prevention activities will also reduce appraisal costs. Gupta and Campbell (1995) add, that the most cost-effective category for quality spending is the prevention category. As a COQ system is implemented, the objective of this system is to discover the level of quality which minimizes the total COQ. (Schiffauerova and Thomson, 2006) The relationship between prevention, appraisal, and failure costs and their effect on the total COQ have been visualized with two approaches. These classical and modern approaches are presented in figure 3.

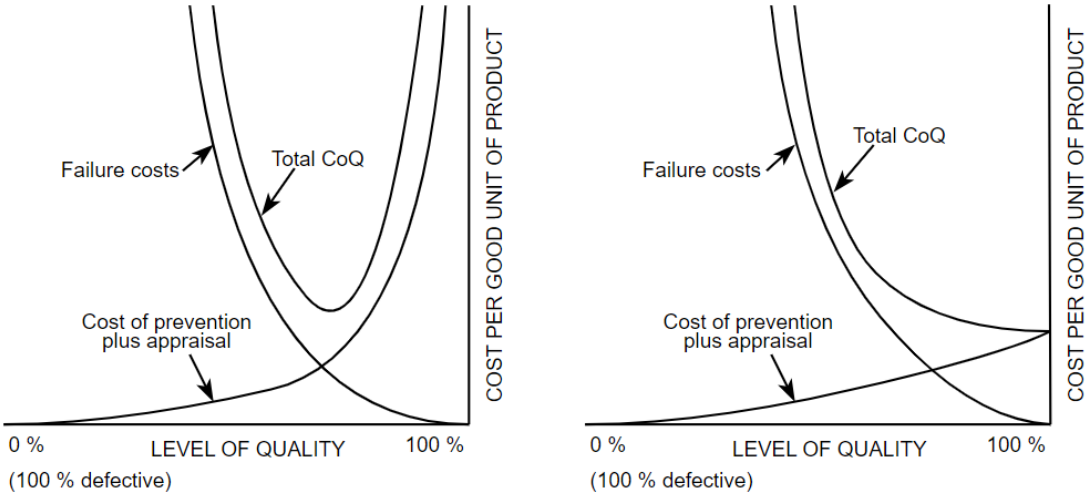


Figure 3. *Classic view of PAF costs on the left, and modern view on the right, according to (De Feo, 2017, chap. 25.8; Schiffauerova and Thomson, 2006).*

According to the classical view, the optimal total COQ level would occur at the point where cost of prevention plus appraisal exceeds failure costs. From this point forward, investing more into prevention and appraisal will only increase the total COQ level. According to Schiffauerova and Thomson (2006), this view has been challenged in more recent literature, stating that investing in prevention can be justified in all circumstances, and **that the optimal quality level equals to zero defects.** To add on this, the classical PAF model is regarded as accurate for providing a snapshot of the current and static state of COQ. However, recognizing that companies evolve and learn from their mistakes, the modern version is more commonly referenced in recent literature (Plewa et al., 2016). Judging by this, as the prevention category is the most cost-efficient, companies could quantify the cost-effectiveness of the quality function by calculating the percentage of “cost of good quality” (including prevention and appraisal cost) out of the total COQ. If this kind of quality cost ratio was implemented though, it would need confirmation on the optimal COQ, because according to the classical view, high percentage of prevention and appraisal costs is not optimal in all situations. Regardless of this division on economic COQ levels, the main principles of the PAF model are still widely accepted (Schiffauerova and Thomson, 2006).

On the contrary to the wide acceptance, the PAF model has also received criticism and has been challenged with alternative COQ models. Some of the criticisms include:

- It is difficult to decipher, which actions stand for prevention of quality failures, because nearly every activity that a well-managed company does has something to do with preventing quality problems (Krishnan, 2006; Tsai, 1998).
- The focus of the PAF model is on cost reduction, and the impact of improved quality to price and sales volumes is ignored (Krishnan, 2006; Tsai, 1998).

- The PAF model pays little attention to subcontractor or supplier-generated quality costs or to customer-related costs (Williams et al., 1999), and ignores intangible quality costs, such as ‘loss of sales’ and ‘loss of customer goodwill’ (Krishnan, 2006; Tsai, 1998).
- The PAF model does not align with the continuous quality improvement nor with the process improvement aspects of total quality management (TQM) practice (Krishnan, 2006; Tsai, 1998).

As a conclusion of this criticism, the PAF model does not offer a comprehensive approach to the quality issues that a company comes across, and the categorization by the PAF elements itself can be challenging. However, as established, the PAF model approach to COQ has developed. As a contradiction to the criticism, Sower (2010, p. 313) includes ‘loss of customer goodwill’ as a component of external failure costs. Thus, some intangible quality costs have indeed been included in the PAF model.

Multiple COQ models have emerged, some of which tackle the criticism faced by the PAF model. In addition to the PAF and Crosby’s models, Schiffauerova and Thomson (2006) classify COQ models that exist in literature into process cost, opportunity or intangible cost, and ABC models. Opportunity or intangible cost models tackle the PAF model issue of not taking intangible costs, meaning costs that can only be estimated, into account in total COQ (Schiffauerova and Thomson, 2006; Tsai, 1998). In these models, the costs could be addressed with extra dimensions to the PAF model: cost of inefficient resource utilization and quality design cost, or by incorporating them into traditional PAF quality expenses (Schiffauerova and Thomson, 2006).

Anoher alternative is the activity-based costing (ABC) model. Activity-based costing divides an organization into activities: resource use is calculated by each activity, and the costs are allocated to cost objects based on the use of each of the activities (Suomala et al., 2011, chap. 5.7). In the case of the ABC model, collection of quality cost data is linked with accounting systems. According to Sower (2010, p. 318), quality cost data collection is often started with analyzing the data collected by cost accounting. In addition to or together with the ABC model, COQ data collection can be facilitated with enterprise resource planning (ERP) systems. ERP, as defined by Sower (2010, p. 320), is the framework for defining, organizing, and standardizing the business processes needed to effectively plan and manage an organization, in order for an organization to use its internal knowledge in seeking external advantage. While ABC provides a conceptual basis for capturing and managing quality costs, ERP systems provide reporting and record-keeping processes that can then be used to apply these concepts (Sower, 2010, p. 319).

In this section, concepts of quality costs were examined. COQ and COPQ were defined as separate concepts, and the different approaches to model them were presented. Most widely recognized COQ model is the PAF model, which comprises of prevention, appraisal, and internal and external failure costs. The components, visualization, criticism and alternatives of the PAF model were examined. Additionally, the collection methods of quality data were discussed briefly. Next, the concept of performance measurement is discussed, in order to later define, what the uses for measurement are in the quality management context. This understanding can then be used to determine which activities should be supported by the quality measurement system being developed in this study.

2.3 Performance measurement

Performance is a key concept in business, and performance information is gathered, analyzed, and communicated in organizations. The process of quantifying the effectiveness and efficiency of action can be defined as performance measurement (Neely et al., 2005). With performance measurement, the demonstration of the results is possible, both internally, and to the key stakeholders. Measurement transforms the identified success factors of an organization into action goals in accordance with the roles of different organizational levels, units, or individuals (Suomala et al., 2011, chap. 7.3). Thus, performance measurement can be thought to operationalize the big picture objectives of an organization's strategy.

To understand the connection of quality and performance measurement, and to connect performance measurement to the operations in the case company, the purpose and use of performance should be clarified. In addition to cascading the company's strategy and objectives down the organization, which is one of the most acknowledged purposes for performance measurement (Korhonen et al., 2023; García-Álvarez and Atristain-Suárez, 2020, p. 140; Bititci et al., 2018; Jääskeläinen and Luukkanen, 2017; Franco-Santos et al., 2012; Kaplan and Norton, 1992), it has other uses in companies as well. In order to discuss the uses of performance measurement, a concept of a performance measurement system (PMS) should be defined. According to Bititci et al. (2018), it is a process (or processes) of setting targets, developing a set of performance measures, collecting and analyzing, reporting, deciphering, reviewing and taking action on performance data. This way, performance measurement as a concept can also be tied into an organization's operations. Different kinds of performance measurement systems will be covered in detail in chapter 2.6.

In addition to strategy implementation, performance measurement can be used in several activities. According to Franco-Santos et al. (2012), the purposes of modern performance measurement systems are to inform decision making, evaluate organizational and managerial performance for informational or motivational purposes and in some cases influence monetary rewards. These systems play a vital role in strategy, management process and communication, and generate capabilities that make organizational excellence possible. (Franco-Santos et al., 2012). Furthermore, performance measures can guide to realize the important areas to focus on. (Korhonen et al., 2023) This way, performance measures can help in resource allocation. In their research, Jääskeläinen and Luukkanen (2017) discuss that performance measurement is often promoted as a facilitator of reporting, budget monitoring, decision making, and information provision, in addition to strategy implementation. To summarize, performance measurement can be used to:

- Cascade the company's strategy and objectives down the organization, help in setting performance targets.
- Generate performance capabilities and support performance development.
- Evaluate organizational and managerial performance, and monitor target attainment and thus facilitate reporting.
- Inform decision-making and help in allocating and prioritizing resources.
- Facilitate budget monitoring and influence monetary rewards.

This list has similarity to the definition given to performance measurement systems by Bititci et al. (2018). Measurement should not be thought of as a goal itself, but rather **as a tool for more effective management**. If an organization seeks to effectively use its performance measurement results, it must transition from measurement to management. (Amaratunga and Baldry, 2002) Thus, it seems that the need for performance measurement is heavily dependent on the value that it brings to management.

According to Bititci et al. (2018), the basis of performance measurement and management (PMM) systems lie in management control theories, and based on the definition by Melnyk et al. (2014), performance measurement and management consists of the key elements that form a control system, which are measure, compare, analyze, and act. Furthermore, in a dynamic environment, the structure would be **measure, compare, analyze, correct, and prevent** (Bititci et al., 2018).

This subchapter clarified the use of performance measurement, and linked it heavily to performance management, and finally to general management control structures. In conclusion, performance measurement serves multiple purposes, and does not work solely as a tool to implement organization's strategy, even though that is an acknowledged function of performance measurement. This subchapter discussed the use on a general management level. Next, the focus shifts into discussing the use of measurement in this study's context, which is quality measurement and the use of measurement in quality management.

2.4 Use of performance measurement in quality management

In the last subchapter, the background for the use of performance measurement was established**. Performance measurement is used as a tool to management, and as a part of a performance measurement and management process**. Now the discussion should be brought into quality perspective. To develop a more proactive and balanced quality measurement system in the case company, it should be made clear who uses this kind of measurement system and to what purpose. This way, it is then possible to determine what function the system should support and, on the other hand, to determine what purpose the system should fulfill. Based on this, let's next discuss the popular concepts of managing quality, and how measurement can be utilized as a tool to these processes in the examined quality function of the case organization's business line.

Before discussing performance measurement in quality management, the concept of quality performance should be defined. Earlier, performance was established to be closely linked to the measurement of success in business activities. Thus, by definition, quality performance must be linked to the measurement of success in quality-related activities. According to Saab et al. (2018), quality performance can be defined as the degree of fulfilling critical-to-quality performance expectations and requirements, which satisfy stakeholders. This definition fits the quality definition used in this study, and thus:

Quality performance is the degree of fulfilling such performance expectations and requirements that are critical to quality.

By this definition, quality can be seen as an organizational outcome, which was a part of the "Big Q" definition of quality, according to Cameron and Sine (1999). However, quality performance is not equal to quality management. With that said, in an empirical study on 262 Indian manufacturing companies, Patyal and Koilakuntla (2017) found that QM practices have a positive effect on quality performance, and that quality performance has a

positive effect on overall business performance. The definitions and connections of these three key concepts in this study are visualized in figure 4.

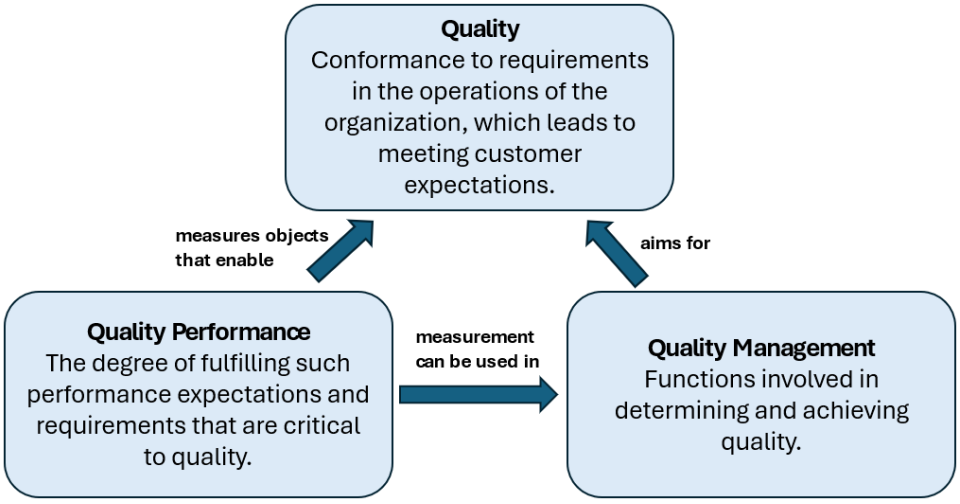


Figure 4. *The concepts of quality, quality management, and quality performance, and their main connections to each other.*

This visualization highlights, that quality performance measurement can be used in quality management, and that quality management activities aim for quality. This clarification is helpful, because there is literature that for example, discuss about the measurement of quality management performance (Saraph et al., 1989), which is not the focus in this study.

One use of measurement in quality management context is similar to the profound use of performance measurement: as a form of operationalizing company strategy. This utilization is a part of the SQM approach (Sower, 2010, p. 20). According to Parvadavardini et al. (2016), in a company practicing SQM (which incorporate inspection, QC, QA, and TQM), the principles are integrated into the whole organization and with key business processes. Making quality happen, i.e., conversing quality targets and goals into results, is done through managerial processes (De Feo, 2017, chap. 7.7.8). In these activities of quality strategy deployment, a report package or a scorecard of measures should be designed for upper managers to keep them informed, and to call them for action in case of exceptions. These scorecards should show trends of performance against goals, and generally assist upper managers to meet financial goals. (De Feo, 2017, chap. 7.7.8) On a strategic quality management level, the use of measures align well with the performance measurement uses presented in chapter 2.3.

In practice, there are a lot of different ways in which companies execute their quality management. These include, but are not limited to: performance excellence, operational excellence, business excellence, Toyota production system, Lean Six Sigma, ISO 9000

standards, and Total Quality Management (De Feo, 2017, chap. 1.4; Montgomery and Borror, 2017; Lakhal, 2014; Li and Al-Refaie, 2008). Slack and Lewis (2020, p. 242) refers to these concepts as ‘pre-packaged’ approaches to the operations improvement management. Six Sigma is a currently popular business improvement approach, that seeks to locate and eliminate causes for defects by focusing on the critical outputs for the customer (Li and Al-Refaie, 2008). The ISO 9000 series are standards for quality systems, but do not describe how such a system can be implemented. (Sower, 2010, p. 109) However, according to Montgomery and Borror (2017), Six Sigma and the ISO 9000 series certifications are not in themselves sufficient as quality management systems. According to Lakhal (2014), ISO 9000 and 9001 standards are directly linked to TQM philosophy, and Najmi and Kehoe (2001) propose that there is a number of studies which claim that ISO 9000 certification works as a stepping stone towards total quality. According to Najmi and Kehoe (2001), the quality development after ISO certification should focus on (1) suppliers; (2) employees; (3) management; (4) processes; (5) quality information systems (QIS); and (6) customers. With these linkages, it seems that the TQM philosophy should be discussed further.

Total Quality Management appears as a popular subject among quality performance literature (Adem and Virdi, 2023; Karamouz et al., 2020; Wei et al., 2019; Saab et al., 2018; Montgomery and Borror, 2017; Parvadavardini et al., 2016; Chen, 2015; Lakhal, 2014; Pimentel and Major, 2014; Sousa and Aspinwall, 2010; Chang, 2006a, 2006b; Kaynak, 2003; Pun, 2002; Najmi and Kehoe, 2001; Cameron and Sine, 1999). In chapter 2.1.2, TQM was defined along SQM, QA, QC, and quality improvement concepts. It is an integrative management philosophy, with the purpose of continuously improving the quality in products and processes in order to achieve customer satisfaction (Chen, 2015). The approach adopts quality development and improvement, and quality maintenance activities and aims to facilitate operations in the most cost-efficient way in an organization (Adem and Virdi, 2023). With the ambition to achieve customer satisfaction through improved quality (Adem and Virdi, 2023), the TQM approach is well in line with the quality definition used in this study. According to De Feo (2017, chap. 6.2), the beforementioned concepts of performance excellence, operational excellence, and business excellence are often used interchangeably with TQM to comprise the all-encompassing nature of the quality management in an organization. In Japan, the term total quality control (TQC) refers to this same concept (2017, chap. 6.2), and should not be confused with the term quality control (QC), which was defined in subchapter 2.1.2. An important takeaway from the discussion on TQM is, that although some quality activities, such as quality audits,

may be allocated to some function in an organization, quality as a whole happens with the co-operation of the whole organization.

Even though there is variance in the approaches to quality management, there are also components to them that they all share. According to Sower (2010, p. 108) and Arter (2002, p. 18), a *quality management system*, which includes the collective plans, events and activities in the organization that ensure that a product, service or process satisfy established requirements, always includes four fundamentals:

1. **Planning**: It involves devising a comprehensive plan for quality-related activities. It includes assigning responsibilities and ensuring clear accountability for each task. Additionally, this phase defines the expectations and needs of customers and other stakeholders.
2. **Performance**: The planned activities are carried out as per the established plan. Detailed records are maintained to enable the comparison of actual performance with the planned performance.
3. **Measurement**: The outcomes of the executed activities are measured against predefined standards using various evaluation methods such as audits, inspections, and reviews. Valuable insights from customer feedback are integrated into this evaluation process.
4. **Improvement**: Continuous evaluation is essential for identifying areas of improvement and addressing any existing issues. This ongoing improvement cycle ensures the refinement and optimization of the entire process over time. (Sower, 2010, p. 108; Arter, 2002, p. 18)

These fundamentals do not apply only on quality management systems, however (Arter, 2002, p. 18). To draw similarities between performance measurement and quality literature, it was established in the subchapter 2.3, that performance measurement and management systems follow a similar control system structure of measure, compare, analyze, and act (Melnyk et al., 2014). These control system building blocks have several names, such as the feedback loop (De Feo, 2017, chap. 6.3.), continuous improvement cycle (Chang, 2006a), or the PDCA cycle (Plan-Do-Check-Act) (Arter, 2002, p. 19). The PDCA cycle was first introduced by the quality guru Walter Shewhart, and later updated to PDSA cycle (Plan-Do-Study-Act) by W. E. Deming (Sower, 2010, p. 13). This continuous cycle is visualized in figure 5.

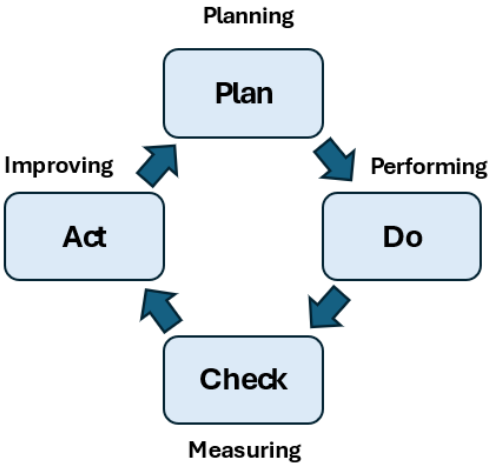


Figure 5. *The continuous improvement cycle (PDCA cycle), modified from (Arter, 2002, p. 19).*

Even though this continuous improvement cycle can be visualized as a simple concept, it clearly depicts the use of performance measurement as a component in a quality management system; or in any management control system (Arter, 2002, p. 19), to be precise.

Performance measurement is integrated in the check function of the PDCA cycle. Quality control is a necessary process in quality improvement (Saab et al., 2018), and according to Juran's basic quality processes, quality control focuses solely on activities related to measurement (De Feo, 2017, chap. 6.3). This quality control process is depicted in figure 6.

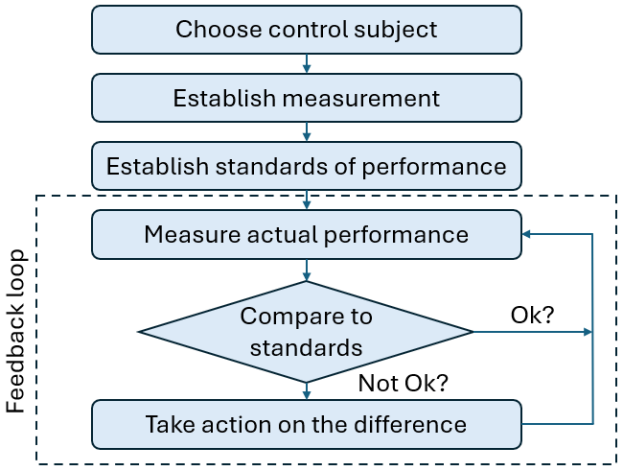


Figure 6. *A flowchart describing the control process, modified from (De Feo, 2017, chap. 6.4.).*

The flowchart depicted on the figure shows how measurement can be used in the continuous quality improvement process in practice.

The continuous improvement process operationalizes an integral use case for quality performance measurement in the quality management context. Even though there are numerous approaches to quality management, the continuous improvement cycle seems to be stably incorporated in them. According to Saab et al. (2018), the continuous improvement cycles included in for example Lean, Six Sigma, Business process management, and evidence-based management methods are variants of the PDCA cycle for quality improvement. For example, the currently popular Six-Sigma approach includes a DMAIC procedure, which stands for Define-measure-analyze-improve-control (Li and Al-Refaie, 2008). According to Gitlow (2005), DMAIC or PDSA cycles can be used in organizations when applied to dashboards designed to enhance process performance. *Dashboards* are tools used by management in order to clarify and assign accountability for the critical key objectives, key indicators, and tasks or projects needed to lead a company towards its mission (Gitlow, 2005). Jääskeläinen and Roitto (2016) clarify this by stating that dashboards are a way to visualize a performance measurement system, and enables interactivity, and automatic updates to the data. In addition to the Six Sigma example, the continuous improvement cycle works as the control loop used in TQM as well, and according to Chang (2006a), the cycle requires feedback from quality performance indicators, which are the base for corrective management action.

As a conclusion to this subchapter, it can be stated that performance measurement is integral to quality management and quality improvement. Quality performance measurement can be used in strategic quality management as a way to cascade the quality strategy down the organization, and it is also an integral part of continuous quality improvement. To emphasize this, according to Najmi and Kehoe (2001):

“Quality improvement without measurement is like hunting ducks at midnight without a moon; lots of squawking and shooting with only random results and with a high probability of damage.”

Furthermore, as continuous improvement works as a key feature in Quality Management (Saab et al., 2018), the use of performance measurement in quality management context is clear. In summary, quality performance measurement is used as input data to quality management activities that support the organization in reaching their strategic targets with more informed control and decision-making, and working as an integral element in continuous improvement processes.

In order to develop quality performance measurement in this study, it is useful to discuss, what qualities the individual performance measures should fulfill, and what kind of framework the performance measures should form. Thirdly, it is useful to understand, how this

kind of framework should be designed in practice. After these topics, the discussion is brought back to quality to confirm, that the discussed framework practices are fitted into the quality perspective.

2.5 Individual performance measures

In organizations, performance can be measured in numerous ways. Traditional performance measures come from costing and accounting systems, with a heavy emphasis on financial measurement (Neely et al., 2007, p. 12; Bourne et al., 2000; Wisner and Fawcett, 1991). A sole financial performance measurement has, however, been criticized as insufficient in business enterprise management (Bourne et al., 2000). Next, different types and individual performance measures are examined, as well as the attributes and challenges related to them.

Performance measurement in an organization is a multidimensional entity. According to (Kennerley and Neely, 2002), a performance measurement system consist of three components: individual measures, that quantify the effectiveness and efficiency of actions, a set of measures, which combines the assessment of performance in an organization, and finally a supporting infrastructure, which enables acquiring, collating, sorting, analyzing, interpreting, and disseminating of data. Let's first focus on the individual measures.

Individual components of a performance measurement system can be referred to with several names, which can cause confusion. Examples of these are as performance metrics, performance indicators and performance measures (Van Looy and Shafagatova, 2016). Van Looy and Shafagatova (2016) consider them as synonymous, but (Eckerson, 2010, p. 198) defines metrics and indicators as separate concepts. According to Eckerson, a metric is a measurement of business activity, for example total sales. Then, a metric that measures business activity against a goal is defined as performance indicator. (Eckerson, 2010, p. 198)

Performance measures can be categorized into different types. Parmenter (2019, p. 3) divides performance measures into result and performance indicators. Result indicators refer to the sum of several teams' input. They are useful for looking at the combined teamwork, but do not help management in decision-making, because pinpointing a problem to a specific team is difficult. Performance indicators, on the other hand, measure the work that is tied to a team or a cluster of closely working teams, and thus, give the measurement clarity and ownership. Some of these indicators in the groups are more important than others, and thus, four groups are formed: key result indicators (KRIs),

result indicators, performance indicators, and key performance indicators (KPIs). KRIs give the management an overall picture of how the organization is performing over a period of time. They are, however, of little use to management, since they are reported late, and do not tell how to improve the results. (Parmenter, 2019, pp. 3–6)

KPIs, on the other hand, focus on those aspects of organizational performance, that are most critical for current and future success of an organization (Parmenter, 2019, p. 6; Kerzner, 2017, p. 122). They offer information on how the organization is performing 24/7 in their critical success factors, and by acting based on them, management can improve performance (Parmenter, 2019, pp. 6). According to Kerzner (2017, p. 121), KPIs also function as early warning signs that, if an unfavourable condition exists but is not addressed, the results could be poor. Kerzner (2017, p. 122) also adds, that a KPI is a metric that measures how well an individual or the organization performs on operational, tactical, or strategic level activities. According to Kerzner (2017, p. 128), defining and selecting KPIs is significantly easier when the critical success factors (CSFs) are first defined.

According to Eckerson (2010, pp. 198–199), there are also two main types of metrics, outcome metrics and driver metrics. Eckerson highlights KPIs as a type of metric, as well. Van Looy and Shafagatova (2016) also recognize the division to performance outcomes and performance drivers. Eckerson (2010, pp. 198–199) points out, that outcome metrics are sometimes called lagging indicators, and driver metrics as leading indicators.

Leading and lagging indicators appear as a widely used categorization (Parmenter, 2019, p. 16; Suomala et al., 2011, chap. 7.3; Neely et al., 2000). According to Neely et al. (2000), results, such as financial performance, are lagging indicators, and determinants, such as quality and innovation, are leading indicators.

Although important, some performance measures have more desirable attributes than others, and some may be more fitting for the organization’s objectives than others. Goodness of measures can be approached from multiple standpoints. According to Suomala et al. (2011, chap. 7.3), three key requirements for measures are relevance, reliability, and validity. Relevance appears as the measure’s ability to depict important things to the organization, reliability as its ability to produce reliable and precise information, and validity as the ability to produce such information, that describe the intended activity without bias. (Suomala et al., 2011, chap. 7.3) These three attributes are picks from a wide range of desirable elements. A more comprehensive list of good measure attributes gathered from the literature is depicted in table 1.

Table 1. *Attributes of good performance measures*

Characteristics of effective performance measures	**Mentioned in**
1. Strategic and aligned, at least a link to one of organization's CSFs.	(Parmenter, 2019, pp. 154–155; Gray et al., 2015, p. 46; Suomala et al., 2011, chap. 7.3; Eckerson, 2010, pp. 209–212; Malina and Selto, 2004; Neely et al., 1997)
2. Timely.	(Parmenter, 2019, pp. 154–155; Gray et al., 2015, p. 65; Eckerson, 2010, pp. 209–212; Neely et al., 1997)
3. Focusing the measures on exceptions.	(Parmenter, 2019, pp. 154–155)
4. Remove damaging or dysfunctional measures.	(Parmenter, 2019, pp. 154–155)
5. Simplicity, understandability.	(Parmenter, 2019, pp. 154–155; Gray et al., 2015, p. 65; Suomala et al., 2011, chap. 7.3; Eckerson, 2010, pp. 209–212)
6. Benefit of measuring is greater than the cost.	(Parmenter, 2019, pp. 154–155; Gray et al., 2015, p. 65; Malina and Selto, 2004)
7. Relevance.	(Parmenter, 2019, pp. 154–155; Suomala et al., 2011, chap. 7.3; Eckerson, 2010, pp. 209–212; Malina and Selto, 2004; Neely et al., 1997)
8. Comparability to other organizations.	(Parmenter, 2019, pp. 154–155)
9. Owned, accountability.	(Eckerson, 2010, pp. 209–212)
10. Actionable, action is possible based on measure results.	(Eckerson, 2010, pp. 209–212; Malina and Selto, 2004)
11. Referenceable, the origin data of the measure is accessible.	(Eckerson, 2010, pp. 209–212)
12. Accuracy, reliability.	(Gray et al., 2015, p. 65; Suomala et al., 2011, chap. 7.3; Eckerson, 2010, pp. 209–212; Malina and Selto, 2004; Neely et al., 1997)
13. Correlated, measures drive desired outcomes.	(Eckerson, 2010, pp. 209–212; Gray et al., 2015, p. 65; Malina and Selto, 2004)
14. Game-proof, freedom from deliberate distortion of results.	
15. Standardized, ambiguity.	(Eckerson, 2010, pp. 209–212; Gray et al., 2015, p. 65; Neely et al., 1997)
16. Validity.	(Gray et al., 2015, p. 65; Suomala et al., 2011, chap. 7.3)
17. Diverse and complementary.	(Suomala et al., 2011, chap. 7.3; Malina and Selto, 2004)
18. Reflect the business process, part of a closed management loop.	(Neely et al., 1997)
19. Based on trends and ratios rather than snapshots and absolute numbers.	(Neely et al., 1997)
20. Focus on visual impact and improvement.	(Neely et al., 1997)
21. Use of automatically collected data as part of a process.	(Neely et al., 1997)

As can be seen from the table, the list of the desired attributes is rather exhaustive, but most of the listed attributes appear more than once in the researched literature and thus, appear relevant. It comes evident, that it may be challenging to design such measures that are able to fulfill all the attributes listed.

Indeed, literature (Parmenter, 2019, pp. 150–152; Kerzner, 2017, p. 154; Gray et al., 2015, p. 11; Neely et al., 2005; Malina and Selto, 2004; Hauser and Katz, 1998; Kaplan

and Norton, 1992) affirms the existing challenges in finding, creating and using good measures. In their book, Gray et al. (2015, p. 11) present fundamental, but common challenges related to performance measurement in general. These include: the illusion of control that measurement generates for management, the dysfunctional behavior of employees caused by excessive pressure to meet performance targets, gaming and cheating that may occur among employees to play the system in their favor, and the issues in financial rewarding related to performance measures. (Gray et al., 2015, pp. 11–12) Consequently, even at general level to performance measurement, there are challenges to tackle.

When the examining shifts from general challenges to individual performance measures' issues, as in the case of the attributes of good performance measures, the list is long. Hauser and Katz (1998) list seven pitfalls (which lead to selecting counterproductive metrics) to avoid, including delaying and using risky rewards, making metrics hard to control, losing sight of the objective, choosing wrong metrics, assuming that personnel have no options, and thinking too narrowly. In this context of finding and selecting good measures, Malina and Selto (2004) also deem it as being difficult. Parmenter (2019, pp. 150–152) lists similar challenges already brought up by Hauser and Katz with a few additions. According to Parmenter, challenges occur if the measures have no connection to the organization's CSFs. In addition, KPIs linkage to performance-related pay and overreliance to financial measures are seen as issues, as well as their design by untrained staff. (Parmenter, 2019, pp. 150–152) Relating to individual performance measures, Neely et al. (2005) propose a list of issues that could be researched, including how to design such measures, which do not encourage short-termism, and how to ensure that corrective actions follow measurement. In conclusion, numerous attributes and challenges of individual performance measures can be found in the literature. After examining the research on individual performance measures, next the focus is on performance measurement systems.

2.6 Performance measurement systems and frameworks

A performance measurement system can be defined as a set of measures used to quantify the efficiency and effectiveness of actions (Neely et al., 2005). As established in the previous subchapter, creating, finding, and using of individual performance measures can pose a challenge. Thus, the challenges do not disappear, when discussing about performance measurement as a set of measures, as a system, or as a framework: this leads to a conclusion that there is variety in quality of different performance measurement systems. In spite of the challenges, performance measurement is needed, and

performance measurement systems have a strategic role in organizations (Chytas et al., 2011; Neely et al., 1994). Simply, performance measurement systems are a way for the organization to carry out desired strategy.

As discussed in the previous subchapter, there are different ways to categorize individual performance measures. Different kinds of categorizations help organizations to define such a set of measures, that reflect their goals and assesses their performance appropriately (Kennerley and Neely, 2002). One of the most well-known performance measurement system framework is the Balanced Scorecard (BSC) (Cooper et al., 2017; Taticchi et al., 2012; Suomala et al., 2011, chap. 7.3; Neely et al., 2005; Bourne et al., 2000), developed by Kaplan and Norton (1992). The balanced scorecard (Kaplan and Norton, 1992) is based on the principle that the performance measurement system should give decision-makers information that addresses the following questions: how does the organization look to their shareholders (financial perspective), what must the organization excel at (internal business perspective), how do the organization's customers see them (customer perspective), and how can the organization create value and improve (innovation and learning perspective). Compared to the traditional financial measures, the BSC aims to balance external and internal performance measures, and also offer indication both on future performance and on what has been achieved in the past (Bourne et al., 2000). Although popular, the BSC is not without issues. For example, it does not take into account the competitor perspective (Neely et al., 2005), and does not advice in implementing the performance measurement system (Bourne et al., 2000). Chytas (et al., 2011) also criticize the fact that the design techniques for the BSC are poor, the cause and effect chain of the measures are problematic, and that the equal weighing and the ignorance of trade-offs between the measure categories are relevant issues. Among the mentioned criticism, Parmenter (2019) addresses the BSC issue of developing the framework from up to bottom in the organization, and instead proposes to enforce a bottom to up perspective.

To tackle the criticism faced by the Balanced Scorecard, Kaplan and Norton (2004) developed the concept of the strategy map. It is a framework for linking the different Balanced Scorecard perspectives, and the performance measures included in them, to the company strategy. The strategy map template is presented in figure 7.

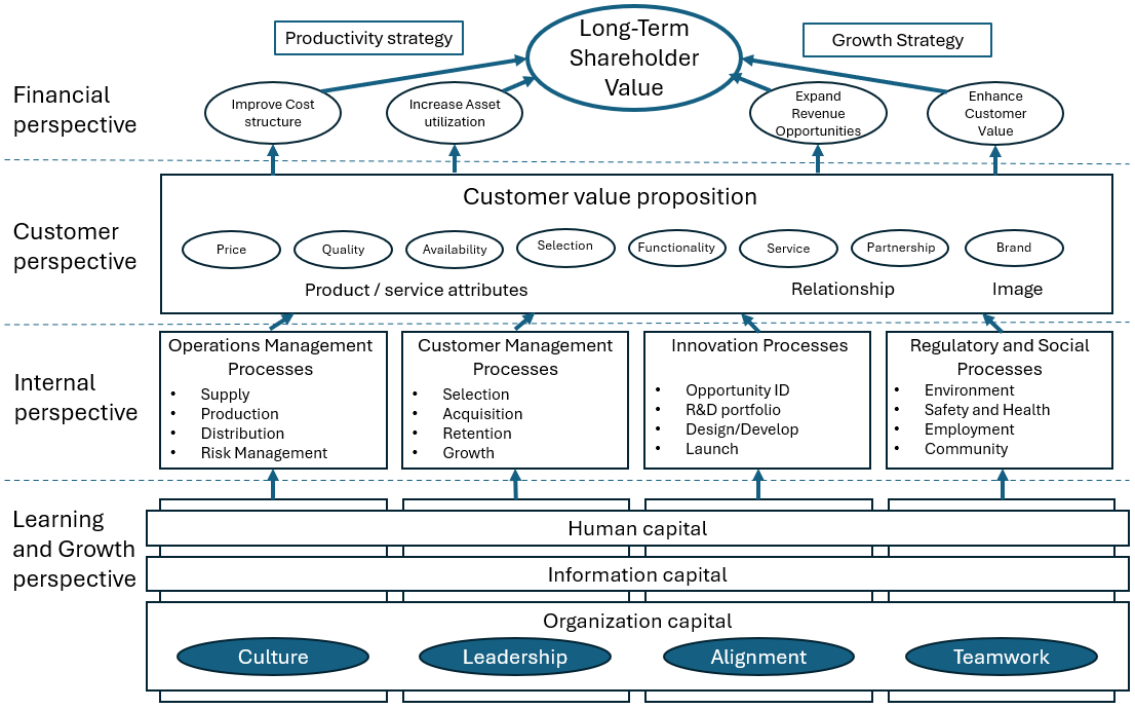


Figure 7. *The strategy map template, according to Kaplan and Norton (2004).*

According to Kaplan and Norton (2004), the strategy map can serve as a checklist: if a strategy of an organization is missing elements from the strategy map, the strategy is likely flawed. According to a study (Goldstein, 2022) on implementing the strategy maps in a middle management setting, strategy maps helped organizations in operationalizing and communicating the strategy, but also measuring the strategy. Thus, the use of the strategy map can help in establishing a balanced approach to the measurement system designed in this study. As an acknowledgement, according to Chytas et al. (2011), the idea of the strategy maps can be developed even further, by incorporating fuzzy cognitive mapping technology to figure out the causality and relationships between different measures. Nevertheless, the strategy map seems to be a relevant tool in building the framework for the measures.

In a literature review of performance measurement models, Van Looy and Shafagatova (2016) mention, that in addition to organizational models, performance measurement frameworks can focus on processes as well. What's more, Neely et al. (2005) suggests that rather than proposing performance measurement frameworks, other authors provide criteria for performance measurement system design. Thus, in addition to finding a measurement framework to be used, for the framework to deliver value, the process of populating the framework must to be understood (Neely et al., 2000). In other words, it is relevant to discuss the attributes of individual measures and follow a framework that the measures can be placed to, but in addition to that, the process of filling the framework

with the measures should be discussed. This will be the next and final topic regarding the general development of a performance measurement system.

2.7 Developing a performance measurement system

Performance measurement as a system is complex. The definition of measure types, the mapping of different measures' desired attributes and examining the different performance measurement system frameworks help in understanding the development context. However, every organization is unique, and according to (Neely et al., 2005), producing a single, unambiguous performance measurement framework seems unrealistic. Considering this, let's next focus on examining a systematic process to develop a performance measurement system in practice.

The performance measurement system development process can be divided into parts, and based on the literature, the process should include certain elements. Building the performance measurement system is a process, in which the aim is to form a clear understanding of the object or phenomenon that is measured (Suomala et al., 2011, chap. 7.3). According to Bourne et al. (2000) the performance measurement system development can be divided into three main phases: the design, implementation, and use of the performance measures. This is the sequence of the phases through which the system should progress, even though the phases are conceptual. The main process should also include updating processes, such as reviewing targets, developing and reviewing measures and challenging the strategy on which the system is based on, to update and continuously improve the system over time. In addition to the main phases presented, Taticchi et al. (2012) adds assessment as the first phase, in which the current system capabilities are evaluated, in order to plan future development. In the scope of this study, the development of the quality performance measurement system mainly focuses on the design phase. However, this does not rule out such activities that help in implementing the designed quality performance measurement system in the future; the design, implementation and use phases are conceptual, and can overlap (Bourne et al., 2000).

To utilize the PMS development process in this study successfully, the process phases should be defined on a more practical level, and by focusing especially on the design phase. The design follows the assessment phase, and, according to Bourne et al. (2000), the design phase can be divided into identifying key objectives to be measured and designing the measures themselves. In carrying out this phase , Bourne et al. (2000) also mention the use of workshops, in which the academic facilitators help a management team to identify stakeholder needs and thus identifying objectives, and later form the design of new performance measures and the measurement framework. Also Parmenter

(2019, p. 44) emphasizes the use of workshops to train the staff to develop measures. In his KPI development methodology, Parmenter as well, uses a three-stage project structure, including getting the organization committed to the change, identifying CFSs, and determining the measures and getting them to work. In this structure, the assessment and implementation phases are built into these steps.

In addition to depicting design process stages, literature (Neely et al., 2000; Hauser and Katz, 1998; Vitale and Mavrinac, 1995) presents desirable characteristics, that should be considered in the process. Neely et al. (2000) present a list of desirable characteristics of a performance measurement system design process, which is visualized on table 2.

Table 2. *A framework for the design process of a performance measurement system, according to Neely et al. (2000).*

Desirable characteristics of a performance measurement system design process	**Desirable characteristics of the output of the process**
Performance measures are derived from company's strategy.	Benchmarking can be enabled/facilitated with performance measures.
The purpose of every performance measure is made unambiguous.	Preferring ratio-based measures to absolute numbers.
Data collection and calculation methods for the level of performance are made clear.	Performance criteria are directly controlled by the evaluated organizational unit.
Everyone (employees, managers, and customers) is involved in the selection of the measures.	Preferring objective performance criteria over subjective ones.
The selected performance measures take the organization into account.	Adopting non-financial measures.
The process is easily revisitable, and when circumstances change, the measures should change as well.	Performance measures are easy to use and simple.
	Performance measures provide fast feedback.
	Performance measures stimulate continuous improvement rather than only monitoring.

In this table, two categorizations are visible: the left column presents specific characteristics that should be considered in the design process itself, and the right column offers desirable features more on individual performance measures, which would come out as results of the successful design process. To add on the list of desired process characteristics, Hauser and Katz (1998) also mention the balancing of internal and external needs for the performance measurement system.

The PMS development process used in the study is formed by acknowledging the desired PMS design process characteristics (Neely et al., 2000; Hauser and Katz, 1998; Vitale and Mavrinac, 1995), and by combining previous literature on the process phases (Parmenter, 2019, p. 44; Taticchi et al., 2012; Suomala et al., 2011, chap. 7.3; Neely et al., 2005; Bourne et al., 2000). The process is presented in figure 8.

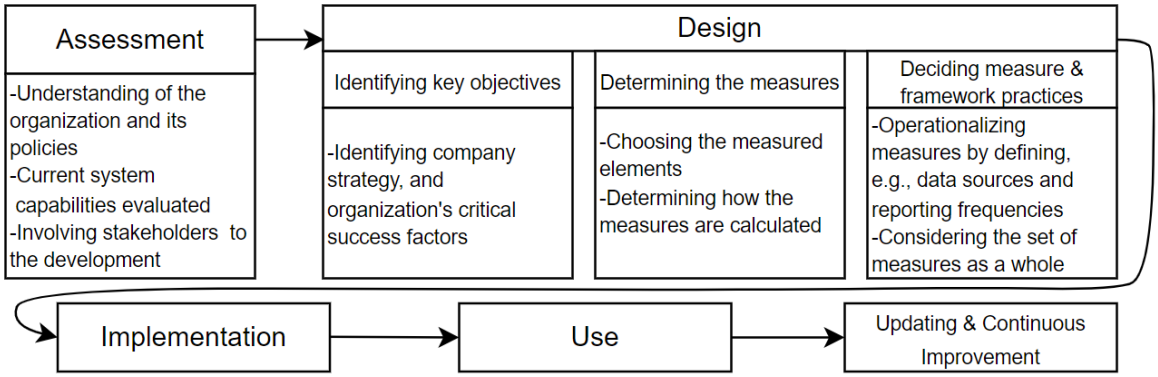


Figure 8. *Performance measurement system development process.*

The figure covers the main steps in the development process and aids in making the development work more systematic. Even though the presented process considers the desired process characteristics presented earlier, it does not offer clear confirmation on the goodness of process results, that is the individual measures and the system. Neely et al. (1997) tackles this issue by presenting a performance measure record sheet, which can be used to design and audit performance measures. By combining this sheet with the desirable characteristics of the design process output listed in table 2, a check sheet for the developed measures can be formed. The check sheet is presented in table 3.

Table 3. *The performance measure record sheet, adapted from (Neely et al., 2000, Neely et al., 1997)*

The performance measure record sheet
The measure title should be self-explanatory and clear: it explains what the measure is and why it is important. The measure is easy to use.
The measure has a purpose. The rationale underlying the measure has to be specified.
The measure relates to business objectives.
Performance criteria are directly controlled by the evaluated organizational unit, and the preference is objective performance criteria over subjective ones.
The set of measures should be in balance, for example adopting both financial and non-financial measures.
The measure should have an appropriate target, and benchmarking should also be enabled.
The formula for the measure should be specified, the preference is ratio-based measures rather than absolute numbers.
The frequency of measuring as well as reviewing and reporting the performance should be decided, reflecting on the measure importance and data availability. The preference is for the measure to provide fast feedback.
A person is identified for reporting and collecting the data, and the data source should be specified.
The person who owns the measure and the person who is to act on the data should be identified.
It is specified what is done based on the measurement results, i.e., the management process on the results. The focus should be on improvement, rather than only on monitoring.

This check sheet can be used during the development process to follow and redirect the design of the measures in the desired direction, and thus support the development process. The check sheet includes certain elements, such as the data aspects, that also appear in the design process depicted in figure 8. This way, the check sheet can also be used at the end of the design phase to confirm that the necessary development process steps were taken.

In subchapters 2.5 and 2.6, the topics of performance measurement were discussed further. This was done to define and understand the key concepts regarding individual performance measures, as well as the performance measurement systems. For this study, it is also relevant to bring the concepts into a more practical level, and subchapter 2.7 offered literature-based methods with which the development process for new measures and the measurement system in the case company can be done more systematically, and thus, likely offer more desirable results. Now, the general basis for performance measurement development has been established, and the focus shifts into integrating quality as a concept to the performance measurement setting.

2.8 Quality performance measurement systems

In the chapters 2.6 and 2.7, the focus was on the performance measurement systems and related literature. Now, the focus shifts into discussing what kind of quality-specific performance measurement frameworks have been established in theory and practice. This way, the frameworks established in chapter 2.7 can be developed further to better fit the quality context.

As established in chapter 2.4, quality performance measurement has an integral role in quality management activities. In an empirical study on Indian manufacturing companies, Parvadavardini et al. (2016) found that wholesome strategic quality management increases overall quality performance in organizations. Conversely, Pimentel and Major (2014) suggest that the main reason for the ineffective results of total quality management is poorly designed performance measurement systems. Thus, proper quality performance measurement can be integral in improving quality performance, but the system must be designed well. Let’s next discuss, what aspects should be taken into account when a quality performance measurement system is developed, and what frameworks are found for this from theory and practice.

2.8.1 Quality performance measurement frameworks

One type of quality performance measurement framework found in the literature (Karamouz et al., 2020; Wei et al., 2019; Pimentel and Major, 2014; Kaynak, 2003) is aiming

to combine quality management frameworks, such as TQM, with performance measurement systems, particularly the Balanced Scorecard. According to Karamouz et al. (2020), reliable performance measurement is considered as one of the dimensions in TQM. Even though Pimentel and Major (2014) address the issue that more case studies should be conducted on the subject and suggest there being a literature gap, other research have found similarities with TQM and the Balanced Scorecard. For example, in a study on the relationship between TQM practices and firm performance, Kaynak (2003) lists multiple interpretations of TQM dimensions, but often they contain the same categories as in the BSC, such as continuous improvement and learning, customer focus, and process management. Furthermore, Pimentel and Major (2014) state, that TQM follows four governing principles: delighting the customer, people-based management, continuous improvement and management by fact, which fully line up with the four Balanced Scorecard perspectives. Wei et al. (2019) also add in a study on Taiwanese manufacturing companies performance measurement systems and TQM practices, that firms that are adopting a TQM approach, should redesign their performance measurement systems by combining financial and non-financial (internal process, learning and growth, customer, and supplier) measures together. To conclude, this TQM/BSC framework would apply the Balanced Scorecard approach with the TQM aim of achieving customer satisfaction through continuous quality improvement.

Following the TQM approach, De Feo (2017, chap. 7.6.3) propose, that when determining key (quality) strategies, it may be needed to assess the organization on the areas of

- Customer satisfaction and Customer loyalty.
- Costs related to poor quality or processes, products or services.
- Employee satisfaction and organizational culture
- Internal business processes, that include suppliers
- Benchmarking

It could thus be beneficial to establish quality performance measures from these areas. Furthermore, De Feo (2017, chap. 7.7.8) propose that when creating a scorecard, the measures should include leading, concurrent, and lagging indicators, and also data on cost of poor quality. Furthermore, in a quantitative study on 28 international, Egyptian pharmaceutical organizations, Elkanayati and Shamah (2019) found that the Balanced Scorecard practices correlate positively and significantly to quality performance, and that quality performance has a strong and significant positive correlation with business performance. Elkanayati and Shamah (2019) suggests managers to implement the basic

elements of the Balanced Scorecard to enhance quality and business performance in their organization. These arguments support the concept of integrating a balanced scorecard framework to quality performance measurement.

Another approach to quality PM frameworks is to develop it based on quality costs. In their study, Shin et al. (2018) present a Quality Scorecard (QSC) based on the Prevention-appraisal-failure categorization. The aim of this scorecard is to measure organizational performance levels based on the organizational performance of quality. Through the PAF categorization, the QSC offers future-oriented and non-traditional performance indicators in addition to traditional measures, which is ideal. The logic behind the PAF categorization is the following: investment in prevention and appraisal activities reduce internal failure costs, and also failure external costs, such as service warranty and recovery costs, as well as the costs related to loss of goodwill due to poor quality or management. Out of these two categories, preventative investments are more efficient in reducing the costs. Also, investments in prevention is expected to reduce appraisal costs as well. In the QSC, failure costs have been grouped under the term final results. Thus, the measures are categorized into prevention, appraisal, and final results measures. These three categories can be then divided into simple, general, and detailed measures, based on how specific or general they are in the organization. A simplified version of the QSC wheel visualization is presented in figure 9 with example measures.

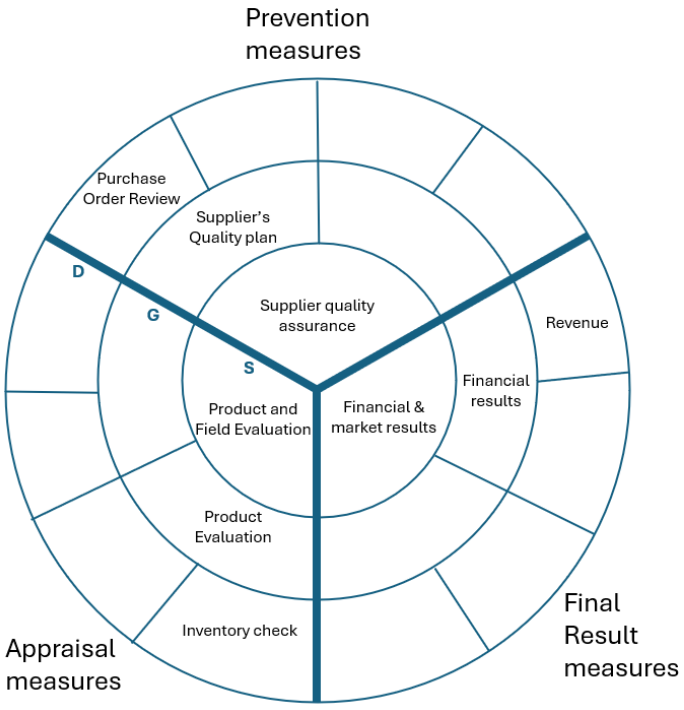


Figure 9. *A simplified QSC wheel according to Shin et al. (2018) with example measures.*

In the complete wheel, there is 15 simple, 30 general, and 60 detailed level measures. This wheel can be used as a basis for visualizing the balance status of the current performance measurement system especially from the qualitative aspect, and also help in guiding the development of a quality-oriented performance measurement system. (Shin et al., 2018)

The third approach to quality-oriented performance measurement system is the Kanji Business Excellence model (KBEM), which bases on the TQM principles (Kanji, 2008). The model alone is not a performance measurement system, but rather a model of interrelated principles and concepts in order for business excellence to happen. However, measurement is an integral part of it, and the KBEM again draws similarities to the Balanced Scorecard. The visualization of the KBEM is presented in figure 10.

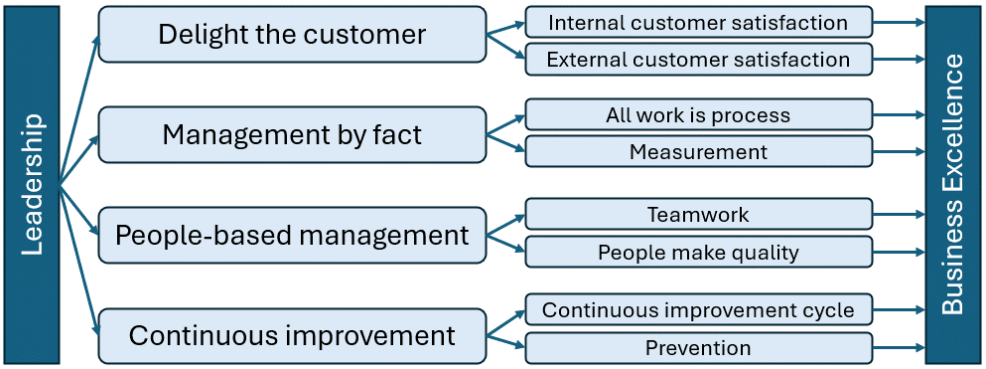


Figure 10. *The Kanji Business Excellence Model, modified from (Kanji, 2008).*

In the model, a requisite for Business Excellence is leadership, following similar categorization to the Balanced Scorecard. If a performance measurement system was developed based on these categorizations, it would be quality-oriented, basing on the TQM principles.

In a case study by Jochem et al. (2010), a quality-based performance measurement system and its implementation process is presented. The system itself mostly follows the development steps presented by Neely et al. (2000), and the quality-aspect and quality performance measurement seem in this framework to be outside of the focus. Therefore, the content of this framework is not discussed here further. The last framework discussed here is the quality development framework presented by Najmi and Kehoe (2001). In their approach, they state that there is no universal performance measurement system applicable to all organizations, but present a framework , which comprises of three dimensions: quality-related, time, and financial measures. In the study, the framework is used to assess post-ISO 9000 quality development. Thus, the framework's use is not directly applicable to the purpose in this study, but relevant measures may be found in

the measurement set regardless, because the set is derived from relevant literature (Najmi and Kehoe, 2001) . The set of measures with the categorizations is listed in table 4.

Table 4. *The measurement set examined, according to Najmi and Kehoe (2001).*

Dimension	Quality	Time	Financial
Measures	Incoming parts quality In process quality Product quality Errors defects & rework Field failure under warranty Customer complaints	Production lead time Cycle time Flexibility On-time delivery Product development time-scale	Inventory turnover Production cost Cost of quality Sales Growth rate Market share

Here, the set comprises of 16 measures, including cost of quality and in process quality for example. This set of measures is not a tested in practice and should not be considered as such, but the measures presented here may appear in the empirical part of this study. According to De Feo (2017, chap. 20.5.2), there are five general classes for quality measures, which are defects, COPQ, product and process features, customer needs and customer behavior. Compared to the list of 16 measures by Najmi and Kehoe (2001), these lists seem to align quite well.

As a conclusion, there seems to be no universal quality performance measurement framework with specific measures in the literature or put on to practice, but the studied frameworks base on quality-cost based categorizations, or alternatively on the combination of TQM and Balanced Scorecard frameworks. Assumably, both viewpoints should be considered when designing a quality performance measurement system in this study.

2.8.2 Developing a quality performance measurement system

When considering the development of quality measurement and quality performance measurement systems, the quality literature discusses the desirable characteristics of individual measures and quality targets, and also the preferred elements in the design process for the measurement system. This division has similarities to the discussion on the development of performance measurement systems in general, in chapters 2.5, 2.6, and 2.7. According to Juran's Quality handbook (De Feo, 2017, chap. 6.4.3), when setting the quality targets for the organization to which the quality performance will be measured against, the goals should be legitimate, measurable, attainable, and equitable. The handbook also includes a list of ten principles of effective quality measurement (De Feo, 2017, chap. 20.4): this list has similarities to tables 3 and 4, but adds on them by stating

that it is particularly important to define the purpose and use for measurements in quality improvement, and that customer-related measurements should be emphasized.

A quality performance measurement system can be developed with differing practices. Chang (2006a) lists several factors that are critical to the success of these systems, these include: upper management support, identifying a few critical key measures, the involvement of all organization and staff, the clear communication of strategic targets, and including customers in the measurement process. Furthermore, Sousa and Aspinwall (2010) present a step-by-step process for developing a performance measurement system for quality performance measurement and quality improvement uses. The process steps are:

1. Overview, motivation & leadership commitment
2. Define and communicate vision, mission & strategy.
3. Identify current state
4. Define and prioritize objectives.
5. Develop a PMS
6. Plan improvement actions
7. Implement actions
8. Review, standardize and learn

These development process steps are very similar to the process presented in figure 8. Regarding the development of the quality performance measurement system, Jochem et al. (2010) present a KPI implementation time line matrix, where the proposed measures in the framework are categorized on how much effort their implementation requires, and how direct or long-term their implementation will be. A similar categorization may be helpful to management in this study, as well.

2.9 Proactivity in quality performance measurement

As the final main concept in this study, let's discuss about proactivity and its application to quality performance measurement context. Proactive behavior is a desired element of personal behavior, as well as in management. Being proactive means taking control in order to make things happen, instead of watching them happen (Parker et al., 2010). On a personal level, proactivity has three elements: it is change-oriented, future-focused and self-starting. (Parker et al., 2010) According to Crant (2000), three general actions for proactive behavior are identifying opportunities to improve, challenging status quo, and creating favorable conditions.

When it comes to proactive management, Thierauf (2001, p. 72) explains it by comparing it to reactive management, which means solving current problems as they arise. In contrast to reactive management, proactive (or preventive) approach keeps decision-makers on top of problems by involvement in problem finding, versus just in problem solving. In summary, proactivity in management is tackling and mitigating issues before they occur, and thus seeking places for improvement from the future. Proactive management is desirable, because the problem-finding approach works as a precondition to a company's competitiveness improvement in modern, business landscape (Thierauf, 2001, p. 73). The proactive problem-finding approach can also be tied into the organization's critical success factors, and thus make the approach appear critically relevant. When the proactive management approach is tied with decision-making based on refined and processed data, the effectiveness of the management activities can improve significantly compared to a reactive approach. (Thierauf, 2001, p. 73)

It appears that proactive management approach is a management style to be headed towards to improve decision-making and management effectiveness. Next, integrating proactivity to QPM is discussed from three different perspectives: proactivity based on risk-based thinking, forecasting methods and lastly as an inherent element of certain concepts already discussed in this chapter.

2.9.1 Increasing proactivity in quality performance measurement by incorporating risk-based thinking

Risk-based thinking is acting on future problems, and thus facilitating proactivity in quality context. In fact, Nyoman and Geraldin (2009) define proactivity through risks: according to them, term proactive is used to imply preventive nature of an effort, and that tackling risk causes could prevent the risk from realizing. Risk itself is defined as the *effect of uncertainty* (ISO 9000, 2015), or as such an uncertain event, that if realized, it will have an effect on achieving objectives (Popova et al., 2019). In quality context, *quality risk* is defined as "… *the impact of uncertainty on the achievement of quality objectives aimed at ensuring the sustainable development of an organization through a balanced satisfaction of the requirements of its stakeholders.*" (Zhemchugova and Levshina, 2020). According to Popescu and Dascalu (2011), quality and risks complement each other, risks should be incorporated in quality processes, and that both risks and quality should be components of an indicator system that measures organization's performance. Even though risk as a concept is already found in QMSs, with risk-based thinking it is ensured that the risks are managed throughout system processes (De Feo, 2017, chap. 11.3). It appears, that incorporating risk into quality may bring value as a proactive approach.

Management of risks as seen as important to business, and to quality with ties to proactivity, but its integration to quality measurement and management context is not without issues. According to Hijazi et al. (2019), proactive risk management is about providing information to relevant parties on how to utilize resources in a best way to prevent unwanted events from realizing. Thus, risk management must be incorporated into business, and it also has relevance to performance: risks can be integrated into target setting and to performance measurement (Neely, 2007, p. 269). More specifically, risks could be integrated as key risk indicators as a part of a balanced scorecard, for example (Neely, 2007, p. 269). However, when risk management has been sought to be integrated into quality management practices in organizations, multiple issues have been faced. According to Popova et al. (2019), barriers for developing risk management in QMS processes include the low level of culture on proactive management in general, and the insufficient competencies of teams and individuals on risk management in different quality functions. The research field on this topic seems fairly recent, and according to Samani et al. (2019), KPIs of risk-based QMS processes could be studied further. Even though quality and risks are interrelated, only few academic contributions have discussed about the integration and relationships between QMS and risk management system (RMS) (Samani et al., 2019).

While risk is not a new concept in the field of quality, a recent change in the ISO 9001 standard has spiraled the discussion on integrating risk-based thinking into quality management systems. ISO 9001, which is a generally accepted standard for quality management system requirements, had some changes, when it updated from the 2008 to the 2015 edition (Fonseca et al., 2019; Fonseca, 2015): the concept of risk-based thinking was included, and it replaced the so-called preventive actions concept from the last edition. This change reinforces the connection between the nature of risks as a preventive or proactive approach in quality management systems context. Actually, in an empirical study on 300 ISO 9001 certified organizations, the organizations rose risk and opportunities determination and adoption of risk-based thinking as one of the most beneficial elements in the 2015 standard compared to the last edition (Fonseca and Domingues, 2018). In another survey-study of 222 organizations (Fonseca et al., 2019), the respondents considered that the adoption of risk-based thinking is the major benefit to be realized in implementing the ISO 9001:2015, but at the same time, as a major difficulty to be overcome. In an empirical study on quality managers from European SMEs (Chiarini, 2017), there seems to be lack of practice in implementing the risk-based thinking requirements of the ISO 9001:2015. Chiarini (2017) also mentions, that the most relevant risk that the manufacturing companies brought up regarding the different risk

sources drawn from ISO 9001:2015 audits was the internal production of nonconforming products. To summarize, the risk-based thinking approach to QMSs brought up by the ISO 9001:2015 update is seen as a relevant topic, and its integration can help improve quality and overall competitiveness (Popova et al., 2019) of the business, but there seems to be challenges in conducting the actual implementation.

In conclusion to the risk concept as a proactive approach to quality performance measurement, the risk management integration itself is seen as adding value both to performance measurement and quality management as a proactive approach. However, barriers to implementation exist, including the lack of competencies to risk management in quality functions, and the need for practices and procedures to make the implementation happen. One common risk source that was brought up in the ISO 9001:2015 implementation context was the internal production of nonconforming products. Attention to this risk source should be paid to in this study.

2.9.2 Other possibilities

One possibility for adding proactivity to quality performance measurement may be to include elements of forecasting, that is predictions made by studying historic data and past patterns. According to Saab et al., (2018) present quality performance control methods in business process intelligence are limited by a reactive focus: taking action after an extreme performance deviation from requirements to quality, also called quality anomaly, occur. In their study (Saab et al., 2018), a predictive quality performance control framework is proposed, which uses time-series analysis and machine learning to detect quality anomalies proactively. This appears as a viable option to be acknowledged for increasing proactivity in quality performance measurement, but because of its complexity and lack of application to practice, it is not studied further in this study.

The concept of proactivity has a broad definition, and proactive elements of performance and quality measurement can be found from the established literature. For example, in cost of quality research, the prevention aspect of the PAF model can be thought of as a proactive approach in the quality cost domain: prevention costs are expenses that go into prevention of defects and non-conformities (Cheah et al., 2011). Thus, measuring some prevention cost elements could provide indication on future quality performance.

In performance measurement research, proactivity can be tied to specific characteristics of individual performance measures or measurement systems. In regard to the individual measures, leading indicators are thought of as drivers of performance (Eckerson, 2010, pp. 198–199). Thus, incorporating leading indicators to the performance measurement

system is indeed forming it to be more proactive. For example, in the Balanced Scorecard, in addition to lagging financial measures, the balance is found by incorporating measures that indicate future performance (Bourne et al., 2000). In these of PMSs, a key issue is finding the correlation between drivers and outcomes, so that the leading indicators can predict quality reliably.

2.10 Synthesis of the literature review

This subchapter concludes the theoretical background of this thesis. The synthesis includes two sections: first, the frameworks concluded from the performance measurement and quality literature are presented. Also, it is explained how the theoretical frameworks are utilized in the empirical part of the thesis. The second section reflects on how the literature review managed to aid in answering the research questions in this study.

The use of quality performance in this study is based on the definition of quality as an outcome and target, in which conformance to requirements in organization's manufacturing practices appears as the economic level of cost of quality, and where there appears no cost of poor quality. This outcome is desirable, because it increases customer satisfaction and profitability. The activities towards these strategic targets are measured through quality performance measurement, in a process of continuous improvement for the measured organization. This theoretical basis is visualized in figure 11.

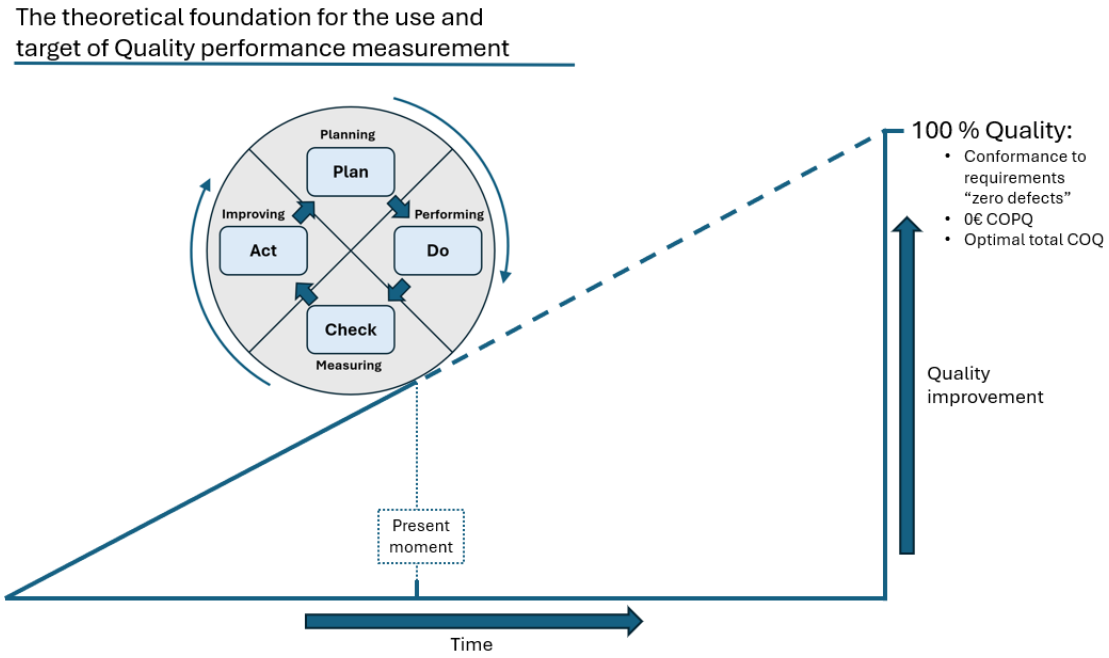


Figure 11. *The theoretical foundation for the use and target of quality performance measurement in this study. Deduced from the concepts of COQ, zero defects, continuous improvement, and TQM discussed in chapters 2.1.-2.4.*

Reflecting on this basis, the unambiguous definition of quality and the similarities between the concepts of quality and performance in the literature (Melnyk et al., 2014; Sower, 2010, p. 108; Tangen, 2005; Arter, 2002, p. 18) made the forming of this basis demanding. In the figure, continuous improvement is seen as a quality management activity which targets quality improvement over time.

Based on the use and target of quality performance measurement, the concepts in the literature (Popescu and Dascalu, 2011; Schiffauerova and Thomson, 2006; Kaplan and Norton, 2004) from which this study can draw indicators from can be concluded. The TQM and Balanced Scorecard concepts were proposed to have similarities in chapter 2.8, so the balanced approach to measurement should be regarded in the quality performance measurement context. Similarly, the cost elements of the PAF model, as well as risks and forecasting activities can be sources for quality performance measures in this study, as discussed in chapter 2.9. The visualization for these indicator sources is conceptualized based on figure 11, in figure 12.

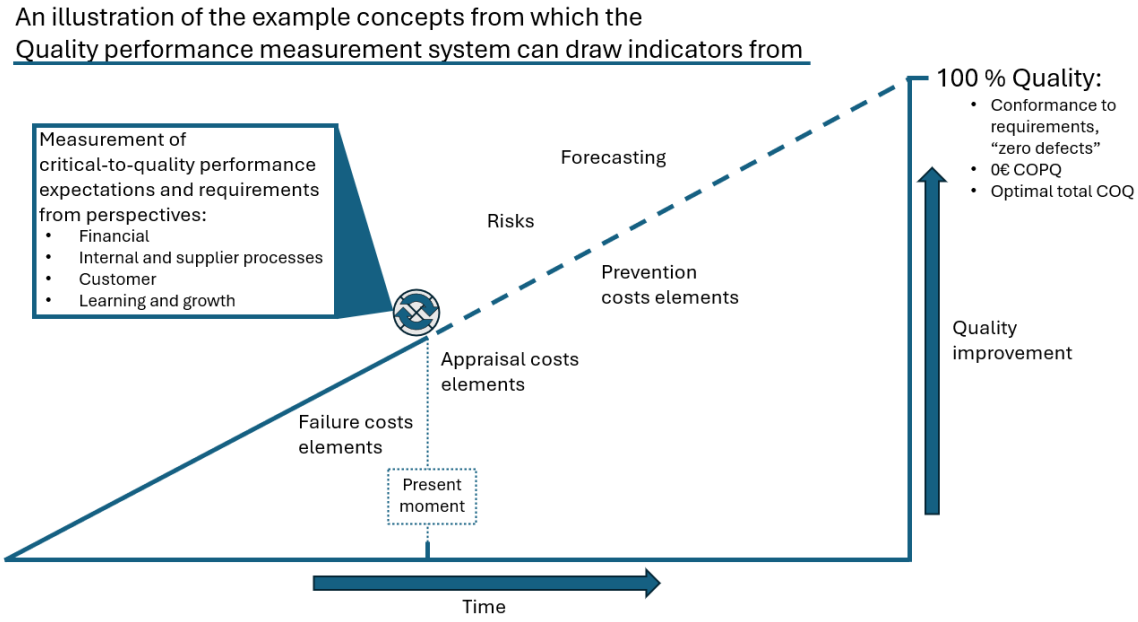


Figure 12. *The concepts from which the quality performance measurement system designed in this study can draw indicators from. Deduced from chapters 2.2, 2.8., and 2.9.*

The figure aids in connecting the relevant concepts of performance measurement to the quality concepts frame of reference.

After understanding the more abstract elements of this theoretical background, four main practical frameworks for this study are presented. The first one is the framework for the quality performance measurement system. This framework is based on fitting the studied quality concepts and quality strategy targets to the strategy map template, which was presented in chapter 2.6. The framework is presented in figure 13.

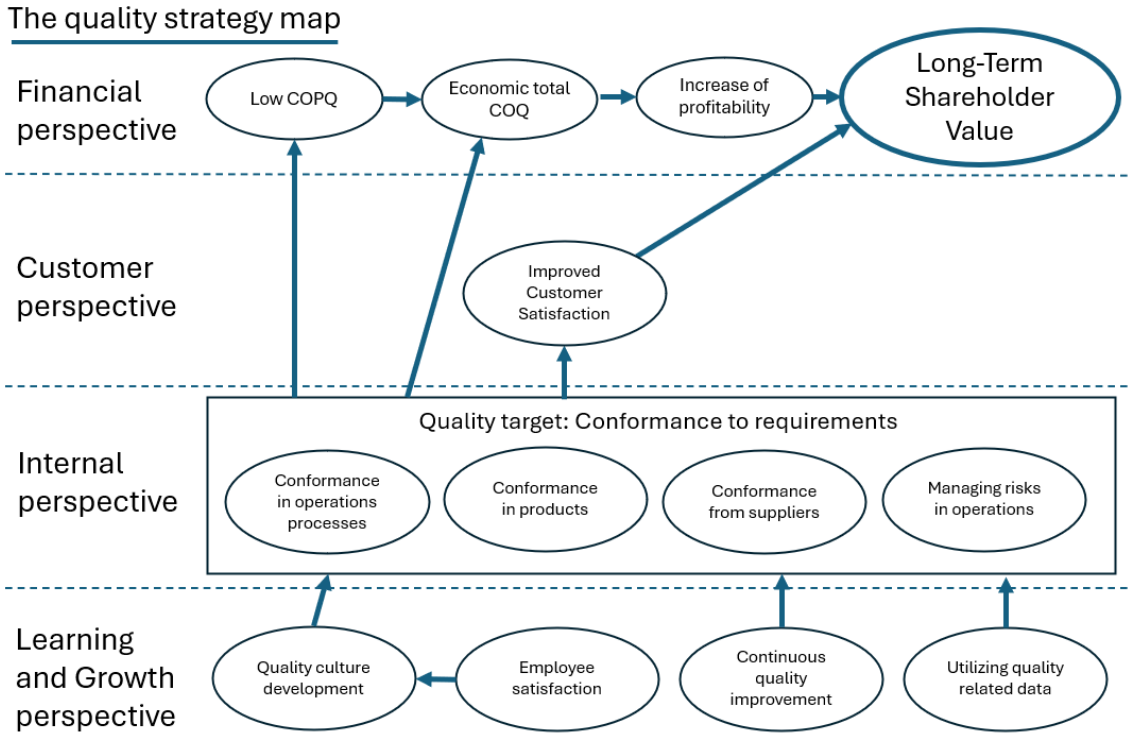


Figure 13. *The quality strategy map, using the template from (Kaplan and Norton, 2004).*

This framework attempts to follow the balanced approach of the Balanced Scorecard by applying the strategy map template, while connecting the different quality concepts on a hypothetical level. This quality map bases both on the manufacturing-based and the 'Big Q' view on quality defined in this study. To clarify, the 'utilizing quality related data' objective incorporates the management by fact perspective brought up by Pimentel and Major (2014) in TQM research, but can also incorporate other data-related concepts, including the forecasting approach to proactive measurement, brought up by Saab et al. (2018).

The second framework tackles the issue of proactivity in quality performance measurement. By utilizing the table 1 of attributes of good performance measures and the proactivity definition discussed in chapter 2.9, a list of attributes of proactive performance measures is formed. The list is presented in table 5.

Table 5. *The proactive characteristics of performance measures.*

Proactive characteristics of performance measures	**Mentioned in**
1. Strategic and aligned, at least a link to one of organization's CSFs.	(Parmenter, 2019, pp. 154–155; Gray et al., 2015, p. 46; Suomala et al., 2011, chap. 7.3; Eckerson, 2010, pp. 209–212; Malina and Selto, 2004; Neely et al., 1997)
2. Timely (and future-oriented).	(Parmenter, 2019, pp. 154–155; Gray et al., 2015, p. 65; Eckerson, 2010, pp. 209–212; Neely et al., 1997)
3. Actionable, action is possible based on measure results.	(Eckerson, 2010, pp. 209–212; Malina and Selto, 2004)
4. Correlated, measures drive desired out-comes.	(Eckerson, 2010, pp. 209–212; Gray et al., 2015, p. 65; Malina and Selto, 2004)

The table presented only includes characteristics referencing the proactive nature of measures found from table 1, and is not an exhaustive list in determining the goodness of measures from all aspects. However, it can be used to assess, whether a performance measure is proactive or not.

The third framework synthesized from the literature is the development process for the quality performance measurement system. This framework is based on the performance measurement system development process depicted in figure 8, and is updated with elements from the studies discussed in chapter 2.8, and fitted development scope in this study. This framework is visualized in figure 14.

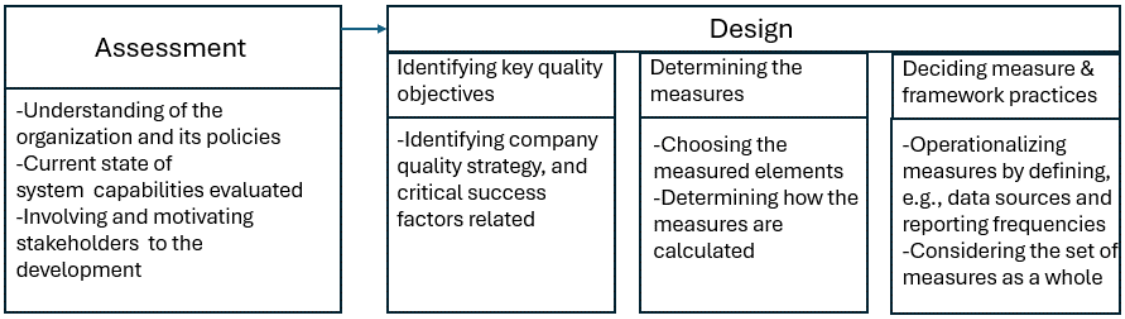


Figure 14. *The Quality-based performance measurement system design process.*

The general framework depicted in figure 8 was suitable for the quality context, and thus, the modifications to the quality-based framework are minor.

The fourth and final framework is the so-called quality performance measure record sheet. The record-sheet is based on the performance measure record sheet presented in table 3, and updated with the findings from chapter 2.8. The framework is presented in table 6.

Table 6. *The quality performance measure record sheet.*

The quality performance measure record sheet
The measure title should be self-explanatory and clear: it explains what the measure is and why it is important. The measure is easy to use.
The measure has a purpose. The rationale underlying the measure has to be specified, especially in measurements in quality improvement.
The measure relates to quality objectives.
Performance criteria are directly controlled by the evaluated organizational unit, and the preference is objective performance criteria over subjective ones.
The set of measures should be in balance, for example adopting both financial and non-financial measures, and customer-related measures should be emphasized.
The measure should have an appropriate target, and benchmarking should also be enabled.
The formula for the measure should be specified, the preference is ratio-based measures rather than absolute numbers.
The frequency of measuring as well as reviewing and reporting the performance should be decided, reflecting on the measure importance and data availability. The preference is for the measure to provide fast feedback.
A person is identified for reporting and collecting the data, and the data source should be specified.
The person who owns the measure and the person who is to act on the data should be identified.
It is specified what is done based on the measurement results, i.e., the management process on the results. The focus should be on quality improvement, rather than only on monitoring.

Again, the updates from the general performance measure record sheet presented in chapter 2.7. are minor, because the empirical studies on the topic of quality performance measurement did not offer similar complete listings.

These four frameworks established from the literature are used in the empirical part of this study. Even though the frameworks are concluded from the observations in the literature, they are based on well established, general research, which are then scoped to fit the quality perspective better. The quality strategy map and the list of proactive elements in performance measures can be used as the tools for aligning both the current situation regarding the quality performance measurement system in the case organization, and the final quality performance measurement system proposed in this study. By aligning the current situation in the case organization with the proposed strategy map, the possible need for improvement can be visualized. At the same time, because the presented strategy map is not engineered to fit the case organization specifically, and because the definition of quality in the literature is not unambiguous, and according to Garvin (1984), different definitions to quality can exist even inside organizations, the fitness of the quality strategy map as a framework remains to be seen in the empirical part of the study. On the other hand, the framework is quite general by design, and other frameworks presented earlier are used to support the design process, as well.

While the quality strategy map and the list of proactive elements in performance measures are used to frame the current situation and evaluate the occurring change in the development, the other two frameworks, the Quality-based performance measurement system design process and the quality performance measure record sheet are used to govern and scope the development process itself. The design process offers a guideline for the order of development actions. Furthermore, the record sheet can be used as a check sheet for deciding the measurement practices in the design phase and thus also guide in the design process, but it can also be used for inspecting that the necessary development steps were taken.

Next, let's discuss how the researched literature managed to initially answer the research questions of this study. The main findings and the chapters in which they are discussed are presented in table 7.

Table 7. *The research questions, and initial answers to them based on the literature.*

Research Question	Answers to the question, based on the literature	Related Chapter
RQ1: How to develop a balanced quality performance measurement system in a manufacturing company's business line operating in paper machinery industry?	By forming a framework aligned with the definition and targets regarding quality.	2.1, 2.2, 2.3, 2.4, 2.6, 2.8
	By following an established design process for populating the framework with measures.	2.7, 2.8
	By confirming the fitness of measures using a developed quality performance measure record sheet.	2.5, 2.8
SQ1: What is the current state of data gathering, measurement, and reporting regarding quality? What numeric data is available?	No input.	-
SQ2: What quality performance measures are needed, and why?	Quality performance measures must be aligned with the uses for quality management purposes, including the target of conformance to requirements, and the activities of continuous quality improvement.	2.1, 2.2, 2.4
SQ3: How to increase proactivity in quality performance measurement?	By developing such a balanced measurement system, which, in addition to outcome measures, includes measures that drive future performance.	2.8, 2.9
	By using predictive analytics on predicting quality anomalies.	2.9
	By measuring prevention cost elements from the PAF categorization.	2.2, 2.9
	By incorporating risk-based thinking into quality performance measurement.	2.9

As can be seen from the table, SQ1 was left completely unanswered by the researched literature. This is since this supporting question is aimed at the case organization specifically and is targeted to be answered in the empirical part of the study. Furthermore, the tools presented to answer RQ1 are utilized in the empirical part of the study. Additionally,

the concepts presented to answer SQ3 are to be considered in the empirical section as examples of categories to draw proactive quality measures from.

In conclusion, the researched literature contributes to this study by helping to set the basis for the use of performance measurement in the quality setting and offers understanding on how performance measurement and proactivity can be utilized in quality management practices. Furthermore, it clarifies what concepts should be studied further in this research, and enables the formation of the four practical frameworks used in the empirical part of the study.

3. RESEARCH METHODOLOGY

The purpose of this chapter is to describe the research methodology used for this study, thus answering the question of how the results in this study were reached, and why the selected methods are suitable to the context of this study specifically. The chapter is divided into three parts: first, the overall research design of the study is discussed, based on the research questions and objectives for the study. Secondly, the practical process of conducting the research is presented, and finally, the data collection and analyzing methods for the empirical data of this research is discussed.

3.1 Research design

This subchapter introduces the methodological choices made and justifies their application to this study. The methodological choices are summarized in table 8.

Table 8. *The summary of the methodological choices made in this study.*

Methodology	Choice	Details
Purpose	Exploratory and theory refinement	The study aims to apply and refine the established theory onto the case organization's setting. On the other hand, the study aims to understand the precise nature of the issue in the organization context and is therefore exploratory.
Philosophy	Pragmatism	The aim of this work is to provide practical solutions to research problems.
Approach	Abductive	Incorporating existing theory where it is appropriate, to build new, or modify existing theory on proactivity and development of performance measurement in quality management setting.
Method	Multi-method, qualitative	The development needs and uses for the measurement system differ, and the variables are intertwined, difficult to measure and mostly non-numerical, so a qualitative method is required to study them.
Research strategy	Single case, embedded case study	The focus in the study is on a single function in a large corporation, but the analysis extends to the groups surrounding it.
Time horizon	Cross-sectional	The time designed for the thesis restricts the usage of other time horizons.

The order of the methodologies in the table is mainly based on the research onion levels presented by Saunders et al. (2019, p. 130). The techniques and procedures, which are

the innermost of the levels in the research onion, are further discussed in subchapter 3.3.

This research aims to fulfill a theory refinement purpose, but also an exploratory purpose. According to Saunders et al. (2019, p. 186), the way of formulating the research questions will lead to either exploratory, explanatory, descriptive or evaluative research, or to a combination of these. Exploratory purpose suits with research questions beginning with 'what' and 'how', and fits into the research if the aim is to clarify, and understand the precise nature of a problem, issue or phenomenon (Saunders et al., 2019, p. 187). This suits well with this study's research questions, and the unambiguous nature of the theory surrounding the study topics. However, scoping the research to a specific function and business line in an organization also leads this study to restructure the established performance measurement theories based on the empirical results. Then, the purpose of this research is also to discover how the performance measurement and proactivity theories apply to the quality management setting, and this leads to the theory refinement purpose, presented by Voss (2002).

When making methodological choices, it is good to take into account the underlying beliefs and assumptions about the development of new knowledge and the nature of knowledge, as these assumptions shape the researcher's thinking and attitude towards research questions, methods and research results (Saunders et al., 2019, p. 130). These beliefs and assumptions are called a research philosophy, the selection of which helps in other methodological choices as well as in the consistency of the entire research project (Saunders et al., 2019, pp. 130–131). To answer the research questions in this study, a pragmatic research philosophy is chosen, since the aim of pragmatism is to provide practical solutions and outcomes to research problems (Saunders et al., 2019, p. 151). As established, the solution to the practical issue of the organization is at the center of this study. The nature of the information obtained from this study also steers towards pragmatism; information is valued based on how it enables practical action to succeed (Saunders et al., 2019, p. 151).

The approach to theory development in this study is abductive, which suits the purpose of this study well. In the abductive approach, data is collected to explore a phenomenon by identifying themes and explaining patters, to produce new, or modify existing theory (Saunders et al., 2019, p. 153). This is subsequently tested by collecting additional data (Saunders et al., 2019, p. 153). In abductive reasoning, thinking is initiated by something concrete, which is first structured on the basis of different theoretical models and frameworks, for example, from which the return is to concreteness (Anttila, 2014, sec. 7.1). This reasoning suits this research setting well, because the reasoning is started by the

concrete issue of quality performance measurement system development, and through literature and empirical research, the return is to solve the practical problem.

The research questions in this study lead the methodological choice to qualitative methods. According to Hirsjärvi and Hurme (2022, chap. 2.4.2), in qualitative research, it is assumed that the variables studied are intertwined, complex and difficult to measure. At the same time, Saunders et al. (2019, p. 179) state that qualitative research deals with non-numerical material such as words and images. These are relevant attributes to this study, as well. The primary data collecting method for this study is the set of semi-structured interviews, but it is complemented with secondary data, such as internal documentation. These techniques are covered more in detail in subchapter 3.3. This way, the choice for this study is multi-method qualitative (Saunders et al., 2019, p. 179). Use of multiple methods can be typical to pragmatist approach (Saunders et al., 2019, p. 145), where the aim is for best possible outcomes.

The study focus on one corporation's business line and its quality management practices viewpoint, and also the nature of the main research question leads the research strategy to a case study. Case study is used, for example, to increase knowledge about an individual, groups, or organizational phenomena (Yin, 2014, p. 4). According to Baxter and Jack (2008), a case study should be used, for example, when the aim of the study is to answer 'how' and 'why' -type questions and when the context of the topic being studied is relevant to the research. This reasoning suits the exploratory and theory refinement purpose as well. According to Yin (2014, pp. 53–56), the case study strategy can focus on a single or multiple cases, and be holistic or embedded in nature. This study focuses on a unique, single case, which is also the organization that gave the assignment of this study. Due to the time and possible availability issues, a multiple case strategy, where benchmarking to other organizations could have been possible, was not applied. However, in this study, the case is rather embedded than holistic. A holistic approach would concern the organization as a whole (Yin, 2014, p. 55), and in this study, the scope is on specific groups inside the larges corporation, including the Paper Business Line's quality function, but also the business units under the business line, and the upper management levels that the business line quality function reports to. Furthermore, even though inter-organizational benchmarking is not utilized, the embedded nature of the case study covers the examination and analysis of the practices of quality functions in other business lines inside the corporation.

A constructive research strategy was also considered for this study. The constructive research approach can be thought of as a special case under the general case study strategy, and it centers around facilitating change by creating innovative constructions to

solve practical problems (Lukka, 2003). In addition to practical relevance, the construction should provide theoretical contribution (Kasanen et al., 1993). Superficially this would seem to fit the pragmatic philosophy and the study setting well. However, according to Lukka (2003), an implementation of an construction that has been designed earlier, should not be regarded as an constructive approach. Thus, even though the presented frameworks in the literature review are fitted into the quality management setting, they base heavily on established research, and cannot be considered as innovative constructions. However, this does not mean, that this study does not include elements that can be included in the constructive approach: according to Saunders et al. (2019, p. 190), the boundaries between different research strategies are often open. For example, the testing of the practical usefulness of the construct, which is an integral part of the constructive research strategy (Kasanen et al., 1993), is used in this study as well to add validity to the research. Thus, even though there are elements from the constructive approach in this study, the purpose is to refine an existing theory by implementing and modifying established constructs in the case context and for these reasons, the main research strategy in this thesis is the single case, embedded case study.

As the final methodological choice presented in the summary table, the time horizon in this study is cross-sectional. This means, that the study on the subject happens at a particular time (Saunders et al., 2019, p. 212). Conversely, a longitudinal time horizon would offer a possibility to study change over time, but this is not possible in the relatively narrow timeframe of this thesis. Thus, the choice for the time horizon is cross-sectional.

3.2 Research process

This section outlines the research process undertaken to achieve the results of this study. The research was initiated in response to a practical challenge identified by the case organization. This challenge also presented an opportunity to contribute to academic literature.

The research began with the definition of the research's purpose and research questions, including one primary question supported by sub-questions. These questions guided the investigation and ensured that the study's scope was both focused and comprehensive. A detailed research plan and project schedule were developed to outline key milestones,

timelines, and responsibilities, providing structure and direction for the project. The different data sources and the practical results of the research are presented in figure 15.

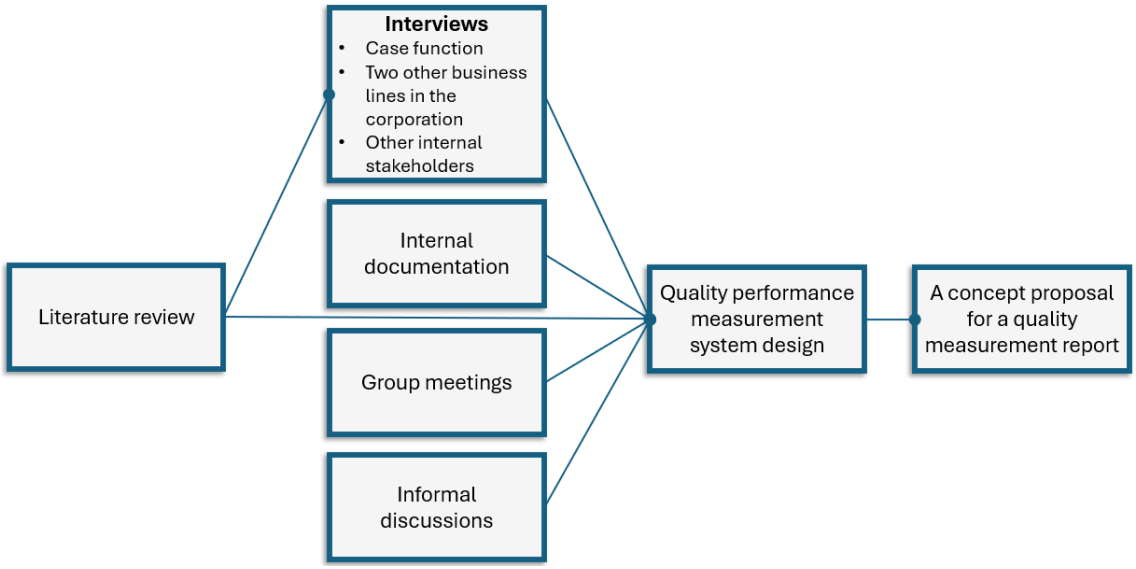


Figure 15. *Data sources and the practical results of the research.*

The first major task in the research process was a comprehensive literature review. This phase established a theoretical understanding of quality performance measurement concepts while identifying practical and established frameworks to guide the study. The review helped inform the development process and served as a basis for analyzing empirical findings. Among the frameworks identified was a quality-based performance measurement system design process, which provided a structured guideline for the study. As (Hirsjärvi and Hurme, 2022, chap. 2.1) emphasize, understanding existing research is essential for advancing knowledge, and this principle was central to the early stages of the project.

Following the literature review, internal documentation related to the case organization and the broader context of the study was collected. This documentation provided data on the organization's existing infrastructure, management practices, and quality measurement systems, forming a layer for subsequent analysis.

Interviews with key stakeholders were conducted to complement the internal documentation. The primary aim of these interviews was to gather practical insights into the current state of the quality performance measurement system, the organizational infrastructure surrounding it, and potential areas for development. These discussions also clarified the critical success factors and strategies of the corporation's and the business line's quality functions, providing valuable input for the system's design.

The analysis phase combined findings from the internal documentation and interviews to identify opportunities and challenges in the organization's measurement practices. A

total of 42 quality performance measures or measurement object proposals were collected during this phase and categorized using the Balanced Scorecard framework. The selection and refinement of these measures were carried out through group meetings with stakeholders, during which their definitions, relevance, and practicality were critically evaluated. To ensure clarity and usability, a strategy map was developed to visualize the quality performance measurement framework. In parallel, the measures were operationalized by defining their data sources, calculation logics, and reporting frequencies. This process was guided by a quality performance measure record sheet derived from the literature review, which provided a structured approach to documenting and defining each measure.

The development of the new QPMS drew on findings from the literature, internal documentation, interviews, group meetings, and informal discussions, as illustrated in figure 15. The resulting system was designed to align with organizational goals while addressing gaps in the existing practices. As the project progressed, the analyzed data were systematically documented as findings in chapter 4 of this thesis.

Once the development work was complete, the findings were presented to company stakeholders. This included a concept proposal for a new quality report designed to visualize the results of the developed measurement system, enhancing its practical usability. The conclusion of the research project saw the finalization of the thesis, which involved writing the introduction, discussion, conclusion, and abstracts. A final presentation of the completed study was delivered to key organizational stakeholders to ensure the findings were communicated effectively.

Although presented here in a linear format, the research project was not entirely sequential, as there was a lot of overlap in the different stages of the project. Furthermore, the research scope and the practical execution plan were modified and refined in the early stages of the project to better address organizational needs and the emerging outlook on the research subject.

3.3 Data collection and analysis

In this subchapter, the techniques and procedures used to collect and analyse data in this thesis are presented. The main sources of data in the thesis were conducted interviews, in addition to the internal documentation data from the company, and the knowledge derived from the literature research. These data are supplemented with group meetings and informal discussions with the Paper Business Line Quality function personnel. The aim of the interviews is to gain understanding of the current situation and

development needs regarding the quality performance measurement system in the scope of this study, and thus help answer the related research questions SQ1 and SQ2 presented in chapter 1. The interviews will also contain questions about proactive quality performance measurement, and thus contribute to answering SQ3. Additionally, answering these sub-questions will contribute to answering RQ1.

For qualitative research, unstructured and semi-structured data collection methods are suitable (Saunders et al., 2019, p. 179). Semi-structured interviews are chosen as the primary data collection method used in the empirical part of this study, and they are preferred over the unstructured interviews, in which the data analysis may prove to be too challenging. The semi-structured approach allows people to present their own interpretations on the research themes (Hirsjärvi and Hurme, 2022, chap. 3.1.1), which supports the exploratory purpose (Saunders et al., 2019, p. 444), and the pragmatic philosophy of this research, allowing more thorough answers to the research themes.

When deciding on the sampling practices, the pragmatic aim for functioning, practical solutions, and the qualitative approach is considered. Thus, a natural pick for the sampling technique is non-probability sampling, which is typical for qualitative research (Saunders et al., 2019, p. 179). More specifically, purposive sampling, and critical cases are used as the sample (Saunders et al., 2019, p. 297). With the critical cases sample, those organizational groups and individuals that are closely affected by the outcomes of this study can be heard. Also, the input data from these specific groups is seen as integral in the development process. With this sampling technique, the sample size ended up being 19, which, when qualitative interviews are used, fits inside the non-probability sample size norms of 15 to 60 (Saunders et al., 2019, p. 317).

The interview framework was formed based on the research questions, and it utilized the theoretical frameworks established in the literature review. In a semi-structured interview, the interview framework revolves around themes and key questions related to these themes. (Saunders et al., 2019, p. 437) The questions are formed before the interviews, but the semi-structured nature allows flexibility during the interview (Hirsjärvi and Hurme, 2022, chap. 3.1.1): for example, the order and phrasing of the questions can be altered, and clarifying questions can be asked (Saunders et al., 2019, p. 438). The main themes in the interview were the current state of the quality reporting and quality performance measurement, development needs and possibilities to quality performance measurement, and thirdly, the development specifically from the proactivity perspective. These themes and specific questions under them are intended to align with the design process of performance measurement system presented by (Neely et al., 2000), and also with the quality-based performance measurement system design process presented

in figure 14. The researched literature in chapter 2 and the ISO 9001 (2015) standard were also examined to form the questions related to proactivity. In addition to the main themes, background and final words were included to the script. When the specific questions were formed, attention was paid in keeping the questions open ended to allow for comprehensive responses, and also guide the interviewees by first asking more simple questions, and as the interview progresses, more specific questions are asked.

The 19 interviews were conducted as individual interviews rather than as group interviews, for example, in which case the risk could have been that, for example, the organizational hierarchy could have affected the participation activity of certain interviewees. The interviewed personnel were coded numerically, and their role in the company, and the date and length of the interviews are presented in table 9. All the interviewees are personnel from either quality or operational excellence functions.

Table 9. *Interviewed personnel and their roles in the corporation, interview dates and lengths.*

Interviewee	Role in the company	Date	Length (h)
1	Director, PAP Operational Excellence	21.2.	0:57
2	Senior Manager, PAP Operational Excellence	23.2.	1:27
3	Vice President, PAP	4.3.	0:55
4	Vice President, COF Operational Development	7.3.	0:56
5	Manager, COF Operational Development	11.3.	0:55
6	Director, Services Business Line	5.3.	0:55
7	Director, Flow Control Global Operations	8.3.	0:53
8	Director, Business Unit 2	12.3.	0:57
9	Director, Business Unit 4	4.3.	0:56
10	Director, Business Unit 3	28.2.	0:54
11	Director, Business Unit 1	11.3.	0:49
12	Director, Business Unit 2	28.2.	0:46
13	Manager, Business Unit 2	5.3.	0:53
14	Manager, Business Unit 3	6.3.	1:00
15	Engineer, Business Unit 1	1.3.	0:50
16	Specialist, Business Unit 4	18.3.	0:54
17	Director, Business Unit 5	6.3.	0:26
18	Global Solution Lead, COF Finance	14.3.	0:56
19	Manager, SA Strategy	26.3.	0:49

To clarify the reporting structures and the relationships between different groups represented in the interviews, figure 16 is presented. The figure depicts the interviewed organization, with the interviewee coding from table 9.

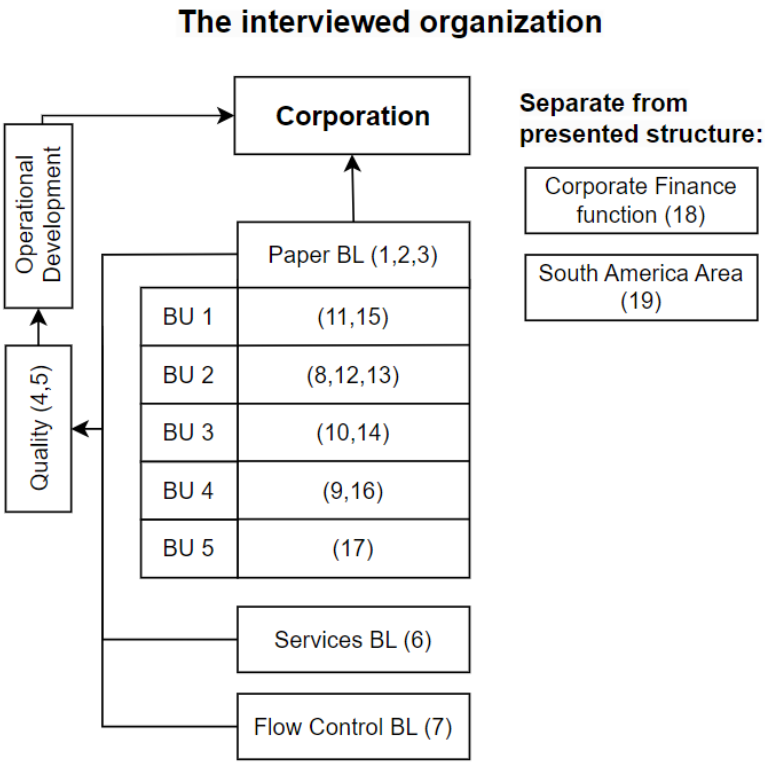


Figure 16. *The organization parts that were interviewed, with interviewee coding.*

Interviewees 18 and 19 were separate from the presented organization structure. These interviewees were not included in the original interview round, but were added as they were suggested to have valuable information regarding the research topic, according to interviewee 4.

All but one of the interviews were held via Microsoft Teams, to keep the interview conditions as constant as possible. The interviewees were contacted via email, together with a calendar invite to schedule the meeting. The attachments to the email included the interview script both in English and in Finnish. 13 of the interviews were held in Finnish, and 6 in English, because it was the preferred language for these participants. The final versions of the interview scripts are presented in appendices A and B. Furthermore, an info sheet was sent together with the scripts, which included general information about the interview and data confidentiality, about this study, interview themes, and definitions to key terms, including quality, quality performance, performance measurement and proactivity. This was done, because sending relevant information beforehand to the participants can promote credibility (Saunders et al., 2019, p. 452). During the interviews, notes were taken on a general level, and the interviews were also audio-recorded by the participants' permission. This can be beneficial, because audio-recording allows the interviewer to concentrate on the interview situation and provides unbiased and accurate

record, but the notes can emphasize thoughts and events that may not be evident from the recording (Saunders et al., 2019, pp. 461–463).

The data collected from the interviews is complemented with secondary data. One form of this can be structured data, such as internal documentation (Saunders et al., 2019, p. 341). According to Saunders et al. (Saunders et al., 2019, p. 351) in general, it demands significantly less resources to use secondary data compared to collecting the data yourself, and this suits the pragmatic philosophy well. In this study, internal documentation was utilized, and its purpose is to aid in understanding the case context and the current situation, which relate directly to research questions RQ1 and SQ1. The internal documents included quality-related procedures searched from the organization's document management tool, organizational charts gathered from the company's organization chart database, and three intranet sites describing the organization policies, and the data warehousing solution which is in development in the corporation. The utilized documents and their codes are presented in table 10.

Table 10. *Names and codes of the internal documents utilized in this study.*

Code	Type	Document Name
D1	Corporation intranet site	Paper - Operational Excellence
D2	Corporation intranet site	Quality Targets
D3	Corporation intranet site	Business Analytics Module (BAM)
D4	Organization chart	OrgChart PAP Operational Excellence
D5	Organization chart	Quality OrgChart
D6	Procedure	Continuous Improvement in **company name*
D7	Procedure	Policies for Quality and Health, Safety and Environment (HSE) management
D8	Procedure	Quality Governance in **company name*
D9	Procedure	Quality Performance Indicators
D10	Procedure	Cost of Poor Quality Reporting
D11	Procedure	Quality Assurance and Quality Control
D12	Procedure	Customer Quality
D13	Procedure	PAP COPQ Forecasting
D14	Procedure	Risk and opportunity management process in project business

In addition to being used as data in chapter 4, the organizational charts were used to understand the reporting structures, presented in figure 16, for example.

As secondary data, group meetings were also held in the design phase of the quality-based performance measurement system. The participants for these meetings were the

case business line's quality function personnel, totalling three people, including the researcher in this study. The purposes for the group meetings were to aid in deciding individual measures and the measurement framework practices.

After the empirical data was collected, it was analyzed. The interview data analysis begun with preparing the data for the analysis, by transcribing the collected recordings data: an automatic transcription tool in Microsoft Stream was used to produce verbatim text files from the interview audio-recordings. All of the interviews were listened again with the transcribed text files and with the interview notes to capture the meanings behind the wordings, and to make sure, that different accents, for example, did not lead to data quality errors. With this, an overview of this data could be transcribed as well as selected quotes. This technique follows the second level of transcription, overview and selected quotes, presented by Koskinen et al. (2005). Thus, transcript summaries (Saunders et al., 2019, p. 649) were formed first according to the interview framework themes. These summaries were gathered to an Excel table, which contained 76 cells, and 6700 words in total.

The abductive approach to theory development in this study guides the data analysis towards theory-tied analysis (Tuomi and Sarajärvi, 2018, chap. 4.2). More specifically, thematic analysis is utilized (Saunders et al., 2019, p. 651). Following the thematic analysis guidelines, the preprocessed interview data is coded, meaning that a phrase from the transcribed data is labeled to a code that resembles the phrase content and meaning. Thus, phrases with the same codes can be grouped and examined together. Furthermore, the coded phrases were categorized to specific themes. To elaborate, interview data are organized with coding them, and then codes are organized by categorizing them together to themes (Saunders et al., 2019, p. 659). The themes were derived from the existing literature and the research questions. On the other hand, the categories align with the interview themes, which are mostly again derived from the literature. Furthermore, the themes were modified and refined based on the data collected in the interviews, if that was seen necessary. The analysed themes were:

- Characteristics of the industry
- Existing measures
- Functioning of the measurement system
- Needs for development
- New measure proposals
- Incorporation of proactivity

- Other observations

Based on these categorizations, an Excel table was formed, which in total comprised of 219 rows of phrases, each of which were coded. The total number of codes was 55. An illustrative sample of the categorization and analysis table done is visualized in table 11.

Table 11. *An illustrative sample of the categorization and analysis table used.*

Interviewee	Phrase from the interview	Theme	Code
17	We need to ensure that our customer is happy, so that we get the next order. It is not only about the quality costs, we should also be quicker in solving the problems on the customer side. So, there is a risk if the focus is too much on the quality costs.	New measure proposals	Customer satisfaction
10	If people from different functions can utilize different structures or different "goggles", that would be good. We need specific data with the help of the systems. We see the huge total amounts, but can't really break it down, and see where they come from.	Needs for development	Lacking drill-down opportunity
3	"Because the reason for the measurement is that you can react in some way, we don't measure because of the measurement, but because you can identify what needs to be improved"	Functioning of the measurement system	Measurement leads to development actions
...	...	...	...

The findings of this analysis are presented in chapter 4, by utilizing the categorizations presented in the table.

The secondary qualitative data, meaning the internal documents, is also analyzed and reported thematically, in order for the qualitative data as a whole to be analyzed systematically and communicated in a clear way. This internal documents data was used to complement the results found from the semi-structured interviews, and most importantly, help in understanding the case setting and the current situation in the quality function. The complementary nature of the findings from the internal documents are discussed along other empirical results, following the same thematic categorization in chapter 4.

4. FINDINGS

In this chapter, the collected empirical data is analyzed, and the findings from the research process are presented. The chapter structure reflects the research questions, and includes the themes described in subchapter 3.3. The subchapter 4.1 addresses the SQ1 from the case organization perspective, “What is the current state of data gathering, measures used, and reporting regarding quality? What numeric data is available?”. Assessment of the current state aids in addressing the need for quality performance measurement and its development in subchapter 4.2, which reflects the research question SQ2, “What quality performance measures are needed, and why?”. Thirdly, the results relating to the proactivity aspect in quality performance measurement are presented in subchapter 4.3, partly answering the SQ3, “How to increase proactivity in quality performance measurement?”. Finally, the developed quality performance measurement system is presented in subchapter 4.4., which in part addresses the RQ1, “How to develop a balanced quality measurement system in a manufacturing company’s business line operating in paper machinery industry?” Further discussion on the findings is presented in chapter 5, where the empirical results are reflected on the researched literature.

4.1 Current state of quality measurement in the case organization

The case corporation develops and supplies process technologies, services, and automation for paper, pulp, and energy industries. It has over 19 000 employees working in five business lines, one of which is the Paper Business Line. The corporation follows a matrix organization structure. In the case of the Paper Business Line quality function, this occurs as the reporting responsibility to the Paper Business Line Operational Excellence organization (D1, D4) , as well as to the corporate quality function (D5). This reporting structure is visualized in figure 16. From the business line perspective (D4), the quality function covers five units, which are titled Business Unit 1…5. According to the Paper Business Line Operational Excellence organization (D1), the quality function focuses on supporting the Paper organization in fulfilling customer’s, and other stakeholders’ requirements. Targets for the quality function are to have efficient processes, low cost of poor quality and high customer satisfaction in all operations, together with all functions (D1). From the Quality organization perspective (D8), the roles of the quality function are to (1) form, assure, and improve quality practices with systematic quality management in all operations, (2) support personnel in quality-related matters to meet

corporate and customer requirements, and (3) facilitate the continuous improvement and quality culture development. At the business line level, the quality function, among other roles, manages quality performance (D8). At the corporation level of the quality organization, there is a commitment to keep improving the quality performance continuously, which is included under the corporation-wide *Excellence in processes* critical success factor (D2). This commitment is cascaded onto business line level quality functions. The main target of quality operations is to improve internal quality performance, and make sure, that customers are satisfied (D2). A measurable quality target is to reduce the cost of poor quality.

4.1.1 Characteristics of the industry and the corporation

The paper machinery industry, in which the Paper Business Line operates, brings characterizing elements to the case quality function and its quality performance measurement. When considering the offering of the business line, it is characterized by long, and large-scale customer deliveries in the form of projects (interviews 1, 4). According to interviewees 1 and 12, the projects can take several years, and a typical project time window can be 5 years (interview 1). The projects are also capital heavy (interviews 1, 3, 8). The paper machines also have small tolerances (interview 2), and the product repeatability is small (interview 2, 10). According to interviewee 3, vice president in Paper Business Line, these characteristics bring the quality focus to product quality. The production of the machines is also complex. Even though interviewee 3 highlights, that the business line has a lot of own production, interviewee 8 clarifies:

"There is never a fully self-manufactured machine, nor is there a fully subcontracted one."

Still, interviewee 12 emphasises, that in the industry, customers expect exceptional quality and that the customer interface is strong in the business. These characteristics can be compared to other businesses inside the corporation. The interviewee 1 compares the paper machinery business to the services business line, where the deliveries are smaller in size, but the volumes are bigger. Interviewee 7 also emphasises, that there is variation in business models between business units.

The inclusion of different businesses also characterizes the Paper Business Line's quality. Even though the big projects and small volumes were emphasized, interviewee 18 states that the business line in its entirety is a huge entity, including serial production, machinery manufacturing and project deliveries, and interviewee 14 follows this by stating that the large size of the organization can be an issue. The issues may appear, if the

business line is thought of as a homogenous entity. For example, the quality organizations inside different business units are resourced differently (interviewee 8). In addition, interviewee 3 states:

“Reporting in general is challenging because units and businesses are in different systems. It is a large company, and the quality maturity varies a lot inside the organization.”

Relating to the same issue, interviewee 5 states that the attitude towards quality suffers from compartmentalization:

“The company’s attitude towards quality today is to some extent siloing, one would have to understand that quality is on everyone's shoulders.”

Interviewee 5, who works as a manager in corporate operational development, states that the responsibility of quality should be on everyone’s shoulders, not just on the quality function’s.

Several of the interviewees also described the quality culture in the organization. Overall, the interviewees (1, 4, 6, 8, 10, 12, 14, 18) agree that the quality culture has developed to a good direction over the years. Quality as a concept is more on management agenda (interviews 4, 6), and on the contrary to interviewee 5, the ownership of quality has shifted from the quality function to different functions (interviewee 8, 10) and to everyone in the organization (interview 12). According to interviewee 14:

“Company approach to quality has evolved from just tying it to ISO standard requirements to a more solid quality culture.”

The grown interest and commitment to quality has also risen the expectations for quality activities. The organization demands more timely quality reporting (interview 14), and the organization has agreed to move towards proactive measurement (interview 1), and there is development in moving from result measures to more action-based measures (interview 14). Even though there have been changes and development in quality measurement, interviewee 18 highlights, that in cost of poor quality reporting, some things are in a state of underdevelopment. Furthermore, interviewee 3 states, that the Paper Business Line quality has a quality control and audit focus, which offer a past view to quality (rather than a proactive view).

The definition of quality is not unambiguous in the interviewed organization. According to a director in the Paper Business Line, quality can be defined as follows:

"Quality is that we meet the set requirements for the product or service that we have agreed with the customer."

Also, interviewees 8 and 13 point out, that quality can be inspected internally, but also by the quality experienced by the customer. On the other hand, interviewee 6 sees quality as the resulting factor of all activities in the organization, and interviewee 10 concludes that quality means different things for different people.

4.1.2 Functioning of the measurement system

The quality performance measurement system which is in the focus of this study, functions as a part of both the Paper Business Line management, and the organization-wide quality organization. According to the Quality Performance Indicators Procedure (D9), different kinds of quality indicators are used to represent the result of the organization, and can be tied to quality objectives, which are defined on corporate level, quality initiatives and/or to quality measurements, which can be defined on various organizational levels. Furthermore, according to the Quality Governance procedure (D8), the performance measurement results are reported in monthly and quarterly meetings, where actions based on the results are initiated.

The positioning of the quality function in the corporation dictates what kind of things it should measure. The corporation uses a QM, QA, QC categorization in dividing the quality framework into areas of responsibility (D11). The Paper Business Line quality function operates in the quality management (QM) area, where the focus is on all organizational processes that ensure quality. According to interviewee 18, the QA and QC areas function more within a certain process block, compared to the QM area, where the scope is the whole performance of the organization. Even though interviewee 18 states, that at this upper level, the measures used are result indicators, there is still potential for proactivity, as well.

The scope in which the business line quality function should operate in, and the role of quality management in the organization is brought up in the interviews. It is noted that the quality organization is not the one that leads the organization that produces the quality measurement results, such as the quality costs (interview 6). This compartmentalization, which is brought up by interviewee 3 and also by interviewee 5 when discussing about the quality culture, should be issued. According to interviewee 6, quality should be built into all levels of the organization, in a way, that for example project management would be responsible of its own quality goals.

The organizational structure and its effect to the measurement setting is evident, but it also challenges the selection of the ‘right’ indicators to follow. Interviewees 1, 14 and 16 state, that every function and each business unit have their own, selected and more specific, and action-based measures. Even though the quality function is supposed to

cover the overall processes that ensure quality, the view to the performance of the organization is limited (interview 1):

“The measuring is very extensive in the organization, but what is the view of each person, for example the leader of the quality function, to the indicators in question? Own focus areas are viewed with a narrow scope.”

Interviewee 2 emphasises this by stating:

“There is no compiled place to get measurement results, and some measures are not thought of as quality measures, even though they could be.”

The targeted scope for the quality performance measurement is wide, due to the positioning of the quality function.

Ten interviewees (1, 2, 3, 4, 7, 8, 9, 11, 14, 17) brought up the fact that an integral function of the measurement system is to facilitate development. This is summarized by interviewee 3:

"Because the reason for the measurement is that you can react in some way, we don't measure just because of the measurement, but because you can identify what needs to be improved."

The results of the performance measures can be used to initiate development actions and projects on strategic and/or annual level (interviews 2, 11), by, for example, defining the improvement areas and assigning responsibilities (interviewee 9). They can also be used for communication (interviewee 8), and for motivating the development functions by justifying their existence (interview 7). The performance measures should be utilized to facilitate movement into the right direction of quality improvement (interviews 11, 14). On the other hand, if the performance measure results meet the targets that are being set, no actions are needed, either (interview 17). This does not necessarily mean, that such a measure would be of no use, but ideally in the corporation, the performance measurement systems are updated and useless measures are removed, if they were deemed useless (interviews 1, 19).

4.1.3 Existing measures

Currently, the main measurement themes which the Paper Business Line’s quality function manages are the Cost of poor quality, and the Continuous Improvement -related incident and event completion rates. These measures and their trends are brought up as the most relevant quality performance indicators on corporate quality level, as well (D9).

The COPQ is the main measure in the quality function (interviews 1, 2), and it is measured both in euros and in relation to net sales. Its purpose is to provide a perspective to process performance and to process disruptions (D10). The financial COPQ data is categorized, and in addition to total sums of COPQ, the data can be cascaded onto the organization and examined by processes, business units, and functions (interviews 1, 2, 9). The COPQ comprises of internal and external failure cost data, collected from across the organization (D10). The COPQ data is collected from markings in different ERP activities, and from several ERP systems, it flows through data storages to be used in visualizations and monthly quality reports. In addition to reporting the occurred COPQ, the upcoming COPQ is estimated through COPQ forecast (interviews 1, 2). It comprises of a baseline, known but not realized or booked COPQ, and of identified COPQ risk values (D13).

The continuous improvement measurement is based on a global feedback handling software, which is a tool used to collect and manage Continuous Improvement (CI) and HSE events, such as incidents, observations and improvement ideas, which can be triggered from multiple sources, such as from meetings, audits, and daily operations (D6). The pure amounts of events and incidents are also followed, but the main measure is the completion rate of handling the events (interview 1). For example, an incident is marked completed if necessary handling steps are taken to prevent the incident from happening again. The completion rate is calculated by the ratio of completed number of CI events divided by the total number of reported CI events. The rate is calculated monthly, by reflecting the time frame of past 12 months. (D6). Similarly to the COPQ measurement, the CI events completion rate can be divided into function, and business unit specific ratios. The ratios are calculated in the mentioned global tool, and reported via MS tools, for example. This measure can be used in examining where in the organization events and incidents are happening, and where bigger development actions should be initiated (interview 2). The completion rate percentages are followed monthly, and if there are changes in the results, analysis is initiated to figure out the causes of changes, for example changes in resourcing (interview 1). Furthermore, the measure reflects the continuous improvement actions done in the organization, and also the quality culture in the business line (interview 2).

In addition to these main measures, other used measures of the quality function are also mentioned in the interviews. Interviewee 1 states that the number of development actions from audits is followed, and also the coverage of ISO certificates in the organization. These are measures for the quality processes incorporated in the corporation’s management system. In addition to these, the business line quality-related development projects

and their execution is followed (interview 1). These measures are not, however, regarded as KPIs in the quality function. One other measure which is reported monthly along the COPQ and CI events, is supplier claims in euros. This measure, does, however receive criticism from several interviewees, and it is deemed as being somewhat useless at the business unit level (interviews 8, 11, 12, 13).

4.1.4 Data availability in the current systems

The current main measures have their own data sources, COPQ data is collected from several ERP systems in the organization, and the continuous improvement event and incident completion rates are calculated by using data collected in the organization-wide feedback handling software. At the time of conducting this thesis, the organization is developing a new enterprise data warehousing solution, Business Analytics Module (BAM), which is meant to consolidate data from multiple sources, and provide solution for all analytics and business reporting purposes in the organization (D3). Thus, the BAM will increase the data visibility to other functions in the corporation significantly (interview 1). From the case quality function perspective, when the BAM is operational, it will consolidate the beforementioned ERP and feedback handling software data (D3). Additionally, it will offer data from, for example, a HR process tool, customer surveys, and supplier management systems. In addition to improvement on reporting and measurement practices on established quality measures, additional access rights can be requested to gain visibility on other functions' data and dashboards, including production, project deliveries, and procurement. (D3) Although the BAM was not operational during the scope of this thesis, the ongoing data warehousing solution development allow for more comprehensive measurement possibilities for the quality function in the future.

4.2 The need for quality performance measurement development

The assessment of the current situation regarding the quality function's quality performance measurement revealed the wide target scope of the measuring, extending to cover the whole business line's operations. The current main measures are the COPQ, which offers insights into process performance and disruptions from financial perspective, and CI events and incidents completion rates, which reflect continuous improvement and quality culture in general. However, the current situation is not entirely satisfactory; there seems to be a need for development.

4.2.1 The development needs of individual measures

To utilize the measures effectively, the measures should have specific characteristics. The measures should offer real-time information for management, and they should be based on extensive and high-quality data (interview 1). Furthermore, the measures should utilize automatic elements (interviews 1,2) in, for example the categorization and updating of data (interview 1). Interviewees 8 and 13 also emphasize, that indicators' function and the results they offer should be simple, and easy to understand. These characteristics should not, however, lead to excessive use of resources, and the benefit of measuring must be greater than the costs it creates (interview 2).

All of these expectations are not met with the existing measures. One major issue is the reliance on lagging measures in the quality function's set of measures. The main measures are based on historical data, and they are result-based, when action-based measures would be desirable (interviews 1, 2, 3, 8, 12, 17, 18). This does not seem to be a new issue:

"This [Thesis topic] *is a really good topic, because this is the eternity of headaches in quality that one looks in the rearview mirror."*

The main issue with the lagging measures is that they do not provide efficient input to develop operations in real time. For example, interviewee 12 brings up, that COPQ reporting can bring up incidents from several years ago, to which improvement actions have already been initiated when they have occurred.

There are also issues in the technical aspects, and in the underlying data to the current main measures. Data quality issues were brought up by 9 interviewees, and they agree that the COPQ source data is collected inside different units and functions in different ways, and thus lack harmonization. Also, employees face challenges in marking COPQ on time, which decreases the quality of the source data. The data quality issues lead to another mentioned main issue, which is brought up in 9 interviews, and is the lacking drill-down opportunity especially in COPQ measuring. This means that the data is not categorized in a way that would enable the examination of cost of poor quality on operational and function level. This issue is brought up especially on business unit level. The large total sums of COPQ on business line level do not offer much information to the individual employee. Interviewee 15 illustrates the issue:

"End-users, i.e. employees who make quality cost markings in operations and processes, should have visibility to the things they report."

Thus, bringing the COPQ data closer to the functions could initiate corrective actions and quality culture improvement on the shop-floor level (interview 18). This issue is not exclusive to the COPQ measure, because according to interviewee 10, there are difficulties in extracting data for different functions from the feedback handling tool utilized in the CI measures. This brings up another issue, which relates to the usability of the feedback handling tool: in many cases, the users cannot use the systems effectively (interview 11). Interviewee 8 emphasizes the issues with the tool:

“It is a really rigid tool to use, there would be a lot more efficiency in measuring and developing the quality if the tools used were better.”

Thus, it is found that the usability of the IT systems and the source data issues lead to decreasing the usability and reliability of the main measures.

4.2.2 Development needs for the measurement system

Apart from the technical issues and the characteristics of individual measures, the quality performance measurement system as a whole receives criticism. The used measures do not offer a holistic view on quality (interviews 2, 12), which would be the ideal state, when the role of the business line quality function is considered. The quality function focuses too much on a few measures, when complementing, already existing data not thought as belonging under quality could be incorporated onto the set of measures (interviews 2, 12).

It appears that the set of measures do not offer a comprehensive and balanced view to the quality performance of the business line (interviews 1, 2, 3, 4, 6, 8, 12, 18). The COPQ measure has too much emphasis on the measurement system (interview 2), and it offers a lagging view to quality. The quality function should understand the big picture (interview 6) by looking into different perspectives, in addition to the financial perspective, because one single measure is not sufficient to indicate quality (interviews 6, 12). This way, quality could also be better incorporated into projects and processes. In the current situation, interviewee 8 states:

"Quality doesn't show in process meetings because our metrics don't give it a chance."

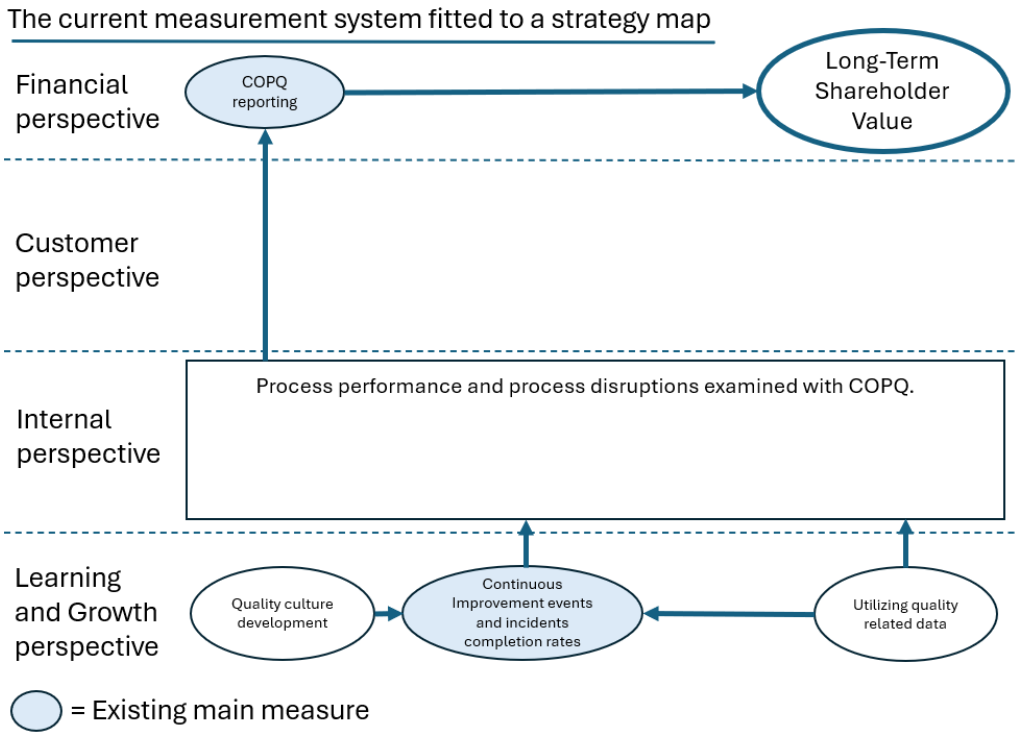
However, although there is a need for more leading indicators, the balanced approach also requires lagging indicators (interviews 2, 3). Even though there is a need for measurement development, it does not indicate that the established measures should be removed. Interviewee 18 supports this statement, and also states that perhaps the focus should be on developing and making good use of the existing measures, rather than creating a large set of measures to be followed in one single report.

The selected set of measures must offer a way to facilitate development in the organization. It should offer results and information that can be used in daily management in the functions of the organization (interview 13), and offer opportunities to change things (interview 14). The measures should be utilized as a guide to develop operations into the right direction (interview 11). The development of the quality performance measurement system should take these needs into account.

4.2.3 Visualizing the current situation and development needs

The current situation regarding the quality performance measurement system in the quality function is synthesized by utilizing the quality strategy map and the proactive characteristics of performance measures presented in subchapter 2.10. The quality strategy map is presented to emphasize the view that the existing measures offer as a quality performance measurement framework. This is visualized in figure 17.

Figure 17. *The existing main measures fit onto a strategy map framework.*



The visualization depicts the heavy emphasis on the COPQ reporting, and highlights that the current measurement system is not balanced, by the four categories presented in the map. For example, the customer perspective is missing from the existing measures, even though it is a clear target for the quality function. It is good to note though, that customer satisfaction is still measured at the business unit level, but not at the business line level, which is the case function. At this stage, the existing measures can be fitted into the four perspectives, but it leaves the relationships between different perspectives

quite ambiguous. In the Learning and Growth perspective, quality culture development and utilizing quality related data are retained from the quality strategy map presented in the subchapter 2.10. Continuous Improvement events and incidents completion rates are heavily linked to the quality culture development in the interviews, and the utilization of quality related data is an integral part of the function of the existing measures, even though there being quality issues in the data (see subchapter 4.2.1).

The proactivity of the existing measures is evaluated by reflecting them on the proactive characteristics table introduced in the literature synthesis sub-chapter 2.10, in table 5. The evaluation is summarized in table 12.

Table 12. *Evaluation of the proactivity of the existing main measures.*

Proactive characteristics of performance measures	**The evaluated measure**	
	COPQ, absolute €,and % out of net sales	**CI events & incidents completion rate**
1. Strategic and aligned, at least a link to one of organization's CSFs.	Low COPQ and its reduction is a target of the corporate quality function, and for the Paper Business Line quality function.	Continuous improvement is tied to *Excellence in processes* CSF.
2. Timely (and future-oriented).	COPQ markings offer a view of past incidents. COPQ forecasting attempts to estimate future performance.	Relatively real-time, does not offer future-oriented data.
3. Actionable, action is possible based on measure results.	COPQ is a result-based measure, and does not provide sufficient data to initiate actions on a business line level.	Limited, the impact of the CI events is not measured.
4. Correlated, measures drive desired outcomes.	COPQ does not in itself drive desired outcomes, because it reports financial outcomes.	Yes, the measure reflects quality culture and continuous quality improvement, but the impact of the events is not measured.

Both measures, being the main quality performance measures for the quality function, are linked to the critical success factors of the organization, and to the quality targets discussed in subchapter 4.1. The COPQ financial data offer a lagging view to past incidents and non-conformities, and thus, by these characteristics, is not regarded as a proactive performance measure. The CI events and incidents completion rates are meant to provide a view to quality culture and continuous improvement, and thus offer indication on future quality performance. However, in the current situation, the true impact of the measured handling and improvement actions based on the events is not measured, and thus, the correlation between continuous quality improvement in the organization and the CI events and incidents completion rates remain uncertain. Furthermore, the poor usability of the feedback handling tool decreases the reliability and timeliness of the source data. In conclusion, the existing main measures have few proactive characteristics: COPQ measurement offers a result-based and financial view to quality, and while the CI

events and incidents completion rates can be linked with continuous improvement, current measurement practices and issues related to the IT systems weakens the validity and proactivity of the measure.

4.3 Incorporating proactivity into quality performance measurement

In addition to the current state assessment, and the general development needs regarding the quality performance measurement of the business line's quality function, the interviews were used to collect qualitative information from the interviewed organization, regarding the incorporation of proactivity into the developed quality performance measurement system. This was conducted by asking several questions relating to the proactivity theme in the quality context, such as the question 4.1 visible in Appendices A and B. The concept of proactivity is examined further, because it has been set as a development target in annual and strategic levels in the Paper Business Line's quality function (interview 1). Furthermore, examining proactivity in the case context is relevant, because in the literature (Parker et al., 2010; Thierauf, 2001, p. 73), incorporation of the proactive management approach can lead to more effective management, which can in turn lead to overall competitiveness of the organization. Next, the main findings from the interviews regarding the quality performance measurement development from the proactivity standpoint are presented.

4.3.1 Sources for proactivity in quality performance measurement

A major theme relating to the incorporation of proactivity in the case setting is the concept of risk and opportunity management, which is brought up by over half of the interviewees (1, 2, 3, 5, 7, 8, 10, 11, 17, 18). Risk and opportunity management is already utilized and lead by project management, but it is not yet utilized properly in quality management. From projects perspective, risk and opportunity management includes risk identification in various phases of customer projects. The risks and opportunities are collected to a risk register software, where controlling actions for the risks are also documented (interview 1). The risks can be examined by their financial impact on the projects.

The quality function could benefit from incorporating risk into its management practices. Currently, there are some risk & opportunity processes existing in the business unit 2, for example, but their rather low maturity does not provide possibilities for timely and proactive risk mitigation actions (interview 8). Overall, however, the concept of risk and opportunity management is not utilized properly in the business line's quality function.

The number of quality-related risks and their probabilities of occurring could be better anticipated by utilizing the risk register (interview 8). Interviewee 8 states:

"One way to incorporate proactivity would be to be able to correctly identify risks. You can't predict everything, but I think it's a tool that we use too little of."

Even though interviewees agree widely that the incorporation of risk & opportunity management could be beneficial, it is not without issues. Interviewee 18 mentions, that if quality wishes to include risks more into its reporting and measurement, it may have good potential for improvement, but the management responsibilities should then be clarified. Interviewee 2 also mentions that the roles of quality and project management regarding the risk & opportunity management should be clear.

In the quality function's context, the risk register could be utilized in several ways. In general, the risk register can be used for identifying project-related risks and make the risk management activities visible for the quality function. In addition, the risk register could be utilized in estimating the upcoming cost of quality more precisely (interview 2). Automatic linkages could be made between the quality costs and the risks in the risk register, and thus quality-related risks, their management and, for example, COPQ forecasting could be more efficient and accurate (interviews 1, 2).

Another main theme regarding proactivity from the interviews is the balanced approach to quality performance measurement. Several interviewees mentioned, that in addition to the heavy emphasis on the financial COPQ measurement, more viewpoints should be incorporated to quality measurement to predict quality development more reliably. For example, interviewees 4 and 8 list customer perspective, continuous improvement and employee trainings perspective and the internal processes along with supplier perspectives as the desirable viewpoints, which are well aligned with the balanced scorecard approaches (Kaplan and Norton, 1992) to measurement. Interviewee 12 mentions, that quality function should not necessarily rely only on the data that is produced by the quality organization but widen the scope to take into account measures owned by processes, for example, to create a balanced scorecard to quality, which would incorporate both leading and lagging indicators. Especially the leading indicators of the balanced approach, such as quality culture development (interviews 9, 11) are thought of as being proactive, acting as predecessors to good quality.

The interviewed organization offered several suggestions of elements that precede good quality. Continuous improvement was emphasized not only as a part of the balanced scorecard approach, but as an indicator on how the organization has learned and im-

proved from the issues in the past (interview 18). Supplier quality is also seen as a predictor of quality in the organization's own operations, and its measurement could be improved (interviews 4, 7). Conducted quality trainings and employee competency levels are also seen as relevant predictors to overall quality.

Forecasting and predictive analytics based on historical data could be possible ways to increase proactivity in the case context. The forecasting aspect is linked to the risk and opportunity management concept (interviews 2, 8, 10), and risks could be better utilized in forecasting the costs of poor quality that will be realized in the future. However, interviewee 18, who leads the global ERP development and implementation in quality processes, for example, and has a long experience in quality management in the Paper Business Line, emphasizes and encourages the use of statistical analyses in quality performance measurement. As sources for the analyses, COPQ data could be utilized, and financial data from changes in the structure of projects during their life cycle. These analyses could be utilized in noticing trends and characteristics in certain projects and products more reliably, and thus facilitate more informed and more proactive decision-making. According to interviewee 18, statistical analyses in these uses could be utilized more in the corporation. In summary, in addition to utilizing the risk register in managing quality-related risks, statistical, predictive analytics could offer tools to increasing the proactivity of the quality performance measurement system.

In summary, multiple different viewpoints and concepts are linked as sources for increasing proactivity in the case function. The most attention is paid to the concept of risk and opportunity management, and its integration via the risk register data source to the quality performance measurement system. In addition to the risk aspect, the balanced measurement aspect and themes from measurement perspectives, such as quality culture development, quality trainings, were linked to increasing the quality measurement proactivity. Finally, the utilization of predictive analytics as a form of forecasting future performance was brought up.

4.3.2 Benefits and risks in increasing proactivity

The concept of proactivity is approached in the interviewed organization from many perspectives. Similarly, increasing proactivity involves certain expectations and identified risk factors in the organization. Proactivity is strongly associated with more accessible, relevant data that enables knowledge-based decision-making (interviews 5, 11). On the other hand, the development of proactivity is also associated with more efficient problem solving. The expectation for the development of proactivity from this perspective is that problems would be detected in own manufacturing, rather than at customer project sites

(interview 1, 17). Proactivity is also associated with faster responsiveness to different issues (interview 18).

Possible risks associated with incorporating proactivity to the quality performance measurement were explored. The reason behind this was to utilize the information in the development process, highlighting possible issues that should be avoided or made decisions on. One main risk was that management, and the organization is not committed to the change and development. According to interviewee 4, in quality-related and other indicators, the organization is not used to proactivity, so the attitudes of the upper management may be challenging to shift. Interviewee 8 also states that the quality function cannot make this shift on its own, and the quality function should receive support from the surrounding organization. Furthermore, if the developed measurement system were to include measures that are not traditionally thought of as quality measures, and are managed and owned by another function in the corporation, there can be a risk for unclear division of management responsibilities (interview 18).

Another frequently mentioned risks were the possible data reliability and usability issues regarding new measures. If the source data for possible measures is not already categorized to suit the uses for the quality function performance measurement, the needed measures cannot be implemented short-term (interview 1). Effective, proactive management based on the measures can also be compromised, if new measures are created excessively, just because there is a lot of data available (interviews 12, 13, 14). Finally, regarding the data reliability, interviewee 1, who will be a key user for the developed quality performance measurement system states, that proper understanding and trust in proactive and predictive measures must be in place. This way, management can make correct conclusions based on the results and thus steer the organization into the right direction.

4.4 The designed quality performance measurement system

The design process for the developed quality performance measurement system followed the process phases described in figure 14. The first phase was the assessment phase, which is described in subchapters 4.1 and 4.2, and was based on the data from the interviews and the internal documentation. The characteristics of the industry, and the corporation surrounding the case quality function were evaluated in subchapter 4.1.1. Additionally, in subchapter 4.1.2, the overall function of the measurement system was examined. In the business line quality function, the scope of the measurement reaches the performance of the whole organization, which poses a challenge in selecting the right indicators. This means, that because the quality function acts as a support function to

the business line, the performance measures do not measure the quality function's operations, per se, but rather focus on the overall functioning of the organization, from the perspective of quality. The findings of these previous subchapters helped in understanding the environment in which the performance measurement system operates in, and to understand the organization and its policies better.

The existing measures and the development needs regarding them, and the measurement system in general were assessed in subchapters 4.1.3, and 4.2. Currently in use there are two main measures, the COPQ reporting and the CI events and incident completion rates, both of which received improvement suggestions from the interviewed organization. This was done to evaluate the current capabilities and deficiencies of the current measurement system. Additionally, in subchapter 4.1.4, BAM, the data warehouse solution under development in the corporation was discussed. The new solution will significantly increase cross-functional data availability and provide a data source for more comprehensive measurement possibilities.

One segment of the assessment phase in the Quality-based performance measurement system design process depicted in figure 14 is the involvement and motivation of stakeholders to the development process. The key users for the developed measures were already motivated and involved in the development process. The assignment for this thesis came from the case quality function, and thus they were already invested in the development. In addition, inclusion and motivation were carried out in three ways:

1. Participants from the organization surrounding the case function were invited to the interviews, in order to hear their perspectives on the current situation and the development needs.
2. Other business lines inside the corporation were utilized as benchmarking opportunities, and interviewees from related functions of different business lines were selected.
3. The main users of the developed quality performance measurement system were involved in determining the measures and deciding the measure and framework practices. The main users were also updated on the progress of the development in weekly held private meetings.

The organizational commitment to the development helps in gaining deeper knowledge on the context for the developed performance measurement system (Sousa and Aspinwall, 2010), and also in implementing the proposed system (Parmenter, 2019, p. 45).

The information gained from the assessment phase helped in identifying the key quality objectives for the case quality function. According to (Bourne et al., 2000), the process phases for the performance measurement system are conceptual, and can overlap. This was noticed when moving from the assessment phase to the design phase. The identification of the corporation's quality strategy, and the critical success factors related to it

could be established already at the beginning of the assessment phase using the available internal documentation discussed in subchapter 4.1. However, only after the interviews were held and the interview data was analyzed, the objectives for the quality measurement development for the case quality function were discovered.

The following subchapters are aligned to the last two phases of the quality-based performance measurement system design process according to figure 14. The determination of the measures is depicted, and the decisions regarding the individual measures and the designed quality performance measurement framework are presented.

4.4.1 Determining the measures and deciding measurement practices

Determination of the measures to be included in the developed quality performance measurement system depended on several information sources. The existing measures in the use of the case quality function were determined based on the internal documents D6, D9, D10, and D13, and complemented with the data from the interviews. The interviewees also provided proposals for new individual measures and measurement objects in the quality performance measurement context.

A total of 42 quality performance measures or measured object proposals were collected. The existing measures, and the new measurement proposals are presented in table 13. In the table, the measurement objects and the performance measures related to them are categorized based on the four perspectives of the Balanced Scorecard (Kaplan and Norton, 1992).

Table 13. *The existing and proposed performance measures and measurement objects, categorized according to the Balanced Scorecard perspectives (Kaplan and Norton, 2004, 1992).*

Perspective	Measurement object	Related performance measure
Financial perspective	COPQ	COPQ / Net sales*
		COPQ forecast*
		COPQ*
		Lost sales due to poor quality
		COPQ without cost source code
		COPQ not coming from warranty projects
	Profitability	EBITA
	Total COQ	Quality cost ratio
Customer perspective	Customer satisfaction	Net Promoter Score (NPS)
		Speed of solving customer problems
		Loss of goodwill due to poor quality
	Conformance seen by customer	OTD on project handover to customer
		First time right from own operations to customer
		Performance guarantees achieved on time
		Customer claims count
Internal perspective	Supplier quality performance	Supplier claims count*
		First time right from supplier to own operations

		Number of supplier evaluations done
	Process compliance & performance	Quality processes compliance*
		PEM gate decisions on time
		High Priority process compliance
		Output of a process phase compared to the need of the next process phase
	Risks	Known vs unknown risks to COPQ
		Project risks related to COPQ
Learning and Growth perspective	Continuous improvement events	Events completion rate*
		Events completed on time
		Events overdue
	Quality competencies and training	Quality Training amounts
		Level of Quality competence
	Impact of improvement efforts	Reoccurrence rate of Quality incidents
		Effectiveness of CI projects

*Existing performance measure

Even though the interviews provided several performance measure proposals, customer satisfaction, process performance, quality trainings, and project risks were the elements of measurement that were stressed the most, according to the number of mentions from the interviewed personnel. For example, the quality function does not have comprehensive visibility to the performance of the processes in the business line, which prevents effective process development from the quality perspective (interviews 1, 8, 12, 17). Overall, the proposed measurement objects and related performance measures emphasized the customer perspective, as well as the internal perspective, which are not currently measured in the quality function with the existing main quality performance measures, although the measurement of quality processes compliance and the supplier claims count can be tied to the internal perspective. There were also proposals that would diversify the financial and learning and growth perspectives. The elements of profitability and total cost of quality were proposed as financial measures, and quality competencies and impacts of the improvement efforts were proposed to be measured and could be tied to the learning and growth perspective.

Next, the measured elements, which would be at the same level as the measurement objects in table 13, were selected for the designed quality performance measurement system. The information gathered during the assessment of the current state and the development needs for the quality performance measurement system were utilized in selecting the measured elements. Group meetings were held with the key users of the developed measurement system to provide feedback and align the proposed measures further with the objectives of the quality function. In these meetings, the table 13 list of measures and measurement objects was used as the starting point for the discussions. During the meetings it was confirmed that the measurement objects presented in table 13 were indeed seen as necessary viewpoints, and aligned with the critical success factors regarding quality. However, one measurement object, customer feedback handling,

was added to the customer perspective to emphasize how problems are solved from the customer perspective. Additionally, measurement objects of continuous improvement events and the impact of improvement efforts were combined as the Effectiveness of CI event handling because they were seen to include closely related performance measures. Furthermore, the wording of certain measured elements was specified.

Along with selecting the measured elements, the performance measures related to them were refined in the group meetings based on the initial set of measures in table 13. The existing main measures, the COPQ and the CI Events were seen as relevant and tied to the objectives and strategy of the quality function and were kept in the designed measurement system. However, the timeliness of the CI events needed to be emphasized, and the current measure was targeted to measure the on-time completion rate of the CI events. The existing supplier claims count measure, which was criticized to having little utility, was replaced by the supplier first time right measure, which provides a ratio instead of an absolute number. The existing quality process compliance measure was incorporated into the overall process compliance measure. Attention was paid to limit the number of selected measures, because too many measures can cause confusion and challenges to their management (Kerzner, 2017, p. 154). This issue was also brought up as a risk in the interviews (interviews 12, 13, 14).

The group meetings provided a list of measured elements, and performance measures related to them, which would be selected to the designed quality performance measurement system. Further specifications on these measures would be decided. The list of selected elements and measures is presented in table 14.

Table 14. *The selected elements to measure quality performance in the case business line's quality function, and performance measures depicting them.*

Perspective	Measured element	Related performance measure
Financial perspective	COPQ	COPQ* (% of Net sales)
		COPQ forecast* (€, % of Net sales)
		COPQ* (€)
	Profitability	EBITA (€)
	Total COQ	Quality cost ratio (%), COGQ/(COGQ+COPQ)
Customer perspective	Customer Satisfaction	Net Promoter Score (NPS)
	Conformance seen by customer	OTD on project handover to customer (%)
		Performance guarantees achieved on time (%)
	Customer feedback handling	Customer CI event on-time completion rate (%)
		Customer claims (€, pcs)
Internal perspective	Supplier quality performance	First time right from supplier to own operations (%)
	Process compliance & performance	PEM gate decisions on time (%)
		Process compliance, incl. quality process compliance* (%)
	Risk and opportunity management	Project risks related to COPQ (€)

Learning and Growth perspective	Quality competence	Quality Trainings (h, completion %)
	Effectiveness of CI event handling	Reoccurrence rate of Quality incidents (%)
		CI event on-time completion rate (%)

*Existing performance measure

The initial calculation logics are also presented in parenthesis beside each measure. In the set of measures there are absolute financial and hourly amounts, and ratio-based measures.

After the proposed quality performance measures were selected, their measurement practices were defined further. The quality performance measures were operationalized with the help of the quality performance measure record sheet steps presented in table 6 in another set of group meetings with the quality function personnel. The operationalization was done during the design process to make the future implementation of the measures easier, but also to recognize the readiness of the quality function to take the selected measures into use. The level of detail in defining the measurement practices depended on whether the measure was already in use by the quality function, such as the COPQ measures. In these measures, the practices were already defined, but in completely new measures, such as in the Quality cost ratio, the defined practices remained on a general level, regarding the ownership of the measure, for example. At the same time, some steps, such as the formulas of the measures, and the titles, were already defined in the previous process steps.

4.4.2 The proposed quality performance measurement system

The group meetings concluded the design process for the quality performance measurement system. The relationships between the chosen measured elements are illustrated with a strategy map, which is presented in figure 18.

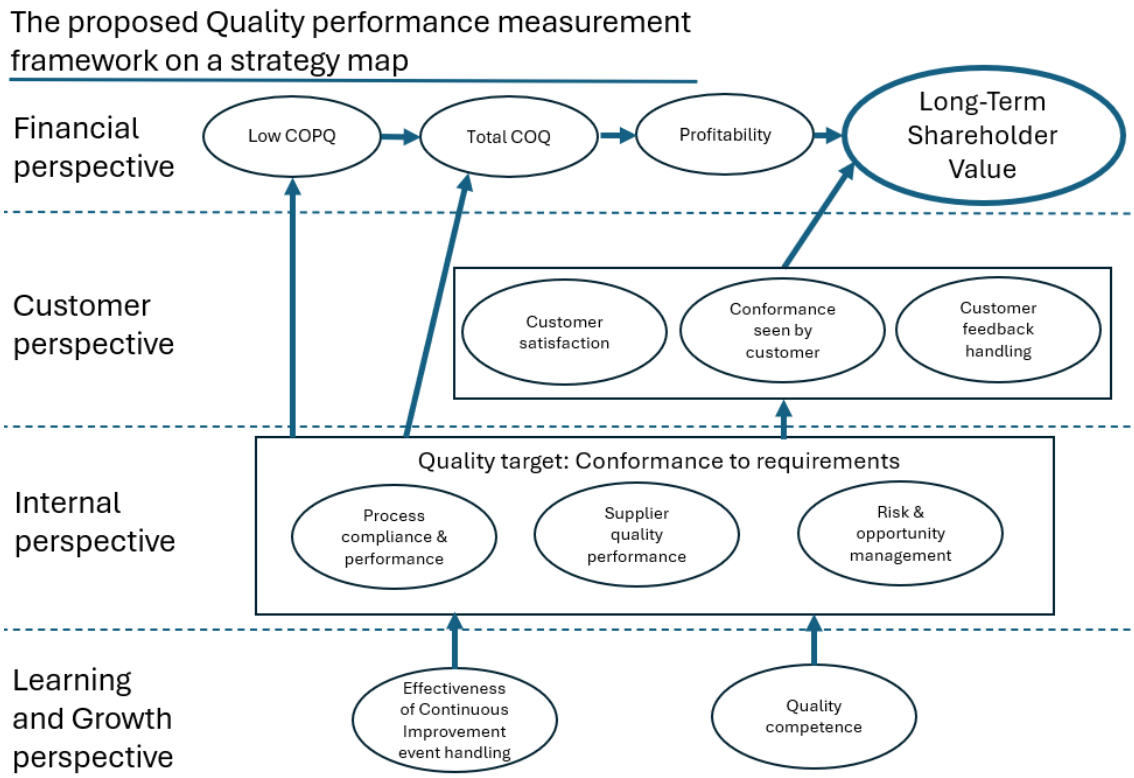


Figure 18. *The proposed quality performance measurement framework depicted on a strategy map.*

The implications of the strategy map are further discussed in chapter 5. The defined individual measures are presented by the four balanced scorecard perspectives, and by considering the measures related to each measured element. In the following tables 15, 16, 17, and 18, the proposed performance measures are given descriptions, and their applicability to the case quality function is described.

The financial perspective presented in table 15 includes three measured elements: COPQ, profitability, and total cost of quality. The cost of poor quality is depicted with the existing performance measures, including the costs in euros, as well as a percentage out of the net sales in the organizational units examined. Furthermore, the COPQ forecast, which is currently used in estimating the upcoming COPQ, is retained as a performance measure, providing future indication on the cost of poor quality. However, the established COPQ measures contain further development opportunities, as described in subchapter 4.2.1. For example, the drill-down opportunities to the result data could be improved to improve the analysis based on the measures. The profitability is depicted with EBITA, which is already in use in financial reporting and regarded as a KPI on the corporation level, but before not considered as depicting quality. Interviews 1 and 2, and the group meetings highlighted the importance of this measure's indication on examining

operational productivity and profitability in the corporation. For instance, EBITA addresses the effect of COPQ, but also other operating expenses to overall profitability, and thus offers a more comprehensive and general view to financial performance.

Table 15. *The proposed performance measures from the financial perspective.*

Financial perspective			
Measured element	Performance measure	Description	Applicability
COPQ	COPQ* (% of Net sales)	Measures Cost of Poor Quality as a ratio to net sales.	In use in monthly reporting
	COPQ forecast* (€, % of Net sales)	Estimates upcoming COPQ, is comprised of a baseline, known but not realized or booked COPQ, and of identified COPQ risk values.	In use in monthly reporting
	COPQ* (€)	Measures Cost of Poor Quality as a financial amount.	In use in monthly reporting
Profitability	EBITA (€)	Earnings before interests, taxes, and amortizations. Financial measure available from financial reporting systems.	In use in the corporation, data available at the business line level to be applied to the framework. Will be reported monthly.
Total COQ	Quality cost ratio	Measures the ratio of cost of good quality (COGQ) to the total cost of quality, comprising of COPQ and COGQ. COGQ comprises of preventive and appraisal activities that go into achieving quality.	Will be included in monthly reporting. Cost of good quality data is not comprehensively estimated in the corporation, and thus the implementation needs effort.

*Measured currently in the case function

The third measured element in table 15 is the total cost of quality, which is measured with the so-called quality cost ratio. The quality cost ratio calculates the proportion of the costs of good quality (COGQ) to total quality costs, and thus describes the distribution of quality costs to COPQ and COGQ. This measure bases on the PAF approach to quality costs (De Feo, 2017, chap. 25.8; Schiffauerova and Thomson, 2006), and to the proposition that it is always cost-efficient to invest in prevention and appraisal activities to reduce COPQ. The proposal for this type of measurement was addressed directly in the interview 8, and support for this measure arose in the group meetings, to provide indication on what is done in the corporation to ensure quality. The maturity in the corporation to implement the measure is low, because COGQ is not currently estimated in the organization. However, the corporation has defined COGQ to cover the cost of quality management, including inspection and testing cost, corrective actions cost, and prevention costs (D10). The key issue in the implementation is to decide, whether this categorization is followed, and what activities in the corporation should be regarded as prevention or appraisal activities.

The customer perspective is measured through customer satisfaction, conformance seen by the customer, and customer feedback handling. The measures are presented in table 16. Customer satisfaction is measured with the Net Promoter Score and can be incorporated into the quality performance measurement framework with established data source. Performance guarantees achieved on time and OTD on project handover to customer depict the conformance of the business line's output that can be directly observed by the customer.

Table 16. *The proposed performance measures from the customer perspective.*

Customer perspective			
Measured element	Performance measure	Description	Applicability
Customer Satisfaction	Net Promoter Score (NPS)	Ratio based on how likely the customers would recommend the company.	Available from the corporation customer satisfaction surveys, data available at business line level. Applicable to reporting in quality, will be reported quarterly.
Conformance seen by customer	OTD on project handover to customer (%)	Ratio based on the on-time delivery of projects handover to customer compared to the total amount of project deliveries.	Measurement used in project management, can be applied to quality framework with existing data, reported quarterly.
	Performance guarantees achieved on time (%)	Ratio based on on-time achievement of project performance guarantees made to the customer compared to all projects.	Measurement used in project management, can be applied to quality framework with existing data, reported quarterly.
Customer Feedback Handling	Customer CI event on-time completion rate (%)	Ratio that calculates how many of the continuous improvement events initiated by the customer were completed on time, compared to all closed events.	New measure, data available from the global feedback handling software. Reported quarterly.
	Customer claims (€, pcs)	An absolute measure supporting the customer perspective. Customer claims financial and numerical amounts between chosen period, for example YTD or R12 months.	Data available from the global feedback handling software, existing indicator in the corporation, implementation to the framework can be done quickly. Reported quarterly.

The third measured element is customer feedback handling, and it is measured with customer continuous improvement event on-time completion rate, and with customer claims. These measures offer indication on how well customer issues are handled, and the number and financial amounts of nonconformities from the customer perspective.

The internal perspective comprises of three measured elements, including supplier quality performance, process compliance and performance, and risk and opportunity

management. The need for adding emphasis on measuring process compliance and performance was emphasized widely in the interviews (1, 2, 4, 8, 13, 14, 17), but the current data availability does not allow for inspecting the operational processes of the business line comprehensively.

Table 17. *The proposed performance measures from the internal perspective.*

Internal perspective			
Measured element	Performance measure	Description	Applicability
Supplier Quality Performance	First time right from supplier to own operations (%)	Ratio based on how many of the articles delivered from suppliers are delivered correctly, with no need for reworks.	Data from the ERP system, application tested in a benchmarked business line. Reported quarterly.
Process compliance & performance	Process compliance, incl. quality process compliance* (%)	Ratio measuring overall process compliance in the business line. A possibility to drill down to inspect the compliance for each process. Includes the quality process compliance, currently measured in the case function.	Visibility is limited to processes compliance, not all processes have defined performance measures. The application demands a unified data storage solution. Reported quarterly.
	PEM Gate decisions on time (%)	Depicts the compliance of a project management process, the Project execution model (PEM). The measured decisions are made at the end of each project phase, to allow move on to the next phase. The ratio measures the decisions made on time and can be evaluated by each project.	Measure in use in project management, applicable to the framework. Reported quarterly.
Risk and opportunity management	Project risks related to COPQ (€)	Depicts the amounts of potential COPQ-related risks by utilizing the risk register.	The project risks data is available in the risk register governed by project management, but the risk amounts are not coded according to COPQ. Reported monthly.

*Measured currently in the case function

Further development of collecting and synthesizing the process compliance and performance data is needed to report them in the quality performance measurement framework. The quality process compliance, which is currently measured by the case function, should be incorporated in the general process compliance measure. A key process performance measure available for implementation is the PEM Gate decisions on time, which depicts the compliance of a project management process. The third measured element is the risk and opportunity management, and it is measured with the project risks related to COPQ. This measure aids in identifying quality-related risks and provides information for proactive risk mitigation actions.

The fourth perspective is **the learning and growth perspective**, and it includes the elements of quality competence and effectiveness of Continuous improvement events handling. Presented in table 18, quality competence is measured with the quality trainings completed in the organization by training hours and completion percentages.

Table 18. *The proposed performance measures from the internal perspective.*

Learning & Growth perspective			
Measured element	Performance measure	Description	Applicability
Quality Competence	Quality Trainings (h, completion %)	Measures the completed quality training hours and completion percentages.	Available HR process tool data can be utilized, the implementation can be done when the BAM is operational. Reported quarterly.
Effectiveness of CI event handling	Reoccurrence rate of Quality incidents (%)	Ratio based on quality incidents that have reoccurred compared to all handled quality incidents in a chosen period, for example YTD or R12 months.	Raw data available from the global feedback handling software, but links between reoccurring incidents demand categorization. Reported quarterly.
	CI event on-time completion rate (%)	Ratio that calculates how many of the continuous improvement events were completed on time, compared to all closed events.	New measure, utilization of data available from the global feedback handling software. Reported quarterly.

The existing continuous improvement measures are proposed to be replaced with reoccurrence rate of quality incidents, and with CI event on-time completion rate. This is done to provide more information on the impact of the continuous improvement activities in the case business line, rather than only focusing on how many continuous improvement events were handled in the global feedback handling software.

5. DISCUSSION

In this chapter, the findings of this study are judged, and their implications are reflected based on research literature. This is done with the aim to improve the validity of the case research results, and highlight new knowledge generated in this study. This chapter gives answers to the research questions. The structure of this chapter follows the research question structure, first discussing the implications on the three sub-questions, and secondly, addressing the main research question. Finally, development proposals are made for the case organization based on the empirical findings and researched literature in this study.

5.1 Drivers for change in quality measurement

First, the findings address

SQ1: What is the current state of data gathering, measurement, and reporting regarding quality?

by revealing several critical gaps in the case organization's quality measurement practices. The organization has yet to achieve Total Quality Management (TQM) or Strategic Quality Management (SQM) maturity, with its current focus on Quality Control (QC) and Quality Assurance (QA) rather than a holistic Quality Management (QM) approach still intended by the corporation's internal documentation (D11). Interviewee 3 highlighted that the Paper Business Line's emphasis on auditing and quality control offers a retrospective view of quality, lacking the proactive, improvement-driven perspective central to TQM (Sower, 2010, p. 20), for example. Organizational silos further hinder the integration and collective ownership of quality, as noted by interviewee 5, creating barriers to cross-functional collaboration. Although various quality-related metrics and practices exist at both business line and organizational levels, they are not effectively reported or managed within a quality management context. This limits the organization's ability to fully leverage its quality performance potential. The quality function's role, instead of embodying a holistic oversight of quality as modern theories recommend, appears narrow and focused on reporting and operational oversight. Interviewee 15 observed that the visibility of quality initiatives is minimal at the operational and project levels, which weakens alignment with the principle that quality should be a shared responsibility across all

levels. This situation underscores the need for a more integrated, organization-wide approach to quality that embraces TQM principles and fosters proactive, cross-functional collaboration.

The cost of poor quality (COPQ) is widely used as a measurement for assessing quality, offering a measurable target for the quality function while supporting improvements in quality performance (D2). However, the excessive focus on COPQ seems to present challenges. Interviewee 15 noted that COPQ metrics often fail to provide actionable feedback to the employees making the data entries, diminishing their motivation. Furthermore, while COPQ aligns with the goal of error-free production and complete process conformance (Sower, 2010, p. 11), it may not be sufficient as a sole metric. Kaplan and Norton (2004) argue that financial outcomes, while critical, are lagging indicators of success, whereas internal processes—key drivers of value creation—serve as leading indicators. As Gupta and Campbell (1995) also highlight in the context of quality costs, detecting problems earlier reduces the effort required for their resolution. Additionally, models like PAF, which focus exclusively on quality costs, overlook the broader impact of quality improvements on factors such as pricing, sales volumes, supplier quality, and continuous improvement (Krishnan, 2006). Over-reliance on COPQ can also create an illusion of control for management, where measurable outputs mask deeper systemic issues (Gray et al., 2015). While improved quality performance reduces COPQ (Wei, 2019), and as such, COPQ can offer an indication on quality development, an overemphasis on this measure risks narrowing the organization's focus, potentially ignoring other relevant dimensions of quality and value creation.

The appropriate use for financial versus operational measures often depends on the organizational level, with a critical transition point where financial metrics are prioritized over operational data for effective communication and reporting (Merchant et al., 2017). In the corporation, this transition appears to occur at the business line level, which is the case function inspected in this study. The business units' (which report to the business line level) focus is more on developing operations, while the upper management wishes to see good results (interviewee 7). This complicates the reporting and communication of measurement and limiting opportunities for development.

A significant challenge in quality performance measurement in the case organization lies in the availability and usability of data, which can be improved via the implementation of the planned Business Analytics Module. Interviewees (e.g., interview 1) emphasized that the availability of relevant data is a persistent issue, a problem also identified during the development phase of this study, which revealed the need for new data sources to implement the proposed quality performance measurement system. The organization's

large and fragmented structure, coupled with varying levels of maturity across units (interviews 3, 14, 18), worsens these challenges. Building a comprehensive measurement framework is more challenging in such a context, leaving gaps in the data needed to drive meaningful improvements in quality performance. Without reliable and accessible data, the organization risks undermining the effectiveness of its quality initiatives and limiting its potential for further, strategic quality improvement.

5.2 Use of quality performance measurement

This section addresses

SQ2: What quality performance measures are needed, and why?

by exploring the role of performance measurement systems in aligning quality management with organizational goals and addressing both external and internal challenges. Performance measurement systems are developed due to external pressures, in this case ISO 9001 requirements for example, and internal challenges like data limitations and over-reliance on metrics such as COPQ. These drivers, including the need to address dysfunctional behaviors and gaps in actual performance as well as legislation, highlight the necessity of refining measurement systems (Kennerley & Neely, 2002), to align with organizational goals and improve quality management.

One key need for quality performance measurement stems from the organization's ISO 9001 certification, which defines the requirements for the quality management system (interviews 1, 14). While compliance with ISO 9001 establishes a strong foundation, transitioning from meeting these requirements to embedding them effectively into management and operations is crucial. Literature (Namji, 2001) indicates that the absence of a well-designed performance measurement system is a significant obstacle in evolving from ISO 9000 compliance towards Total Quality Management (TQM). Such systems are crucial for translating ISO objectives into operations, a process that demands effective leadership and management. Furthermore, poorly designed measurement systems often undermine the effectiveness of TQM initiatives, as they fail to adequately support or evaluate quality improvement efforts (Karamouz, 2020). In this context, performance measurement becomes essential not only for aligning operations with ISO goals but also for driving the overall impact and success of quality management practices. By implementing a well-fitting performance measurement system, the organization can ensure that ISO compliance evolves into a proactive and integrated approach to quality management.

Quality performance measurement is integral to quality management, as management and measurement are inseparable (Lebas, 1995). Dashboards and other measurement tools are often derived from quality management frameworks such as PDCA and DMAIC, bridging performance measurement with quality management theory in a meaningful way (Gitlow, 2005). Interviews confirm that over half of respondents view performance measurement as essential for facilitating development, particularly through continuous improvement cycles. Furthermore, performance measures must be strategically aligned with organizational goals to ensure their effectiveness (Chytas et al., 2011; interviews 2, 11). Performance measurement serves various purposes, including reporting (interviews 1, 8, 11, 12, 13, 18) and employee rewarding (interviews 2, 5, 6, 7). However, misuses such as manipulating measurements to present misleading results—can undermine its successful incorporation (Gray, 2015). When designed and implemented correctly, performance measurement not only supports development but also strengthens the strategic integration of quality management across the organization.

Effective performance measurement systems are needed for improving organizational performance through improved quality. As noted in this study, quality improvements reduce costs and align closely with customer perceptions, a key element emphasized in interviews 8 and 13. Each functional area should establish relevant measures to manage performance effectively (Wisner and Fawcett, 1991). Quality, by the definition in this study, enhances organizational outcomes, making functional quality measurement critical to strengthening quality management and driving performance improvements (Hietschold, 2014). Research supports this relationship, demonstrating that quality management directly impacts quality performance, which in turn improves organizational performance (Patyal and Koilakuntla, 2017). Management plays a crucial role in integrating these elements, linking quality practices to strategic objectives (Lakhal, 2004). This need for alignment is further underscored in the strategy map presented in subchapter 5.4, highlighting how targeted improvements in quality performance measures facilitate continuous improvement and organizational success.

5.3 Proactivity of quality performance measurement

This section directly addresses

SQ3: How to increase proactivity in quality performance measurement?

by examining strategies to make measurement systems more forward-looking and aligned with future-oriented quality management practices. Exploring the proactive aspects of performance measurement offers new insights for advancing the field. Proactive

measures emphasize future-oriented activities, which are better positioned to sustain organizational performance over time (Bitici, 2011). Jääskeläinen and Roitto (2016) suggest that further research into the proactive use of measurement could be done, underscoring its relevance for evolving measurement practices. However, the transition to proactive measurement is not without challenges. Empirical findings highlight risks such as lack of management commitment (interview 4), the need for cross-functional support, and fragmented management responsibilities (interview 18). These findings underline the importance of addressing organizational and leadership factors when adopting proactive measurement strategies. Next, the themes of risks, proactive quality costs and other leading indicators from the developed quality performance measurement system are discussed.

Integrating risk-based thinking into a quality management system (QMS) is critical for enhancing proactive quality performance measurement. Limited research exists on the connection between QMS and risk management systems (RMS), yet their integration is increasingly recognized as vital for improving organizational efficiency and effectiveness (Samani et al., 2019; Popescu and Dascalu, 2011). Both risks and quality are essential components of performance measurement systems that can drive preventive and future-focused actions (Popescu and Dascalu, 2011). The ISO 9001:2015 revision reflects this perspective by replacing "preventive action" with "risk and opportunity" management, emphasizing the role of risk-based thinking in achieving quality improvements (Fonseca, 2019; 2015).

Despite this potential, risk-based thinking has not been incorporated into the case organization’s quality measurement system, presenting a significant missed opportunity. Over half of the interviewees (1, 2, 3, 5, 7, 8, 10, 11, 17, 18) highlighted the importance of risk and opportunity management in achieving proactive quality measures. However, challenges persist, including insufficient management competencies, unclear responsibilities, and limited cross-functional collaboration (Popova et al., 2019; interview 18). While these barriers must be addressed, respondents (Fonseca, 2019) also identified significant benefits in adopting risk-based approaches, particularly in improving quality performance and aligning measurement systems with organizational strategy.

The second key theme for proactive quality measures are prevention and appraisal costs, key components of the PAF quality cost model. Prevention costs focus on mitigating potential quality issues through the design, implementation, and maintenance of quality systems, reducing the likelihood and impact of failures (Sandoval-Chávez and Beruvides, 1998). Appraisal costs, on the other hand, involve monitoring and measuring quality to detect deviations early, enabling corrective action before products or services reach

the customer. Together, these costs support a proactive approach to quality by addressing issues at their source, minimizing failures, and enhancing overall organizational performance. However, even though the designed quality performance measurement system incorporated the quality the measure “Quality cost ratio”, considerable resources must be allocated into developing the cost of good quality data, because this data is not currently available in the organization. This measure could, however, offer significant improvement in the proactivity of the measurement system, while still offering easily understandable financial data.

In addition to incorporating risks and the PAF model measures, the proactivity of the quality measurement system can be enhanced by including such leading indicators, that have a cause-and-effect relationship on traditional, financial quality measures, such as the COPQ. Measures such as the Customer Continuous Improvement event on-time completion rate provide indication on how efficient the continuous improvement event handling process is, and thus offer a view on the quality culture in the corporation. That is, even though the measure itself does not predict how the events are closed and is not proactive in that context, it can offer indication on how quality is prioritized and how much care is put into quality improvement across the business line, which can indicate either good or bad results regarding the conformance in end products, for example. In conclusion, these types of measures from the Learning and growth perspective (Kaplan and Norton, 2004), for example, are proactive indicators for the larger context of quality in the business line. The strategy map can thus offer an illustration on these cause-and-effect relationships (Jääskeläinen and Roitto, 2016), but the issue in these visualizations is that they do not confirm whether there are actual correlations between the different measurement elements. The relationships could be studied further using different mapping technologies (Jääskeläinen and Roitto, 2016; Chytas et al., 2011), to aid in gaining trust on these type of proactive measurement practices.

The reactive nature of quality measurement seems to be a persistent issue in the case organization (interviewee 18). Based on the definition of quality in this study, quality is conformance to requirements, and conformance happens during operations, or actualizes after manufacturing due to non-conformities. Thus, the nature of quality as it is defined often offers lagging indication on conformance. On the other hand, when addressing the company as a whole, quality itself can be a predictor of organizational success (Neely et al., 2000; Kaplan and Norton, 1992) and thus, even lagging quality metrics can offer leading indication on the whole organization’s success. So, the proactiveness or “leading nature” of the indicator can depend on the level of examination and on the ob-

server. This subjective perspective on proactivity can also highlight the different perspectives and needs towards the performance measurement system development and its correct measurement weightings. For example, a vice president leading the business line can be content with the COPQ measurement, as it functions as one KPI for the overall operations of the business line. Conversely, a business unit quality manager can see COPQ as a measure that is over-emphasized, rigid, and offers little value to the individual operator on the shop floor. Neither of these perspectives are inherently wrong or right, per se, but they effectively highlight the different needs of different stakeholders for measurement.

5.4 Reflection on the quality performance measurement system development

This section synthesizes findings from the study to answer

RQ1: How to develop a balanced quality performance measurement system in a manufacturing company's business line operating in paper machinery industry?

Drawing on the results from the sub-questions and leveraging both theoretical and empirical understanding, the study provides a comprehensive response to this main research question.

Quality, as highlighted in the Balanced Scorecard framework, is inherently proactive in its approach (Garvin, 1987; 1984). However, a notable gap exists in the literature concerning the integration of Quality Management Systems (QMS) and Performance Measurement Systems (PMS) (Pimentel and Major, 2014). Addressing this gap requires overcoming the significant challenge of combining Total Quality Management (TQM) principles with performance measurement practices, an effort that, while complex, promises substantial benefits for organizations that succeed (Pun, 2002).

The strategy map and proactive elements list (in table 5) were used in evaluating the current state of the quality performance measurement system and in formulating the proposed system. The proactive elements list highlighted that while Continuous Improvement (CI) is conceptually proactive, its practical effectiveness is limited due to inadequate measurement practices and IT-related challenges in the organization. Furthermore, the list confirmed that COPQ is not inherently proactive and revealed a gap in addressing correlations—a key characteristic of effective metrics, as emphasized in literature (Gray et al., 2015, p. 65; Eckerson, 2010, pp. 209–212; Malina and Selto, 2004). For possible future applications, the list could be enhanced by incorporating the importance of correlations when used alongside strategy map frameworks.

Implementing the strategy map into the case organization context needed effort. For example, the diverse and often ambiguous definitions of quality in the literature, as noted by Garvin (1984), complicated its initial development. Variations in quality definitions within the organization further hindered alignment. Despite these challenges, the strategy map provided a structured framework to integrate quality performance measures with strategic objectives, supporting the transition toward a more systematic and proactive approach.

The strategy map, based on Kaplan and Norton's (2004) framework, served three key functions in this study, as illustrated in figure 19. First, it was used to visualize the theoretical foundation of a quality strategy framework. Second, it helped map the current state of quality performance measurement within the case organization. Lastly, it provided a visual representation of the proposed quality performance measurement framework, offering a structured pathway for its development.

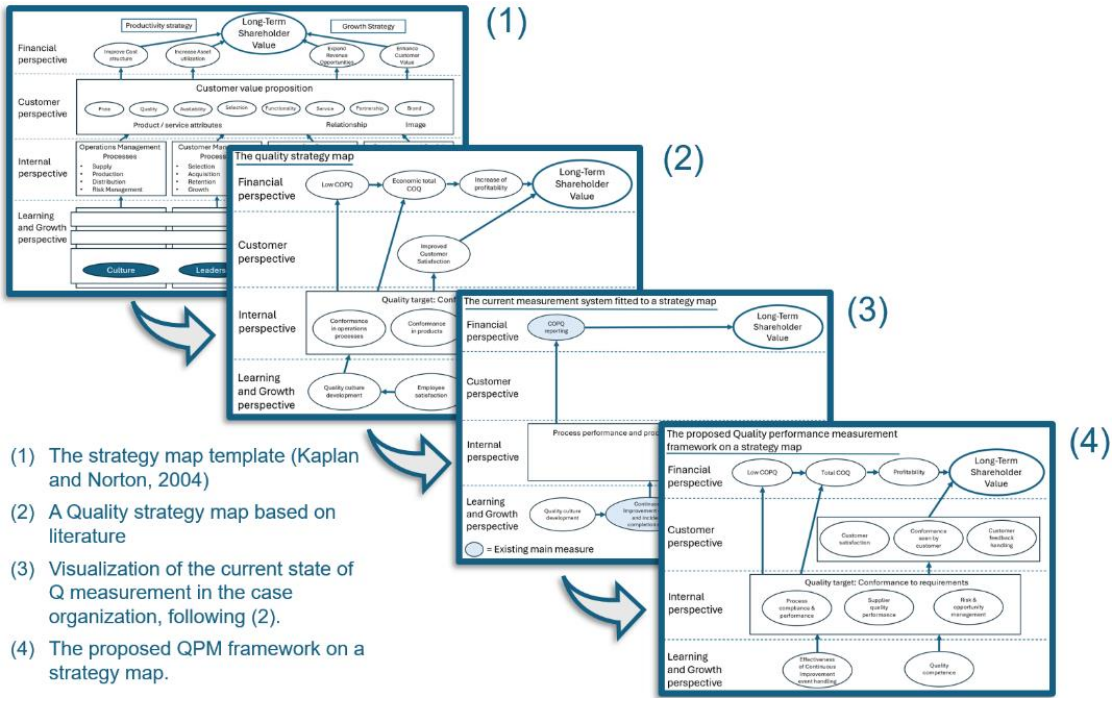


Figure 19. *The application of the strategy map in this study.*

The strategy map also supported the exploration of proactive quality measures. By illustrating the potential predictive value of metrics not traditionally considered quality-related, it helped broaden the organization's understanding of quality. Moreover, the map effectively highlighted the lack of balance in the current measurement system, as identified by several interviewees (i1,2,3,4,6,8,12,18). This imbalance underscored the need for a more comprehensive and aligned set of metrics, a concept widely recognized as essential for quality management.

Additionally, the strategy map emerged as a valuable tool for communicating quality-related strategies and objectives, especially at the business line level. It offered a clear rationale for adopting a broader range of metrics beyond COPQ, which could enhance buy-in from management, a critical factor in the successful implementation of performance measurement systems.

The development of the quality performance measurement system combined elements from the strategy map framework and principles for quality performance measurement system design (Parmenter, 2019, p. 44; Taticchi et al., 2012; Suomala et al., 2011, chap. 7.3; Sousa and Aspinwall, 2010; Chang, 2006b; Neely et al., 2005; Bourne et al., 2000; Neely et al., 2000, 1997), creating both opportunities and challenges. While the process-oriented approach provided a structured pathway, the strategy map inherently directed the development toward specific outcomes. This two-level framework approach, while beneficial, risked confusion, as the simultaneous use of a predefined framework and a development process required careful integration. The alignment of quality-related critical success factors (CSFs) with the Balanced Scorecard framework added complexity, as ensuring strategic coherence demanded significant effort. Furthermore, the distinction between creating a new measurement system and updating an existing one, highlighted by Bourne et al. (2000), was critical in navigating this process. Ultimately, balancing structure of the strategy map and flexibility of the system design principles proved to be a useful combination in quality performance measurement development, despite of the challenges.

Developing the quality performance measurement system faced several challenges, both conceptual and practical. Among these were issues highlighted by Gray et al. (2015, pp. 11–12), such as the illusion of control fostered by measurements, dysfunctional behavior stemming from excessive performance pressure, and gaming or cheating to manipulate results. Similar concerns surfaced in interview data suggesting these issues must be addressed in the future. Another challenge involved determining the appropriate number and scope of measures. As noted by Parmenter (2020), Neely (2000), and Keegan (1989), and mentioned by interviewees (i12, i13, i14), too many measures can dilute focus and complicate management. In response, a third measurement tier was introduced in the strategy map and the designed system to clarify groupings and relationships among measures, a modification that could be considered in future development in the field. Furthermore, the complexity of aligning the business line's scale and the quality function's role with its surrounding organizational structure presented difficulties in selecting appropriate measures at different levels. Finally, ownership and accountability for

measurement results emerged as concerns, requiring careful allocation of responsibilities between line functions and supporting functions, as advised by Neely et al. (1997, 2000). These challenges underscore the literature's notions of importance for designing a measurement system that is both comprehensive and manageable, with clear accountability structures.

Preceding the development proposals for the case organization, the final theme regarding this discussion is the comparison of the designed quality performance measurement system in this study to the models and systems found in the literature. The developed quality performance measurement system in this study can be compared to established frameworks in literature, such as Shin's (2018) PAF-based quality framework, and the Kanji Business Excellence Model (Kanji, 2008). Despite the variety of approaches, the Balanced Scorecard (BSC) was deemed a suitable foundation for the case organization due to its alignment with quality measurement needs, as it was found useful in the literature (Karamouz et al., 2020; Wei et al., 2019; Pimentel and Major, 2014; Kaynak, 2003), and also due to its ability to bridge quality management and strategic goals. Thus, this study establishes new information to the research field by connecting dots between TQM and the Balanced Scorecard, by depicting that a suitable balanced measurement system can be developed through a development process in the context of a quality organization striving towards a comprehensive quality improvement culture and fulfilling ISO 9001 requirements. The utilities of the BSC and the strategy map lie not only on their theoretical basis but also in their practical application for aligning and communicating quality objectives.

The integration of quality costs into the BSC framework offers an operational advantage, as proposed by Shin et al. (2018) and Sower (2010). One of the established frameworks, The Quality Scorecard Wheel (Shin et al., 2018) demonstrates that the PAF model's prevention and appraisal costs can complement traditional BSC perspectives, enriching the framework's applicability. For organizations with legacy systems centered on COPQ, as in the case organization, this integration provides a clear path for evolving quality performance measurement systems while leveraging familiar structures. Conversely, for organizations already using the BSC in other functions, extending it to include quality costs can enhance coherence and usability. Interestingly, both approaches include similar measures, but differ in how they categorize and prioritize them. Selecting a framework should account for organizational culture, familiarity with existing systems, and strategic alignment to ensure smooth implementation and buy-in from stakeholders. In this way, this study provides a valuable roadmap for designing a flexible, context-sensitive quality performance measurement system.

5.5 Development proposals for the case organization

In addition to the development of the quality performance measurement system for the case organization, several further development proposals arose from the study. Several of these proposals center around the development of the infrastructure surrounding the proposed QPMS, to implement the system successfully in the future. The development proposals are categorized into short- and long-term suggestions, inspired by the KPI implementation timeline matrix from Jochem (et al., 2010).

To support the implementation of the proposed quality performance measurement system, several short-term development steps are recommended. First, **allocating resources to improve data categorization** and the **usability of IT systems** is essential for enhancing decision-making accuracy and the utility of performance data. Additionally, **clarifying roles and responsibilities**, especially regarding risk and opportunity management, would address organizational ambiguities noted during interviews. **Benchmarking**, as suggested by De Feo (2017, chap. 7.6.3), could be employed to identify best practices and accelerate system adoption. Furthermore, attention should be given to the reasons managers resist adopting dashboards, as highlighted by Allio (2012), to ensure effective engagement. A balanced approach to measurement is evidently preferrable within the organization, as seen in Table 13, indicating **the need to emphasize process compliance and performance metrics**, which were widely highlighted in interviews (e.g., 1, 2, 4, 8, 13, 14, 17).

Long-term initiatives should focus on embedding proactive quality management deeper into the organizational culture. **Addressing risks**, such as internal production of nonconforming products, which were identified as critical in ISO 9001:2015 audits (Chiarini, 2017), should be prioritized. **Investing in forecasting and predictive analytics capabilities**, as suggested by Saab et al. (2018), offers significant potential; time-series analysis and machine learning can proactively identify quality anomalies. Additionally, **modifying the reward system to move beyond COPQ-based incentives** is critical, as the current approach may disincentivize reporting issues. Adopting a more comprehensive Total Quality Management (TQM) framework (Sower, 2010, p. 20) by **implementing matrix management structures and integrating Quality and HSE metrics into team KPIs** would encourage shared accountability for quality outcomes. Lastly, **enhancing drill-down analysis capabilities** could boost employee motivation and foster a stronger quality culture. The continued exploration of the Quality Cost Ratio is recommended as a longer-term metric refinement opportunity to sustain improvements.

6. CONCLUSION

This chapter completes the study. The conclusion addresses key findings, as well as managerial and scientific contributions of this study. Furthermore, the evaluation and limitations of the research are discussed, along with future research opportunities.

6.1 Key findings

This study addressed the research sub-questions (SQ1, SQ2, and SQ3) to develop a comprehensive understanding of quality performance measurement in a paper machinery manufacturing context, ultimately answering the main research question (RQ1). Regarding SQ1, the study revealed significant gaps in the current state of data gathering, measurement, and reporting. While lagging indicators, such as the COPQ, are emphasized, they fail to capture proactive insights or establish cause-and-effect relationships within the quality management framework. Issues such as fragmented organization, insufficient data availability, and the absence of TQM and SQM principles hinder progress toward a balanced and proactive quality measurement system. A key observation is that performance measures must align with hierarchical management levels to ensure relevance and impact. Moreover, embedding quality measurement within the broader management structure emerged as a critical factor for achieving a more holistic approach to quality performance.

In addressing SQ2, the study identified that the need for the quality performance measurement system development was in response to external pressures, such as the ISO 9001:2015 revision, as well as previously mentioned internal challenges. Furthermore, data drill-down capabilities and proactive control mechanisms remain inadequate, limiting the ability of the quality function to facilitate real-time operational improvements. Effective quality performance measurement systems were found to have the potential to significantly enhance organizational performance by bridging these pressures and challenges. Importantly, the proactivity of specific measures depends on user perspectives and their integration into operational workflows. The study underscores the need for a balance between reactive and proactive measures to meet both compliance requirements and strategic quality objectives.

To address SQ3, the research highlights the necessity of adopting risk-based thinking, predictive analytics, and a balanced set of leading and lagging indicators. Integrating these elements within the PMS framework allows organizations to connect measures

with cause-and-effect relationships that drive desired quality outcomes. Achieving this requires a commitment to change, clear delineation of management responsibilities, and enhanced data management competencies. Proactivity, a recurring theme in the findings, is rooted in principles such as the PAF cost model and ISO 9001:2015's emphasis on risk-based thinking. While these measures foster continuous improvement, challenges such as limited IT capabilities and inadequate continuous improvement (CI) practices must be addressed. To overcome these obstacles, the study proposed a two-level framework approach, combining the Balanced Scorecard and strategy map methodology with adaptable design principles to ensure theoretical rigor and practical applicability.

Answering RQ1 holistically, the study found that adopting strategic alignment through tools like strategy maps and the Balanced Scorecard enables organizations to incorporate proactive elements into quality performance measurement. Strategy maps were instrumental in visualizing the theoretical underpinnings of quality strategies, diagnosing current measurement practices, and communicating proposed frameworks. A two-level framework approach used in this study can aid in setting clear goals for the target state of the measurement framework, and with the design process, effectively guide the development of a quality performance measurement system. By aligning with literature on performance measurement design processes, this approach offers a practical method to track and improve quality performance while enhancing organizational outcomes. Furthermore, adopting such a process enables flexibility and context sensitivity, ensuring the system adapts to the organization's culture and existing practices for seamless implementation. However, achieving an effective quality performance measurement system involves overcoming several practical issues, such as selecting an optimal number of measures, ensuring clarity in measurement groupings, and establishing clear accountability. The study proposed new measures, including leading indicators for risk and opportunity management, and refining the measurement of quality costs to foster a proactive and balanced approach. By aligning performance measurement literature with quality management principles, the findings offer a roadmap for organizations to enhance their quality performance while achieving strategic alignment and operational efficiency.

6.2 Contribution

This study provides both managerial and scientific contributions, offering perspectives and actionable recommendations for advancing quality performance measurement in the paper machinery industry and beyond.

From a managerial perspective, the findings highlight short-term priorities for developing the measurement infrastructure, including allocating resources to improve IT systems, clarifying management roles, benchmarking against other companies, and emphasizing process compliance and performance. In the long term, the organization is encouraged to incorporate risk considerations into quality performance measurement systems, invest in predictive analytics, and modify incentive systems to reduce overemphasis on COPQ. These initiatives can foster a transition toward Total Quality Management (TQM), enhancing shared accountability and improving the organizational quality culture. Additionally, the study underscores the importance of maintaining and further refining the newly designed quality performance measurement system to ensure its sustained impact on quality management effectiveness and efficiency. While this research focuses on a specific case, its findings have broader applicability, particularly for manufacturing organizations adhering to ISO 9001 standards. Tools like the strategy map demonstrated versatility, offering actionable perspectives for organizations aiming to align quality management with broader performance objectives.

From a scientific perspective, this research contributes novel advancements by bridging the gap between TQM principles and the Balanced Scorecard (BSC) framework. The study expands upon existing models, such as the Quality Scorecard Wheel and Kanji's Business Excellence Model, demonstrating how the BSC can integrate quality costs and align with ISO 9001 requirements. This adaptability allows organizations to evolve their legacy systems while maintaining strategic coherence. By aligning TQM with performance measurement practices, the study addresses a significant gap noted in the literature, particularly the challenges of integrating Quality management systems and Performance measurement systems. Furthermore, the study offers practical examples of the quality performance measurement system development process, emphasizing the importance of clearly defining the concept of quality within organizations and identifying relevant metrics that balance organizational and functional perspectives.

A key contribution of this study is the two-level framework approach to developing quality performance measurement system, combining the Balanced Scorecard with quality management principles to establish a proactive, balanced measurement system. This approach highlights the value of tools such as the strategy map, which supports the exploration of proactive quality measures, aligns strategic objectives with operational metrics, and fosters continuous improvement. The introduction of concepts like the quality cost ratio provides a foundation for further research into proactive measurement practices. Ultimately, the study advances the academic discussion by illustrating how organ-

izations can integrate TQM principles with the Balanced Scorecard to build comprehensive quality improvement cultures that fulfil ISO 9001 requirements. This connection between theoretical rigor and practical applicability enhances the field of quality management, offering both researchers and practitioners a structured pathway for innovation in quality management and performance measurement.

6.3 Evaluation and limitations of the research

This study successfully addressed the research questions by applying and refining established theory within the context of the case organization. As described in Chapter 3.1, the study aimed to both explore and refine theory and gain an in-depth understanding of the specific quality measurement issues within the organization. The study met its purpose by thoroughly analyzing the existing quality performance measurement practices and developing a framework tailored to the organization's needs.

The trustworthiness of qualitative research can be evaluated with four criteria:credibility, transferability, dependability, and confirmability (Shenton, 2004). The *credibility* of the research was supported by a data validation process, including transcription of interview data, review of recorded interviews, and their comparison to automatic transcriptions to ensure accuracy. The researcher's prior familiarity with the organization further increased credibility, as did the use of multiple research methods and data triangulation, including internal documentation, interviews, group meetings, and informal discussions. Data from different business lines within the case company adds reliability to the findings. However, to increase reliability and mitigate company-specific biases, incorporating data from different companies would have enhanced the validity of the conclusions. This was, however, out of the scope of this thesis due to limited resources.

The *transferability* of the study means that the study has been described in such a way that it would be possible to repeat it in another environment by another researcher (Shenton, 2004). The study's transferability was carefully considered, with efforts to document and present the research context in as much detail as possible while preserving participant anonymity. While the case study approach limits generalization, the in-depth description of the organization's current situation, characteristics, and operational context improves the study's potential for transfer to similar environments.

To ensure *dependability*, all processes and changes made during the study must be documented (Saunders et al., 2019, p. 217; Shenton, 2004). Dependability was ensured by documenting all research processes and changes made throughout the study. *Confirmability* is sought by minimizing the researcher's influence on the results, i.e. by being

as objective as possible and avoiding presuppositions (Shenton, 2004), and it was maintained by minimizing researcher bias. Despite efforts to remain objective, the researcher's prior experience with the company could have influenced the research approach and findings, as is often the case with qualitative research (Saunders et al., 2019, p. 447). Furthermore, the methodological choices made in the study were also largely affected by the researcher's own skills and knowledge.

The research had several limitations. The narrow scope of the study limits its generalizability. Since the research was conducted within a single company, the findings may not be directly applicable to other industries or organizations with different characteristics. Moreover, while the developed quality performance measurement system is highly relevant to manufacturing companies, its applicability to different industries or organizations of varying sizes may be more challenging. Furthermore, the data analysis may be influenced by the researcher's own interpretations, as the code names, for example, were decided by the researcher. Potential biases in the semi-structured interviews also raise concerns about objectivity. Additionally, the purposive sampling method used to select interviewees based on their assumed roles within the corporation may have introduced participation bias, potentially skewing the sample. While the sampling strategy aimed to capture a range of perspectives, the selection of participants could have limited the diversity of views. Participation bias occurs when certain individuals are more inclined to volunteer for research activities, resulting in a skewed sample that may not fully represent the broader population or phenomenon being studied (Saunders et al., 2019, p. 448). Although efforts were made to minimize interviewer bias, variations in how questions were posed could have influenced participant responses. As noted by Saunders et al. (2019, p. 437), the reliability of semi-structured interviews may be questioned due to the difficulty in standardizing them.

6.4 Future research

Future research could explore several key areas to further develop quality performance measurement systems. One potential avenue is the continued implementation of the PAF quality costs model, particularly in organizations with established COPQ reporting, to enhance proactive cost management. Further research could also focus on the utilization of the Quality Cost Ratio in quality measurement, exploring how this measure can provide a more comprehensive view of quality performance. Another area for investigation is the generalization of this study's results across various case settings, industries, and organizational types to assess the broader applicability and identify industry-specific differences.

Emerging technologies, such as machine learning and AI, can offer opportunities to improve data gathering efficiency, map correlations, and predict quality issues before they occur. These technologies could also automate data analysis and enhance decision-making in real-time. Finally, studying the integration of QMS and PMS offers potential for improving alignment and maximizing organizational performance. This area of research could provide valuable contribution into effectively incorporating quality measures into strategic performance frameworks. These research directions could advance quality management practices, providing organizations with more efficient tools for improving quality and operational performance.

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APPENDIX A: INTERVIEW SCRIPT IN FINNISH

1. **Teema: Tausta**
    1.1. Voisitteko antaa lyhyen yleiskuvan roolistanne ja vastuualueistanne yrityksessä?
    1.2. Kuinka kauan olette olleet yrityksessä ja millainen kokemuksenne on laadunhallinnasta ja raportoinnista yleisesti?
    1.3. Miten *_company name_* suhtautuminen laatuun on kokemustesi perusteella kehittynyt?
    1.4. Mitä erityispiirteitä vastuualueesi toimiala (ja markkina) tuo laadun mittaamiseen ja raportointiin?
2. **Teema: Laaturaportoinnin ja suorituskyvyn mittauksen nykytila (Neely et al., 2000; Eckerson, 2010 p.5; Suomala et al., 2018)**
    2.1. Voisitteko kuvata tärkeimmät mittarit, joilla laadun suorituskykyä mitataan ja raportoidaan työssäsi tällä hetkellä?
        2.1.1. Mihin näitä mittareita käytetään?
        2.1.2. Mihin toimiin mittareiden tuottamat tulokset tyypillisesti johtavat?
    2.2. Mitä menetelmiä tai työkaluja liiketoimintayksikkönne tällä hetkellä käyttää laadun suorituskyvyn tietojen keräämiseen, analysointiin ja raportointiin?
    2.3. Miten arvioisit laaturaportoinnin ja mittareiden hyvyyttä tällä hetkellä omassa työnkuvassasi?
        2.3.1. Millaisena koet mittarien kyvyn kuvata organisaatiolle tärkeitä asioita?
        2.3.2. Millaisena koet mittarien kyvyn tuottaa luotettavaa ja tarkkaa informaatiota?
        2.3.3. Millaisena koet mittarien kyvyn tuottaa nimenomaan laatua kuvaavaa informaatiota harhattomasti?
    2.4. Kuinka paljon työaikaa tuntitasolla käytät kuukaudessa laaturaportin muodostamiseen?
    2.5. Kuinka paljon työaikaa tuntitasolla käytät kuukaudessa laaturaportin tulosten analysointiin?
    2.6. Miten käytössä olevat mittarit liittyvät yrityksen ja liiketoimintalinjan strategiaan ja strategian painopisteisiin (must-wins)?
    2.7. Miten hyödynnät nykyistä mittaristoa johtamistyössä ja päätöksenteossa?
    2.8. Millaisia haasteita tai rajoituksia kohtaatte nykyisessä laadun mittauksessa ja raportoinnissa?

3. **Teema: Laadun suorituskyvyn mittaamisen kehittäminen (Neely et al., 2000)**
    3.1. Mitkä nykyisistä laadun mittareista ovat hyödyttömiä, tai mille ei ole käyttöä?
    3.2. Miten ja miksi nykyistä laatumittaristoa ja sen puutteita, tulisi mielestäsi kehittää?
    3.3. Minkälaisia laatumittareita olisi mielestäsi syytä kehittää, kun tavoitteena on laadun suorituskyvyn parantaminen?
    3.4. Mikä/mitkä ilmiöt/tapahtumat organisaation laatuun liittyen ovat sellaisia, joita ei tällä hetkellä virallisesti mitata, mutta joiden ilmeneminen kuitenkin kuvastaa merkittävästi laadun suorituskykyä?

4. **Teema: Laadun mittaamisen kehittäminen proaktiivisemmaksi (Neely et al., 2000; ISO 9001:2015)**
    4.1. Mitkä tekijät mielestäsi edeltävät ja ennustavat laadun suorituskyvyn kehitystä?
    4.2. Mitkä strategiat tai aloitteet ovat tällä hetkellä käynnissä laadunhallinnan proaktiivisuuden edistämiseksi **company name* ja/tai liiketoimintayksikössä?
    4.3. Miten proaktiivisuus tulisi ottaa osaksi laatujohtamista? Miksi?
    4.4. Organisaation näkökulmasta, mitä muutoksia tai parannuksia uskotte tarvittavan proaktiivisen laadunhallinnan käytäntöjen kehittämiseksi ja toteuttamiseksi?
    4.5. Mitkä ovat mielestänne merkittävimmät riskit laadun suorituskyvyn mittaamisen ja laadunhallinnan kehittämisessä ja proaktiivisuuteen pyrkimisessä?

5. **Lopuksi**
    5.1. Onko sinulla jotain täydennettävää vastauksiisi, tai muuta kerrottavaa käsiteltyihin teemoihin liittyen?
    5.2. Voiko sinuun olla yhteydessä, jos jotain haastattelussa esiintynyttä vastausta halutaan selventää?
    5.3. Onko sinulla suosituksia tai ehdotuksia tämän haastattelurungon kehittämiseksi, tai jatkotutkimukselle tällä alueella?

APPENDIX B: INTERVIEW SCRIPT IN ENGLISH

1. **Theme: Background**
   - 1.1. Could you provide a brief overview of your role and responsibilities within the company?
   - 1.2. How long have you been working in the company, and what is your experience in quality management and quality reporting in general?
   - 1.3. Based on your experience, how has **company name* 's approach to quality evolved?
   - 1.4. What specific characteristics does the industry and market of your business line or area of responsibility bring to the measurement and reporting of quality?

2. **Theme: Current state of quality reporting and quality performance measurement (Neely et al., 2000; Eckerson, 2010 p.5; Suomala et al., 2018)**
   - 2.1. Could you describe the key measures used to measure and report quality performance in your current work?
     - 2.1.1. What are these measures used for?
     - 2.1.2. What actions do the measurement results typically lead to?
   - 2.2. What methods or tools does your responsibility area currently use for collecting, analyzing, and reporting quality performance data?
   - 2.3. How would you assess the current goodness of quality reporting and measurement in your role's context?
     - 2.3.1. How do you perceive the ability of measures to depict important aspects for the organization?
     - 2.3.2. How do you perceive the ability of measures to provide reliable and accurate information?
     - 2.3.3. How do you perceive the ability of metrics to provide unbiased information to describe quality specifically?
   - 2.4. How much time on an hourly basis do you spend monthly on compiling quality reports?
   - 2.5. How much time on an hourly basis do you spend monthly on analyzing the results of quality reports?
   - 2.6. How do the current measures relate to the company and business line strategy and must-wins?
   - 2.7. How do you utilize the current set of measures in management and decision-making?
   - 2.8. What challenges or limitations do you encounter in the current quality measurement and reporting?

3. **Theme: Development of quality measurement and reporting (Neely et al., 2000)**
   - 3.1. Which of the current quality metrics are deemed useless or have no utility?
   - 3.2. How and why should the current set of quality measures and its deficiencies be improved, in your opinion?
   - 3.3. What kind of quality measures do you think should be developed to improve quality performance?
   - 3.4. What phenomena/events related to organizational quality are currently not officially measured but significantly reflect quality performance?

4. **Theme: Developing quality measurement towards proactivity (Neely et al., 2000; ISO 9001:2015)**
   4.1. What factors do you believe precede and predict the development of quality performance?
   4.2. What strategies or initiatives are currently underway at **company name* to promote proactive quality management?
   4.3. How should proactivity be integrated into quality management? Why?
   4.4. From the organization's perspective, what changes or improvements do you believe are needed to develop and implement proactive quality management practices?
   4.5. What do you consider to be the most significant risks in measuring quality performance and developing quality measurement towards proactivity?
5. **Final words**
   5.1. Do you have anything to add to your answers or any other information related to the discussed themes?
   5.2. Can you be contacted if any clarification is needed regarding your responses during the interview?
   5.3. Do you have any recommendations or suggestions for improving this interview framework or for further research in this area?