



Improving financial decision making within German SMEs by incorporating digitalization within an expanded FAP model.

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Special thanks are extended to the interview participants in this research. The results have enabled me to make a significant contribution to science and research in financial decision making at German SMEs and to add knowledge and recommendations to science and managerial practice.

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Abstract

Financial decision making is a key element for any German company. SMEs are the backbone of German industry and make a key contribution to employment, innovation and growth. This research project explores the methods relied upon by German SMEs regarding financial decision making and the need to consider digitalization in the decision making process. This promotes better financial decision making in practice and contributes to theory.

Using a mixed-method approach including a case study, this research project explores the need for digitalization and improved financial decision making in SMEs by interviewing members of senior management. The research paradigm is pragmatism, which is also a key element in practice for senior management (Madden, 2021).

This study shows that senior managers in German SMEs understand the importance of digitalization in the context of financial decision making, yet do not include aspects of digitalization in their appraisal of financial matters. A risk that also arises as companies frequently do not properly understand their own profile and respective, individual, degree of digitalization. This research project provides an improved and more advanced financial appraisal model and includes digitalization aspects in the overall decision making process. German SMEs that will utilize the improved FAP model in the future will have the opportunity to make better financial decisions. The findings show the need for an improved FAP model and the promotion of improved financial decision making models.

Currently, many companies rely on standard NPV calculations as their sole decision making model, with most relying on a single variable. Relying on a single variable poses risk of not capturing other relevant elements within financial decision-making. This improved financial decision making model includes an index for strategy, project risk and digitalization as well as the NPV calculation.

By employing the improved FAP model, any German SME will gain the opportunity to improve its financial decision making as well as to include the key staff members in the decision making process to take better informed financial decisions.

Furthermore, the research results based on the case study and the interviews with managers of German SMEs provide additional insights into the current situation of German SMEs in the context of this research project.

Keywords: German SMEs; financial decision making; Financial Appraisal Profile Model (FAP Model); digitalization; senior management, decision making

Declaration of Original Content

I declare that the content of this thesis is my own work except where indicated by specific reference in the text. Furthermore, I declare that this DBA thesis was carried out in accordance with the guidelines and regulations of the University of Gloucestershire. I affirm that this thesis has not been submitted as part of any other academic award or to any other educational institution in the United Kingdom or abroad.

All views and opinions expressed in this DBA thesis are without exception mine and not, in any way, those of the University of Gloucestershire.

Signed

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Abbreviations

ACCA	Association of Chartered Certified Accountants
ARR	Accounting rate of return
B2B	Business-to-Business
BCR	Benefit cost ratio
CBA	Cost Benefit Analysis
CEA	Cost-Effectiveness Analysis
CEO	Chief Executive Officer
CFO	Chief Financial Officer
COVID-19	Coronavirus disease 2019
DBA	Doctor of Business Administration
DCIA	Digitalization of company IT activities
DDI	Digital Density Index
DPP	Discounted payback period
ECB	European Central Bank
ERDF	European Regional Development Fund
ERP	Enterprise Resource Planning
ESG	Environmental, Social and Governance
EU	European Union
FAP	Financial Appraisal Profile Model
FED	Federal Reserve System
ICT	Information Communication Technology
IfM	Institute for Mittelstandsforschung
ISO	International Standards Organization
IOT	Internet of Things
IT	Information Technology
KfW	Kreditanstalt für Wiederaufbau
MCDA	Multi-Criteria Decision Analysis
NPV	Net present value
OECD	Organisation for Economic Co-operation and Development

PB	Payback Period
R&D	Research & Development
RO	Research Objective
ROI	Return of Investment
RQ	Research Question
SII	Science Impact Index
SME	Small or Medium-Sized Enterprise

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Chapter 1: Introduction

This chapter provides background to the research and defines the research problem and objectives. It describes the evolution of the research problem and justifies the research project, defining gaps in the existing literature and offering details of the personal background of the researcher. The later part presents the research ethics and explains the organization of the thesis. This chapter is followed by the literature review in Chapter 2.

1.1. Background to the research

“Digital technology, pervasively, is getting embedded in every place: everything, every person, every walk of life is being fundamentally shaped by digital technology — it is happening in our homes, our work, our places of entertainment. It’s amazing to think of a world as a computer. I think that’s the right metaphor for us as we go forward.”

Satya Nadella, CEO of Microsoft

The information age could be said to have started with the invention of the digital computer by John Atanasoff (Stern & Freeman, 1988) ninety years ago. At the end of the 1990s, rapidly expanding access to the internet allowed companies to develop the first purely digital business models, challenging existing business models and forcing business leaders to adapt to a new and frequently faster pace in this changing business world. SMEs operating in Germany are subject to pressure from other countries and the digital age – without change, their traditional business models may become obsolete. The increasing importance of information technology has led many organizations to integrate digital strategies into their daily operations in order to improve customer services, reduce operational costs, improve production quality, increase profits and market penetration and improve

internal decision making (Meng, 2009; Spath, 2013). This challenge facing German SMEs is addressed by suggesting an improved model with an additional digitalization factor for financial decision making.

Alongside the challenges posed by advancements in information technology as part of the next industrial revolution, the other key element of interest rates needs to be considered. In the past decade, central banks all over the world have lowered interest rates to all-time lows or even negative rates, affecting the widely used financial appraisal techniques that use discount rates as part of the appraisal and decision making process. While financing costs are lower, it is likely that the financial appraisal methods currently employed suggest the approval of investments or projects that should have not been approved. The inclusion of additional factors in the calculation could help to reduce a potential overreliance on one single key factor, which may be misleading as discount rates are based on current market rates that do not reflect the real market risk. This presents a problem for German SMEs as the European Central Bank sets its benchmark interest rates based on pan-European assumptions, taking into account factors such as the weak fiscal situation in other Euro countries and pandemic measures (Benigno et al., 2022). The interest rate required and justified for Germany may be very different from the rate currently set (Fink & Kappner, 2017).

1.1.1. Evolution of the research topic

As the CEO/CFO and supervisory board member of various companies, I have had the opportunity to work in various industries and company types and to build a strong professional network. Digitalization and financial appraisal methods have been part of the challenge in my work over the past 15 years, in particular, the overreliance on quantitative financial decision-models and the underestimation of factors such as company strategy and digitalization in the financial decision making process.

Against this background, the current research topic originated from the managerial question of how to improve financial decision making while taking into account digitalization and expert input from various company departments. Financial decision making has been further skewed since the financial markets crisis of 2007, as interest rates have been reduced, with this key element of traditional financial appraisal methods resulting in a more positive appraisal of project cashflows. In addition, financial decision making lies primarily with the finance department or the managing director of a company, depending on the company size and structure. Without the involvement of other staff, financial decision making outcomes are seen as resulting from decisions taken by top management rather than based on the input of expert knowledge from the team.

Despite my practical observations, scoping the literature on digitalization and improved financial decision making theories did not lead me to discover an existing link between the two concepts. Instead of identifying relevant concepts to combine these two aspects, my search found a gap in the literature. A theoretical topic worth further exploration emerged from a managerial question.

In the literature, only one model could be identified that provides a sufficient basis for the required approach. The so-called FAP model (Financial Appraisal Profile Model) was developed by Frank Lefley and Bob Ryan in 1999, but limited literature could be found on it. It essentially relies on three dimensions: a financial perspective, a strategy index and a project risk index. The model itself is rather complex and time consuming to prepare and, as of the time of the literature review, appeared not to be applied by any organization as part of a standard financial appraisal toolbox. Moreover, at the time it was developed, digitalization did not play the key role in the business world that it does today.

Therefore, this research attempted to add to the theory by exploring and developing an improved financial-decision model with a digitalization factor, facilitating a better understanding of financial decision making processes

within a company with a digitalization index as well as helping company leaders to gain a better understanding of the company's investments.

1.2. Research problem and questions

As mentioned above, this research centres on questions of decision making, financial appraisal and digitalization within the context of German SMEs. The desire for additional insights in this area and an improved approach to investment decision making are based on my own background, as the managing director of a German SME within the manufacturing sector and managing director of a holding company that invests in German SMEs. My aim is to gain a better understanding of investment decision making and to develop an improved decision making model combined with a digitalization factor. I believe that digitalization is key in any investment decision as it has the potential to transform an industry and create new business opportunities but can also destroy a business if the right investment decisions are not taken. The overarching aim is to develop and promote an improved decision making model, which includes aspects of digitalization and fosters a team approach to investment decisions.

In developing this thesis, the following questions have been addressed, leading to the research objectives identified.

1. What drives investment decision making in German SMEs?
2. To what extent are investment decisions in SMEs based on digitalization aspects?
3. What are the key factors influencing investment decision making?
4. What processes are used in making investment decisions and to what extent are investment decisions based on qualitative criteria and models, such as the FAP model, as well as quantitative techniques and digitalization aspects?
5. Could an integrated digitalization criterion within the FAP model improve the decision making process?

These questions evolved from starting points and are answered in this thesis. The problem is not resolved by presenting a new improved financial decision making model; this is, rather, a starting point to continue the research and develop the model further by adjusting the variables and promoting the improved decision making model to the business community in Germany.

1.3. Justification of the research project

This thesis evaluates aspects of digitalization in financial decision making within German SMEs. It is entitled *Improving financial decision making within German SMEs by incorporating digitalization within an expanded FAP model*.

The thesis poses the question of how digitalization affects financial decision making and how a multivariate and pragmatic model such as the FAP model will be improved by expanding it for a digitalization index. Digitalization is a key focus for senior management in any company or industry. It helps organizations to improve processes and may create competitive advantages, but it also challenges existing business models and, therefore, financial appraisal models.

The primary aim of this research project is to improve financial decision making in German SMEs through improving the existing FAP model by adding a digitalization factor. The expanded FAP model will allow decision-makers to improve the quality of the decision making process to help create value for an organization, as the improved model will not lose its versatility, whether in improving investment processes, considering the expansion of buildings, plants and machinery, or evaluating a restructuring process. The latter is a key element, as digitalization ultimately forces SMEs to adapt to a digitalized world. The drive to digitize company processes is driven by a strong assumption that it will improve organizational performance and build

competitive advantage, equally important for both the survival and the growth of the business (Peppard, 2016).

External factors also require companies to improve their digitalization. One such factor is big data; new emerging digital technologies such as artificial intelligence, blockchain technology and the internet-of-things are projected to have far-reaching effects on business (Ng & Wakenshaw, 2017; Wedel & Kannan, 2016). Recent research by Pfister and Lehmann (2022) identified that German SME companies create value and achieve a measurable positive return on investment (ROI) by using certain digital technologies. Based on input from 48 companies, the study reported a weighted ROI average of 33.77%, with a median of 5.29% of investments in digital technologies.

Within the various decision making management spaces in SMEs, the area of investment decision making requires management to rely on realistic and reliable appraisal models. The majority of businesses rely solely on quantitative discounted appraisal models that do not take into account external factors such as company strategy or digitalization (Nadkarni & Prügl, 2020). The FAP model represented the first step to incorporating additional factors such as company strategy and additional risk factors. In this research, the FAP model will be further refined to equip management in its decision making to make better appraisal decisions by including digitalization as a factor. This is not an easy task. Simon (1955) observed that a compromise must be found between pure theory and practicality. It should also be noted that no single appraisal method is ever the perfect fit for the evaluation of a project.

Digitalization is not regarded as a threat or negative aspect in this research but, rather, defined more generically as a factor to be included in the improved FAP model. Reference is also made to the impact of elements of digitalization on German SMEs, as reported by interview partners. The key to this project is that a pragmatic approach for the improved model is developed that is suitable and relevant for practical application and the improvement of financial appraisals within German SMEs.

This research project also considers the acceptance of improved financial appraisal models within the business community analyzed. It examines the predominantly used financial appraisal models, the reasons for using these and how an improved FAP model will add value to the decision making process within a company in terms of investment decisions to be taken.

Moreover, the thesis will touch on existing financial appraisal models, as these are relevant to the development of an improved financial decision making model. These will be discussed within the literature section. There is no intention to criticize existing models or finance theory; rather, to argue for an improved financial appraisal model for practical application within companies. This research is, thus, influenced by practical aspects rather than offering only theoretical discussion. The aim is not to develop a new theory; existing theory will be used to improve the business world problem of financial appraisal within a digitalized world.

In the finance industry, digitalization has already been branded as a disruptive element that has transformed the financial industry and financial services. This revolution is not driven by banks but by non-bank innovators offering improved financial technology products and services to customers. This impacts the value chain not only for financial institutes but also for their clients, including German SMEs (EU Commission, 2016).

Since the financial crisis of 2007–2008, financial appraisal models worldwide have been severely affected by rapid changes in the discount factors relied on by standard financial appraisal models.

Aside from the financial and strategic aspects within a decision making process, in particular in business, the organization as a whole needs to be considered. SMEs are often managed by a small team and therefore the human element grows in importance. From this perspective, Dutta and McCrohan (2002) highlight the role of top management in adopting the organizational characteristics likely to achieve satisfactory information security. Moreover, when change is triggered by external factors, only top managers have the ability to act as change agents to create a favorable

environment (Yu et al., 2022; Rohlfer et al., 2021). It has also been demonstrated that top managers have the necessary authority to influence employees, thus enabling them to overcome organizational resistance.

Strategic financial management (SFM) refers to “financial management theories according to which financing should be conducted in the most proper way, the collected capital should be utilized and managed in the most effective way in enterprises and decisions on the reinvestment and distribution of profits should be made most reasonably” (Liu, 2010, p.132). It comprises “financial strategies which are goals, patterns or alternatives designed to improve and optimize financial management in order to achieve corporate results” where financial strategy “represents a path to achieve and maintain business competitiveness and position a company as a world-class organization” (Salazar et al., 2012, p.95). Efficiency improvements are expected across all dimensions of the balance and profit/loss sheets: revenue generation (improved client sales penetration, improved client support), lower costs (automated processes and robot-bots, straight-through-processing), more effective risk management (improved scoring, fewer operational issues, more sophisticated risk modelling) and better financial appraisal methods (Desmet et al., 2021; Fernández-Olano et al., 2015; Gottlieb & Willmott, 2020; Rutkowsky et al., 2015).

In 2016 the European Commission proposed that the Digital Agenda form a major pillar of the Europe 2020–2025 strategy (European Commission, 2016).

Studies show that, despite the importance of strategic thinking and implementation in the conduct of financial management in SMEs, which have to operate amid high levels of risk and uncertainty with limited resources, SME owners and managers regard the production, service or marketing functions as priorities, particularly in the startup phase of new ventures, which eventually results in poor financial management and, in most cases, the failure of the business (Jindrichovska & Kubickova, 2016). It is also reported that SME owners or entrepreneurs, until recently, have tended to overlook elements of strategic management (Karadag, 2015),

although the lack of strategic outlook on financial issues is a major threat to the longevity of SMEs as “many of the factors that contribute to failure can be managed properly with strategies and financial decisions that drive growth and the organization’s objectives” (Salazar, et al. 2012, p.93).

A study by the University of St. Gallen (2011) asked decision-makers to evaluate the financial appraisal model that they believe their company will rely on in the future, resulting in discounted cashflow models rather than a more sophisticated approach, as has also been already noted in research into the financial appraisal model (Lefley, 1994, Lefley and Sarkis, 1997, Shil et al., 2021). Furthermore, research by Adobe and the CMO Council (2015) concluded that uncertainty in business case development needs to be addressed by standard business case methods, such as NPV or payback period, equipped with more sophisticated methods of evaluating current and future cash flows from digital processes. Similar results on primary reliance on quantitative models by SMEs can be also found in developing countries including Ethiopia (Jifar, 2020). The key element in digital processes and projects is that they address disruptive innovations and new business models for which limited or no historical data or management heuristics are available. The conclusion recommends finding a combination of classical standard appraisal models and digitalization aspects.

It should also be considered that the most frequently used discounted cashflow models, such as IRR and NPV can provide inconsistent rankings. Debate on this subject has lasted for more than 100 years (Osborne, 2004).

The terms information system and information technology generally differ in that information technology refers to technical operating systems and host information systems, whereas information systems extend the concept to include human activity within the process. However, the two terms are often used synonymously and, in this thesis, are interchangeable.

1.4. Research objectives

Following the definition of the research problem and the questions leading to it, the research objectives were then developed with the intention of being easy to understand, suitable for the research project, and identifying relevant issues to be resolved. Research objectives should describe concisely what the research aims to achieve and provide direction for the study. A research objective must be achievable and defined with consideration of the available time and resources and the infrastructure required (Gabelica et al., 2022). The research objective is the written definition of the gap in knowledge to be filled by the researcher. Taking the above into account, the following are the objectives for this research project:

1. To investigate how German SMEs integrate aspects of digitalization into their current financial decision making processes;
2. To explore the extent to which digitalization can be incorporated into the FAP model as a means of enhancing mainstream financial decision making models for German SMEs and how expanding the FAP model will contribute to knowledge;
3. To develop a practical application of the FAP model within the German SME sector by integrating digitalization alongside the current, traditional decision making approach, to fit the post-digitalized decision making environment.

1.5. Research questions

The research objectives describe the broad issue that will be address through the research. The research questions are narrowed down to a specific issue to be addressed in the research. The three research objectives stated in the section before are further refined by the research questions as follows:

- Is there a need in German SMEs to integrate digitalization in their decision making process?
- How can an improved FAP model contribute to improved decision making at German SMEs?
- How to define digitalization and its benefits for a German SME?
- How to integrate digitalization into an improved FAP model?
- How to practically apply the improved FAP model within a German SME?
- What are the key considerations for an improved FAP model?

Each research objective is followed by two research questions providing further guidelines on the structuring of the questionnaire questions and the case study. For each research objective two research questions have been defined.

1.6. Research gaps

This thesis develops a deeper understanding of financial decision making and digitalization within German SMEs while addressing the following research gaps:

First, despite the importance of financial appraisal and decision making, the majority of SMEs in Germany still rely purely on quantitative financial appraisal models such as NPV calculations. In this context, a few empirical studies have been conducted on the FAP model application in the Czech Republic and the UK (Hynek et al., 2015; Lefley, 2013) but none on German companies.

Second, traditional financial appraisal techniques assume that value can be measured reliably and objectively. However, the hidden or intangible value of digitalization cannot be measured easily and a purely monetary approach may not be appropriate. In this case, a combined quantitative and qualitative approach would be more appropriate to achieve the research objectives. Digitalization is a factor that cannot be reliably or independently measured.

As digitalization increasingly affects traditional business models and concepts, it should play an important role in any financial decision making. There is increasing research on digitalization and its importance for businesses but none, either empirical or conceptual, on benefits.

Third, the traditional FAP model contains the quantitative dimension of financial appraisal using a traditional NPV calculation, as well as qualitative factors, to arrive at a strategy index and risk index. Expanding the traditional FAP model with an additional index improves it conceptually for a post-digitalized world. In a pre-digitalized world, the FAP model functions well, and empirically enough evidence was found for the model to function. Within a post-digitalized world, the FAP model requires an additional variable to allow improved reliability and useability. There is, however, no conceptual or empirical literature on an expanded FAP model.

Fourth, previous studies on digitalization and financial decision making have examined the impact of digitalization on organizational improvement, not as part of a qualitative and quantitative financial decision making model that aims to provide additional support for informed decision making given the financial challenges posed for German SMEs.

Lastly, the basis of this research project is the FAP model, which was developed approximately two decades ago; to date, however, no substantial literature body has been produced on the concept. This may be due to several factors, including its complexity, that it is not well-known or simply because other models are now more popular. At the same time, businesses are challenged by new competitors and digitalization concepts that challenge but have the potential to improve existing business models.

1.7. Contribution to knowledge

By answering the research questions, this thesis makes several contributions to the literature.

- The FAP model currently relies on three dimensions: a net present value calculation, a risk index and a strategy index. Adding a digitalization index creates an improved FAP model that provides relevant outcomes for improved financial decision making within German SMEs.
- An improved post-digital financial decision making model is proposed by this research.
- No previous research has explored expanding the FAP model with a digitalization index. This thesis provides evidence for the need for an improved FAP model.
- This thesis supports the need for German SMEs to improve financial decision making by moving away from traditional, often one-dimensional appraisal models.
- This thesis advances improved financial decision making by promoting a different approach, involving additional stakeholders in the process as well as relying on an additional index.
- A key advantage of the improved model is its generic applicability, as it can be adapted to any type of organization.
- The thesis also provides empirical insights from German SMEs on financial decision making.
- This thesis provides researchers in financial decision making with a new model that can be replicated in future research studies on other organizations. This will not only help extend the understanding of financial decision making but also avoid the sole reliance on a single financial decision model.
- The case study is based on a German SME, to demonstrate the relevance of the model and its applicability within the context of this research.

1.8. Research scope

There is no existing literature on improving the FAP model with a digitalization index. Some previous studies have attempted to apply the FAP model to various organizations in the UK and the Czech Republic. However, these studies were used to empirically prove the applicability of the FAP model (Hynek et al., 2015; Lefley, 2013). In the field of digitalization and financial decision making, numerous studies have been produced but these frequently only examine one single variable, omitting questions of usefulness to improve financial decision making. For a meaningful outcome, the benefits of the FAP model and digitalization should be combined to allow informed financial decision making within organizations.

A study by Bouwman et al. (2018) on the European Union's Envision Project Horizon 2020, to empower SME business model innovation, found that digitalization deeply affects SME business models in companies that operate within a traditional business model. These business models are subject to digital transformations such as Blockchain and Industry 4.0, which will affect SME business models. With the EU's formulation of its Horizon 2020 project, the need to consider digitalization as part of the decision making process has already reached the political agenda and gained prominent support.

Although it would be helpful to measure the impact of digitalization on decision making within financial appraisals through quantitative, objective measures, such measures are not readily available. One alternative is to use aid measures such as the digitalization index computed by Katz et al. (2014). The index was originally construed to measure a country's digitalization index and was adopted to measure the metrics of a standard SME.

Financial decision making within SMEs is impacted by ownership structure. The personal characteristics and attributes of owner-managers influence the decision making process (Sobaih et al., 2022). Borgia and Newman

(2012) found a relationship between managerial attitude and characteristics on one hand and total leverage of a firm on the other and found that a greater risk propensity allows managers to use more debt. Ownership structure plays a crucial role in the financial appraisal decision making of SMEs. According to Van Caneghem and Van Campenhout (2010), both the quality and quantity of information are important in deciding the financial structure of a firm. All these studies highlight the importance of qualitative variables in financial decision making, especially for SMEs. It should be noted that the SMEs in this study are not owner-managed; professional managers commonly base their decision making on informed analysis.

As the managing director of a German SME, also responsible for investments in further German SMEs, I have limited the scope of the study to German SMEs and do not include large companies in the study. As described above and identified in the literature section, the German SME environment is unique within Europe and, therefore, only SMEs in Germany were considered for the study. However, to avoid a local concentration, SMEs in the south, middle and northern parts of Germany were included.

1.9. Organization of thesis

This thesis is organized in five parts: Chapter 1: Introduction, Chapter 2: Literature review, Chapter 3: Research methodology, Chapter 4: Research model development, Chapter 5: Data analysis and results, Chapter 6: Discussion, and Chapter 7: Conclusion. Figure 1.1 shows the structure of the thesis:

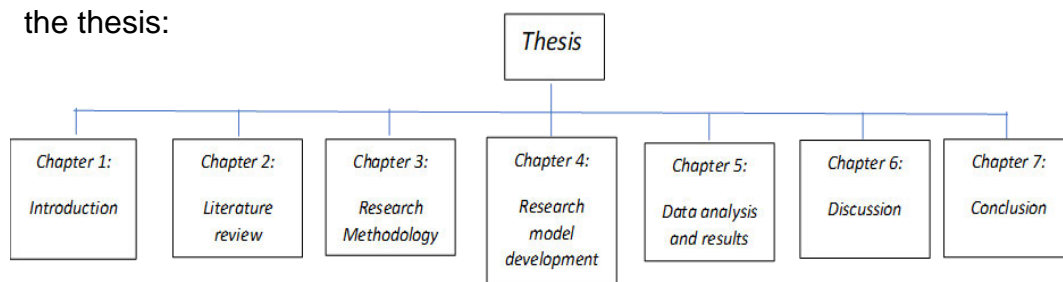


Figure 1: Thesis structure

Source: Author

Chapter 1: Introduction. This chapter provides the background to the research project, outlines the research problem and questions and offers justification for the research. It also explains the research objectives. As the foundation of the thesis, it identifies the research gaps and explains the contribution made to knowledge in theory and the practical world. The ethical aspects of the research and the overall research approach are described, and the chapter closes with a description of the organization of the thesis.

Chapter 2: Literature review. The literature review is narrative. The focus on comparatively new developments and concepts in this research requires the support of a comprehensive literature review. A critical reflection on and discussion of the existing literature are important aspects of developing this thesis. However, the focus on the FAP model and the research on digitalization provides only a limited body of literature to date as both concepts are relatively new; research is still ongoing and concepts being tested. This implies that further research is required to close the gaps identified in the literature. Frequently, academic researchers suggest avenues for further research in their published papers, to identify further potential research areas and offer ideas to other researchers to expand knowledge. This is not an act of altruism: it supports the researcher and their ideas as key researchers and references in academic research are identified by the number of citations in the work of others.

The literature review is structured in three parts. First, it considers the principal attributes of an investment decision and the decision making process within companies. The literature review identified the perceived weaknesses in this area and the improved model was developed by addressing these weaknesses. The second part concentrates on the FAP model and the current strand of research. This is followed by a review of digitalization aspects, identifying the strengths and weaknesses of current research into digitalization and financial decision making.

Chapter 3: Research methodology. This chapter provides a detailed description of the research development, questionnaire and validation

process. It also explains the research paradigm and gives a short overview of the research paradigm insights. Further, the sampling, data collection and analysis procedures are described here together with their underlying concepts.

Chapter 4: Research model development. In this chapter, the improved FAP model is established informed by evidence from the previous research items. Details on the questionnaire development are also included in this chapter, as well as a section on the COVID-19 implications for the research process and research model development.

Chapter 5: Data analysis and results. This chapter is organized in three sub-chapters. The first part provides the descriptive statistics from the quantitative data analysis from the questionnaire. Thereafter, a detailed description is given of the steps taken to lead the exploratory data analysis. The second part describes the tests of significance, reliability of data and predictive validity, and presents the results. In the last part of this chapter, the research findings are presented together with the final model.

Chapter 6: Discussion. This chapter is divided into two parts. The first covers the application of the improved FAP model in a case study at an SME. The second answers the posited research questions.

Chapter 7: Conclusion. This chapter first discusses the research implications and limitations. It then presents the conclusions on the research questions and research problem.

Chapter 8: Future research. The last chapter offers suggestions for future research and identifies gaps in the literature that may be useful avenues for future research.

Chapter 2: Literature review

The literature review provides a comprehensive overview of the theory and current status of the research and identifies a gap in the literature, justifying the need to develop an improved FAP model. For the purpose of this research project a narrative literature review is conducted. Within this section, literature on the various elements of the existing FAP model is covered as well as supporting literature providing evidence on the digitalization index. Following the literature review, Chapter 3 provides insights into the methodology of this research project.

2.1. Introduction

The decision making process in an SME is viewed as a key element in the success of the business. Recent research shows that many different solutions, methods and frameworks have been developed and contribute to improved decision making processes in SMEs (Ardakani & Avorgani, 2021). Information technology tools, business intelligence tools and artificial intelligence tools are key elements in the decision making process, and most businesses within the scope of this research project do not yet use advanced financial decision making tools to improve their decision making. The volume of research in this stream has increased since the 2000s with the increasing importance of technology for businesses (Hauser et al., 2019). The literature review conducted during this research project reveals that research in the area of financial decision making is still insufficient; studies do not show a holistic overview of the process and digitalization is not sufficiently linked to financial decision making, in particular within an advanced model. This chapter provides an overview of the context of the research project. The sections that follow contain an overview of perspectives on the financial decision making process, information technology tools, management decision frameworks used to support the

financial decision making process, and an overview and justification for setting the study in Germany. These elements lead to the literature gap, research questions and conceptual framework.

2.2. Structure of literature review

First, an overview of key contributions to the literature is given, followed by a review of the literature on the research paradigm and research views. The elements and techniques of financial appraisal models and the development of the FAP model are then presented, followed by a deeper literature review of the techniques available and frequently applied by practitioners and theoretical frameworks. Thereafter, the definition of German SMEs is reviewed along with the need to include digitalization in the FAP model. The next section outlines current trends and developments in literature in the field, and the chapter concludes by providing evidence for the case study and research of this project.

2.3. Knowledge Gaps in the financial decision making process

The academic literature on financial decision making, digitalization and general management topics has grown in line with developments resulting from digitalization and an overall increase in the literature. Whilst the existing literature mostly discusses methods of handling a combination of financial decision making calculations and tools, and the few theoretical multi-criteria tools that do not consider the advancements of digitalization, there is no available multi-criteria, financial decision making tool that includes a digitalization factor and can adequately address all the inherent and current problems. Furthermore, there is a need to integrate the available decision-support methods into a robust system that can help

practitioners facing multiple stakeholders and multi-criteria decisions under uncertain conditions within a digitalized environment (Trstenjak et al., 2022). The same applies to the financial decision making process.

2.4. Key contributions to literature

Key contributions are identified by the number of citations found in the respective research field as counted by Google Scholar and Web of Science. The primary contributions to the literature are divided into the following categories: i) Research paradigm and philosophy; ii) Decision making within corporate and financial investment appraisals; iii) Risk and uncertainty and capital investment; iv) Digitalization and digitization of SMEs; v) Investment appraisals in SMEs in Europe; and vi) FAP model.

The following key contributions to the literature have been identified:

- i) Dewey (2008); Kasser (1999); Guba & Lincoln (2005); Webb (2012);
- ii) Alkaraan and Northcott (2002); Irani et al., (1997); Jensen and Meckling (1976); Locke (2011);
- iii) Tversky and Kahnemann (1974); Hakansson, (1969); Williams and Baláž, (2011); Markowitz (1952); Sharp (1964); Navarro and Fantino (2005); Pierce (2007);
- iv) Degryse (2016); Lefley (2000); Leyh and Bley (2916); Kotarba (2017);
- v) Jindrichovska & Kubickova (2016); Lefley and Sarkis (1997); Berghoff (2006);
- vi) Lefley (2000) Lefley and Ryan (2005); Lefley (2006); Lefley, (2015).

In the key contributions identified, it is already evident that a wide body of literature exists in some fields while for the FAP model itself few studies are available. Overall, the various areas of the literature show a clear connection, identifying and supporting the importance of a multi-criteria approach to the appraisal of capital assets and the need to bond these together within a structured framework.

The identification of key research relies on the number of citations found in online resources that capture this number. Sophisticated concepts including the Science Impact Index (SII), developed by Lehl (1999), have been promoted, but these are less relevant for this research as the literature and bibliographical resources already provide sufficient evidence to identify key contributions to the literature. This approach helps to identify important contributions to the literature body in the area under review and ensures adequate coverage of literature and key contributions.

2.5. Literature on the research paradigm

2.5.1. Classical and philosophical pragmatism

Pragmatism is an empiricist epistemology formulated mainly by John Dewey and Charles Sanders Peirce and is often summarized as a “what works” approach (Dewey, 2008). Classical pragmatism is often seen as a contrast to the theory of truth, and argues that theories are merely “instruments, not answers of enigmas in which we can rest” (James & Gunn, 2000). Pragmatists at the time saw their epistemology as representing a return to common sense and experience and, thus, rejecting the flawed philosophical heritage that had distorted the work of earlier thinkers.

The most important characteristic in philosophical pragmatism is, therefore, “value in practical purpose”, which provides a standard for the purpose of truth in statements, appropriateness of actions, and value in the case of appraisals. Pragmatism is widely seen as an important research paradigm in social research, as it breaks down the dualism between realism and

idealism; in this respect, its importance is related to that of the separation of post-positivism and constructivism in applying the philosophy of knowledge to social research (Guba & Lincoln, 2005). To extend this thinking, in this philosophical system, post-positivists claim that the world exists apart from our understanding of it, while constructivists insist that the world is created by our conception of it. For Dewey (2008), these two assertions are equally important claims about the nature of human experience. On one hand, our experiences in the world are necessarily constrained by the nature of that world; on the other hand, an individual's understanding of the world is inherently limited to their interpretation of their experience. Within this system, it is assumed that an individual is not free to believe anything they like if they care about the consequences of acting on those beliefs. Within Dewey's pragmatism, with its emphasis on experience, ontological arguments about the nature of the outside world versus the world of our conceptions are simply discussing two sides of the same coin.

Charles Sanders Peirce was the founder of American pragmatism, later referred to as pragmatism. Peirce was influenced by the work of German philosopher Immanuel Kant and by Thomas Reid (Legg, 2021). Peirce published many works on mathematical logic and psychology and formulated the pragmatic maxim (Kasser, 1999). He laid out the philosophical foundations for pragmatism in discussions at the Metaphysical Club in Cambridge in the early 1870s (James & Myers, 1992; Legg, 2021). Pragmatism was first coined as a term in the publication "Pragmatism: A New Name for Some Old Ways of Thinking" (James, 1907). Jacoby (1908) credited Pierce with defining the term "pragmatism", although Jacoby's own pragmatic understanding of the world deviated from that of Pierce, as he viewed it more individually and subjectively. James believed in individual thinking on effectiveness and achievement, while Pierce advocated a more impersonal approach, defined as the rational influence of thinking. This assertion allowed a universalized pragmatism. Pragmatism developed from an approach to analyzing the logical foundation of the sciences into a foundation for the assessment of knowledge. According to James's pragmatism, truth is that which works. The decision as to what works is

based on examining proposals in reality and ascertaining that some propositions appear to be correct (Schmidt, 2020).

The key point is that the paradigm of pragmatism can account for one of its most distinctive features – the importance of distinguishing between post-positivism and constructivism without relying on metaphysical assumptions about ontology or epistemology. Pragmatism not only replaces arguments about the nature of reality as the essential criterion in differentiating approaches to research; it also recognizes the value of those different approaches as research communities that guide choices about how to conduct scientific enquiry. As a result, pragmatism acts as a new paradigm, replacing thinking about the differences between approaches to research by treating those differences as social contexts for enquiry, as a form of social action rather than abstract philosophical systems. Dewey's work has been widely recognized in education; he was a leading figure in developing modern pragmatism.

Pragmatism itself is rooted in the concept of academic scepticism. It dates back to the ancient Pyrrhonism that held that theories and sense impressions were unable to distinguish truth from falsehood accurately (Machuca, 2021). This sceptical view helps us to understand that, within pragmatism, things are not important for what they are but for what they value. This is based on a hierarchy of values established by an individual. Any action is, therefore, only worthwhile if the hierarchical system of values is achieved. Pragmatism implies the accomplishment of the same. This obsession with action is seen as a crucial characteristic of pragmatism.

Returning to the present, these beliefs are also seen today in the pragmatic utility functions concept employed in the digitalized world. Advanced synthetic intelligence systems, including supercomputer systems such as Deep Blue, base their understanding of the world on concepts of "ideal goals" and "pragmatic goals", where the ideal goal represents the ultimate target to be achieved. Pragmatic goals are redacted versions of the ideal goal, faster and easier to compute. The sum of pragmatic goals computed brings a self-improving system closer to the ideal goal or the orientated

account of a pragmatic theory of truth that claims that an experimental claim is correct if its reception is maximally beneficial.

However, enquiry and research are specific realms of experience and as, such, represent only part of Dewey's wider philosophical system. For Dewey, questions related to politics were at least as important as those related to research, as discussed in the following section.

Within classical pragmatism, it is not enough simply to accept the "what works" approach, because it ignores choices about both the goals to be pursued and the means of meeting those goals. Therefore, it is important also to consider the difference made by selecting one research method over another and the importance of and reasoning behind the selection of research questions. The technical decisions made concerning the research methods are also important because of the commitments made in this choice to pursue one route rather than another to reach our research targets. In relation to mixed methods, this approach is summarized by Dezin (2012) as follows:

"The mixed-methods research links to the pragmatism of Dewey, James, Mead, and Peirce are problematic. Classic pragmatism is not a methodology per se. It is a doctrine of meaning, a theory of truth. It rests on the argument that the meaning of an event cannot be given in advance of experience. The focus is on the consequences and meanings of an action or event in a social situation. This concern goes beyond any given methodology or any problem-solving activity. (p. 81)"

The literature on combining qualitative research with limited quantitative elements within the pragmatic paradigm is discussed in a separate section below.

2.5.2. Neo-pragmatism (post-Deweyan pragmatism)

Neo-pragmatism is often referred to as “post-Deweyan pragmatism”. In pragmatism, researchers frequently diverge from the classical pragmatist perspective on either their philosophical methodological position or their conceptual view. Neo-pragmatism accounts for this, as the theoretical framework is rather broad (Capps, 2019). Within neo-pragmatism, further influences from both the anglo-analytical stream and continental stream can be identified. While the anglo-analytical stream is primarily due to the influence of linguistics in philosophy, the continental streams are based rather on genealogical approaches to philosophy (Webb, 2012).

2.5.3. Empiricism

In philosophy, empiricism is a theory that states that knowledge comes primarily from sensory experience (Curd & Psillos, 2010). The term derives from the Greek word “empeiria”, meaning experience. It is one of several views of epistemology, the study of human knowledge, alongside rationalism and scepticism. Empiricism is the theoretical view that all behaviour is acquired through experience in the form of knowledge; it is not attributable to instincts or traits. It emphasizes the role of empirical evidence over that of innate ideas or traditions in the formation of ideas (Baird & Kaufmann, 2019). Empiricism embraces the philosophical theory that all concepts originate in experience. It holds that any concept about or applicable to things can be experienced, that all rationally acceptable beliefs or propositions are justifiable or knowable only through experience, and that knowledge is tentative and probabilistic and subject to continued revision and falsification (English, 2006).

Pragmatism represents a radical departure from previous philosophical arguments about the nature of reality and the possibility of truth. As Hall (2013) expresses it, pragmatism offers “an alternative epistemological paradigm”. In this new worldview, knowledge comprises warranted

assertions (Dewey, 2008) that result from acting and experiencing the outcomes of those actions.

Empiricism is often divided into two philosophical theories: (i) the theory of meaning, which holds that language can be understood, or notions required for any intelligible thought possessed, only if their users can associate them with things that they have experienced or could experience, and (ii) the theory of knowledge, which views the justification of some beliefs as depending ultimately and necessarily on experience (Miłkowski, 2017).

In the early modern philosophy of the early 17th century, the term “British empiricism” was coined to distinguish the beliefs of the empiricist Francis Bacon from those of the rationalist René Descartes. John Locke and David Hume were the primary exponents of British empiricism in the 18th century, while John Locke is credited as a founding father of empiricism with his publication of “An Essay Concerning Human Understanding” in 1689. In this, he proposed that the only knowledge humans can have is *a posteriori*, dependent upon sense experience. According to Locke, our knowledge of things is a perception of ideas that are in accordance or discordance with one another, unlike Descartes’ quest for certainty. This implies that empiricists deny the implication of the corresponding innate concept thesis – that we have innate ideas. Moreover, the concept of causality is denied: a strict application of the theory allows purely empiricist research only to observe two or more phenomena that follow one another sequentially but cannot explain that one phenomenon is caused by another.

In the 18th century, David Hume developed the ideas of empiricism to a new level of scepticism. Hume argued, in keeping with the empiricist view, that all knowledge derives from sense experience, but he accepted that this has implications not normally acceptable to philosophers. Further, he divided human knowledge and understanding into two categories: relations of ideas and matters of fact. He postulated that no knowledge, even about the most basic belief, can be conclusively established by reason. He concluded regarding the problem of induction that there is no certainty that the future will resemble the past and that belief in an external world and belief in the

existence of the self were not rationally justifiable (Costa, 1988). It could, therefore, be argued that pragmatism is derived from empiricism.

Furthermore, in the context of a research project with a practical background, it is important to note that experiences gained from practical observations are relevant within the field of empiricism within pragmatism. The term “experience” is comprehensive, encompassing knowledge and understanding of those things and objects of which we have experience (Russell, 1912). Defining this further, Legg and Hookway (2019) stated that, for pragmatists, theoretical insights are of practical value when they engage with the real world, at a particular place and time.

2.5.4. Differences between pragmatism and empiricism

Pragmatism and empiricism are two concepts of experience, as already noted. The pure definition of empiricism is the direct observation of the objective world. In rationalism, any deductions based on intuition can create knowledge without prerequisite sensory experience. Since knowledge is gained prior to experience, rationalism is associated with the term “a priori” and therefore, also known as “aprioris” (Sala & Kabeshkin, 2022). This differentiates rationalism from empiricism, which is associated with the idea of “a posteriori” knowledge gained after experience (Ajvazi, 2022). However, some empiricists argue that all these mental processes derive from primary experiences, at least initially.

Pragmatism is the formation of this conceptual manipulation so that the organism can physically achieve its conceptual desires. It rejects traditional dualisms (e.g. rationalism vs. empiricism, realism vs. antirealism, free will vs. determinism, Platonic appearance vs. reality, facts vs. values, subjectivism vs. objectivism) and generally prefers more moderate and commonsense versions of such dualisms based on how effectively they resolve problems (Onwuegbuzie & Johnson, 2004).

A major difference between empiricism and pragmatism is that empiricism is the pursuit of knowledge purely through experience, especially by means of observation and sometimes by experimentation, while pragmatism is the pursuit of practicality over aesthetic qualities, with a focus on facts rather than emotions or ideals (Jordan, 2013). Dewey (2008) expressed this as concepts of experience, one dating back to Ancient Greece, and the other to the British empiricists. The Greek understanding of experience was a practical one, bound by nature, culture and tradition. A person who had experience, in this sense of the word, had completed an activity over an extended period and consequently acquired a certain, skilled knowledge.

In contrast, the British empiricist concept centered around intellectual thinking, pure reasoning and knowledge. In this view, the acquisition of experience is a passive event: it is the passivity in relating to experience that gives it its epistemic worth; it tells us about the world only in so far as we add nothing to it (Dewey, 2008).

2.6. Literature on the FAP model: theoretical and practical aspects

The financial appraisal profile model was developed as an integrative model relying on three different dimensions of financial decision making. As described by Lefley (2000; 2006) it aims to improve decision making.

2.6.1. The need to extend the existing FAP model

The economy, business and society are driven by the need to adopt, change and develop as we live in an ever-evolving system with an unquantifiable number of known and unknown variables. In the financial crisis of 2007, the failure of purely statistical and quantitative models to quantify and compute events was dramatic. The need for improved models was clear, as decision making within a company is not purely financial. To improve decision

making and financial appraisal processes, a model is needed that is based on a multicriteria and multi-disciplinary approach, including not only the financial aspects of an investment decision but also the strategic and project-specific risk factors, as well as including a digitalized variable to improve the overall decision making process.

The FAP model was first introduced by Frank Lefley in the early 2000s before the failure of purely quantitative appraisal models became evident in 2008–9 following the financial crisis. However, despite its different and improved approach to financial appraisal, the model is not yet widely used or applied as a standard approach. This may be because it is a relatively new model and requires a time-intensive analysis and appraisal process before an informed decision can be reached. Moreover, the need for improved financial appraisal models was not a focus for many industries, including German SMEs, as the leading central banks saw lower interest rates, or even negative rates, as key to any quantitative or discount-based model and flooded the markets with liquidity to help companies access funds easily. This process skewed the risk profile for any investment decision as cash became a very cheap resource, allowing companies to invest in projects that did not require a thorough process.

The current FAP model is focused on a three-dimensional approach as described before. The concept of Industry 4.0 introduced by the German industry association, however, proposes digitalization as a new and additional dimension. The benefits of digitalization are not limited to German companies: digitalization can offer a positive impact on decision making in any type of company (Tubman, 2022). Besides the challenge of digitalization, the changing financial environment, in which central banks are starting to reduce quantitative easing measures and increase interest rates, will make the financial component more relevant again, forcing companies to improve their financial appraisal processes due to the rising cost of acquiring liquidity.

In developing any new model, it is important to first establish the need for that model. Through an examination of the literature and questionnaire

responses from both practitioners and academics, this research was able to identify the perceived weaknesses of conventional capital investment appraisal models and the concerns over the limitations of such models. The advantage of adopting this approach is that these weaknesses and concerns are well documented (e.g. in leading academic and professional journals) and are, therefore, widely acknowledged. By reinforcing the knowledge in the literature with the current opinions of both academics and practitioners, it was possible to confirm that an acceptable solution had not yet been found. This was later supported by a single case study.

This research approach strengthened the argument for an improved financial appraisal model and, by identifying the strengths and weaknesses of current models and the underlying model for this project, provides sufficient evidence to improve the existing FAP model with a digitalization factor and provide a case study for German SMEs. The conceptual development of the improved financial appraisal model based on this general research methodology embraces a multi-theoretical approach, taking into account the broader aspects of an investment decision, as suggested by the FAP model, combined with the digital dimension. The model was developed with input from semi-structured interviews with senior management practitioners in German SMEs. The research approach sought critical comments on the models currently used from professionals conversant with the appraisal of capital projects, and gathered pragmatic opinions as to the model's perceived acceptability and superiority over existing, and currently widely accepted, capital investment appraisal procedures, finally tested in a case study.

2.6.2. Theoretical and practical issues

New financial concepts, models or additions to existing models are generally met with hesitation (Powell & Kusuma-Powell, 2015). This holds true within an organization, where new concepts require full support from top-level management. Without support from the top, any change to existing

ways of doing business or the introduction of new concepts or models will not be effective. As a result, large organizations frequently have change management departments that help managers to facilitate change and alleviate employees' fears, in this context about the decision making process. In theory, it is easier to support the improvement of existing models, as the academic focus on problem-solving and extensive testing of currently prevailing theories create a culture of change, while there may be a tendency to improve models theoretically with few relevant practical benefits (Powell & Kusuma-Powell, 2015).

The FAP model faces such challenges: despite its practical and pragmatic development and its comprehensive approach, it is not widely used. The application of new models and concepts often depends on external pressure, frequently from stakeholders or economic circumstances. The model was developed in the early 2000s as a new mixed-methods model, at a time when regulators and companies were focused on purely quantitative models that failed to capture long-tail events in the financial crisis. The central banks then stepped in and reduced interest rates, resulting in much lower discount factors and helping investment decision-makers to invest in projects that would not have been viable otherwise. This distortion often goes hand in hand with the personal beliefs and interests of decision-makers, who are frequently incentivized for making certain decisions.

Financial investment decisions, according to Marsh (1990), are made by an individual, a human being, who does not only have the company's interests in mind but also considers their own perspective in terms of individual costs, gains or risks.

Marsh's view aligns with the principal and agent problem, described by Jensen and Mecklings (1976) in their agency theory. Both agent and principal are utility maximizers and, as a result, will not always act in the best interests of the other party. This was generally described as the asymmetric information dilemma, where the principal may be sufficiently

concerned that his position will be exploited by the agent (Jensen & Meckling, 1976).

As a result, companies today require senior managers to sign a conflict of interest policy before being appointed, to confirm that the individual “possess the highest personal and professional ethics, integrity and values, and be committed to representing the long-term interest of the shareowners” (ROY Group, 2019).

Managers, however, have different needs and must take decisions that are not only beneficial to the organization but also to themselves as individuals. It cannot be assumed that managers will act according to the rational financial models of investment decision making or any document they may have signed at the time of appointment. They control a commercial organization with multiple demands, and they need information and models that will allow them to make effective, transparent, and broad-based decisions. Their actions will be monitored both internally and externally and they need to be able to justify their decisions to stakeholders and other interest groups.

Furthermore, with the arrival of digitalization, decision making models need also to consider the interference caused by a wholly new variable. In the past, financial appraisal decision making frequently operated on a purely quantitative basis, depending on the level of interest rates as a key variable. However, with widespread digitalization, completely new industries have emerged and the largest companies in the world are now software and digital companies. The key variable for these companies is not the interest rate but the digitalization factor (Hoßfeld, 2017). This factor needs to be computed and integrated into existing models; however, this depends highly on the industry and other external factors, with no one-fits-all method.

From a pragmatic perspective, the separation of ownership and control is not as radical as agency theory may suggest. The interests of managers are interwoven with those of shareholders through remuneration incentives that often include share options or long-term performance indicators,

making the managers co-owners. Recent developments also include a “Say on Pay” for listed companies, where shareholders must approve the remuneration scheme at the annual general meeting. However, any new management decision making model must consider the needs of managers and therefore recognize the importance that agency theory may play in the decision making process. The model must benefit not only the managers but the organization, by giving managers a tool that will enable them to make more effective decisions that are primarily aimed at benefiting the long-term interests of the shareholders. This includes the need to consider additional changes to existing models with the arrival of Industry 4.0 (Strozzi et al., 2017).

Furthermore, organizational agility is seen as a necessity rather than an ideal in today’s fast-paced world (Alavi et al., 2014). In a study by the Economist Intelligence Unit, the vast majority of executives (88%) identified agility as a key factor in global success (Chen et al., 2014). Agility offers two main benefits: first, the ability to respond to business threats in a timely manner and, second, the ability to identify and capitalize on opportunities as they present themselves. Organizational agility can offer a distinct, long-term advantage in company performance (Alavi et al., 2014). Sambamurthy et al. (2003) assert that digitalization increases the capabilities of organizations, agility among them.

The overall notion of the improved model should, therefore, be supported by economic theory by adopting the shareholder long-term value maximization goal, an assumption implicit throughout this thesis. It is argued throughout this thesis that the long-term maximization of financial value must also consider the strategic risk factors and digitalization factor (some of which may not be valued in financial terms but as score values) with respect to each proposed capital investment. While the investment decision will be made, in part, on scores, the ultimate result of the project (and the organization as a whole) will be seen in monetary terms. The dilemma is that not all these monetary values will be known at the time the decision is made, but to ignore them would be fatal. Using score values as a heuristic

for monetary values, with respect to strategic and specific risk factors, will enhance the information on which a decision is made and support the economic underpinning of the model.

The theoretical framework of this research includes the theory of income and value; the economic theory of risk; the theory of decision making under constraints; management models of choice, the theory of principals and agents, the utilization theory, and the concepts of Industry 4.0 and agility, with other theories referenced as required.

Each of these theories has made it possible to focus on (i) the decision requirements of the firm, (ii) the constraints that bind those decisions (individual and group rationality and processes) and (iii) the available information. The aim has been to refine the quality of the process so that it draws in a variety of modelling tools within the context of realistic and achievable organizational practice. While the research recognized a range of agency problems, it does not assume that the polarity of the model fully describes organizational life. For example, managers as agents may have an equity interest as well as an interest in their own compensation and benefits. The model presumes a network of cooperating stakeholders with overlapping interests; thus, the problems posed by the pure principal and agent model – moral hazard, adverse selection and information asymmetries – do not fully apply.

Another relevant issue is that the ECB and FED have started to increase base rate interest rates again, which will directly affect the cost of lending and, therefore, the interest rates used in the NPV calculation of the FAP model.

2.6.3. Financial appraisal techniques

This section discusses the relevant financial appraisal techniques. Many different financial appraisal models are well known and well researched in terms of their underlying theories. However, in practice, only a few models

are frequently used and relied on in making decisions. These are merely discounted cashflow models. Moreover, in the regulated space of banks, the regulator and financial oversight institutions require their members and the financial institutes operating in the area to use certain models for their financial analysis and appraisals. This also holds for valuer and appraisal companies, which are required by law to rely on and apply certain measurements and instruments.

The importance of financial appraisal methods in the investment decision making process is already well researched and detailed in various studies. Although the literature acknowledges the existing heterogeneity of appraisal methods, as mentioned earlier, it fails to consider adequately the possible implications of the heterogeneity of the objects of appraisal. An empirical study in the UK by Ballantine et al. (1995) found a lack of discussion in the accounting and finance literature on the application of financial appraisal methods in appraising IT investments. The empirical results fail to consider the problems encountered by practitioners when using financial appraisal techniques for IT investment appraisals. The study found that NPV and IRR are the methods of choice, while payback and ARR methods are also relied on, but to a lesser degree (Shahriar et al., 2021). It should also be noted that expenditure levels in financial appraisals in IT are estimated to be between 1% and 5% of revenue in the USA (Gartner Research, 2017), an increase from the previously cited 1% to 3% in earlier US research (Lee et al., 2004). Given the high levels of total cost in IT investment, appraisal should be of high importance for decision-makers within an organization. Despite the growing importance of IT appraisal and the digitalization of the business environment and associated growing costs, arguments have been proposed for not using financial appraisal methods for IT investments.

Digitalization and IT investment have been placed on the political agenda by various governments. In Germany, the German Ministry of Economy and Energy annually surveys the development and impact of digitalization improvements in various industry sectors. The latest report, for 2020, finds a digitalization scale of 54% out of 100%, where 100% is a fully digitalized

company or industry sector (BMWK, 2020). The research estimates that German SMEs have a 48% degree of digitalization; as a result, further investment in IT and improved digitalization are recommended. Furthermore, the survey finds that only 18% of respondents believe that digitalization is not important for this industry sector, while 46% see it as of the highest importance. The relevant aspect for this research project concerns improvements in internal processes towards improved digitalization: only 3% of respondents report that digitalization improvements are not required, while 67% believe that they are important (BMWK, 2020). The findings within the manufacturing industry are well above overall industry averages. This is also represented in investment targets: while 8% of companies responded that no investment in improving IT structures or digitalization was expected within the next year, 20% plan strong investment and 22% medium investment in IT improvements and the digitalization of processes.

2.6.4. Arguments against the financial appraisal of investments with digitalization input

Despite increased levels of expenditure and the growing importance of IT and digital business strategies, no adequate appraisal technique combined with a digitalization variable has yet been identified for investment decisions. In the literature, the issue of appraising investments has been widely discussed, with several academics suggesting that purely financial appraisal methods are inadequate or inappropriate for the measurement of investments, especially in relation to IT or digitalization investments. On the justification of IT investment decisions, Hochstrasser (1993) argues that prevailing appraisal techniques centre on financial analysis with an emphasis on profit. He argues that such measures are inappropriate for IT investment, given the nature of IT investment and the measurement of benefits achieved. A purely quantitative metric appears for Hochstrasser (1993) inadequate in the short term. Moreover, as digital business

increases, IT has also intensified e-commerce (Alfonso et al., 2021), which may benefit companies with digital business activity.

Similar arguments are proposed by Keen (1981), who finds that traditional cost-benefit analysis is not a suitable technique to rely on when appraising IT investments, especially in decision support systems, given that the results are primarily qualitative and therefore difficult to measure with standard financial appraisal techniques. Andriushchenko et al. (2019) argue that cash flows from financial project are known, which is – alongside other major limitations – a key problem in that IT investment does not directly yield quantifiable cash flows and frequently requires substantial upfront investment.

Furthermore, the definition of IT or digitalization investment depends on the type and area of the organization (Greco et al., 2022). In general, IT infrastructure encompasses all resources and tangible assets directly related to the deployment, maintenance, operation and use of information and communications technology. This typically comprises IT hardware – such as servers, workstations and desk-top personal computers – but also all active and passive elements of the networking infrastructure (e.g. switches and cabling). As found by Dewan and Ren (2007), not all investment in IT equipment and digitalization projects leads directly to positive results for an organization. It should also be noted that the on-going and recurring costs of provisioning and operating the IT infrastructure form an integral and indivisible part of any such investment decision. This is also found in research by Otim et al. (2012), who analyse the risks of company investment in information technology. It is therefore difficult to quantify the benefits through a solely quantitative approach as found by Irani and Love (2002).

2.6.5. Need of unification and enhancement of the FAP model

As outlined in section 2.6.1, there is a need to improve the FAP model. In addition to improving the existing FAP model, enhancement is also an important aspect of improving the FAP model. A unified FAP model helps to determine the methods, practices and architectural patterns that lead to the best results in the organization. A unified FAP model acts as a bridge between different variables and analyses and enables the contextualization of data sources across multiple inputs. It serves as a foundation upon which data can be consistently combined and correlated, enabling the application of the FAP model across different organizations and improved financial decision making. Widespread and accepted financial decision making typically involves monolithic analysis within a static environment that relies on a single form of analysis. In general, improving financial decision making requires an improvement towards informed decision making. This requires understanding the requirements, data sourcing and validation, development of the new model, testing and subsequent application. In developing the digitization index and improving the FAP model, as described in the following sections, it becomes clear that the standardization of the FAP model also requires that the existing indices, while independent, still work in combination with the new digitization index and, in combination, provide meaningful results and support informed decision making. As a result, the construction of the digitalization index also follows similar process steps as the development of the existing strategy and project risk indices. A central standardizing factor is the expert panel that provides the key variables to be considered and evaluated, which are calculated in the respective calculation steps for each of the individual factors. Using a more standardized approach can also support the creation of an improved model for financial decision making in the future.

Improving the unification of the FAP model elevates the strengths of each individual variable, while reducing complexity, providing the organization with an integrated and improved financial decision making solution.

2.7. Literature on SMEs and Mittelstand

2.7.1. Definition of the SME and Mittelstand

The literature contains various definitions of SMEs; generally, the term refers to a small business based on the number of employees or annual turnover or both (Zahoor et al., 2020). However, it should be noted that an SME is not a small version of a large company (Storey, 1994). The context of this study is the SME sector in Germany, to whose stability the strength and resilience of the German economy are often attributed. It is a unique element of German economic performance and attracts interest from abroad (BMWK, 2013). The EU definition of an SME does include companies that form part of the German *Mittelstand*, a term that cannot be directly translated from German into English without losing its specific meaning (Czegledi et al., 2015). In comparison, the US definition by the SBA includes companies that have a turnover of close to one billion USD, but are defined in the US as medium-sized businesses (Child et al., 2022). While an SME as per EU definition is based on maximum 50 million Euro turnover.

The German definition of *Mittelstand* takes into account social and psychological factors, which are crucial for an understanding of the peculiarities, significance and performance of this specific group (Günterberg & Kayser, 2004).

The European Commission categorizes SMEs by number of employees, annual turnover and annual balance sheet, while the German Institute for Mittelstandsforschung (IfM) uses a different quantitative differentiation, closer to the specific German understanding of *Mittelstand*, as SMEs in Germany provide substantial employment. The quantitative definitions from the European Commission (2021) and the IfM (2016) are depicted in Table 1.

EU/ European Commission definition					IfM Germany			
Size	No. of employees		Annual turnover	Annual balance sheet	Size	No. of employees		Annual turnover
Micro	Up to 9	and	Up to €2m	Or	< €2m	Micro	Up to 9	Up to €2m
Small	10 – 49		€2m - €10m		€2m - €10m	Small	Up to 49	Up to €10m
Medium	50 – 249		€10m - €50m		€10m - €43m	Medium	Up to 499	€10m - €50m
Large	<250		≤ €50m		≤ €43m	Large	<449	≤ €50m

Table 1: Quantitative definition of SME

Source: IfM, (2016); European Commission, (2021)

The main difference between the EU definition and IfM definition are for defining medium and large sized companies in terms of annual revenue. IfM also includes companies with number of employees of up to 499 within the medium definition, while the EU defines companies with more than 249 employees as large companies.

According to the IfM, only approximately 8% of German SMEs fall within the IfM's definition of Medium SMEs (IfM, 2016). Overall, German SMEs generate 84% of turnover in the construction, accommodation, and food services sectors, although large SMEs dominate the turnover in general.

Research by the EU shows that there are today approximately 3.6 million SMEs in Europe compared to approximately 16,000 large companies according to the EU definition. While the vast majority of German SMEs are micro-enterprises with up to 9 employees and an annual business volume of less than 2 million EUR, mostly within the service sector ("SME policy in the EU", 2022), there is no doubt that SMEs play a vital role within the German economy.

Germany's Federal Statistical Office publishes an annual report providing detailed insights into the country's corporate structure and the importance of the *Mittelstand* (Statistisches Bundesamt, 2022). German SMEs

represent 99.3% of all enterprises in Germany, while within the manufacturing sector 97.3% of all enterprises are SMEs.

Understanding the difference between the EU und Mittelstand definition of SMEs by IfM, within this research scope, the EU definition is applied also as a criterion for the sampling size in respect of the interviews.

2.7.2 Digitalization of German SMEs

Digitalization strategy of Germany

Germany follows an integrated digitalization strategy, which was last refined in 2022 and established certain milestones to be achieved by 2030 (Bundesregierung, 2022). It is divided into three fields of action: "Connected and digitally sovereign society", "Innovative economy, working world, science and research" and "Learning, digital state". Especially the field related to economy is of relevance for this research project. This includes improved and fair access to data and also better understanding the current state of digitalization within companies in German, in particular SMEs due their economic importance. As part of the development of the Digitalization strategy, for the first time a digitalization index was developed, reporting a Germany-wide index value for 2022 is 108.9 points compared to 107.9 points in 2021. For the construction of the index a total of over 2,000 SMEs where being asked. The index value of small and medium companies with 1 to 249 employees continues to grow moderately from 93.9 points in 2021 to 94.8 points in 2022. While within this group the small companies are the least digitized company size class.

2.7.3 Current state of digitalization of German SMEs

Germany's Federal Statistical Office also provides insights into digitalization. Approximately 95% of all corporations use computers and have internet access, while 33% of SMEs use the internet to sell products. Schuchmann and Seufert (2015) formulate this finding more precisely and

find that digitalization is an issue for all types of industry and all sizes of company.

A key performance indicator for German SMEs is its track record as an innovation enabler and an effective productivity increaser (Pustovrh et al., 2017). In the context of digitalization, the overall penetration of companies implies that SMEs are still in an implementation phase in which changes have not yet made a significant impact on productivity (Owalla et al., 2021). According to van Ark (2016), the dynamics of digitalization have only just started.

Critical voices include Eisert (2014), who found that around two-thirds of SMEs he interviewed were unaware of the Industry 4.0 concept and therefore had no digitalization strategy. Similarly, Rickmann (2014) found that German SMEs are not taking action towards digitalization. This confirms the findings of a study by Herkommer (2014), who reported "both managers and staff are not very well prepared, and eight out of ten enterprises feel abandoned by politics with regard to Industry 4.0". In contrast, large companies are found to have adopted a digitalization strategy, frequently referencing their strategy to large US technology companies such as Amazon, Microsoft or Google. A study published by the IT service provider CSC concludes that Industry 4.0 and digitalization are simply too demanding for German SMEs (Perspektive Mittelstand, 2021). The Digital Business Readiness study from 2021 draws the following conclusion: "Many enterprises are lacking financial and often human resources too, to promote digital change internally."

However, these findings contradict the perceived opportunities and potential for German SMEs in the context of digitalization and the fourth industrial revolution (Eisert, 2014). Data from Thomé (2021) on e-commerce and e-procurement as part of a digitalization strategy finds that annual growth rates in both areas will increase to over 15% annually by 2025 and that German SME's are shifting their focus on digitalization to sales and procurement.

2.7.4 Digital technologies used by German SMEs

There are many different trends like big data, cloud computing, Industrie 4.0, the Internet of Things (IoT) and Artificial Intelligence (AI) that are emerging at a fast pace and are also followed-up by German SME companies. But, digitization is not merely about improving solutions that already exist. This is what makes it different from the incremental innovations that have traditionally characterized the German economy. It is also about going into a new direction and requires German SMEs to understand their own current state of digitalization, but as well what direction they are going. A large challenge is finding the right skilled worker and adopt to a changing mindset of employees (Federal Ministry for Economic Affairs and Climate Action, 2022). Research by Pfister & Lehmann (2023) finds that substantial practical relevance for SME managers can be achieved by following concrete guidelines for entrepreneurs seeking to increase their business performance by digitizing their business model by learning from companies that have been already successful in transforming their business model. Furthermore, it is important that the technologies being reviewed by German SMEs are fit to the company targets, processes and product. As outlined by Barker (2016), there are also findings that German SMEs do hesitate on adopting new technologies, like cloud computing and are compared to other advanced economies have a significantly less positive view on certain digitalization technologies.

2.7.5. Decision making in SMEs

To evaluate decision making within SMEs it is important to look at the predominant structure within SMEs. The management leadership structure cannot be isolated within an SME and strong leadership skills are crucial to its success (Ikupolati et. al, 2017; Yahya, 2011). The literature suggests that SME leadership follows a model of commitment to ownership, risk and business opportunity (Burns, 2016; Laforet & Tann, 2006). Other studies, however, identify issues with poor administrative skills and limited

ownership and management awareness (Bloom et al., 2017; Lee, 2011; Roland, 2018). Despite the conflicting views in the literature, it should be emphasized that SMEs dominate in all types of business operation. Their managements are required to demonstrate superior leadership skills due to the high level of international competition and the industry standards to be followed.

The key decision-makers in SMEs are the top-level manager or owner (Dakup, 2018; Gibcus, 2009), frequently an owner-manager who is the managing director and has a significant financial stake in the company. This individual has their own attitudes and decision making preferences. The decision making process itself is influenced by moods and personality, experience, framing, overconfidence, sunk-cost effects and personal heuristics (Caruso & Sharif, 2006; Navarro & Fantino, 2005; Ott et al., 2022; Tversky & Kahnemann, 1974). In SMEs without an owner-manager, key decisions are subject to limiting constraints such as the company values or philosophy, which is relevant for this thesis conducted with various key SME decision-makers. This is important to note in the context of the theoretical framework, as probably the most influential organizational decision making theory – the garbage can model – posits that all problems and solutions swirl around in organizations before agents solve the problem in an uncoordinated manner. It is therefore important to bring the problem and solution together by connecting key decision-makers, who bring different angles to the table, within a financial decision making process (Sauder et al., 2021).

Top-level decision-makers should be well equipped with a detailed understanding of customer needs, business operations and processes as well as competitive advantage (Deros et al., 2006; Dakup, 2018). A key differentiator for SMEs is that they are more involved with their customer base and closer to the markets than large companies (Deros et al., 2006; Chaudhuri et al., 2022).

Due to the importance of SMEs for the German economy, frequent analyses have been made of SME management styles and whether they emanate

from the owner or key manager (Dakup, 2018; Hankinson et al., 1997). Frequently, there is little to separate the owner-manager of an SME from the SME itself, although this depends on the size and the age of the SME in Germany. Many SMEs are currently in a transition phase where the founder is stepping aside and either their children are taking over or an external manager is stepping in. The owner-manager of an SME, however, tends to be involved in all aspects of the operations and decision making of their firm; the sum of expertise resides in them and the degree of expertise can vary enormously (Hurmerinta-Peltomaki & Nummela, 1998; Stasch & Ward, 1987). Owners are frequently associated with a “doing” attitude: they try to solve problems as they arise and take decisions as needed (Corbett, 2005; Matthews & Scott, 1995). This is true for smaller companies within the SME space; however, larger organizations with external managers are required to develop decision making processes implemented by key decision-makers.

This study focuses on businesses that fall within the category of large SMEs, with a sufficient degree of organizational and decision making processes in place.

2.7.6. Performance management at SMEs

To evaluate the decision making and results of good or poor judgement, it is important to ensure that performance management can be linked to the decision making process (Kennerley & Neely, 2002). In the literature, the balanced scorecard is an important performance management framework as it bases its results on different perspectives to reach a conclusion based on multiple metrics (Pierce, 2022), similar to the FAP model approach. In larger organizations, balanced scorecards are widely used and extended by additional factors such as environmental perspective. However, research by Brem et al. (2008) on performance management within the SME sector found few studies exploring this issue within SMEs. The authors state in their conclusion that the personal characteristics of the decision-maker and

the SME itself need to be taken into consideration in any performance management or performance review system.

2.8. Literature on decision making

2.8.1. Definition of a decision

The simplest form of decision making is the choice between two alternatives. However, decisions are far from simple, and theories surrounding them have been the subject of focus and debate throughout decades of interdisciplinary research (Hansson, 2005). Managerial decision making is further complicated by the fact that managers frequently seek to avoid making a decision or obscure their decision to avoid being held responsible for an unfavourable outcome. Mintzberg and Waters (1990), therefore, see action as the key element in determining a decision. As soon as an action can be observed, patterns can be observed, and the role of the decision in determining these actions can be inferred by looking for a point where consensus emerges before the action (Fulop et al., 1999). In effect, Fulop et al. (1999), say that a decision is too imprecise a concept to work with and displace it in favour of action, although they conclude that the decision is a necessary prior condition for action. The literature contains no uniform definition of a decision and, therefore, for this thesis, the definition of Eilon (1969) is accepted – that the decision-maker must choose from several alternatives, comparing and evaluating their potential outcomes before arriving at a choice.

2.8.2. Development of decision making theories

The theories around decision making cover a wide field in literature and science, with a long tradition reaching back to the philosophers of Ancient Greece, who focused primarily on the physical world and how to explain it. The philosophy of decision making gained popularity as early democracy

emerged in Greece and power was transferred from a single ruler to the common people, while the people still sought guidance from priests and oracles, like that at Delphi. Humans asked the gods for advice and support in their decision making, and praised or blamed them for the results of their good or bad choices.

Modern decision making emerged in the 7th century AD with the recognition of zero as a number by the Indian mathematician Brahmagupta in his work *Brāhmasphuṭasiddhānta* (Boumans, 2015). The ancient Greeks were aware of zero as a number but questioned how zero, representing nothing, could still be something, and failed to recognize its importance. Following its recognition as a number, zero was included in the emerging Hindu-Arabic numeric system that reached medieval Europe in the High Middle Ages. This numeric system helped to simplify calculations and motivated philosophers to investigate the nature of numbers. With philosophers starting to question numbers, calculations and forming early concepts of number theory, the notions of probability and games of chance were explored by Gerolamo Cardano in 1545, one of the first known to work with complex numbers (Harripersaud, 2022). Cardano's work contains the foundations of mathematical probability theory about one hundred years before Pascal and Fermat (Harripersaud, 2022).

The French mathematicians Blaise Pascal and Pierre de Fermat developed a way to determine the likely outcome of a simple game. Their contributions helped to develop more advanced understandings of probability, risk and pay-off structures (Zwilling, 2013). They formulated the definition for mathematical expectation and laid out the principal of choosing the value with the highest expected value (EV), where probability (p) and an amount of money (x) for each gamble (i=1,...n) could be calculated:

$$EV = \sum p_i x_i$$

Figure 2: Expected value formula

Source: Author

Based on this work, the Swiss mathematician Daniel Bernoulli started his work on the study of random events that formed the basis for today's risk management and numerical decision making. Bernoulli focused not on events themselves but on the humans who desire or fear certain outcomes to a greater or lesser degree (Kusolitsch, 2014). Bernoulli aspired to create a mathematical tool that would allow anyone to estimate their prospects from any high-risk undertaking, considering specific financial circumstances. Carl Friedrich Gauss brought his geodesic and astronomical research to bear on the bell curve of normal distribution, and Francis Galton followed with his regression towards mediocrity and the stability of types (Krashniak & Lamm, 2021). The first rational decision making models in business and economy were discussed by neoclassical economists including Max Weber and Adam Smith. From their perspective, the rational behaviour of agents in the economic system was solely aimed to maximize their utility. This concept led later to that of the so-called "homoeconomicus" (Locher et al., 2013).

Further research by Frank Knight (1957) distinguished between risk, when the probability of an outcome is possible to calculate (or is knowable), and uncertainty, when the probability of an outcome is not possible to determine (or is unknowable) – an argument that rendered insurance attractive and entrepreneurship, in Knight's own words, "tragic". Two decades later, John von Neumann and Oskar Morgenstern laid out the fundamentals of game theory, which is concerned with situations where decisions are influenced by the unknowable decisions of "live variables" (Buchanan & O'Connell, 2006). They formulated their research in the expected utility hypothesis and defined rational choice as a form of mathematical formula.

Decision theory attracted increasing attention as an interdisciplinary science, with important contributions by von Neumann and Morgenstern (2007) with their theory of games and economic behaviour. They describe entrepreneurs and consumers as purely rational, behaviour-driven, market participants solely focused on maximizing their personal returns, and describe the axioms used to compute the expected utility. Consumer

maximum utility is represented by satisfaction with a purchase while, for an entrepreneur, maximum utility is represented by maximized return.

Maurice Allais (1953), however, found that such axioms required proof that the existence of the utility function was systematically violated by the behaviour of human decision-makers. He further found that this holds not only for complicated decisions but also for relatively simple ones. These findings led to the eventual evolution of normative and descriptive theories (Diemer & Lallement, 2020).

The behavioural model opposes the rational model. Simon (1955) developed the concept of the behavioural model in the late 1940s, when he described the theory of bounded reality. He described the influence of human attitudes on decision making and the degree to which purely rational decision making is impeded by human influence. A surge in popular science publications can be found in this area, showing the interaction of human behaviour and organizational influence. Simon's thesis (1955) was developed further in the 1970s in Kahneman and Tversky's prospect theory, a descriptive theory that demonstrates that market participants do not act as purely rational players, as assumed by the maximum utility theorem developed by von Neumann and Morgenstern (Reiss & Heilmann, 2021).

Despite its popularity, there have been challenges to prospect theory, which centres on ideas of regret, attitudes, vague beliefs and lack of awareness. Indeed, lack of awareness presents a challenge for all extant normative theories of choice. Depending on the human system, which Tversky and Kahneman (1981) research defines as System 1 (rational) or System 2 (emotional), different sets of emotional systems are triggered, with additional implications of overconfidence, loss aversion and optimistic bias. Rational and behavioural views are important in understanding the decision making process for this thesis and are therefore explained further below (Buchak, 2022). Decision making theories need to evolve further with artificial intelligence playing a significant role in supporting or replacing human decision-makers (Duan et al., 2019).

The following section discusses the various views and key concepts of decision making.

2.8.3. Rational view

The rational view is based on a rational, quantifiable, mathematical approach, typically represented by a calculation of maximum utility. The decision model within the rational perspective is typically based on clearly defined decision rules and decision fields, represented by environmental conditions, assigned results and action alternatives. A decision problem by definition requires a minimum of two alternatives, each of which must be evaluated to define the potential prospect structure and, hence, the decision (Neuert et al., 2015). It is important that the measures applied are not manipulated by the decision-maker and that it is clear whether the decision is made under conditions of certainty or uncertainty.

Decision making under conditions of certainty means that the decision making process is led by a decision-maker who is appraised of the true condition of all the alternatives. All relevant information is known, and all alternatives are clear. Decision making models are frequently built on the assumption of certainty as they are easier to build and set up (Bamberg et al., 2019). In contrast, in decision making under uncertainty, the decision-maker knows the alternatives but does not have all the relevant information. Consequently, the result is not known, and any alternatives are uncertain. Moreover, it may be impossible for the decision-maker to calculate the likelihood of conditions materializing, negatively impacting the possible result (Neuert et al., 2015).

For decision making, it is important to define clearly the differentiation of environmental conditions in the context of digitalization (Hoßfeld, 2017). To improve decision making in digitalization models, we need to include mathematical logic in their systems to accommodate a comprehensive decision making process.

2.8.4. Human view

Human and behavioural aspects of decision theory gained wide support from psychological scholars in the last century. The first steps were taken by Simon (1955) with his theory of bounded reality; later, Tversky and Kahneman (1974) made a substantial contribution with the development of behavioural economics. Kahneman (2011) described decision theory from a psychological perspective, adding that decisions are emotionally not rationally driven. Depending on the level of emotions involved, as this depends on the subjective mindset of the researcher, he distinguishes between Systems 1 and 2 as described in the previous section. The research by Kahneman and Tversky on behavioural decision making shows a strong opposition to the rational view. Within prospect theory research, the element of loss aversion suggests that participants try to avoid losses while there is huge opportunity for gain. This behaviour is contrary to rational choice with a pure focus on maximizing utility. On the other hand, “optimistic bias” suggests that risks are undervalued and potential gains overestimated (Sharot, 2011). Moreover, the relationship between gains and losses is not a straight line but, rather, a hyperbolic form.

2.8.5. Heuristics in decision making

Heuristics play a dominant role in all decision making theories and for all humans (Arnott, 1998; Kahneman et al., 1982). Where a human decision-maker violates expected utility, this is a result of heuristics, a concept in the literature linked to that of framing mechanisms that influence how a decision-maker reacts (Meinert & Krämer, 2022). A decision-maker is more likely to accept a present frame than try to change it, look at the problem again and construct their own frame (Tversky & Kahneman, 1981). This concept has practical implications for decision making within an SME. In practice, the decision-maker should consider the person who asks for the decision, as they rely on a different frame if a problem is raised by a trusted

long-term employee rather than a new joiner. They are also sensitive to influencing factors such as non-verbal communication.

The latter is important as humans tend to be subject to the concept of anchoring (Hammond et al., 2006). Anchoring allows a decision-maker to put a possible solution to a problem into context, which facilitates to some extent being bound to reach an acceptable solution (Shifei et al., 2022). Key heuristics are described in the next paragraphs.

Opinions on anchoring vary in the literature, with some blaming anchoring for poor decision making (Röseler et al., 2021), assuming that a bad anchor or poor assumption will lead the decision-maker to the wrong solution. Another effect that has a significant influence is overconfidence, relevant where management is dominated by a strong entrepreneurial individual. Overconfidence can lead a decision-maker to be over-optimistic about a positive outcome from a certain decision, ignoring the potential disadvantages, and giving excessive weight to the positive aspects (Berner & Graber, 2008). Despite its potential risks, overconfidence is an important characteristic of an entrepreneur working on a business idea. Without this overconfidence, he would never have started the business, as no reliable data or information was available to make a rational decision based on fact (Lynch, 2011).

Another heuristic is the concept of sunk cost, well known in the accounting literature and a common decision making pitfall. Sunk costs describe the cost and resources that have been invested in a project and lead decision-makers to persist with a project that has not achieved the expected outcome and is frequently loss-making. The decision-maker attributes disproportionate importance to the funds already lost rather than simply stopping the project and moving on. This is a common mistake in modern organizations where decision-makers are afraid of admitting a mistake or a wrong decision and continue to put resources into a loss-making venture (Khan & Tariq, 2022).

Representativeness describes the tendency of a decision-maker to generalize from a small non-random sample to a much larger outcome (Atanasiu & Ruotsalainen, 2019). Decision-makers tend to take decisions based on personal experience, frequently ignoring the relevant information available to them. Moreover, the aforementioned heuristic can have an exponential impact if compounding evidence comes into play that leads a decision-maker to seek viewpoints similar to their own to confirm their position and decision (Hammond et al., 2006). Negative information is filtered, while confirming voices are given disproportionate weight in the decision and viewpoint of the decision-maker.

Tversky and Kahneman (1971) identified the heuristic of availability, where the probability of an outcome is based on how easily it comes to mind. In the decision making process, it should be noted that the above heuristics apply only to the decision-maker's experience. Gigerenzer and Goldstein (1996) concluded that the rationality of decision making can be substantially improved where the decision-maker is aware of the concepts of rational probability theory and knows the above common heuristics. While "known unknowns" indicate the gaps in our knowledge of which we are aware, "unknown unknowns" extend to uncertainty beyond the actual state of knowledge itself (Gigerenzer & Gaissmaier, 2011). The research in this area helps to search for practical and applicable decision making strategies for managements constantly under pressure, and operating with incomplete information under conditions of stress.

2.8.6. Advanced decision making by naturalistic decision making

Classical decision making theory works well within the theoretical space, but regularly fails to support decision making in the real world, where challenges are more practical than within the specified setting in theory (Klein, 2008; (Papathanasiou et al., 2016). The first steps in the direction of naturalistic decision making were made by Orasanu and Connolly (1993), who identified decisions within a naturalistic setting and described the

decision making process within a real-world environment (Klein, 2008). This runs contrary to classical decision making theory, shifting the focus to the external environment (Klein, 2008). Following classical theory, decision-makers are rational people trying to increase utility; however, research by Kahneman et al. (1982) indicates that people use shortcuts and heuristics that should be avoided to reach better decisions. Within the scope of naturalistic decision making, these heuristics are identified and, instead of being treated as shortcuts, are used as a positive learning experience. Naturalistic decision making focuses on the learning and improvements of the decision making process and, therefore, also acknowledges learnings from cognitive shortcuts by decision-makers (Catchpole & Alfred, 2018).

In the real world, the decision-maker is subject to stress, missing or misleading information, risk, and changes in the environment. Within such a setting, there is limited literature showing that the decision-maker goes through the classical sequential process of decision making, evaluating the options available and seeking utility maximization (Langley, 1995). Many good decision-makers can prove that a decision that might qualify as an outlier or irrational in existing models can be justified as a lucky outcome (Klein, 1998).

The key differentiator for advanced decision making within naturalistic decision making theory is that decisions in the real world are observed and therefore of practical relevance to decision-makers in organizations. Classical decision making relies on a clean laboratory environment that can deliver rational results in certain sterile situations. Outside the laboratory setting, major contributions to decision making such as game theory, which laid out the grounds for further research, would have not been achieved (Schneider & Shanteau, 2003). Expert decision-makers familiar with the current environment made observable decisions that are likely given normative behaviour seeking utility maximization but, as soon as these experts were faced with an unfamiliar environment, no seeking of utility maximization was observed (Gigerenzer & Goldstein, 1996). As a result, the

expert decision-maker is a good learning example of how decisions in the real world should be approached.

The roots of naturalistic decision making lie in the medical sector, often at the forefront of new research methodologies. The first experts observed in the context of this new theory were decision-makers in the medical and emergency sector (Elstein, 2001; Klein, 1998). The high pressure, stress, risk and fast decision making in the medical environment are a good approximation for top-level decision making within SMEs, as the level of risk and speed of decision making are comparable. Klein (1998) also proposed a focus less on the decision making framework and rather on the logic and process of the decision-maker acting under pressure.

Critics have suggested that the role of the expert cannot be quantified by normative means and that there is a lack of repeatable proof and, as a result, of laboratory methods in field research (Klein, 2021). Despite the ever-increasing literature on management practices to improve decision making and propose standardized methods (Crandall et al., 2006; Klein, 1998), the debate continues. Considering this debate, Kahneman and Klein (2009) acknowledged the importance of heuristics and biases in decision making and the need for further research, in particular on the expert as a key element in decision making in the real world with a reduced laboratory setting.

2.8.7. Decision making within organizations

Another important element affecting decision making is external influence. Within organizations, the decision making process is defined and established by humans and, therefore, reflects human behavioural aspects. A substantial body of literature exists on process optimization and overall decision making concepts within organizations. Frequently this is related to the organizational structure of a company and established management

styles. Since the COVID-19 pandemic, literature has also addressed big data decision making within organizations (Smeets et al., 2021).

Decision making within organizations is frequently subject to external factors such as bullying, group thinking, company politics, team decision making and organizational structure (Ahmadzadeh et al., 2022; Maharaj, 2008; Mintzberg, 1983). These limitations result in bias and heuristic influence on decision making and reduce the objectivity of any decision and its qualitative output. Research by Charness and Sutter (2012) suggests that decisions made by a group are better than those made by individuals. However, Kugler et al. (2012) find no evidence that groups act more rationally in decision making. The literature suggests improving the rationality and objectivity of decision making by improving the overall decision making framework. As described by Kugler et al., (2012) this is itself highly dependent on the methods used to estimate rational behaviour, which frequently use tests and games.

Louis et al. (1987) found it necessary to describe the process of decision making in categories. They identified three categories: the sporadic decision process, which is informal; the fluid process, which is more formally channelled and predictable, and the constricted process, which is narrowly channelled. The advocates of the rational model pay little attention to the organizational decision making process as environmental aspects are not included in their model (Hickson et al., 1986). Pfeffer (1981) suggested that the context of the organizational decision making process be seen as one input to a quantitative model in the rational view.

The literature on decision making within organizations falls into the following four core categories (Anderson et al, 2015; Kickert, 1980; Simon, 1959), described by March (1994) as follows:

- Knowledge of alternatives: a set of pre-set beliefs or courses of action that have the potential to address the decision problem, and may include inaction;

- Knowledge of consequences: the possible consequences of the alternative courses of action available;
- Consequent preference ordering: the variables to which the consequences of the courses of action can be compared
- Decision rule: the rules by which decision-makers rank and select a course of action from a list of alternatives.

Theoretically, the knowledge of alternatives represents alternative courses of action; the knowledge of consequences simplifies the analysis or interpretation of the contextual information; consequent preference ordering represents the measurable variables that indicate whether a decision problem is solved or the organizational aims achieved, and decision rule represents the rules for ranking and selecting alternatives from the available options through awareness of the knowledge of consequences (Barat, 2018). In the simplest form, all decision alternatives are precisely known. However, in reality, there are many unknowns, and much uncertainty and lack of awareness, and the goal of the decision making can be unclear at the beginning of the process (Conrath, 1967).

The human interactions within organizational units can be probabilistic, the environment in which an organization operates may be uncertain, and the desired outcome of a decision problem can be unclear at the beginning of the process. The literature offers a substantial body of evidence on the factors of uncertainty, risk and ambiguity (Daft & Marcic, 2016).

Digital developments have brought further distortions to organizational decision making processes. A study by Smet et al. (2021) found that organizations are much more aware today than they were 20 years ago of the cognitive biases – anchoring, loss aversion, confirmation bias and many more – that undermine decision making without the participants being aware of them. The process has advanced, and checklists and devil's advocates are frequently used as part of a formalized decision making process. Despite such advances, increased complexity and decision

interdependence, together with the reduced cost of digital communications, have compounded difficulties by bringing more people into the conversation via email and internal knowledge-sharing platforms, without clarifying decision making authority (Smet et al., 2021). The study found that a lack of clarity on the underlying information for decision making, results in disengagement, paralysis and anxiety, ending in poor decisions.

2.8.8. Classification of organizational decision models

Cyert et al. (1963) found that organizational decision models can be classified as programmed or non-programmed. Programmed decision making involves decisions about problems that are certain, with only marginal risk, while non-programmed decision making comes with uncertainty, and the scenarios to be solved are new. Non-programmed decision making is concerned with situations where the alternatives and their consequences and the decision rules cannot be inferred from historical occurrences. The decision making of modern organizations is mostly non-programmed decision making, for example in personnel selection (Albadán et al., 2018). Naturally, a decision-maker adopts different methodological viewpoints to approach these problems. From the literature, organizational decision making frequently distinguishes between normative and descriptive decision making styles and considers a third perspective, the prescriptive decision making style (Bell et al., 1988). A normative decision making process defines how a decision should be made and provides guidelines for ideal decision making. Descriptive decision making describes how the decision-maker makes a decision rather than what should be done in an ideal situation. Prescriptive decision making combines both styles by exploiting normative theories and adopting the useful observations of descriptive decision making (Mandel et al., 2019). These viewpoints are reflected in management classifications that range from an economically rational model to a bounded rational model to an anarchy model. From a management perspective, organizational decision making falls into one of

the four primitive decision making models of management science, the Carnegie model, the incremental process model and the garbage can model (Anderson et al., 2015; Cohen et al., 1972; Cyert et al., 1956; Mintzberg et al., 1976).

2.8.9. Characteristics of organizational decision making

The literature contains various management concepts and organizational decision making models and advocates for methodological rigour in models (Barat, 2018). Dewey's (1910) book *How we think*, promoted a five-stage process while Herbert Simon's *Administrative behavior* (1947) described in more general terms advanced management decision theory at the time of publication.

Simon (1977) was also among the first researchers to propose an iterative decision making process. He identified three phases:

- The intelligence phase, which defines the problem statement;
- The design phase, which investigates the influencing variables, such as context, environment and possible alternatives;
- The choice phase, which selects the most appropriate alternative from a set of given alternatives.

Each phase represents in itself a decision making process, as a choice phase may trigger an intelligence phase followed by a design phase, or a design phase may trigger an intelligence phase; therefore, the decision process can become an iterative process. Simon extended and improved his initial model with an implementation and review phase (Simon, 1977). This model was further extended by Daft and Marcic (2016) who added new decision making categories including non-programmed and programmed decision making, and organizational decision making models such as the Carnegie model and garbage can model (Barat, 2018).

However, while organizational and management decision models have been improved, the effective use of technological and digitalization support is largely limited to programmed decision making and classical management-science decision making problems. This research highlights an opportunity to develop suitable technological and digitalization support to improve organizational decision making. The research hypothesizes a suitable technological support tool to capture and analyze the information needed to explore the knowledge of alternatives, enrich the knowledge of consequences with evidence, and develop effective decision rules for unforeseen situations in the face of increasing complexity (Hevner & Chatterjee, 2010). To this end, a so-called constructs artefact is considered as a proxy index to support the digitalization aspect of the expanded FAP model.

Furthermore, it is important to note that organizational decision making occurs within a complex environment; decisions are not made in a vacuum. The contextual setting should, therefore, be considered, as outlined in key studies (Conrath, 1967; Shapira, 2002; Simon, 1959; Sipp & Elias, 2012). Within the context of modern organization theory, organizations are recognized as open systems (Banerjee, 2021; Kickert, 1980).

2.8.10. Management decision making theory

Management literature can be divided into three broad categories: operational (day-to-day), tactical (mid-term) and strategic (long-term) decision making (Tsitsamis et al., 2008). While a vast body of literature can be found on strategic decision making theory, few studies address the tactical and operational aspects of decision making (Harrington & Ottenbacher, 2009). Modern theories recognize the human element within decision making. Humans fail to gather information without processing it, contravening most rational methodologies, where a problem is defined first and processing occurs later (Klein, 1998). Alongside the iterative model proposed by Simon (1977), modern literature also proposes non-sequential

models, which adjust Simon's model to allow cycles to be performed between stages (Mintzberg et al., 1976).

Even using improved models, a failure to adequately define the problem at the first stage will halt the process and the decision making will fail (Harrington & Ottenbacher, 2009). However, it should be noted that this applies particularly to short-term operational and tactical decision making, simply because for strategic decision making the long term is relevant. Despite extensive research on management decision making, sequential and non-sequential theories shed no light on decision making in SMEs.

More relevant are the modern management theories that go beyond maximized expected utility assumptions. As defined by Simon (1955), the concept of bounded reality suggests that the decisions taken are rational in the purest sense: as decision-makers' computational ability to process all alternatives is limited, they aim to achieve a certain level of satisfaction. This implies that decision-makers within organizations accept solutions that meet their satisfaction expectations without necessarily making the effort to maximize value, possibly resulting in sub-optimal decision making. In this context, the prospect theory developed by Kahneman and Tversky (1979) as a comprehensive descriptive theory looks at actual human behaviour rather than an assumption of a fully rational and objective decision-maker. As outlined earlier, the human factor plays an important role in decision making.

2.8.11. Decision analysis

There has been significant research in the area of decision analysis and the difficulty of reaching a decision. Difficulty increases with the complexity of the decision and analysis (Brauer et al., 2018). Within organizations, decisions need to reflect the complex setting and multi-criteria analysis methods are, therefore, frequently employed. In multi-criteria decision analysis, a decision-maker takes a decision based on numerous attributes,

by assigning a weight to each attribute and approximating the best available option (Pasiouras et al., 2009). As a result, the literature on multi-criteria decision analysis focuses on mathematical toolkits that reduce the available options to a finite number of alternatives and form the key element of diversity in the concept. Moreover, heuristics and biases are accepted in these models and the impact is evaluated in arriving at a suitable solution.

Critics note that multi-criteria analysis does not measure decision difficulty, but only offers learning outcomes to be researched further. In decision analysis, the decision-maker is always present, with all their strengths and weaknesses.

2.8.12. Decision difficulty

In any research into decision analysis, it is important to look at relative decision difficulty. This is frequently seen as another test variable (generally in terms of time to decide) in the decision making process. Much research has been conducted within a laboratory environment, requiring an individual to decide between two elements, defined as outcome and time. Both variables are measured as indicators for problem and decision difficulty, mostly in the context of consumer studies (Broniarczyk & Griffin, 2014), while research around business decisions centres primarily on questions of human behaviour in terms of psychology and, as a result, promotes subjective scales. In biological research, neurological reactions are measured by stimulating the brain with images. Increasing the number of images within a defined time frame increases stress and decision difficulty, and the results can be measured or monitored by an oscillator (József, 2012; Shadlen & Roskies, 2012).

However, the concept of decision difficulty can lead to incorrect conclusions. Frequently, time is quoted as a leading indicator of decision difficulty; however, it could be argued that confidence in the subject and the nature of the decisions required are factors, among others, and therefore it is

important to ensure that any potential influencing factor is disclosed and treated equally (Lynch, 2011).

Another aspect for consideration is that decision-makers may tend to avoid adverse outcomes by not taking decisions (Siebert et al., 2021). Anderson et al. (2015) reviewed the reasons why a decision-maker may avoid decisions and branded these as selection difficulty in his research. The higher the selection difficulty, defined as potential adverse outcome, the more likely that a decision will be avoided. Anderson concludes that it is worth understanding selection difficulty and decision avoidance to reduce decision difficulty in the long term. However, to date, no substantial literature has emerged that focuses on gaining a better understanding of decision avoidance in terms of decision difficulty.

2.9. The development of the Financial Appraisal Profile (FAP) model

Frank Lefley (2000) gained his PhD from his research into and development of the Financial Appraisal Profile model. Lefley and Ryan (2005) emphasize the importance of a profile approach rather than relying on a quantitative NPV calculation alone. In this context, it was proposed that an NPV model be improved by including the discounted payback index and marginal growth rate in a financial profile (Lefley & Morgan, 1999). Thus, the proposed NPVP model assesses the long-term benefit of a project as well as including project time risk and liquidity, which are interrelated factors. Kakati and Dhar (1991) argue that “though many researchers have stressed the need for strategic-financial matching, there have been few attempts to provide an explicit solution to this crucial issue”. The model should provide a detailed profile of a proposed capital investment rather than a single, sometimes arbitrary, figure on which an investment decision is made (Lefley, 2000). Moreover, Lefley (2000) stated that it is crucial that any new model should include improved risk issue treatment and described how the

intangible benefits from the investment are to be measured (Corrado et al., 2022).

The FAP model incorporates three sub-models: the net present value profile (NPVP), the project risk profile (PRP) and a strategic index (SI) as well as a dynamic process to compute the FAP model. The basic set-up shows details of the proposed investment, in particular the nominal investment capital of the project, the project's estimated useful life and the cost of capital (Lefley, 2008). The FAP model is a multi-attribute information model based on a profile concept and is, therefore, more dynamic in its approach than many of the existing conventional investment appraisal models (Lefley, 2000). A pre-requisite of the FAP approach is the need to formulate a detailed conception of the corporate and business strategy of the company, also that the analysis and review of this strategy should be an ongoing exercise. Each company should also consider the maximum level of project-specific risk that it is prepared to accept. Any projects that do not fit into the overall corporate and business strategy of the organization or are deemed to be too high-risk should be removed from the financial appraisal roadmap; only those projects that pass this initial screening should be considered in greater detail (Lefley, 2000).

A key element within organizational decision making is that the FAP model involves a management team approach with the participation of key department leaders or senior managers. Involving key managers as well as other departments in a comprehensive approach brings increased commitment and achieves a more optimal decision than an individual managerial decision that does not necessarily have the support of other departments (Gondal & Shahbaz, 2012). Research by Zaleznik (2004) shows that top senior managers in larger organizations generally prefer to include people from different departments with expert knowledge in the decision making process, while lower-ranking managers tend to take decisions without involving others as much. This suggests that a higher level of experience and rank within an organization favours a multi-disciplinary approach. Sarkis and Liles (1995) argue that organizations must be agile –

able to function across organizational boundaries. A multi-disciplinary approach creates a wider knowledge base for each investment proposal (Lefley, 2000).

To overcome departmental thinking within organizations, Kaplan and Norton (1996) developed the balanced scorecard as an instrument for measuring and overcoming departmental thinking. A balanced scorecard adopts a wide approach to multi-dimensional performance measurement. It originally included four dimensions but has been improved by the addition of dimensions such as the economic footprint (Hansen & Schaltegger, 2017). Dobrovic et al. (2018) suggest the ever-increasing relevance of non-financial indicators for SMEs, due primarily to major impacts on competitiveness, growth, efficiency, digitalization and environmental aspects as well as, ultimately, the survival of an enterprise (Dobrovič & Timková, 2017; Pohulak-Żołędowska, 2016).

While emphasizing the importance of inter-departmental collaboration, a key factor is that each judgement within the FAP model still requires subjective judgments to be made. The element of intuitive judgement appears to have significant influence when making strategic investment decisions (Grant & Nilsson, 2020). The FAP model does not overcome this issue but, rather, broadens the base of factors included in the decision to be made. In this context, the FAP model relies on the Delphi model, which requires a panel of expert managers to share their opinions and values regarding the investment decision to be made. These responses are reviewed by facilitators, and feedback provided to managers that further justifies their decisions. The aim of this process is to reach near consensus. A consensus is reached if any outliers in the dataset have been addressed and mitigated (Bregar, 2019; Ristono et al., 2018), although the risk of group thinking must be identified and steps taken to reduce its influence on the group.

Lefley (2000) identified preferences among managers to consider one financial appraisal model over another and to use a few models to assess risk and respective results in terms of investment decision making. He also

found that combined models for risk and financial appraisal are not as widely used and accepted as some would like to think, leading him to develop the FAP model. The FAP model includes elements of classical financial appraisal models as well as new techniques, and modifies other models – such as the Delphi panel – to create a model that embraces a wider profile of investment opportunity and includes its own structured process (Lefley, 2000; Lefley, 2006).

Following the research, the FAP model positions itself between cash generating and project complexity, with the option to branch out in one or other direction, since some projects are straightforward and ideally suited to a purely cash-focused view in which elements of strategy or risk are insignificant, while other projects have more significant risk or strategy elements (Lefley, 2000; Lefley, 2018)

2.10. Literature on financial appraisal methods

2.10.1. Financial appraisal methods

The recommended analytical methods for appraisal are generally discounted cash-flow techniques which consider the time value of money by relying on a static discount factor. In nature and business, it is generally considered preferable to receive benefits as early as possible while paying costs as late as possible (De La Rosa & Tully, 2021). Costs and benefits occur at different points in the life of a project, so their valuation must consider the time at which they occur. This concept of time preference is fundamental to appraisal; thus, it is necessary to calculate the present values of all costs and benefits. However, the models are often drastically simplified (Gai, 2022), and there is no model in existence that fits all purposes. The most common and best-known appraisal models are explained below, as they also form part of the improved FAP model.

2.10.2. Net Present Value Method (NPV)

The NPV method is widely accepted by practitioners and is relied upon in financial decision making (Correia, 2012). In an NPV calculation, the revenues and costs of a project are estimated and, after being discounted with a market reference rate, are compared with the initial investment amount. Frequently there are various scenarios, with different discount rates and revenue and cost estimates run, and the scenario with the highest positive NPV is generally accepted. Projects with a negative NPV value should be rejected because the present value of the benefit stream is insufficient to recover the cost of the project (Lefley, 2000). The concept of present values was introduced by Irving Fischer in 1907, when he proposed that NPV calculations were an adequate tool to support decision making when expected cashflows were discounted with an appropriate discount rate to reflect an investment's risk (Buchanan & O'Connell, 2006). The formula of the NPV calculation is as follows:

$$NPV = \sum_{t=1}^n \frac{R_t}{(1+i)^t}$$

where:

R_t = Net cash inflow-outflows during a single period t

i = Discount rate or return that could be earned in alternative investments

t = Number of timer periods

Figure 3: NPV calculation

Source: Author

Practitioners see the NPV method as superior to other quantitative investment appraisal techniques – such as IRR and discounted payback – as it offers the option to run different scenarios and includes cost and benefit assumptions. If several independent and mutually exclusive projects are being considered, the NPV method will rank projects in order of descending NPV value. However, a smaller project with a lower NPV may be more

attractive due to a higher ratio of discounted benefits to costs, particularly if there are affordability constraints (Lefley, 2000).

Using different appraisal techniques on the same underlying set of expectations and data will yield conflicting conclusions, as each method has different key drivers. While the NPV method may recommend Project A due to its higher positive cashflow, the IRR method may suggest Project B, based on a higher computed IRR. The NPV calculation is generally considered superior to and more robust than other discounted appraisal techniques as it allows realistic assumptions on the benefit and cost cash flows from and to a project.

The key determinants of the NPV calculation are the appraisal horizon, the discount rate and the accuracy of estimates of costs and benefits.

2.10.3. Discount rate

The concept of discount rates is a key element of the NPV method. A discount rate is used, for financial appraisal purposes, to convert costs and benefits to present values to reflect the principle of time preference. Various methods can be used to calculate the discount rate, including the weighted average or opportunity cost of capital to adequately reflect the time value of money. Discount rates are used for various financial and non-financial operations and are also used to estimate climate change (Srinivasan, 2017). Gormsen and Huber (2022) recently found that discount rates used by companies develop with the cost of capital, but the relation is less than one-to-one, leading to a time-varying delta between discount rates and the cost of capital. Further, there are risk-adjusted suggestions for discount rates, such as risk adjustment for discount rates with a social markup to promote long-term investment in socially relevant investments (Cherbonnier & Gollier, 2022).

2.10.4. Internal Rate of Return (IRR)

The internal rate of return (IRR) is the discount rate that balances the net revenue of a project with the initial investment amount. It is a specified rate that assumes a static balance of cashflows over a given time period. A computed IRR of 5% means that with a discount rate of 5% the project will break even over the given period. IRR is often compared to the hurdle rate, which represents the cost of capital. The hurdle rate corresponds to the opportunity cost of capital; if the IRR exceeds the hurdle rate, the project is accepted.

However, IRR calculations are not appropriate for ranking competing project scenarios as they only report the discount rate at which the project breaks even. It is possible for two projects or scenarios to have the same IRR but different NPV values, due to differences in the timing of costs and benefits. Moreover, applying different appraisal techniques to the same set of data may yield contradictory conclusions. (Wang, 2021).

2.10.5. Benefit-cost ratio (BCR)

The benefit-cost ratio is an indicator used to identify value for money within an investment. BCR is the ratio between discounted benefits, relative to the discounted cost of the project. The preferred option is that in which the ratio exceeds a factor of one. In any event, a project with a benefit-cost ratio of less than one should be not considered for investment. Consequently, the higher the ratio, the more attractive the project. The simplicity of this model is a clear advantage, while its application is mainly in supply-chain appraisal with a focus on transport cost-benefit analysis (Fürtner et al., 2022).

Long-term BCR calculations are sensitive to the discount factor used in the NPV calculation (Yaya & Li, 2014). Moreover, using BCR to rank projects can lead to poor decisions, as a project with a slightly higher BCR ratio will be selected over one with a lower BCR, even if the latter has the capacity

to generate much greater benefits because it has a higher NPV value and is on a larger scale. Moreover, BCR is a relative measure and does not acknowledge the size of the projects being compared. It is also difficult to include non-monetary factors such as willingness to pay (Porter et al., 2009).

2.10.6. Discounted payback period (DPP)

The discounted payback period measures the length of time needed to recover the initial investment or break even (Dai et al., 2022). However, this model does not consider cashflow after the initial investment. The DPP should not be used as an appraisal technique if a concrete decision criterion should be determined. As a result, it should not be the sole appraisal method used to assess a project, but it is suitable for computing a performance indicator to ascertain whether it is worth running a more sophisticated appraisal method.

2.10.7. Sensitivity analysis

Sensitivity analysis is frequently used to better understand how uncertainty influences an output and the results of changing input variables within a certain range. Under IFRS financial reporting requirements, companies must run a sensitivity analysis on foreign exchange (Shoman et al., 2022). In the context of risk management, such analysis is frequently required to better understand the robustness of a model or assumptions such as discount rates, time horizon and value of cost and benefits. The analysis makes it possible to identify those parameters and assumptions to which the outcome of the analysis is most sensitive and, therefore, allows the practitioner to determine which assumptions and parameters may need to be re-examined or clarified.

Sensitivity analysis is the process of establishing the outcomes of a cost-benefit analysis which is sensitive to the assumed values used in the analysis. This form of analysis should also form part of the appraisal of large projects. If an option is particularly sensitive to variations in a variable, then it should be further investigated and probably not undertaken (Tsanakas & Millossovich, 2015). It can be useful to attach probabilities to a range of values to help select the best option. Frequently supported methods are regression analysis and variance-based methods.

2.10.8. Scenario analysis

This method is closely related to sensitivity analysis but, while the latter is based on variables, scenario analysis recognizes that the various factors impacting costs and benefits are inter-dependent. In other words, this approach assumes that it would be unrealistic to alter individual variables while maintaining the remainder constant. Rather, scenario analysis uses a range of scenarios in which all the various factors can be reviewed and adjusted within a consistent framework. These scenarios are often formulated in case scenarios such as a best case/investment case, base case or worst case, with a range of estimated factors influencing the scenario to arrive at the expected scenario case (Li et al., 2022).

When formulating these scenarios and the influencing factors, it is important that appropriate consideration is given to sources of uncertainty about the future such as adequate discount factors. Once the values within each scenario have been reviewed, the NPV of each scenario can then be recalculated.

2.10.9. Switching values

The switching value is the value of the variable at which the project investment decision is changed. This can provide interesting insights into

the change that would make the NPV equal to zero, for example, or by how much costs or benefits must fall or rise respectively to make a project worthwhile (Lawal et al., 2021). The switching value is usually presented as a %age of the value required for the NPV to break even, important information within any decision making or appraisal analysis as a small change in the underlying discount factor alters the result of the appraisal analysis significantly. However, it should be noted that the switching value should be chosen carefully and should also be realistic and justifiable.

Finally, the European Commission has suggested that, when undertaking sensitivity analysis, a useful determinant of the most critical variables is those for which a 1% variation (+/-) produces a corresponding variation of 5% or more in the NPV (EU Science Hub, 2021).

2.10.10. Economic appraisal techniques

Economic appraisal techniques are systematic processes of analyzing all the costs and benefits of the various ways in which the required project objectives can be met. They are widely employed by governments to appraise projects. They can help to assist government decision-makers in ranking projects competing for government funding by priority. Clearly, the results of an economic appraisal will not be the only factor considered in the decision, but they provide important information on the effects of each possible decision and consider non-market impacts such as externalities (Pierce, 2007).

2.10.11. Cost-benefit analysis (CBA)

CBA is a method used to systematically estimate the strengths and weaknesses of known decision alternatives, usually project alternatives, to determine the best option for achieving the desired benefits. Government projects frequently use this method and alternatives are generally accepted

if the benefits exceed the costs. The concept of cost-benefit is based on the 1848 work of Jules Dupuit and subsequent work by Alfred Marshall (Wiener, 2013).

However, even if the benefits of a project exceed the costs, that project will not necessarily be realized, as other projects with a higher NPV may be competing for the same scarce resources or lobby interests may outweigh the benefits. There may be affordability constraints such that even a positive NPV cannot justify the investment. Moreover, the value of a cost-benefit analysis depends on the accuracy of individual cost and benefit estimates, which may be subject to influence from interest groups. The European Union sees CBA as a key to their investment decisions, and CBA is explicitly required, among other elements, as a basis for decision making on the co-financing of major projects included the operational programs of the European Regional Development Fund (ERDF) and Cohesion Fund (Directorate-General for Regional and Urban Policy (European Commission), 2015).

2.10.12. Cost-Effectiveness Analysis (CEA)

In contrast to CBA, CEA does not assign a monetary value to the effect measured, but compares relative cost and outcome in relation to different decision alternatives. It focuses on the impact of the spending on a certain project (Vuori & Ollikainen, 2022) and is commonly used in the health sector where it would be inappropriate to express everything in monetary terms (Lomas et al., 2021). CEA is not used to decide whether a project should be undertaken or not. Rather, it is concerned with the relative costs of the various options available for achieving a specific objective. CEA evaluation is most commonly performed by applying NPV to expected cashflows. It is frequently used within the medical sector, where manufacturers of new medicines in many countries are required to submit a CEA when applying for coverage approval by public or private providers (Xie & Zhou, 2022).

2.10.13. Multi-Criteria Decision Analysis (MCDA)

Stanley Zionts (1979) described multi-criteria decision analysis in his article “MCDM – If not a Roman Numeral, then What?”. MCDA is concerned with structuring and solving decision and planning problems by use of a multiple criteria model that can simulate various outcomes with reference to an explicit set of criteria or objectives. These objectives are well-defined values, such as cost, cash, or targets to be achieved. The advantage of MCDA is that it can also incorporate criteria that do not focus solely on monetary values.

There is a wide range of MCDA methods frequently used by specialized decision making software, but all share the same basic concept of constructing a multi-criteria analysis scorecard and determining the specific weightings to be given to a set of criteria to achieve an objective appraisal of project options and consistent decision making. Judgements and estimates regarding the scoring of investment options should be based on purely objective inputs, and the justification for scoring and weighting decisions must be documented (Zhao & Li, 2022). In this regard, the system should be capable of producing similar results if the selection criteria were applied by different decision-makers, thus creating an informed and transparent decision making process.

2.11. Literature on risk assessment and control

Literature provides a wide body of risk assessment and defining uncertainties that are linked to risk assessment. In terms of capital investment, a tradeoff between future benefits and disciplined spending is described (Rook & Caldecott, 2015). Further diversification is frequently stated as a measurement to reduce risk and control issues, however, for capital expenditure there are limiting factors, mostly financially driven.

Further identification variables are capex evenness and capex density (Rook & Caldecott, 2015).

2.11.1. Risk analysis factors

Likelihood of events occurrence and severity of risk

Risk analysis considers factors generally considers key factors like likelihood of events occurrence and consequences or magnitude of consequences. Likelihood and magnitude of events is frequently measured by a quantitative analysis based on methods like Monte Carlo simulation (Iqbal & Purwanto, 2022). The likelihood of events occurrence is based on the fundamental concept of probability of an event occurring (Kling et al., 2022). Risk magnitude is computed by multiplying the risk likelihood by the risk severity. Both elements are estimates and are frequently based on historical observations or Monte Carlo simulations (Iqbal & Purwanto, 2022). Especially risk likelihood can be affected by various factors among others like environment, people, digitalization/data, management decisions and processes. Similarly, the magnitude of events can be affected by these factors as well. Literature also states that these factors can be biased based on the aim of risk assessment (Marschner et al., 2017; Holmberg & Andersen, 2022).

Other key factors that are described in literature are timing of risk, effectiveness of existing controls, regulatory approach, complexity and connectivity and sensitivity and confidence levels (Rachmadhani et al., 2023). Within the context of SMEs in literature frequently reference is made with ISO 31000 identifying the following risk factors:

Timing of risk

Time as a factor in risk analysis literature is widely described as understanding timing as a key element for risk analysis and risk management. In project related studies risk of time is often seen as an element that depends on the occurrence of external elements, while in

medical research timing is one dimensional as it is often referred to as early as possible (Dang et al., 2021; Toth & Sebestyen, 2015).

effectiveness of existing controls

Organizations with a certain size are required to put high standards on internal controls and risk management, which also includes a review of effectiveness of existing controls. In the SME sector companies, subject to have annual financial statements to be audited are required by law in Germany to follow such procedure (Johannsen & Kant, 2022). Effectiveness testing also includes compliance testing and IT governance review. It should be noted that IT governance also includes digitalization aspects of the organization (Landoll, 2021). Especially, data protection requirements are required to be upheld and fully complied with.

sensitivity and confidence interval

Confidence level and significance level are two important concepts in statistical hypothesis testing. The confidence level measures how confident we are that our conclusions are correct. In contrast, the significance level (also called alpha value) is the probability of rejecting the null hypothesis when it is true (Bhattacharjee & Baker, 2021). The hypothesis testing results are often stated as Type I and Type II error.

As sensitivity and specificity cannot exceed 100%, neither should their confidence interval. Such impossible results arise when the standard large sample method for calculating confidence intervals for proportions is used when the proportion is near to zero or one or when the sample is small, or both. In statistics a confidence interval of 95% with a significance level of 0.05 are common (Bhattacharjee & Baker, 2021).

Regulatory approach

Within SMEs that are subject to annual financial statement audit the internal control systems play an important role and are a review of internal risk

management and related risk analysis factors (Brown et al., 2012). SMEs can use digitalized methods like a big data approach to identify and manage the aforementioned risk factors (Gao, 2022). Listed companies in Germany are required to review and report on their internal control system which includes review of the aforementioned risk factors and analysis (Brown et al., 2012).

Complexity and connectivity

Literature finds that an event can have multiple causes and consequences and can affect multiple objectives (Rachmadhani et al., 2023). Especially for complex analysis an adverse scenario can be triggered by multiple causes. As opposed to risk registers where it is often hard to understand which control, or barrier, is protecting from which threat (Herdmann, 2022; Bär, 2023).

Credibility

Credibility depends on the richness of the data and quality of the analysis and can be enhanced by data triangulation (Kekecs et al., 2023). Low reproducibility of important findings, growing evidence for a systematic publication bias and high prevalence of questionable research practices have increased scepticism about the trustworthiness and credibility of research reports (Nosek et al., 2015). To avoid these items researchers should carefully think about credibility of their project (Kekecs et al., 2023).

Transferability

The concept of transferability corresponds to external validity, providing for generalizing of a study's results. Transferability refers to the extent to which the results and interpretations of a research project can be transferable and relevant to other contexts or settings beyond the (unique) specific research context (Hendren et al., 2022). In this sense, the concept is closely related to the rationalist concept of external validity. It encompasses the ability to generalize or apply the knowledge gained from a study to similar situations,

populations or settings, thus increasing the potential for broader understanding and practical utility. Transferability can be achieved by thorough description of the research project and the underlying assumptions, providing transparency on the analysis leading up to the results (de Wit-de Vries et al., 2018). In qualitative research, transferability differs from the concept of statistical generalizability often used in quantitative research. Rather than aiming for representative samples or statistical significance, transferability emphasizes the richness and depth of the data and aims to capture the complexity and nuances of the human experience in a particular context (Hendren et al., 2022).

With providing that information, the research results may be transferred from the original research situation to another similar situation (Scarrà & Piccaluga, 2022).

Transferability should not be considered in isolation, but always in conjunction with the following two criteria.

Dependability

Dependability of the qualitative data is demonstrated through assurances that the findings were established despite any changes within the research setting or participants during data collection. Dependability refers to the degree of consistency, reliability and stability of results and interpretations throughout the research process. It emphasizes the ability of researchers to establish and maintain confidence in the accuracy and trustworthiness of their study. Dependability is closely related to the rationalist concept of consistency. Dependability requires the establishment of a clear and well-documented research design, including detailed descriptions of the purpose of the research project, methods, and data collection procedures. This transparency allows for potential replicability and review of the research process by other researchers (Hayre, 2021).

Further it involves rigorous data collection and analysis techniques, requiring a strive for consistency and reliability in data collection methods

and ensuring that they are applied consistently across participants, settings, or time periods.

Again, rigorous data collection techniques and procedures can assure dependability of the final data set. Both the process and the product of the research need to be consistent (Lincoln & Guba, 2005; Janis, 2022).

Confirmability

Confirmability of qualitative data is assured when data are checked and rechecked throughout data collection and analysis to ensure results would likely be repeatable by others (Prochner & Godin, 2022). Confirmability refers to the degree of objectivity, reliability and credibility of the results and interpretations derived from qualitative research. Confirmability ensures that the data collected, and subsequent analysis is based on the perspectives and experiences of the participants and not on biased interpretations or personal prejudices of the researcher (Hayre, 2021). This can be documented by a clear coding schema that identifies the codes and patterns identified in analyses. This can be achieved by a data audit prior to analysis can also ensure dependability. The data audit includes audit trail of raw data, analysis notes, reconstruction, and synthesis products, process notes, personal notes, as well as preliminary developmental information (Lincoln & Guba, 2005). In this sense, it is closely related to the rationalist concept of objectivity.

Overall, the approach to sampling differs significantly in quantitative and qualitative research projects and also requires different approach to analysis and review of data. Qualitative samples are usually small and should be selected purposefully in order to select information-rich cases for in-depth study (Scarrà & Piccaluga, 2022).

As seen from the above criteria, qualitative research requires far more documentation than quantitative research in order to establish trustworthiness. Quantitative research, on the other hand, requires more effort during the research design phase.

With qualitative and quantitative research serving different objectives and being designed in a different way, quality assessment criteria must be adapted and adhered to accordingly as outlined in other sections of the literature review.

Influence of techniques on process and outcome of research project

Quality of any research project depends on the overall quality and rigor of a study design and its respective application. In qualitative research the guiding factors are as defined by Lincoln & Guba (2005), who defined a set of criteria for trustworthiness of qualitative research: (a) credibility (vs. internal validity), (b) transferability (vs. external validity), (c) dependability (vs. reliability) and (d) confirmability (vs. objectivity).

2.12. Literature on digitalization

2.12.1. Digitalization

The digital era has shaped new industries, jobs and markets while threatening existing business models, employees and markets (De Groen et al., 2017). With the development of the microchip, the first computers emerged and made their way into both businesses and homes. Soon the first processes were automated and the computers' efficiency and quality of work were found to be superior to that of humans. The success story of the computer is based on the definition of the rules implemented in algorithmic processes. The speed of automation has reached new levels, and the term Industry 4.0 – implying full automation of processes, communication between machines and cognitive computing – was coined by the German government with its high-tech strategy to promote computerization. Digitalization is often referred to as the fourth industrial revolution (Jäger et al., 2016; Papadopoulos et al., 2021). The trend continues and companies are now working on self-learning and self-maintaining artificial intelligence systems that can take the automation of industry and services to the next

level ("Where 4.0 Might Go", 2019). It should be noted that, although digitalization threatens the activities of traditional enterprises, it also creates new opportunities and needs in a new type of intermediation (Nadkarni & Prügl, 2020; Legner et al., 2017).

In digitalization, the key factors of a successful business are transformability and flexibility (Bauer et al., 2015). However, digitalization is more than connecting intelligent devices; it also requires the right decision-maker to empower existing systems and advance processes to fully support the positive aspects of digitalization. This implies disruptive effects on customer structure and operations and may ultimately change entire business models (Westerman et al., 2017).

A paper by Schiffer (2021) published by German Bundesverband der Industrie suggests keeping the following four levels of transformation in mind as key factors when working within a company to formulate a digitalization strategy:

- 1) Big data: storage of data for analysis and predictive analytics;
- 2) Automation: traditional work and artificial intelligence combined to improve efficiency and quality;
- 3) Integration: interconnected supply-chain to allow for shorter production times and improved innovation cycles;
- 4) Digital customer access: emergence of new services and competitors and importance of transparency amid increased competition.

Bean and Davenport (2019), however, argue that companies are failing to become data-driven, based on the alarming results of New Vantage Partners' (2019) 'Big Data and AI Executive Survey', whose participants included 64 C-level technology and business executives from large corporations. It highlights the ongoing need for a data-driven culture, in which data is treated as an important business asset and given more attention, investment and resource.

2.12.2. Influence of digitalization on decision making

Digitalization affects all areas within an organization and requires us to change the way decisions are taken and the basis on which they are made. While decision making is generally a complex process, some decisions are repetitive and based on clear decision criteria (Jeglinsky, 2022), allowing the automation of decision making by enabling computers to take the decision. This opens completely new scenarios and raises philosophical questions. In the past, it was unthinkable that a machine could take an independent decision based on rules and input criteria. Today this is already happening, and people are quite happy to drive cars able to park independently without human intervention. The financial markets have already invested heavily on upgrading automatic trading systems with computers that search and identify patterns autonomously (Brynjolfsson & McAfee, 2018).

These rapid changes require businesses to adapt as well and improve their decision making to stay competitive in the future. Westerman et al. (2017) showed that businesses that managed to change from pre-digital to digital organizations increased their revenue and profit substantially. Improving a company's digital organization helps it to improve its decision making processes (Westerman et al., 2017).

2.12.3. Measuring digitalization

Various concepts have emerged in the context of measuring digitalization, but such measures depend on the definition of digitalization as well as the result to be identified. Most metrics were developed to measure and benchmark countries and their respective economies against one another, but it is equally important for companies to measure their competitiveness against their peer group (Peppard, 2016). In contrast to existing measures for governments and countries, businesses frequently rely on a different set of key decision variables, including risk management, improved cost and

increased revenue (Desmet et al., 2015; Fernández-Olano et al., 2015). The importance of digitalization has also reached the political agenda, with the EU's formulation of Agenda 2025 to improve information and communication technology (EU Commission, 2016), leading companies to establish their own agenda or digital strategies (Sjödín et al., 2021; Kotarba, 2017; Setyoko & Kurniasih, 2022). Although digitalization brings substantial benefits to businesses, it also brings challenges, such as understanding how to measure its value (Fernández-Olano et al., 2015; Kotarba, 2017). It is therefore important to measure precisely the ex-ante and ex-post impact of digitalization and its derived decision making in this regard.

As a result, the OECD has developed a new measurement agenda and asked its members for new statistical and reporting tools to improve the measurement of digitalization in order to make the right decisions (OECD, 2019). In this context, the European Commission developed, as part of Agenda 2020–2025, the so-called Digital Economy and Society Index (DESI) in 2014, to assess digital performance and development within the European economy and population. The index covers not only aspects of economic output and productivity but also the quality of governance and human capital (European Commission, 2016). Earlier digitalization measurement systems are digital economy metrics focused on basic information technology variables, such as internet access type, e-commerce and e-business (Tapscott, 1997). Some of these variables are rather outdated today as the type of internet access is of less relevance due to broadband and LTE mobile connections. However, the increased data exchange needs of Industry 4.0 require even faster connection speeds. Regarding the economic side of computation, the Digital Density Index, developed by Oxford Economics and Accenture, focuses on how technology impacts economic growth (Kotarba, 2017; Macchi et al., 2015). Katz et al. (2014) developed a digitalization index to measure the economic and social impact of digital agendas. The index itself is flexible and allows for additional and changed variables to accommodate the needs of a business given the future economic impacts of the digital agenda expressed as an index return.

McKinsey is also active in this area and developed the Industry Digitalization Index, based on the three dimensions of assets, usage and labour, for which KPIs have been defined (Manyika et al., 2015), similar to the digital enterprise metric and digital client metric, which are also driven by selected computed KPIs (Kotarba, 2017). The measurement of digitalization is a key issue for senior management. A survey by Adobe and CMO Council (2015) found that 39% of respondents who declared digital investments had failed to make a suitable business case for spending. This relatively pessimistic finding regarding budgets and business cases is linked to the very nature of digital projects: frequently they are concerned with disruptive innovations and new business models for which there are limited or no past performance data and, therefore, decision making is more difficult. The uncertainty in business case development needs to be addressed by the business case methods selected (including, among others, the calculation of net present value (NPV), internal rate of return (IRR), pay-back period (PB), return on Investment (ROI)) equipped with more sophisticated methods of evaluating current and future cash flows from digital processes.

2.12.4. German SMEs and digitalization

Every German SME has digitalization on its agenda today, whether to improve its sales support, improve connectivity in the production process or reduce the administrative burden through automation. Significant research has already been completed on manufacturing lines and demonstrates the huge potential of IT in improving SME flexibility (Matejun, 2014). Research by the KfW (2021) provides a representative analysis of the German SME sector in terms of digitalization. They found that the majority of digitalization projects centred on renewal of the IT structure, digitalization of customer and supplier interfaces and reorganization of workflows and administrative processes. German SMEs spent EUR 20.3 billion in 2020 completing digitalization projects. The inclusion of digitalization and its consequent challenges in the decision making process also affects budgets and the key

strategic decisions to be taken. While digitalization is acknowledged as a significant driver of growth, productivity and competitiveness, it nevertheless appears necessary to continue to promote it in Germany's SME sector. However, businesses face a variety of barriers, including a lack of IT skills, unresolved issues relating to data security and data protection, problems in adapting their corporate structure and workflow management, and the unsatisfactory quality of their internet connection (Zimmermann et al., 2017). Enterprises requesting loans for digitalization projects also report greater difficulty in accessing credit (Zimmermann et al., 2017), perhaps unsurprisingly given the similarities between digitalization and innovation projects.

Within the literature, however, there is already substantial research on the impact of digitalization on supply chain management (Brinker & Haasis, 2022; Fazili et al., 2017, Gunasekaran et al., 2018). Earlier research by Schmid (2020) found that SMEs' lack of interest in digitalization is increasing, a trend already noted in a survey for the SME Business Performance Index in 2013, which highlighted the lack of enthusiasm for digitalization (Nadkarni & Prüggl, 2020), and in the results of a survey by New Vantage Partners (2019). The German chancellor, Angela Merkel, stated in 2013 that the internet is uncharted territory for all of us, reflecting the headline of a presentation by the consultancy Arthur D. Little at the Hanover industry fair in 2013 on Industry 4.0: "Blessing or curse for German industry?". The literature also finds that SMEs tend to set artificial spending budgets instead of using a more sophisticated approach to decision making (Bagale et al., 2021).

Challenges and barriers of digitalization in German SMEs

Since the term industry 4.0 has been coined, companies and respective trade associations market digital transformation at German SMEs. Research by Trenkle (2020a) identified various elements of digital transformation in small and medium-sized enterprises. A key element of driving digitalization was identified as strategy (Trenkle, 2020b). Without an

actual valid strategy any digitalization project will pose a challenge for any company. In addition, having the required skills within the IT department and the people not being afraid of change and transformation are other key challenges. As outlined by Schell et al., (2022) it is essential that employees are involved in any digitalization and change projects. A recent article on artificial intelligence published by the German business newspaper Capital, estimated that AI will cost worldwide 300 million full-time jobs in the near term. AI will also bring new jobs, but these jobs may require re-training and re-qualification of existing staff. Challenges also arise around motivating staff to lifelong learning as new technology or new computer systems need to be understood to work with them. There are also concentration risks that if a company is locked in with a certain provider of digitalization services or has adjusted its processes to one provider it is difficult to change to another service provider. Replacing an ERP system may easily take two or three years as a project (ERP Focus, 2022).

Barriers of digital transformation that are frequently seen are related to are improper management of the change project. Digital transformation brings changes in the working environment, requiring employees to a new path of working. Lack of understanding by the workforce will result in a lack of performance (Evdokimova et al., 2023; Jones et al., 2021). Any change project also needs proper resources to be realized, not only financially, but also support of stakeholders and as described above also the required skills available either internally or externally. Also, despite the many advantages, the spread of digital innovation is rather slow and practice shows that digitalization does not ensure rapid growth in productivity and income (Evdokimova et al., 2023).

2.13. Literature on digitalization methodology

2.13.1. Measuring digitalization

There are various concepts and definitions of digitalization, the most common of which are described in this chapter. First, a short definition of digital economy metrics is given, before moving on to the various theoretical concepts of measuring digitalization. In the following chapter, the most important concepts are presented.

For the purpose of this research, the term “digital industry” is defined as the application of digitalization in any type of industry in the German SME context. It is not limited to new technologies that produce digital solutions or to a specified sub-sector or industry within the SME sector in Germany.

2.13.2. Digital Economy Metrics

Don Tapscott first coined the term “the digital economy” in his 1997 published research “The digital economy: promise and peril in the age of networked intelligence”. The concept assumes that within an economic system the use of information technology is widespread, and the following elements are present:

- a) Base infrastructure (e.g. high-speed internet access, computing power);
- b) e-business (business models with high ICT utilization in all office functions); and
- c) eCommerce (utilization of ICT in business-to-business (B2B), business-to-consumer (B2C), and consumer-to-consumer (C2C) transactions.

2.13.3. The Digital Density Index (DDI)

This index was developed jointly between Oxford Economics and the consulting firm Accenture in an attempt to measure how digital technologies impact economic growth. The DDI contains 50 indicators grouped into four activity areas and 18 groups of metrics, as depicted in Figure 7.

The DDI can be modified to accommodate the metrics of an organization as the input factors are also adaptable to a business environment.

Activity area	Description and metrics	
1. Making markets	Increasing digitalization of existing and new markets. Recognition that existing markets becoming increasingly digital and new markets are being created by digitalization	
<i>Metrics</i>	<ul style="list-style-type: none"> ➤ Customer activity cycle ➤ Digitally constable markets 	<ul style="list-style-type: none"> ➤ Interfirm collaboration
2. Sourcing inputs	Use of digital technology to source and/or use factors of production Degree to which digital technologies change the lifecycle of sourcing these factors for the business.	
<i>Metrics</i>	<ul style="list-style-type: none"> ➤ Plant, property, equipment ➤ Labor 	<ul style="list-style-type: none"> ➤ Finance (capital, liquidity)
3. Running Enterprises	Business use of digital technologies and activities to execute key business functions	
<i>Metrics</i>	<ul style="list-style-type: none"> ➤ Technology process ➤ Strategy process ➤ Human capital/talent 	<ul style="list-style-type: none"> ➤ Business model ➤ Innovation ➤ R&D investments
4. Fostering enablers	Changes in institutional and socioeconomic environments to facilitate digitalization	
<i>Metrics</i>	<ul style="list-style-type: none"> ➤ Organizational flexibility ➤ Connectivity ➤ Attitudes in society 	<ul style="list-style-type: none"> ➤ Government spending ➤ Ease of business

Figure 4: Table Digital Density Index

Source: Macci et al., (2015)

2.13.4. Digital Industry Metrics

McKinsey suggested an Industry Digitalization Index to measure the digital status of industries (Manyika, 2015). The Index covers three groups of metrics:

- a) Assets
 - a. digital spending: hardware / software / infrastructure / telecommunication investments
 - b. digital asset stock: hardware / software / data storage / connected equipment
- b) Usage
 - a. Transactions: digital B2C and B2B transactions
 - b. Interactions between firms, customers and suppliers: digital external communication and digital customer service
 - c. Business processes conducted internally: digitized front and back-office processes and product-development software intensity
 - d. Market making / digitally enabled markets: platforms used to connect supplier and customer
- c) Labour
 - a. Digital spending: hardware / software / telecommunication / IT service spending per worker
 - b. Digital capital deepening: hardware / software assets per worker
 - c. Digitalization of work: share of tasks that require workers to use digital tools and processes
 - d. Number of jobs that are digital: hardware / software engineers, ICT department staffing.

As part of their research, Manyika et al. (2015) found that using digital technology improved sales channel productivity in the companies included in the study by 15% on average.

2.13.5. Digital Enterprise Metrics

In line with the well-researched area of national digitalization and the estimation of benefits achieved by digitalizing the economic environment, there are also benefits for enterprises (Kotarba, 2017). However, further variables are required to understand the level of digitalization of the individual business or organization. These additional variables describe the e-commerce performance and customer experience within the company. Frequently used variables are the conversion funnel (visitors, leads, prospects, clients), website statistics (drop-off rate, cost per click, time on site), traffic and lead sources (paid search/affiliate, direct, organic), content quality, customer engagement (churn rate) and sales and revenue per digital client. These variables are the most widely accepted; however, there are many more depending on the company's unique market and approach (Kotarba, 2017).

2.13.6. Digitalization Decision Support Index

Since the COVID-19 pandemic, the need to improve digitalization has resulted in research into new methods to define the degree of digitalization within a company. A wide range of industry reports and academic studies have been produced on digitalization levels (Gandhi et al., 2020; Gruszka et al., 2017). Research by Sezer and Bröchner (2019) identified where digitalization might lead to improvements within companies. As outlined in the other methods in this section, most research estimates the degree of digitalization for a country in a comparison exercise based on a group of variables. However, in business, it is important to reflect the unique position and need of each organization in terms of digitalization, as business models, definitions of digitalization and market areas are unique and, therefore, difficult to measure appropriately. Sezer et al. (2021) describe an approach to measure the degree of digitalization of a certain project by developing a digitalization index. In the context of this research project, the analysis of

the degree of digitalization of a project is a key element. There are a few examples of project-level assessment models. One of the first studies was completed by O'Connor et al. (1999) and proposed a technology use and integration index based on three levels of technology for a total of 68 pre-defined tasks. However, this approach is time intensive, making it impractical for most methods, as reported by Sezer and Bröchner (2019). Therefore, a simpler approach was required, leading to the Digitalization Decision Support Index. This model consists of a three-step approach, and like the existing elements of the FAP model, a Delphi approach is utilized. In the first step, a list of key activities with potential for digitalization are identified by a financial appraisal team. In the second step, these activities are then ranked and analyzed based on factors such as utility, ease of digitalization, degree of pressure and facilitating conditions for digitalization. Data are then normalized and the total digitalization value calculated for each activity, according to the following formula:

$$Total_x = \sum_{i=1}^n U_{x,i} + E_{x,i} + P_{x,i} + C_{x,i} \quad \forall x = 1, \dots, n$$

Figure 5: Digitalization Decision Support Index

Source: Author

Where:

U = usefulness

E = ease

P = pressure

C = facilitating conditions

To avoid potential gender influences, with male and female groups ranking activities differently, Mann-Whitney and Kruskal-Wallis tests can be applied.

In the next step, the degree of digitalization is estimated. As suggested by O'Connor (1999), there are three levels of digitalization for four steps of data analysis, defined as follows:

Degree of Digitalization	Data acquisition	Data entry	Analysis	Reporting
Level 1 => No electronic tools used to complete a work function	Manual	Paper and pen	Paper and pen	Paper and pen
Level 2 => Some use of electronic tools	Digitized data requiring user interpretation	Digitized manually	Manually with basic software	Digitized but manually distributed
Level 3=> Fully automated system to complete the work function	Digitized data not requiring user interpretation	Digitized automatically	Automatically with software	automated

Figure 6: Degree of digitalization

Source: Author

Yang (2008) adds two more categories by splitting Level 2 into a) use of a few somewhat uncommon electronic or mechanized tools and b) use of several specialized electronic or mechanized tools. Boute and Van Miegheim (2020) identified four categories: “digital”, “automated”, “smart” and “automated and smart” to describe the level of digitalization of a process within a company. Previous research describes the level of digitalization on a scale from manual operation to full autonomy using machines but not in terms of full digitalization as defined in the literature section. As well as the degree of digitalization, it is also important to estimate the frequency of IT usage. Isaksson et al. (2009) used a simple scale from “never” to “very often”, while Koekemoer and Smallwood (2007) suggested a five-point Likert scale. To avoid overcomplicating the index, Sezer et al. (2021)

suggest using a five-point Likert scale for a data management project appraisal. The scale ranges from 1 (for 0% to 20% of the time) to 5 (for 81% to 100% of the time).

The construction of the digitalization index is represented in the following equation for each digitalization of company IT activities (DCIA):

$$DCIA_{i,j} = D_{i,j} + f_{i,j} \quad \forall_i = 1, \dots, m \quad \text{and} \quad j = 1, \dots, x$$

Figure 7: Formula DCIA

Source: Author

Where

i = company activity and *m* = number of total activities

D = Degree of digitalisation (level 1 – 3) and

f = frequency of 1 to 5

Figure 8: Degree of digitalization

Source: Author

For each activity, I identified its specific degree of usefulness, ease, pressure and facilitating condition. The sum for each degree of digitalization activity can be formulated as follows.

The degree of digitalization of company activity (DCIA) for activity *i* and each aspect (usefulness, ease, pressure and facilitating digitalization):

$$\text{degree of a company activity} = \sum_{j=1}^x DCDM_{i,j} \quad \forall_i = 1, \dots, m$$

Figure 9: Degree of company activity

Source: Author

The equations above can be simplified as follows:

$$\text{digitalisation index} = \sum_{i=1}^m \sum_{j=1}^x D_{i,j} \times f_{i,j}$$

Figure 10: Digitalization index

Source: Author

Based on the index, a financial appraisal project is scored on a scale from “completely analogue and manual” (up to 20% of maximum index value), a “blend of analogue and manual and digital and manual” (up to 40%), “completely digital and manual” (up to 60%), a “blend of digital and manual and digital and automated” (up to 80%) and “completely digital and automated” (up to 100%).

2.13.7. The digitalization index

The digitalization index was created by Katz et al. (2014). Katz defined digitalization at its most basic level as the process of converting analogue information into a digital format. His definition implies that information from complex situations is transformed in machine language to combinations of one and zero. This requires a robust transformation from analogue to digital in order to avoid misinterpretation, resulting in incorrect results and digital issues. Digitalization has brought about social transformation as a result of the widespread adoption of digital technologies and the advocacy of new technologies by so-called early adopters, who marketed new technologies to share, process, generate, store and handle information.

It should also be noted that digitalization is not achieved by promoting a certain agenda or reaching a comfortable level of development. The improvements and research in digitalization and the process itself are

ongoing. Therefore, the current status of a company represents only a snapshot. Within a well-connected environment, change and the adoption of new digitalization developments are key.

However, it is important to note that digitalization is based on innovations in semiconductor and network technology. Without the advancements in this sector, digitalization could not have become a megatrend, initiating a new business cycle. It would not have had such a substantial impact on personal and professional life without supporting variables such as affordability, reliability and easy accessibility. The digitalization index developed by Katz et al. (2014) was developed to measure the digitalization of countries with the help of a composite index.

2.13.8. Construction of a digitalization composite index

As outlined above, the primary aim of this research project is to improve the existing FAP model by expanding it with a digitalization index. Measuring digitalization should encompass multiple relevant variables of digitalization within an organization in order to capture the full picture and impact, rather than one aspect. A digitalization index should aim to measure the financial and human resources impacts of digital measures.

Based on cluster and categories, the composite index was construed using the following methodology to ensure its validity. In the first step, the theoretical framework and variables were selected. The composite index consists of seven overarching components: affordability, penetration, usability, investment, human capital, interaction and competition. The identified components are equally weighted. Each component comprises a set of sub-components. In total, 28 sub-components are used to compute the composite index. Each sub-index should be normalized; without normalization, outliers skew the dataset resulting in potentially misleading results. Normalization can be achieved by relying on the mean and first standard deviation, flattening the extreme outliers. To check the statistical

soundness, a factor analysis such as the Kaiser-Meyer-Olkin criteria can be employed, as this supports a measure of sampling adequacy and, compared to the Bartlett test, also provides meaningful results if data are not multivariate and normally distributed. The results from the Kaiser-Meyer-Olkin Criteria analysis fall within a range from zero to one (Shrestha, 2021). The general formula for this test is given as follows:

$$MSA_j = \frac{\sum_{k \neq j} r_{jk}^2}{\sum_{k \neq j} r_{jk}^2 + \sum_{k \neq j} p_{jk}^2}$$

Figure 11: Formula Composite index

Source: Author

The investment component is a key element in business and depends on a business's decision to evaluate an appraisal project. Moreover, in digitalization, this is a key consideration, as new technology and the digitization of processes also has implications for company resources and, in particular, human resources. For the latter, usability is an important aspect: if the digitalized element is too complicated, this may require follow-up investment as usability will not be achieved and human capital will need to be further developed. However, some companies are already well advanced with their efforts towards Industry 4.0 and the digitalization of processes. These companies frequently employ a younger and highly educated workforce that is more open to change and the use of new technologies and tools, compared to their lagging competitors.

Following the computation of the composite index, the results can be grouped into three clusters to categorize businesses and present an index factor that allows decision-makers to improve their financial decision making. The clusters are frequently denominated as below:

1. Leader: represented by an index result above 50
2. Transitional: index between 25 and 49
3. Lagger: index below 25.

It should be noted that for companies falling within the transitional or lagger clusters, changes to the company agenda in favour of digitalization can improve their ability to adapt faster to digitalization. There may also be limited access to fast internet network connections depending on the location of the business.

Chapter 3: Research methodology

This chapter lays out the foundations of the methodological approach adopted towards the research problems and the overall research process. It provides insights into the questions and questionnaire structure as well as the case study performed at a selected German SME. The development of the research model will be explained in the following chapter.

3.1. Introduction

This chapter describes the methodology and research approach. The research itself adopts a qualitative approach with limited data collected by closed questions and, therefore, some further justification and explanation are required to support the development of the research in the following chapters, as the existing FAP model is expanded with the additional element of digitalization. The study follows a pragmatic research paradigm and is dominated by qualitative research, supported by quantitative analysis.

The main reason for the selection of a pragmatic research paradigm is my own professional background. I have a pragmatic personality and have spent the majority of my career in senior managerial positions in start-ups, SMEs and large multinationals in Germany and abroad. Working in senior managerial roles in various industries has required a more pragmatic approach towards decision making and finding solutions based on the options available. In my academic work, I have primarily focused to date on quantitative research into financial topics within the paradigm of pragmatism. Based on my academic and professional experience and my own beliefs, I see pragmatism as the ideal approach to combine qualitative and quantitative research as well as bringing academic and more theoretical elements together with professional and more practical research.

However, it should be noted that pragmatism is not monolithic: various definitions, philosophical streams and schools of thought exist, which will be described in the next section. In terms of this project, I work primarily within the neo-pragmatist philosophy, not treating pragmatism as a purely philosophical approach but, rather, focusing on the practical implications and avoiding entanglement with the philosophical foundations of pragmatism.

I do not believe that there is a single perfect approach to research or indeed a single ideal research paradigm. The paradigm war has endured since the 1980s, with advocates of qualitative and quantitative research arguing that their approach is superior and, for the most part, claiming that the two approaches cannot be used together because of their different views of the world (Guba & Lincoln, 2005).

The debate continues but in recent decades a growing community of researchers have advocated for a third research paradigm, one that combines both quantitative and qualitative research (Onwuegbuzie & Leech, 2004). Regardless of paradigmatic orientation, all research in the social sciences attempts to provide warranted assertions about humans, their behaviour and the environments in which they live and evolve (Kaushik & Walsh, 2019).

Qualitative research, combined with limited quantitative elements offers practicing researchers a combination of methodologies that describe and use techniques closer to those used by researchers in practice (Liu, 2022; Onwuegbuzie & Johnson, 2004), while pragmatism also helps to shed light on how research approaches can be mixed to achieve fruitful outcomes and answer research questions (Kaushik & Walsh, 2019).

A particular element of pragmatic research methodology is emphasis on actionable knowledge, allowing research agendas anchored in respondent experiences and, hence, ensure the research is of practical relevance (Kelly & Cordeiro, 2020). Further a final methodological principle defined from the

literature on pragmatism is the principle of inquiry, which links beliefs and action through a process of decision-making (Rescher, 2020).

I believe, therefore, that my choice of pragmatical research is justified, considering the nuances of the combination of qualitative research and limited closed questions for this research project. In the following parts of this chapter, the foundations of the research paradigm are presented, and the applied methodologies explained.

3.2. Methodology and pragmatism

As outlined in the literature section, pragmatism is considered a relevant research paradigm for organizational and business research as well as financial decision making (Kelly & Cordeiro, 2020). Considering the requirements of this research project, pragmatism fulfills the three key methodological principles underlying the pragmatic approach of this research project, which consists of inquiry: (1) emphasizing actionable knowledge, (2) recognizing the interconnectedness of experience, knowledge, and action, and (3) inquiry as a process of experience (Jordan, 2022; Foster, 2023). For pragmatists, the best method is the one that most effectively leads to the desired outcomes of inquiry, regardless of whether it is a single method, multiple methods, or a mixture of methods. (Rescher, 2020). Pragmatism is therefore a rather flexible research paradigm that focuses on outcomes and offers the researcher flexibility in terms of methodology and approaches (Kaushik & Walsh, 2019). The treatment of pragmatism within research methodology is well established in the literature. The key tenets of methodology within pragmatist research are the emphasis on actionable knowledge, recognizing the interconnectedness of experience, knowledge, and action, and finally, viewing research as an experiential process. These key elements influence the research design of this research project and are further elaborated in the following sections.

3.3. Research approach

The selection of an appropriate research approach reflects not only the nature of the study but the research objectives. The two types of approach are categorized as either deductive or inductive (Saunders et al., 2003). A deductive approach can be described as depending on quantitative data collection, whereas an inductive approach mainly uses qualitative data (Collis & Hussey, 2014; Creswell, 2009). However, a deductive approach is driven by the development of conceptual or theoretical structures and then tested empirically (Collis & Hussey, 2014). In other words, the deductive method takes a general theoretical framework and tests its fit for the research outcome. Conversely, an inductive approach builds theories from the observation of empirical reality. According to Easterby-Smith et al. (2012), an inductive approach is particularly useful for understanding why something is happening. The inductive approach applies the evidence gathered to understand how it is interpreted from the research questions and, unlike a deductive approach, can build theory. I believe it is important to follow a pragmatic approach in developing a practical and relevant financial appraisal model. I plan to establish the improved FAP model as the standard investment decision model in the companies I work with.

The research itself is divided into various stages. As mentioned above, this study follows a pragmatic paradigm, which provides the philosophical framework for the mixed-methods approach (Onwuegbuzie & Johnson, 2004; Somekh & Lewin, 2008). Pragmatism is concerned with 'what works' and is linked with utilitarian arguments that what matters is what has 'utility to the individual' (Rutherford, 2013). The pragmatic epistemology gives the researcher greater freedom to decide which research approach should be followed in a specific study (Onwuegbuzie & Johnson, 2004).

Thus, this study collected empirical data via an exploratory case study method. The FAP model supports case study research for strategic and risk indexes. Qualitative research offers insight into personal experiences, augmented by applying multivariate analysis to the collected data inputs.

Within pragmatic research, it is understood that every method has its limitations and that different approaches can be complementary (Whitford & Zirpoli, 2016). This case study was enriched by data collected from a network of professionals and members of professional bodies, with 15 senior financial officers employed by German SMEs selected as a sample for semi-structured interviews. The interview candidates were chosen through purposive sampling, and rigorous sampling procedures were applied to guard against sampling errors. Responses received from interviewees to open-ended questions were codified and categorized in NVivo. Conventional thematic content analysis was used to analyze them, while the literature and underlying text findings were analyzed through summative content analysis (Hsieh & Shannon, 2005). By applying content analysis, both deductive qualitative and inductive qualitative categorization was applied (Mayring, 2016; Kuckartz, 2012).

The responses to closed questions from the interviews and existing studies on financial decision making in German SMEs were used in the qualitative analysis. Multivariate analysis was utilized to test for significance of the underlying data and to test the new model for robustness. The digitalization factor, to satisfy Research Objective 2, was computed using a methodology suggested by Sezer et al. (2021) combined with a delphi approach, with statistical weighting of the results by organizational decision-maker (Simon, 1995). The data were analyzed by applying principal component analysis to reduce the number of dimensions (Bairi et al., 2011). The integration of a digitalization dimension is not a trivial task. One of the most critical aspects of such integration is the appropriate valuation and integration of digitalization benefits and costs into the auditing, control, performance measurement, risk management and capital investment decisions of a project (Friedrich et al., 2009; Tipurić, 2022).

Research stage	Planned work
Stage 1	Literature review, conceptualisation and set up of an initial framework (secondary data collection)
Stage 2	Primary data collection: Exploratory research - qualitative research. The Exploratory research will also inform the explanatory research stage 3
Stage 3	Primary data collection: Explanatory research - quantitative research
Stage 4	Triangulation and final model development and contribution to knowledge

Figure 12: Research stages

Source: Author

From an ethical perspective, I share the view of Punch (2014) that qualitative and quantitative research using interviews involves collecting data from people about people. This means that personal disclosure, authenticity, credibility and guarding against misconduct must be taken into consideration (Israel & Hay, 2006; Kvale, 2007). It was important that I was aware that sensitive, confidential and possibly harmful information might be disclosed during the data collection process and that I needed to clarify who owns the data and ensure confidentiality, if required. Interviewees retained ownership of their voice and were asked whether their names could be published (Creswell, 2009). I kept this in mind when designing the interview questions, conducting the interviews, running the data analysis and reaching my research conclusion.

By combining the results from the literature review, the case study and the questionnaire, all the research objectives could be thoroughly investigated. The managerial implications, limitations of this research and recommendations for further research are discussed.

This thesis is, therefore, concerned with the evaluation and justification of industrial or capital projects and the capital budgeting and decision making processes followed in such evaluations.

3.4. Business ethics and philosophical pragmatism

Modern management literature propagates various management styles and techniques but, in most businesses, the bottom financial line is what counts. The rest is unimportant as it may hinder efforts to reach the goal of maximum profitability (Frederick & Petry, 1990). Business managers typically think of business as a practical endeavour and regard themselves as business pragmatists. A pragmatist, as commonly understood, is someone who knows how to get the job done and does not waste time with unnecessary (over-) thinking. This belief derives from William James, one of the first and most influential philosophical pragmatists, who advocated a view of truth that appears to support business pragmatism's focus on practical results. It is intrinsic to the beliefs and values of the business pragmatist and only differentiates in one element from traditional philosophical pragmatism: the business manager believes there is no place for ethics. Frederick and Petry (1990) suggest that the primary reason that some business managers believe they have no ethical obligation to prevent certain harms is that the prevention of such harms would involve going beyond what is required by law and regulations, and they believe that business is required only to conform to the law, not to go beyond it. To make safety modifications to products or services beyond legal standards could impose costs on the company that are not pragmatically justified (Pouryousefi & Freeman, 2021); thus, such modifications should not be made within pragmatic decision making. Furthermore, managers may prefer to avoid ethics in their business dealings because the language of ethics is frequently seen as a hindrance to achieving business and personal objectives (Jacobs, 2004). Against this, it could be argued that some forms of modern slavery, for example within the so-called shared economy, could be facilitated by a pragmatic approach towards business (Caruana et al., 2020; Schor & Vallas, 2021).

In this research project, I believe that ethics are required and, although the research framework is set within a practical business environment, I will adhere to strict ethics at every stage of my research and will ensure that my philosophical pragmatic research abides by the rules of ethical research as laid down by the university.

3.5. Initial Framework of research project

The initial framework is defined by the steps taken to get to a final model. In the initial phase this process was defined by the initial research objective definitions. This is followed by testing them through development of a questionnaire. Outcome of the interviews are being validated by applying the initial findings from the interviews to the case study and its design. The case study itself provides further insights by providing the theoretical concept and further insights through participants observation. Besides gaining theoretical findings the case study also provides practical insides to test the improved FAP model. Initial conceptualization of the improved FAP model is described in section 3.5. At the end the final model is being presented. In figure 13 below this initial framework is shown.

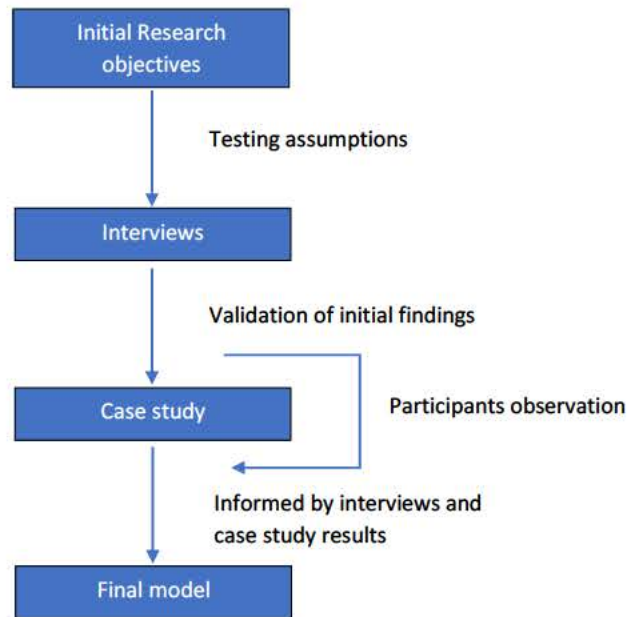


Figure 13: Initial Framework conceptualisation

Source: Author

3.6. Initial conceptualization of the improved FAP model

Following the literature review, the conceptualization of an improved FAP model also requires methodological consideration, as shown in Figure 14.

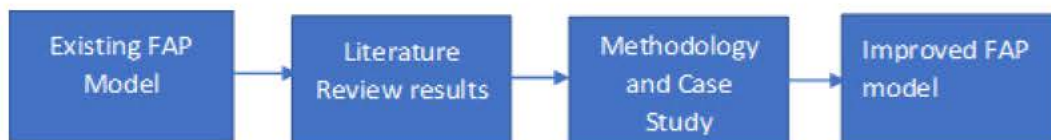


Figure 14: Conceptualization of development of revised FAP model

Source: Author

The results of the literature review suggest that the improved FAP model should be tested by a case study. Like Lefley (2015), who applies the FAP

model in the appraisal of an ICT project, this research project also tests the application of the improved FAP model in a case study scenario. As described by Beck et al. (2020), the initial conceptualization faces a number of limitations as the final model may differ substantially from the initial concept. In terms of an improved FAP model, there is clear evidence in the literature that digitalization plays an important role in decision making processes but to date no improved financial decision making model has been developed to meet the needs of traditional investment analysis while also considering additional factors and including digitalization within its decision making metrics. In this methodology section, the various aspects and requirements of how to construe such an improved model will be explored. After the case study section, the final model will be presented.

3.7. Research methods and pragmatism

The research centers on qualitative research method, but also uses limited quantitative methods, which is permitted by a limited mixed methods approach. The foundations of mixed methods research lie in Dewey's (1910; 2008) lifelong promotion of pragmatism by reorienting philosophy away from abstract concerns and towards an emphasis on human experience. Dewey based his thinking on the concept of experience as a pillar for pragmatic research, centred on the questions "What are the sources of our beliefs?" and "What are the meanings of our actions?"

Beliefs must be interpreted to generate action, and actions must be interpreted to generate beliefs. Dewey describes enquiry as a process of self-conscious decision making. Many problematic situations require thoughtful reflection, and this is where enquiry comes into play. Whether experiences are based on habit or active enquiry, they always occur within a specific context. In this philosophical system, post-positivists claim that the world exists apart from our understanding of it, while constructivists insist that the world is created by our conception of it. For Dewey (2008),

these two assertions are equally important claims about the nature of human experience.

Mixed methods research is defined as research in which the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study. Philosophically, it is the "third wave", or third research movement, a movement that moves beyond the paradigm wars by offering a logical and practical alternative (Sommer Harrits, 2011). Philosophically, mixed-method research makes use of the pragmatic method and system of philosophy. Its logic of enquiry includes the use of induction (discovering patterns), deduction (testing theories and hypotheses) and abduction (uncovering and relying on the best of a set of explanations to understand the results) (Onwuegbuzie & Johnson, 2004). Mixed methods research also is an attempt to legitimate the use of multiple approaches in answering research questions, rather than restricting or constraining the researcher's choices (i.e. it rejects dogmatism). It is an expansive and creative form of research, not a limiting one. It is inclusive, pluralistic and complementary and it suggests that researchers adopt an eclectic approach to the selection of methods and the conduct of the research.

The design of a mixed methods study depends on several key principals and decisions, and no study will be like another (Schoonenboom, 2017). The research design for this thesis considers the suggestions made by Schoonenboom, as outlined below:

- 1) Determine the level of interaction between the quantitative and qualitative strands;
- 2) Determine the priority of the quantitative and qualitative strands;
- 3) Determine the timing of the quantitative and qualitative strands;
- 4) Determine where and how to mix the quantitative and qualitative strands.

Considering these questions, mixed methods research involves philosophical assumptions that guide the direction of the collection and analysis of data and the mix of qualitative and quantitative data within a single study or series of studies. Its central premise is that the combined use of quantitative and qualitative approaches offers a better understanding of research problems than the use of either alone. Combining qualitative research with quantitative elements is important today because of the complexity of the problems addressed and the practical need to gather multiple forms of data for diverse audiences. It has many advantages for the researcher (Gunasekare, 2015).

Another angle of mixed methods research is to assess the outcome, which is not of statistical confidence, but rather reflects confidence in judgement. The validity of a finding is a combination of agreement in one metric and evaluation of evidence (Mastrandrea et al., 2011). Agreement is defined as being an observation in line with research expectation. A high confidence in a judgement is frequently defined as a finding. This confidence level is linked between agreement and evidence. Identifying a finding depends on the researcher's level degree of confidence in an outcome. The higher the level of confidence the higher the level of agreement and the more robust the evidence (Mastrandrea et al., 2011). In table 2 below the confidence scale as a trade-off between evidence and agreement is shown:

Agreement ↑	High agreement Limited evidence	High agreement Medium evidence	High agreement Robust evidence
	Medium agreement Limited evidence	Medium agreement Medium evidence	Medium agreement Robust evidence
	Low agreement Limited evidence	Low agreement Medium evidence	Low agreement Robust evidence
	Evidence (type, amount, quality, consistency) →		

Table 2: Trade-off between agreement and evidence

Source: Mastrandrea et al., 2011

3.8. Sampling strategy and sample size

To answer the research question in the current project, it is important to identify an appropriate sample size and collect meaningful data from key decision-makers. The latter are defined as senior management, C-level directors, managing directors or owners of SMEs. This reduced substantially the number of potential participants and required a different approach to collect data from senior management. I initially decided to target a total of 30 interviews, while in the end I managed to realize 22 interviews with senior management at German SMEs.

An understanding of the different approaches to sampling is important to ensure that the sample obtained provides relevant insights as well as the opportunity for generalization (Cash et al., 2022). By definition, a sample is a fraction of a defined population, where the population is defined as the total number of interview candidates within a specific case (Eisele et al., 2020). As described by Murayama et al. (2022), there are essentially two ways to obtain samples.

Probability sampling (also known as representative sampling), comprises five subcategories: (i) simple sampling, (ii) systematic sampling, (iii) stratified sampling, (iv) cluster sampling and (v) multistage sampling. Non-probability sampling (also known as judgmental sampling) covers methods where the probability of each case is unknown and also comprises five types: (i) convenience sampling, (ii) quota sampling, (iii) snowball sampling, (iv) purposive sampling and (v) self-sampling (Asiamah et al., 2022).

Each of the various methods of probability and non-probability sampling offer advantages and disadvantages. The method selected for this research was a non-probability method, that is, the sample was not obtained by applying random or chance probability as selection criteria. For the specific purposes of this study, I selected a purposive sampling approach based on the reasoning outlined below.

As previously stated, access to the target group is limited; therefore, there was a high level of reliance on contact data from professional associations. Purposive sampling provided the best fit for the sampling purpose and its main advantages and disadvantages for this research project are as shown in Table 3.

Sampling Method	PRO	CONTRA
Purposive Sampling	Wide range of sampling techniques to allow individualization of the sampling process	Judgement applied to select the units of study, including potential bias
	Accurate results for the subgroups	Purposive sampling requires rigorous research steps as it is highly prone to bias
	Only relevant interviewees will be included in the sample	
	Generalization is possible from the sample	

Table 3: Purposive sampling pro/contra

(Asiamah et al., 2022)

For this research project, the sample included data from northern, western and southern parts of Germany. The main reason for this geographical spread was the access to data possible through professional networks that have reach in these areas. From the companies identified, a total of 150 were selected and letters sent requesting an interview. The response rate

was approximately 26%, in line with overall results for B2B surveys (Indounas, 2022). A sample size of 150 is considered an adequate sample for qualitative research and frequently state in literature as a good sample size for quantitative research (Memon et al., 2020; Hennink & Kaiser 2022). The selection criteria for the initial sample were based on the EU definition of SMEs, without considering any particular industry, in an attempt to apply the improved FAP model to a wide range of industries going forward.

Research by Hennink & Kaiser (2022) shows that in qualitative studies, a sample size of 9 to 17 interviews is sufficient to achieve meaningful data and the required data saturation. Others point out that a justification of the sample size is not necessary (Hennink & Kaiser, 2022). Of the original 39 respondents, 22 interviews were realized in the final phase. A key element for the realization of a smaller number of interviews from the group of original respondents is certainly the COVID-19 situation, which was a challenge for the vast majority of German SMEs, and the respective senior management had to focus on coping with the situation and had limited resources available for interviews.

In addition, the sampling was designed to avoid selection bias by not limiting geographical scope and by allowing any type of SME within the sample. However, it should be noted that certain professional associations may only attract certain types of company, which may lead to bias in the data. In this project, this was not the case as the data were sourced from compulsory associations such as the various, geographically independent, Chambers of Commerce, with which all companies must register.

3.9. Research ethics

The current study was subject to certain ethical constraints, due to the form of the research. Regulations exist to ensure that research participants are protected. The University of Gloucestershire has rules which I had to ensure were followed by completing the Ethics Checklist as part of the RD1 and the

necessary forms with support from my two supervisors. Moreover, the university requires its researchers to follow the guidelines in its handbook of principles and procedures.

All participants in this study confirmed their written consent to participate in the research. I also obtained confirmation that their names and companies could be published in this thesis. The interviewees were informed about ownership of their voice, i.e. their views and statements are not being modified (Watt et al., 2020). The participants were fully informed of the objectives and purpose of the study and reassured that their answers would be used only for the purposes of this research. Furthermore, I attempted to create and maintain a comfortable environment for the participants and none were harmed or abused, either physically or psychologically, in the course of the research.

The participants were reassured that their participation in the research was voluntary and that they were free to withdraw from it at any point and for any reason.

3.10. Data types

To achieve the research objectives data must be collected. This study collects both qualitative and quantitative data.

Quantitative data is collected in the form of numerical datasets, mainly using questionnaires, experiments and other numerical forms of data collection. This type of data can be organized and grouped as ordinal, interval, nominal, ratio scale, discrete or continuous data. The quantitative data in this thesis were used to compute the interrelations between the factors that influence financial decision making and organize the results.

Qualitative data, in contrast, gives additional insights into the descriptive aspects and nature of the data. Some researchers argue that qualitative data is of a higher quality than quantitative data as it also includes

observations of the setting. However, it can be subjective and difficult to compare in terms of established research standards. Qualitative data can be collected by questionnaires, observations, analysis of written documents, recordings, transcriptions and interviews. Frequently, these methods are combined. While there is ongoing dispute as to whether interviews constitute quantitative or qualitative research, for this thesis the qualitative research is combined with limited closed questions being asked as part of the questionnaire.

Irrespective of the form of collection, data are divided into categories of primary and secondary data. Primary data are directly collected from the researcher's own efforts and first-hand data sources, and are frequently referred to as vital data, essential for the researcher to achieve their research objectives (Collis & Hussey, 2014). The collection of primary data may take longer and can be costly, but their quality and consistency are of a higher standard.

3.11. Data collection

This research project will be supported by primary data collection through interviews with key financial decision-makers in German SMEs. It is important to gain direct access to top-level senior management to interview the relevant decision-makers. This can be a hurdle, as access to senior management needs to be established before the interviews can be held. To gain such access, I used my professional networks and organizations such as the Verband Deutscher Treasurer (VDT) or local Chambers of Commerce.

The data collection process was structured in four distinct phases:

Phase 1: Collection of data from literature and existing research;

Phase 2: Collection of qualitative data by means of questionnaire-based expert interviews;

Phase 3: Case study and development of the improved FAP model;
Phase 4: Discussion and interpretation in relation to research objectives and overall aim of research.

For the purposes of this qualitative research, interviews were used. Semi-structured interviews in two phases are the method of choice, with the aim to identify the participants' opinions on the research questions. Interviews were held in person or by video conference between myself and the respective interviewee. The main advantage of face-to-face interviews is that they involve personal and direct contact between the interviewer and interviewee, and eliminate non-response rates, but interviewers need to have developed the necessary skills to conduct an interview successfully (Foucault Welles et al. 2022; Oltmann, 2016). In particular, clear and succinct communication is an essential skill in interviewing (Tosey et al., 2022). Compared to unstructured interviews, structured interviews offer less flexibility in terms of flow. However, they help to avoid the formation of unintended conclusions regarding a research subject and keep the interview and data collection process focused, avoiding the risk of deviation from the pre-specified research aims and objectives (Brown et al., 2018).

Using my professional network and his memberships, I selected 30 senior financial officers employed by German SMEs as potential participants for semi-structured interviews. The interview candidates were chosen by purposive sampling, and rigorous sampling procedures applied to guard against sampling errors. The interviewees' responses to open-ended questions were codified and categorized in NVivo and conventional content analysis used to analyse the findings, while the literature and underlying text findings were analysed by summative content analysis (Hsieh & Shannon, 2005). Due to the COVID-19 pandemic, the number of interviewees for the two rounds of interviews in the data collection dropped to a total of 22, but this is a sufficient number of interviews to achieve the research objectives (Green & Thorogood, 2003; Lakens, 2022).

3.12. Question development

Word choice is critical in expressing the meaning and intent of the question to the respondent and ensuring that all respondents interpret the question the same way. Even small differences in wording can significantly affect the answers provided.

A substantial amount of research has been conducted to better understand the impact of different ways of asking questions, as well as to minimize differences in how respondents interpret what is being asked (Dodgson, 2020; Neirotti, 2021). The issues relating to question wording and other associated elements have been addressed within this research project.

To avoid the most common mistakes in the preparation of questions, and to control for quality (Dodgson, 2020), the following key considerations have been addressed. First, an emphasis is placed on asking questions that are clear and specific and that each respondent can answer without requiring further intervention by the questioner. If a question is open-ended, it should be evident to respondents that they can answer in their own words and the type of response expected (issue, problem, financial estimate) should be clear. Before each interview started, the respondents were briefed on the ethics of this research and confidentiality arrangements. Closed questions included all reasonable responses as defined by the researcher (i.e. the list of options was exhaustive) and the response categories were structured so that they did not overlap (i.e. the response options were mutually exclusive).

Moreover, only one question was asked at a time and sufficient time was given for the response. Questions that ask respondents to evaluate more than one concept (such as “How much confidence do you have that your C-level management can handle financial appraisal and digitalization?”) are difficult for respondents to answer and can lead to responses that are hard to interpret. As a result, such questions are avoided or separated into two parts, one concerning financial appraisal and the other digitalization.

In general, questions that use simple and concrete language are more easily understood and more intuitively answered by respondents. Aside from the hard facts involved, it is also important to consider the seniority of the questionnaire population when thinking about how easy it will be for them to interpret and answer questions. For instance, certain concepts, unfamiliar abbreviations or jargon (e.g. FAP instead of Financial Appraisal Profile model) may cause confusion and are therefore to be avoided (Dodgson, 2020).

The questions for the questionnaire were prepared to help achieve the research objectives and were well considered; however, in research about humans by humans, the interviewer must continually think about potential bias and the potential ethical implications of the interview situation.

3.13. Research table

In this project, the questionnaire is an important instrument for primary data collection. As described by Nkomo et al. (2011), the research table is an effective way to provide a structured outline of the link between research objectives, the respective questionnaire or case study questions and the type of data collection used. The overarching research objectives, research questions and respective links to the questions included in the questionnaire are shown in Table 4. The questions asked in the interviews and in the case, study have been derived from literature research. As the interviews were completed before the case study the interview questions also informed the case study and the questions that were also re-used to further forming the final improved FAP model. As being presented in the research table, especially in the case study the questions were based on the practical elements of improved decision making and digitalization. The analysis of the data and the respective category is deductive and inductive (Mayring, 2016; Kuckartz, 2012).

Research Objective	Research Questions	Data collection instrument	Interview questions	Category	Source
To investigate how German SMEs integrate aspects of digitalization into their current financial decision-making processes and how expanding the FAP model will contribute to knowledge.	Is there a need in German SMEs to integrate digitalization in their decision making process?	Literature, Interview	Have you been involved in a digital transformation project/digitalization project within your firm?	inductive	Verhoef et al., 2021
		Literature, Interview	Does your company have a digital native or assigned a senior manager being in charge of digitalization?	inductive	Möller et al., 2020
		Literature, Interview, Case Study	Is the digitalization expert part of the financial appraisal process?	inductive	Verhoef et al., 2021; Yin, 2014
		Literature, Interview	Do you think that financial decision-making should be digitalized?	inductive	Möller et al., 2020
		Literature, Interview	Would you like to have the financial decision-making improved within your organisation?	inductive	Verhoef et al., 2021
		Literature, Interview	Do you think your current financial decision-making framework is adequate for the challenges coming in terms of digitalization and industry 4.0?	inductive	Möller et al., 2020
		Literature, Interview, Case Study	To what extent is your business affected by digitalization and information technology advancements?	inductive	Rachinger et al., 2019; Yin, 2014
		Literature, Interview, Case Study	What do you think are the challenges around digitalization and investment decision-making?	inductive	Möller et al., 2020; Yin, 2014
		Literature, Interview	How much does your company invest in digitalization projects per annum?	deductive	(Finders, 2013)
		Literature, Interview	Annual hours invested in IT qualification	deductive	(Finders, 2013)
	Literature, Interview	% of internet related tasks per employee on average	deductive	(Finders, 2013)	
	Literature, Interview	Smartphones as company phones %	deductive	(Finders, 2013)	
	Literature, Interview	Total failure of IT systems in last 12 months	deductive	(Finders, 2013)	
	Literature, Interview, Case Study	Speed of network access in mbit	deductive	Finders, 2013; Yin, 2014	
	Literature, Interview	Would you consider a digital native?	deductive	Janschitz & Penker, 2022	
	How can an improved FAP model contribute to improved decision making at German SMEs?	Literature, Interview, Case Study	Indicate the largest size of financial project you have evaluated:	inductive	Yin (2014)
		Literature, Interview, Case Study	Does your organization have a formal investment appraisal team?	inductive	Verhoef et al., 2021
		Literature, Interview, Case Study	Is the investment appraisal process formalized in a policy or written work instruction?	deductive	Yin (2014)
		Literature, Interview	What type of company is this?	deductive	Yin (2014)
		Literature, Interview, Case Study	Digitalisation and improved manufacturing methods are branded as "industry 4.0". What do you understand under the term "industry 4.0"?	inductive	Alkaraan et al., 2023; Yin (2014)
Literature, Interview, Case Study		Do you think Corona has any implications on your financial decision making and digitalisation?	deductive	Yin (2014); Setyoko & Kumiesih, 2022	
Literature, Interview, Case Study		Do you think digitalisation brings benefits?	inductive	Verhoef et al., 2021; Rachinger et al., 2019; Yin, 2014	
Literature, Interview		Would you consider a digital native?	inductive	Janschitz & Penker, 2022	
Literature, Interview		Does your investment appraisal process also include qualitative aspects/implications of the investment?	inductive	Lefley, 2000; Lefley, 2015; Jifar, 2020	
Literature, Interview		Could your existing investment appraisal procedures be improved?	inductive	Alkaraan et al., 2023	
Literature, Interview	Do you think strategy, reputation and digitalisation add benefits as additional factors for an appraisal model?	inductive	Alkaraan et al., 2023		
To explore the extent to which digitalization can be incorporated into the FAP model as a means of enhancing mainstream financial decision-making models for German SMEs.	Literature, Interview, Case Study	Are you in charge of financial decision making?	deductive	Tick et al. (2022); Yin (2014)	
	Literature, Interview, Case Study	Who has the decision-making power on investment appraisal?	inductive	Tick et al. (2022); Yin (2014)	
	Literature, Interview, Case Study	Training, education per employee in absolute terms	deductive	Tick et al. (2022); Yin (2014)	
	Literature, Interview, Case Study	% of IT employees in work force	deductive	Tick et al. (2022); Yin (2014)	
	Literature, Interview, Case Study	Investments per employee in absolute terms	deductive	Tick et al. (2022); Yin (2014)	
	Literature, Interview	Number of workplaces with a PC in absolute terms	deductive	Ngereja & Hussein, 2022	
	Literature, Interview, Case Study	Do you think digitalisation brings benefits?	inductive	Rachinger et al., 2019; Yin, 2014	
	Literature, Interview, Case Study	What do you think about an improved financial decision-making model?	inductive	Yin (2014)	
	Literature, Interview, Case Study	To what extent is your business affected by digitalization and information technology advancements?	deductive	Yin (2014)	
	Literature, Interview	Number of company phones in absolute terms	deductive	Tick et al. (2022)	
Literature, Interview	Any access limitations?	deductive	Tick et al. (2022)		
Literature, Interview	What key factors to your take into account in your investment decision?	inductive	Jifar, 2020; Pfister & Lehmann, 2022		
Literature, Interview	What is the preferred method of financial decision making in your company?	inductive	Alkaraan et al., 2023		
How to integrate digitalization into an improved FAP model?	Literature, Interview	Have you heard of the financial appraisal profile model (FAP model)?	inductive	Lefley, 2000; Lefley, 2015	
	Literature, Interview, Case Study	Does your company set quantitative targets to be achieved i.e. savings or investment return per annum in absolute terms?	inductive	Verhoef et al., 2021; Yin, 2014	
	Literature, Interview	What evaluation techniques are used by your company?	inductive	Lefley, 2000; Lefley, 2015; Jifar, 2020	
	Literature, Interview	If no evaluation, how is investment decision taken?	inductive	Kraava et al., 2021; Tiptun, 2022	
	Literature, Interview	Would you consider a digital native?	inductive	Tiptun, 2022; Januchowski, 2022	
	Literature, Interview, Case Study	How do you evaluate capital investment proposals?	inductive	Kraava et al., 2021; Yin, 2014	
	Literature, Interview	Why do you think time, strategy, risk and creditworthiness are the important factors and do you also consider other factors?	inductive	Alkaraan et al., 2023	
	Literature, Interview	Why do you rely on sensitivity analysis and P/R as appraisal methods?	inductive	Alkaraan et al., 2023	
	Literature, Interview	Training, education per employee in absolute terms	inductive	(Ngereja & Hussein, 2022)	
	Literature, Interview, Case Study	Would you consider the following factors as relevant for your decision making process?	inductive	Yin, 2014;	
Literature, Interview	Do you think your organisation should improve the financial decision making?	inductive	Pfister & Lehmann, 2022; Lefley, 2015		
Literature, Interview	Would you consider employing an improved financial appraisal and decision-making model?	inductive	Verhoef et al., 2021		
Literature, Interview	Do you think employing agile methods helps your organisation?	inductive	Verhoef et al., 2021		
Literature, Interview	How often does the formal investment appraisal team meet?	inductive	Alkaraan et al., 2023		
Literature, Interview	What evaluation techniques are used by your company?	inductive	Alkaraan et al., (2023); Hams & El-Messhi, (2011)		
Literature, Interview	What do you think are the challenges around digitalization and investment decision-making?	inductive	(Brunetti et al., 2020)		
Literature, Interview, Case Study	What qualitative considerations are you considering on financial decision-making?	inductive	Kraava et al., 2021; Yin, 2014		
Literature, Interview, Case Study	Do you think Corona has any implications on your financial decision making and digitalisation?	inductive	Brunetti et al., 2020; Setyoko & Kumiesih, 2022		
To develop a practical application of the FAP model within the German SME sector by integrating digitalisation alongside its current, traditional decision-making approach, for a post-digitalised decision making environment.	Literature, Interview, Case Study	Do you plan to update the investment appraisal policy due to the current situation?	inductive	EU, 2015; Gae, 2022	
	Literature, Interview, Case Study	Have you used any other analytical method?	inductive	De La Rosa & Tully, 2021; Shoman et al., 2022	
	Literature, Interview	Have you ever considered economic appraisal techniques?	inductive	Pierce, 2007; Lefley, 2000	
	Literature, Interview	How do you evaluate capital investment proposals?	inductive	De La Rosa & Tully, 2021; Shoman et al., 2022	
	Literature, Interview, Case Study	How often does the formal investment appraisal team meet?	inductive	Adler, 2000; Al-Hadi et al., 2020	
	Literature, Interview	What qualitative considerations are you considering on financial decision-making?	inductive	(Ngereja & Hussein, 2022)	
	Literature, Interview	Do you plan to update the investment appraisal policy due to the current situation?	inductive	Al-Hadi et al., 2020	
	Literature, Interview, Case Study	Have you used any other analytical method?	inductive	Alkaraan et al., 2023	
	Literature, Interview, Case Study	Digitalisation and improved manufacturing methods are branded as "industry 4.0". What do you understand under the term "industry 4.0"?	inductive	Verhoef et al., 2021	
	Literature, Interview, Case Study	Why do you think strategy, discount factor and reputation are the important factors and do you also consider other factors?	inductive	Lefley, 2000; Lefley, 2015	
Literature, Interview, Case Study	Why do you rely on NPV as appraisal methods?	inductive	Alkaraan et al., (2023); Hams & El-Messhi, (2011)		
Literature, Interview, Case Study	Would you consider a more sophisticated model if required?	inductive	Alkaraan et al., 2023		
Literature, Interview, Case Study	Do you think strategy, reputation and digitalisation add benefits as additional factors for an appraisal model?	inductive	(Brunetti et al., 2020)		
Literature, Interview	Would you consider a more sophisticated model if required?	inductive	Maying (2007);		
Literature, Interview, Case Study	What do you think about an improved financial decision-making model?	inductive	Rachinger et al., 2019		

Table 4: Research table

Source: Author

3.14. Questionnaire design

The aim of the questionnaire is to support the development of the expanded FAP model and gather evidence from respondents. Surveyors previously often approached questionnaire design as an art form, but substantial research over the past thirty years has demonstrated the extent of science involved in crafting a good questionnaire (Pew Research, 2019). The questionnaire was designed for qualitative research with limited closed questions to establish the companies within the SME spectrum and get a closer understanding of the companies participating in the analysis. As found by a systematic review by Ricci et al. (2018), qualitative researcher seem to use questionnaire in a growing number for qualitative research, similar to this project.

A further key consideration was to ensure to keep the questionnaire and time spend for the interviews rather short. As a result, it was decided to apply qualitative questions and limited closed questions also in the questionnaire (Dewasiri et al., 2018) to avoid time consuming sequential steps in the research. Also considering the research environment, where senior managements time is constraint.

The selected respondents are senior managers in German SMEs. They are practitioners, and their responses may be biased by their experiences. The more pragmatic will value what works most effectively and is most useful, and their interpretation of reality will be influenced by their own interests and needs. Interviews involve collecting data from people about people and require an awareness of ethics (Punch, 2014; Marsden & Wright, 2010). This means that personal disclosure, authenticity, credibility and guarding against misconduct must be taken into consideration (Israel & Hay, 2006; Kvale, 2007). It is important to be aware that sensitive, confidential and possibly harmful information may be disclosed during the data collection process; thus, clarification about who owns the data is essential and confidentiality must be ensured. The interviewees retain ownership of their voice and have agreed that their names can be published (Creswell, 2009).

The questionnaire was designed in German as the research took place in Germany. Moreover, it was expected that interviewees would be senior managers and, therefore, older. The older generation does not necessarily speak or understand English well and may be reluctant to take part in research conducted in English. Moreover, I wished to avoid potential language barriers.

The questionnaire was designed with a logical flow to the question order, starting with simple questions on behaviours or opinions and progressing to more complex, sensitive or controversial questions. It was divided into four sections. The first part, Section A, collected information about the interviewee and the company they work for. It is important to identify the respondent to ensure that the data collected is useful in answering the research questions. In addition, the confidentiality arrangements were defined including the extent to which the interviewee allowed the usage and interpretation of their responses.

Section B focused on questions gathering more in-depth information on the company and the quality of the fit of the interviewee and their company. The questions were closed, with limited possible answers. The assumption behind this was that the data selection process would guard against outliers that would affect the research outcome. Analyzing these questions was straightforward and allowed me to easily group and filter the dataset to retrieve specific insights.

However, closed questions need to safeguard against human bias. Psychological research indicates that people struggle to keep more than one option in mind at one time. In addition to the number and choice of response options offered, the order of answers can influence how people respond to closed questions. Research suggests that in telephone surveys respondents more frequently choose items heard later in a list (Zikmund et al., 2013). Therefore, the number of potential responses was limited to a maximum of five.

One of the most significant decisions affecting how people answer questions is whether the question is open-ended, where respondents respond in their own words, or closed, where they are asked to choose from a list of potential answers (Pew Research, 2019). Closed questions help people to form an opinion and mention items that may not be cited if not included in the potential responses, either because of personal beliefs or because they respondents simply do not think of them.

Section C of the questionnaire contained opinion questions, with which the respondent could choose to agree or disagree or register a neutral choice. Personal beliefs and views on financial appraisal and digitalization were captured by this part of the questionnaire.

The fourth part, section D, focused solely on the development of the digitalization index, and included both open and closed questions. The first part covered the ground for the creation of the index with the responses received used to construe a typical structure for the index. The second part obtained additional, individual insights into respondents' opinions and beliefs. The structured questions are separated into four parts covering the key issues of affordability, human capital, usage and accessibility. Developing a coherent digitalization factor requires responses to be quantifiable and comparable. Codification of the responses to the open-ended questions supports the findings from the closed questions, as covered in the discussion and analysis section in Chapter 7.

Finally, the questionnaire offers space for additional comments made by the respondent during the interview that are relevant to the research and data collection. These statements are listed in the Appendix and may provide insights for future research.

3.15. Question format

The questions were formatted to provide a variety of measurable data inputs on different scales and followed a logical structure. Four types of question were used:

- Closed questions: in which the respondent could choose between a number of predetermined alternatives (Section B in the questionnaire)
- Questions with multiple-choice answers: in which the respondent was asked to tick the applicable predetermined alternatives (Section C in the questionnaire)
- Questions with a rating scale for answers: in which the respondent decides if a statement is important or not (Section D in the questionnaire)
- Open-ended questions: in which respondents are free to answer according to their own views (Section E in the questionnaire).

Some of these question types are answered by respondents ticking a box; they take up little space and are simple for the researcher to codify and analyze. The resulting data conformed to three kinds of measurement scales: nominal, ordinal and interval. The majority of questions in the questionnaire and also in the case study are open type of questions and require further and more detailed content analysis.

3.16. Expert interviews

Interviews are often seen as a superior data collection method. Qu and Dumay (2011) describe three types of interview in social science research:

Unstructured interviews: The interview follows no defined set of questions. Complete freedom is given to the researcher and interviewee to discuss opinions, behaviours or reactions on a subject. The outcome can be difficult to analyze and compare.

Semi-structured interviews: The interview follows a specific schema, with topics, sample sizes, people to be interviewed, and questions to be asked determined in advance by the researcher, who has more control over the situation, questions and reactions.

Structured interviews: A standard format and questions are used. The interviewee can select from fixed-response categories. A systematic sampling procedure has been performed to select a random number of interview partners from a selected group. The analysis is conducted by a combination of quantitative measures and statistical methods.

According to an exploratory study by Robison (2002), in-depth interviews can be very helpful in discovering what is happening and seeking new insights. Therefore, interviews provide an accurate and clear picture of a respondent's position or behaviour. Qu and Dumay (2011) had similar findings on the nature of open-ended questions and the freedom given to respondents to answer according to their own views with no constraints or limited alternatives to choose from. According to Döringer (2020), experts – also frequently referred to as key agents – are defined as having a pivotal role in decision making. However, there is also criticism towards interviews as a method of data collection mainly around interpretation of data (Hofisi et al., 2014).

Primary data is obtained from expert interviews together with the questionnaire. The in-depth interviews with senior management, to gain data on decision making in the framework of financial investment appraisal and digitalization allowed an examination of the relevance of the data and information for success in the industry. The findings will be analysed with content analysis, applying both deductive qualitative and inductive qualitative categorization (Mayring, 2016; Kuckartz, 2012).

The sampling of expert interview partners was completed in March 2018 and the interviews were held from June 2018 to October 2020, either at the office of the interview partner or via a virtual platform. The questionnaire was not shown to interview partners in advance; only the ethics and disclosure requirements were disclosed in advance, in line with ethical research regulations. The purpose of conducting these interviews was to collect additional data to help answer the research questions.

The experts were chosen based on the relevance of their experience for this research. All participants had substantial industry experience, gained over a long period, and had held various positions in other companies within the scope of research, as documented in the Appendix.

3.17. Coding process

To organize the interview data and extract the relevant information NVivo was used to organize the interviews and support the coding process of labeling and organizing qualitative interview data to identify different themes and the relationships between them (Davidson et al., 2023). The initial coding process is inductive qualitative and deductive qualitative (Yin,2008), i.e. developing codes directly from the data and from the literature. In this way the codes stay close to the data, rather than the ideas and prior understandings of the researcher. The codes where were identified by reading and re-reading the interviews and identifying the codes and themes in NVivo, literature frequently describes this process as cycles. Each iteration refined the codes further, resulting in the final coding table. Detailed explanation of the coding is further described in 5.3.

3.18. Case Study

A case study, employing the empirical technique of participant observation, is often used to ascertain the acceptance and relevance of a specific research observation, but can also be used for data collection (Sirris et al., 2022). Research on case studies by Yin (2008) goes deeper and finds that the case study is characterized by the employment of multiple evidence sources including interview, analysis of secondary data – for instance corporate documents and financial data, focus groups, surveys and observation, which may be analyzed by a variety of methods, including qualitative content analysis and financial analysis (Neukirchen, 2017; Yin, 2014).

According to Yin (2014), a case study can be used to explain, describe or explore events or phenomena in the context and situations in which they occur. This can help to facilitate a better understanding and explain causal links and pathways resulting from new initiatives, services or product development in organizations. It contrasts with experimental designs, which seek to test a specific hypothesis by deliberately manipulating the environment. This approach is widely applied in the healthcare or medical sectors, for example, in randomized controlled trials of new drugs that compare outcomes with a control group. More generally, a case study approach can help to capture information on more explanatory “how”, “what” and “why” questions. The case study approach can provide a reality check and offer additional insights into the gaps that exist and why one implementation strategy may be chosen over another within an organization.

The case study is often perceived as less objective, because its qualitative character results in narrower comparability and a lower likelihood that repetition will achieve the same outcome. This viewpoint is driven by the perceived lower level of quantification, representative validity or robustness than quantitative approaches (Yin, 2014). Compared to standardized responses from quantitative surveys, this is a valid argument. However, the

purpose of case study research is to provide deeper insight into a live contemporary business issue in one or a small number of organizations, allowing other elements – such as emotions and reactions – to be captured in the context of the interview. Therefore, it is the depth of new knowledge and insights gained from experts that is important, rather than the application of the findings to the whole population (Polkinghorne, 2005). As outlined in the section on data collection, purposive sampling in which the researcher selects suitable experts was employed in this study, to ensure that facts and opinions are gained about the research objectives from those closest to the observed problem (Lohr, 2021).

Different conceptions of case study research also exist. For example, the case study is sometimes perceived as an appropriate method in the exploratory phase of an investigation or for descriptive phase surveys or interviews; in the explanatory phase, it is useful in determining causal relationships between the observed phenomena investigated by experiments, a positivist, scientific-like stance (Anjana & Choudhuri, 2018). However, each of these investigative approaches is an option in empirical research methodology, because there are different ways of collecting data and interpreting empirical evidence. When conducting case studies, there is a risk of lack of objectivity, quantification, representative validity or robustness (van Dongen & Sikorski, 2021). However, the rigour of quantitative studies is based on validity exemplified by credibility and trustworthiness, rather than generalizability, and is accomplished by reporting the findings transparently using thick description, which allows the reader to understand how interpretations have been made (Ballinger, 2004; Lohr, 2021).

Essentially, the suitability of the case study as an approach depends on the research objective and specific research questions. The specific structure and methodology of a case study also determine the quality of the insights gained in terms of validity and scientific added value. In this thesis, deep, detailed knowledge is required to answer the research question; thus, the case study is justified as a strategy (Neukirchen, 2017).

The case study and improved investment framework will be tested within the ROY group's German SME business. The ROY group is a former leading sanitary ceramics producer from China. The group decided in 2015 to leave China and build a workshop in Germany to produce high-quality ceramic products. The investment decision and factory decision making process in Germany is used as an example case study for this thesis. Like the human factor of this thesis and investment decision making itself, the case study is centered on human decisions within a company that is working towards Industry 4.0 (Nguyen Ngoc et al., 2021).

3.19. Qualitative and quantitative data collection

Qualitative and quantitative data collection differ by the way of answers both methods provide. Qualitative data answers the 'why' behind a correlation or phenomenon, whereas quantitative data answers the 'what' and 'how' of a behavior (Schoonenboom, 2023). Quantitative data collection is used to collect data about countable, measurable, and number-based data that quantifies correlations into hard facts. Data is primarily obtained by surveys, questionnaires, or available statistical data packages. Results are being formed to formulating and verifying hypothesis around a correlation and numerical verification. There are various sources for quantitative data collection like controlled observations, polls, surveys, and questionnaires. In this research project data is collected by questionnaire, which has limited closed questions. The strength of quantitative data collection is an objective analysis of the data because bias is less likely to occur in quantitative analysis, as the data are statistic in nature. Resulting in less room for a researcher's subjective reasoning to influence results and outcomes (Albers, 2017). Also, the data collection process is frequently easier as usually no detailed explanation is required to be given to the respondent. However, data collection for quantitative data frequently requires a larger number of respondents to achieve a meaningful (Jamieson et al., 2023).

For qualitative data collection there is primarily distinguished between primary and secondary data collection. Primary data is collected directly from the research project participants and used expressly for research purposes. In contrast secondary data is collected by from data that already exists. Secondary data was not collected for the purpose of a research project, but rather for other purposes (Jamieson et al., 2023).

Whereas qualitative data collection is about descriptive and non-numerical data that explains the 'why' behind a phenomenon. In this method frequently semi-structured methods like in-depth interviews, focus groups, and participant observation are employed. Choosing the right method is important to support the research project outcome as each of the aforementioned methods offers different levels of insights. While focus groups allow to collect data rather quickly from multiple participants and can result in a robust conversation between the participants, providing very rich and genuine responses, in-depth individual interviews allow for a more personal interaction with a participant. (Khoa et al., 2023). As qualitative data collection requires more participation by the researcher in the actual data collection process, it should be noted that the research stays neutral or impartial in the process to avoid biases, which is critical to collecting honest and genuine responses from participants. Due to the richness of data frequently qualitative research does not require a large number of participants to generate meaningful data inputs. As outlined before a case study is recognized in literature as a qualitative research method.

3.20. Rejection of other research paradigms and methods

The methods selected in this thesis are based on a best-fit decision, as this thesis adopts a qualitative research design, which is not statistically

representative but an observation of a phenomenon representing complex social realities (Lenger, 2019). For this type of research project, it was necessary to select various methods to collect and analyze data and draw conclusions based on the outcome. To this end, as noted above, several methods were used, including interviews and a case study, a combination of methods and considerations that position this work as qualitative research with limited quantitative elements. In contrast, other schools of thought include positivism, in which ontology is on objective reality and the epistemology of knowledge is real, objective and obtainable through measurement and statistics. In such approaches, only methods that provide statistical or measurable outcomes – such as surveys and statistical analysis – are permitted. In contrast, in the field of interpretivism, the ontology of subjective reality prevails, which asserts that knowledge is dependent on beliefs, values and lived experience (constructivism). In this theoretical perspective, the typical research methods applied are case studies, hermeneutics and field studies (Bouncken et al., 2021).

Both methods have limitations. As a result, pragmatism is the ideal methodology as its ontology is subjective or objective and its epistemology is that knowledge is obtained by doing and acting.

The reason for the qualitative approach with limited quantitative elements has been detailed in previous sections alongside the selected research methods.

3.21. Data collection bias

Any type of data collection may be subject to bias. This occurs when the researcher's personal preferences or beliefs affect how data samples are gathered. In this research project, various biases have been identified in the course of the data collection process. In particular, the key element of digitalization was presented in the semi-structured interview as a positive element, and interviews with key decision-makers were arranged with their

knowledge that the research project centred around the digitalization of investment decision making (Fleming et al., 2022).

The interviews were held in person or through video conference systems and allowed the interviewer to directly interact with the interviewee. However, as the topic of the interview was about digitalization, which is also an important aspect of business decision making a potential bias could occur. This potential bias was identified and, therefore, I decided not to share my personal view on digitalization during the interviews to limit any further potential influence.

It is not possible in research to completely avoid bias, but it is essential that any form of bias is limited. Explicit and systematic methods lead to more reliable results which, in turn, act as a basis for drawing conclusions and making decisions (Neal et al., 2022). However, accepting and identifying bias in the data and sampling process, and recognizing potential bias in the conclusions go some way to limiting the impact of bias on research. Understanding research bias allows the researcher to review the scientific literature and avoid inaccurate conclusions critically and independently. A thorough understanding of bias and how it affects study results is essential for the quality of findings and the conclusion of the research project (Benítez et al., 2019).

3.22. FAP model prior to improvement

The FAP model as developed by Lefley (2001) is currently not widely used by practitioners. A reason for this maybe that as an advanced decision making model the time was not right. As the key driver of financial decision making, discount rate, which is frequently linked to the main refinancing rate, was at an all-time low in the recent years. However, digitalization, also branded as the 4th industrial revolution, drives key decisions at companies (Altintac, 2022). This is not capture by the existing FAP model, as it only captures the project-specific risk, strategic benefits as well as the NPV of a

project (Lefley, 2015). Further in literature no evidence on practical application for SMEs has been found on the existing FAP model. Improving its relevance by adding the relevant factor of digitalization to take into account the ongoing 4th industrial revolution improves the importance of an improved FAP model.

Chapter 4: Research model development

The key aim of this research project is to develop an improved FAP model that includes the additional variable of a digitalization index. This index will help to support improved decision making with a revised financial appraisal decision making model. Evidence of the need to improve the FAP model is provided, together with further links between the questionnaire and the model development. In the last section of this chapter, the influence of COVID-19 on the research is described. The following chapter addresses data analysis and the results.

4.1. Introduction

Models play an important role in research as they can be applied to test and understand multifaceted systems and theoretical constructs and to create connections between research and society (Ke et al., 2021; Bhattacharjee, 2012). A model is a basic representation or abstraction of an actual situation; it shows the direct or indirect interrelationships between actions and reactions in terms of cause and effect. Since a model is an abstraction of reality, it may appear less complex than the reality itself. The model, to be complete, must be representative of those aspects of reality under investigation (Shafique & Mahmood, 2010). The key characteristics of a model, as defined by Leimkuhler (1972), are relatedness, transparency, robustness, fertility and ease of enrichment, or the ability to modify and expand. All these elements are found in the existing FAP model and, therefore, this research project aims to expand this model with a digitalization factor. Like the balanced scorecard model, which was also expanded over time with additional factors, depending on the organization involved, various additional factors can be included such as ESG criteria or carbon footprint. ESG stands for Environmental, Social and Governance

and refers to different criteria from these three areas that can be used to assess the sustainability of a company.

The model applied is the existing FAP model with an extension for digitalization. Alongside data collection and rigorous analysis, the development of the research model is a key element in this research.

As outlined in the introduction, financial leaders can choose from various financial decision models. In certain industries such as banking, mandatory DCF models like VaR must be used and the results reported to authorities. In German industry, there is no such requirement and managers frequently employ models that have been used for decades with known shortcomings such as the IRR (Yan & Zhang, 2022). The literature promotes alternative and improved models, such as the NPV, but many organizations simply accept the risks as their business model has proven stable enough to survive challenges so far.

Companies today generally have an established committee structure to discuss potential investment and appraisal projects (Al-Hadi et al., 2020). In such committees, the qualitative aspects of an investment decision prevail and, as found in the literature, are most often associated with opinions and intuition (Imran & Rautiainen, 2022). Moreover, managers tend to be reactive, not proactive, in this respect and do not take into account what new technology and digitalization can bring to the company in the future.

Furthermore, managers are often incentivized financially to follow a certain strategy or achieve a defined strategy target. This potentially unilateral decision making process may harm a company's performance and results. Single-target decision making models are either purely financial and economically driven or based on one-sided policy, but there is a need to re-think financial decision making by accepting a more multi-faceted approach that looks at investment from different angles. Empiric research by Weerasekara and Bhanugopan (2022) has shown that financial decision making in larger SMEs is often linked to more decision-makers being involved.

This so-called “meeting culture”, established to facilitate decision making but frequently leading to no decision being taken, hinders companies from achieving their full potential, as opinions and discussions are expressed in an unstructured way, influenced by company politics and hierarchy.

To circumvent such shortcomings, the FAP model was developed, with its distinct profile approach that identifies the financial, strategic and risk elements of an investment decision. Also the human factor, such as personal preferences and or past experience, plays an important role in companies’ investment decision making (Nguyen Ngoc et al., 2021).

4.2. The need for an improved FAP model

The FAP model adopts a pragmatic approach towards investment appraisal by combining strategic, risk and financial aspects. The model was based on a management-centric decision making process with a focus on versatile usability for decision making. The financial appraisal techniques predominantly used make their calculations taking no account of a company’s strategy or risk position. By linking the three elements of finance, risk and strategy in one appraisal model, the quality of the decision should be improved and lead to improved company performance (Lefley, 2000).

Other research has previously attempted to link improved financial decision making and investment appraisal models with improved company performance (Alkaraan & Northcott, 2007). In reality, managements tend to continue to use basic financial appraisal techniques, easy to apply and understand, as no direct link between the aforementioned relationship from theory has been observed in the real world.

The continued reliance on basic appraisal techniques is most likely due to promoting short-term results, as reflected in personal short-term financial benefits and personal career advantages as performance is frequently measured by short-term financial returns.

Such short-term incentives go against the need for long-term decision making to improve company performance. However, in owner-managed SMEs, intuition and personal judgement often overrule economic or financial appraisal models. At the same time, books on financial appraisal and better decision making sell well, which may be a sign that managers want to do better and improve their financial appraisal techniques and financial decision making.

The recent COVID-19 pandemic has put substantial pressure on every company in Germany, either through external requirements, such as allowing staff to work from home, or by the pressure to improve efficiency. This has required companies to a) consider digitalization/digitization projects and b) understand their digitalization position. Rather than introducing a new metric on how to measure digitalization in a company, the aim is to improve overall decision making with an improved FAP model and promote an improved method of financial appraisal. The focus is on producing a model appropriate for actual business use and decision making in a more digitalized business environment.

Despite the advantages of the existing FAP model, it is a relatively complex and time-consuming financial appraisal method, due to its set-up. This may be why it is not widely known or applied by organizations in decision making processes.

Most recent studies on digitalization focus on national or industry comparisons and work with standards that do not wholly reflect digitalization needs; for example, fast broadband access does not necessarily mean that the industry or country is a digitalization leader (Forrester, 2018). Moreover, within organizations, the greatest challenge is that any change or transformation process fails due to staff resistance (Bucy et al., 2016). To overcome this issue, it is essential to involve key staff and internally promote projects. This is a key element of the improved financial appraisal profile model.

An improved financial appraisal profile model includes a fourth dimension to measure and estimate the digitalization status of the company. As outlined previously, the improved FAP model includes digitalization as a key variable in today's digital world. Adding another dimension to the FAP model remains true to its original approach. Unlike existing conventional investment appraisal models, it is a dynamic multi-attribute model based on a profiling protocol. To get to the additional attribute of the model the research objectives have been defined to lead the way to an improved fourth dimension FAP model. Not only does it allow additional variables to be considered for investment decision making, but it also can adapt to a unique company situation. The way to the improved FAP model is depicted in Figure 15.

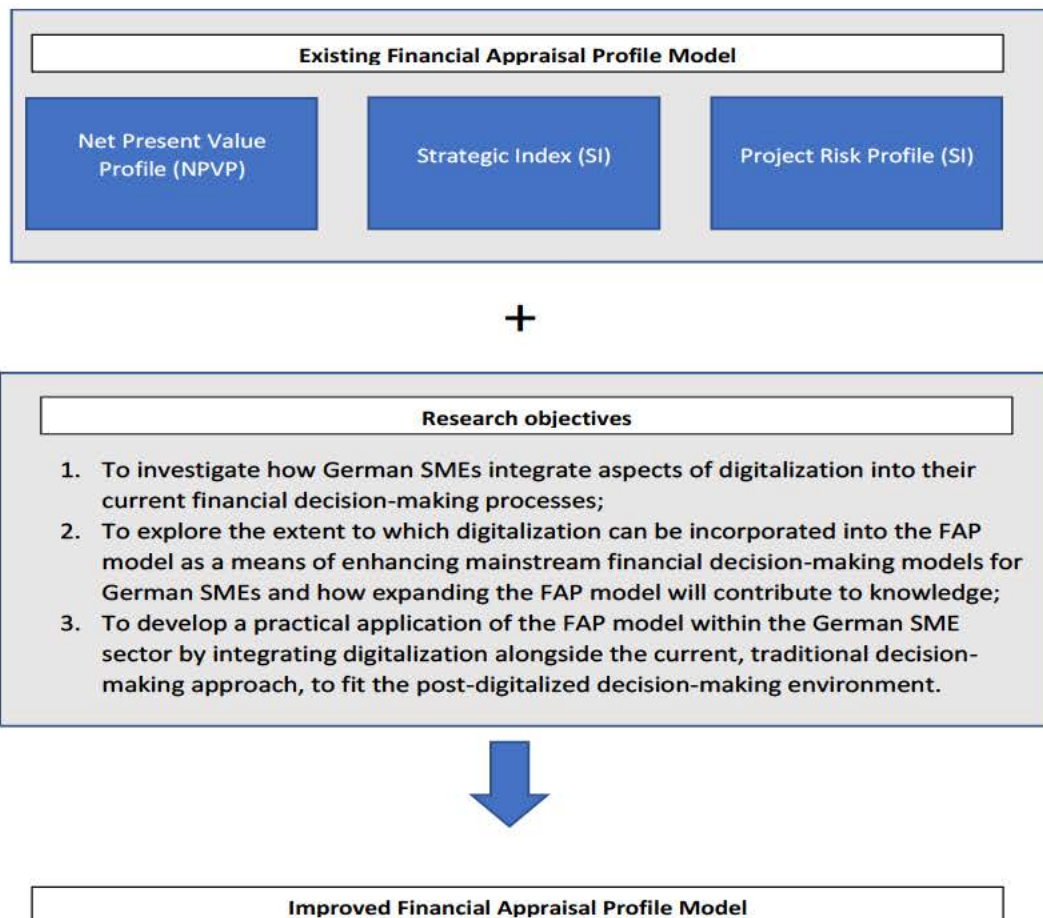


Figure 15: Improved FAP model concept

Source: Author

4.3. Scale development of research model and its validation

Various frameworks have been proposed in the literature to define the scale and result validation of survey-related research. For example, Mackenzie et al. (2005) suggest a framework for formative and reflective constructs, while Dunn et al. (1994) explain a scale development and validation process. Before the research model could be validated, the following steps were taken in its development. As discussed in the introduction to Chapter 1, this research project focuses on the FAP model and the role of digitalization in the financial decision making of German SMEs. The research model and scale are interconnected: the model development influences the questionnaire structure and questions asked. In the following, the scale is explained and the model development defined. The overall process is depicted in Figure 16.

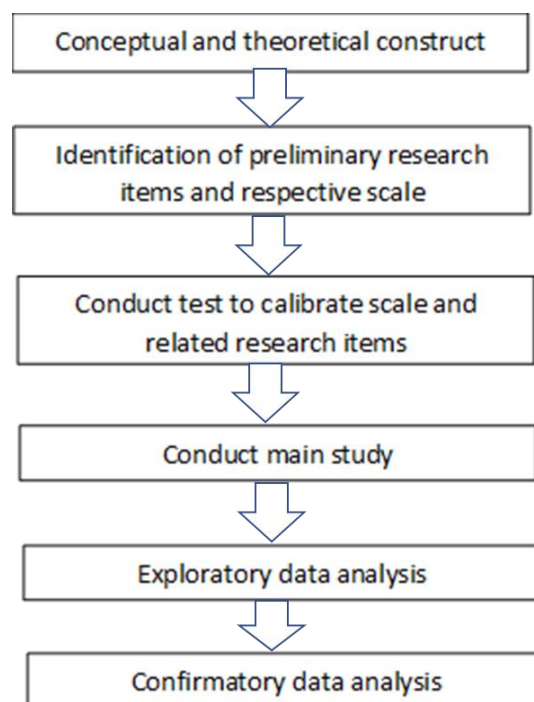


Figure 16: Scale development

Source: Author

4.4. Questionnaire layout and research objectives

The questionnaire and primary research are key elements of this research project. A questionnaire is a standard research tool involving the use of standardized questions in an interview to collect data about people and their preferences, thoughts and behaviours in a systematic manner (Bhattacharjee, 2012). As a result, the questionnaire follows a systematic approach and the questions asked aim to answer the defined research objectives.

As outlined in the section on questionnaire design, the questionnaire is structured in four parts. The first part, A, is not related to any research objective, but provides insights into the company being researched. Section B provides insights on Research Objective 1, to investigate further how German SMEs integrate aspects of digitalization within their financial decision making. These questions set the framework for the digitalization index and determine the preferred analytical methods. Part C paves the way for Research Objective 3, which is concerned with post-digitalization aspects and requires the interviewee to either agree or disagree with pre-defined statements on future development and challenges such as Industry 4.0. Part D supports Research Objective 2 and discusses the digitalization index. This index forms part of the improved and extended FAP model and is a key element for further improving financial decision making with digitalization. Part E combines Research Objectives 2 and 3 and allows the interviewee to respond openly to questions. From a research perspective, this section provides helpful additional insights as each interviewee reacts and responds differently to the questions. This also supports the research objectives as it allows additional insights and enables the objectives to be seen from different angles, relevant to the interviewee and potentially future users of the improved FAP model.

Each section of the questionnaire was created to allow the relevant information to be gathered for this research project, while also facilitating a smooth interview process to promote a high acceptance rate. Open

questions are the ideal instrument for research as they allow the meanings and experience of the interviewee to be captured. In reality, however, this would result in a large rejection rate for the questionnaire as interviewees' motivation decreases with the length of an interview (Schröder et al., 2016). Given the response rate of 34%, the questionnaire is deemed to be relevant as response rates for this kind of questionnaire usually range between 12% and 44% (Wu et al., 2022; Sezer & Bröchner, 2019).

Following a methodical approach, the questions are based on the three overarching research questions.

4.5. Development of the questionnaire questions

The questionnaire was structured and organized as described above. A quantitative written questionnaire with additional free text fields was constructed based on the research questions. The quantitative approach is often seen as typical for testing already well-defined research questions. Closed questions are asked to allow better analysis and comparison of the answers. Given strengthened data protection laws, closed questions allow greater anonymity as only pre-defined answers can be given. A great disadvantage of pre-structured closed questions is the limited range of possible answers. Open questions allow the researcher to capture further insights and information that could not be captured with closed questions (Bortz & Döring, 2005).

The questionnaire was intended to allow straightforward and unbiased answers to increase the likelihood that it would be fully completed. Moreover, the intention was to make the questions easy to understand and precise, to facilitate clear decision making and opinion-sharing. I tried to formulate the questions as simply and precisely as possible, to avoid branching questions ("if no, then continue") and to address only one area of content in one answer option. In principle, the questions do not require a logical structure, but care was taken to avoid contextual effects. It would

also have been possible to reduce contextual effects by asking differently worded questions on the same thematic background at different points in the questionnaire (Rübsamen et al., 2017). However, this would inevitably lead to a more extensive questionnaire, which could possibly lead to a higher dropout rate due its repetitive nature, especially as the interviewees have time constraints. Some evidence suggests that at least 5% of respondents answer scale items carelessly (Meade & Craig, 2012), and this can rise to 60% when respondents receive little or no incentive to complete a questionnaire (Hauser & Schwarz, 2016). For this type of research, the question of incentive is less relevant, but the results for improved financial investment decision making will be shared, anonymously if requested by the participant. This may be considered some form of incentive. To avoid careless responses, which directly challenge the validity of any scale measurement and can lead to misleading findings and conclusions, I conducted all the interviews myself (Bowling et al., 2016; Maniaci & Rogge, 2014) either in person or by means of a video or telephone call. Due to the constraints identified, overcomplicated or time-intensive questions would possibly have led to abstention. If I had not conducted the interviews myself, some participants, responsible sources of important information, may have refused to answer certain questions. However, the interviewer must understand that their presence may influence the interviewee (Adams-Quackenbush et al., 2019; Zhao, 2021). Various biases have been identified in the literature and, as the interviewer, I was aware of potential biases (Cheron et al., 2022). As a result, stringent procedures were established and the questionnaire was designed in stages to try to overcome or avoid potential biases.

A further device used by many researchers conducting a questionnaire is attention checks (Berinsky et al., 2014; Curran, 2016; Huang et al., 2015), usually in the form of items embedded in the first part of a questionnaire with an obvious correct response. Their purpose is to identify careless respondents and allow researchers to screen them out prior to analysis (Maniaci & Rogge, 2014). As an easy and efficient means of protecting scale validity, attention checks are now widely employed and considered to

be a desirable feature in questionnaire designs across all disciplines (Bowling et al., 2016; Hauser & Schwarz, 2016a). Despite their benefits, attention checks have limitations and can also lead to overthinking by interviewees due to their obvious correct response (Curran & Hauser, 2015). Indeed, recent findings showed that the inclusion of attention checks caused respondents to approach subsequent questions differently (Hauser & Schwarz, 2016). No attention checks were included in this questionnaire as it was completed during an interview process and not sent out anonymously.

Developing the questionnaire included putting sufficient thought in the combination of qualitative research and limited closed questions approach. As outlined by Schoonenboom (2017), there is a need to consider the level of interaction between quantitative and qualitative as well as the right priority, timing and understanding on how to mix both. These considerations have been included in the design process of the questionnaire and the decision was taken to prioritise the qualitative questions over quantitative data. Especially, as the research also includes a case study in context of this thesis is regarded as qualitative as the I, as researcher are an insider, and the decision making is down by subjective and multiple individuals. The integration of assessing both perspectives to build in the study accomplishes this aim and provides new insights.

As outlined above, the questionnaire is divided into five parts, including a section on the economic profile of the interviewee. The various parts of the semi-structured questionnaire are outlined in the paragraph below, while the complete questionnaire is shown in the appendix.

4.5.1. Part A – Basic Data

The first section of a questionnaire should define the basic data and establish details of the interviewees (Schnell et al., 1998). The questionnaire in this project starts by collecting the economic and statistical data of the interview partners. However, this preliminary information must not be too

detailed, because "a too detailed description of the organization or persons behind a questionnaire can have a negative influence on the meaningfulness of the answers" (Batinic et al., 2001). It is a key element of this research project that the interviewees are all senior managers or managing directors of German SMEs. The basic data show that all interviewees fall within this category. The basic data are used to categorize and analyse the overall dataset based on the key variables asked for in this section (Yang et al., 2022).

4.5.2. Part B - Multiple-Choice

Frequently questionnaires use a Likert-type scale for possible answers (Steiner & Benesch, 2021). However, in this research, the questions were mostly answered by either "yes" or "no". No abstention option was offered, as it was assumed that all questions could be answered. This narrows down the possible answers and limits the time a person may take to answer a question, reducing thinking time (Greving et al., 2022). This creates a better momentum and encourages the interviewee to respond intuitively, rather than overthinking their answers. The multiple-choice section first addresses organizational questions, transitioning gently from the first part of the questionnaire which covered basic data. The rest of the questionnaire asks for details on investment decision making and methods used or known. This can be used to identify whether advanced methods of investment decision making are already used within the company or whether a more detailed presentation of improved methods for investment decision making is needed (Kung et al., 2017).

4.5.3. Part C – Scaling questions

In this section, the interview partner was asked to respond on a Likert scale. Each question was answered with one response only and neutral responses were possible. There has been some debate in the literature on the optimum

number of points in a Likert scale. Although Bouranta et al. (2009) suggest that 5-point rating scales are less confusing and increase response rates, Diefenbach et al. (1993) report that seven-point item scales were best overall and were felt by respondents to be the most accurate and easiest to use. Westland (2022) suggests that it is more important to focus on the mapping of the information gained from the interviews to avoid potential information loss and proposes a balanced, centred and individual approach to scaling questions. For this research, a five-point Likert scale is sufficient due to the type of question asked.

4.5.4. Part D - Combined scaling and multiple-choice questions

It is common to use a combination of methods in questionnaires. As the questionnaire is structured according to the methods used and key items asked, this section is a combination of both methods (Lane et al., 2021), which can provide additional insights. This requires the questionnaire questions to be created in a way that not only captures the theoretical concept under evaluation but also minimizes the impact of their design characteristics on the quality of responses (Wainer & Thissen, 1992). Using both methods within one question can provide improved response quality and additional information gains (Boateng et al., 2018).

4.5.5. Part E – Open questions

In the last section of the questionnaire, open questions are asked. Open questions can provide interesting qualitative findings that may lead to new insights or help to develop future research ideas (Tenny et al., 2022). Moreover, open questions can support the quantitative findings of research, such as context and sentiment between the numerical results. Two disadvantages are associated with open questions. First, too many open questions can render the analysis and interpretation of the findings extremely time-consuming (Morandini et al., 2021). Second, it can

complicate the comparative analysis of qualitative answers. To reduce this risk, the number of open questions has been limited to the same size as the other questionnaire sections. Open-ended questions can discourage participants with lower levels of literacy or, in this research, a lower level of seniority within the company, which may reduce the quality of answers (Berinsky et al., 2014) leading to a loss of potentially relevant insights. Interviewees may feel more comfortable with closed questions (Reja et al., 2003; Schmidt et. al, 2020). As suggested by Dutta & O'Rourke (2020), the open questions in this questionnaire are genuinely open-ended. The participant is free to answer without any limitations. Two other open question types are defined as either “technically open-ended”, such as year of birth, or “apparent open-ended”, when the respondent is asked to select the answer from a list too long to be included in the questionnaire.

4.6. Covid-19 Implications and link to digitalization

In January 2020, a new virus emerged from mainland China with adverse effects on the global economy and personal lives. A survey by the UK Research and Innovation Centre found that research projects were negatively impacted (UKRI, 2021). The survey cites three main areas of impact: the impact on the research itself, the impact on mental health and the impact on future careers. The impact on conducting research was highlighted, with 58% of respondents reporting that COVID-19 had made it impossible for them to carry out the research they had planned, while 88% of respondents with child-caring responsibilities reported that these associated responsibilities had a negative impact on time for their research. This applied equally to both genders. On the positives, 56% reported that less commuting and 43% that less work-related travel had positive impacts on their time for research. The survey does not disclose information on respondents and, therefore, it can be assumed that few DBA students were involved. COVID-19 had a significant impact on this research on various levels. First, I was faced with an ever-increasing workload due to the

restrictions imposed in Europe, Asia and USA which required tremendous efforts simply to keep my business in operation. In terms of the research itself, it delayed the interviews as interview partners were also facing challenges and prioritising efforts to save their businesses over making time for an interview. A recent study by The Deutsche Institut für Wirtschaftsforschung (German Institute for Economic Research) (DIW), established a connection between increased workload, the economic difficulties of companies due to the pandemic and the resulting measures, especially hard lockdowns around the world (DIW, 2021). The research suggested that the longer lockdowns and other stringent measures were in place, the more difficult the recovery would be, rejecting the V-shaped scenario that some politicians and research institutes suggested during the first lockdown in Europe in spring 2020. Apart from the hospitality sector especially, any type of SMEs were some of the worst affected. As this research project centres on these companies, the effects of Covid-19 need to be examined. Therefore, the interviews were partially repeated to consider this dramatic scenario in the context of this research project. Moreover, digitalization played an increasingly interesting role during the pandemic, with a drastic acceleration in the drive for digitalization within any organization. One of the underlying assumptions of this research project is that digitalization is a variable that can drive economic change and, therefore, needs to be considered in any financial decision making. In the context of COVID-19, the virus could be seen as a fertilizing factor, forcing companies and business owners to invest in digitalization and IT to keep pace and not be driven out of business by their passivity. Research by Deloitte finds that COVID-19 drove digitalization in all business sectors (Deloitte, 2021). Within businesses, the Deloitte data show that digitally mature companies can react to the crisis with above-average flexibility. They tend to take medium- and long-term measures, which enable them to remain at the forefront of competition. As expected, the consumer goods and services industries tended to react more flexibly. For capital-intensive industries such as those in the automotive and chemical sectors, however, structural measures are a challenge. Nevertheless, especially in the

automotive environment, there is a focus on short- and long-term measures, such as cost reduction versus technology investment. In particular, long-term measures are currently being evaluated to improve the overall IT infrastructure, as short-term measures such as asking staff to work from home overwhelm the current IT infrastructure of most medium-sized automotive companies. Finding staff with the relevant IT knowledge appears to be a challenge; therefore, companies are considering relying on external digital workarounds such as cloud-based solutions with pay-as-you-go options until they have established the appropriate IT infrastructure on site.

Many companies and decision-makers, however, are wary of IT and the difficulties surrounding it and therefore have doubts about IT investment, as research by BITKOM (2021) found. The representative study found that over a year after the first lockdown, only 12% of all companies with 20 or more employees still doubted the economic benefits of digitalization for their company. At the beginning of the pandemic, a year earlier, 27% said they were unclear about the benefits, while two years earlier the figure was as high as 34%. At the same time, nearly two-thirds (64%) currently believe that digital technologies are helping their company to cope with the pandemic and in almost all companies (95%), the digitalization of business processes has gained importance as a result of the pandemic. So far, two-thirds of the respondent companies have weathered the pandemic very badly (38%) or rather badly (28%) and only one-third rather well (26%) or very well (5%). Almost one in four (23%) believe they will come out of the pandemic stronger, but more than one in three (38%) see their existence threatened by the pandemic. Bitkom finds that "the pandemic is tearing open a digitalization rift in the German economy". In around half (47%) of the companies, coronavirus has triggered long overdue digitalization projects, but in another half (52%) digitalization projects have been put on hold. Around half the companies (46%) see themselves as pioneers in the digitalization of business and administrative processes, while the other half (50%) are laggards. The current study shows that digital office solutions have arrived across the board in companies, but much potential in the use of individual applications. Thus, 93% say that they use individual solutions

such as CRM, ECM or ERP, and another 4% are planning or discussing such use. However, only 48% digitise documents, 44% use workflow management, for example for approval processes, and 41% use electronic archives and document management. Output management, for example for generating documents, is used by 35%, 27% have introduced digital solutions for cross-departmental research and 21% use digital signatures. Digital communication is becoming increasingly important in the workplace. During the pandemic, the use of messenger and collaboration tools such as Teams and Slack for internal and external communication increased sharply. Two-thirds (66%) frequently use messenger services, compared to just 50% a year ago and only 37% three years ago, while 45% frequently use collaboration tools, compared to 36% a year ago. Video conferencing also became standard in the pandemic, with two-thirds of respondents (67%) using it frequently, compared to 61% at the beginning of the pandemic and just 48% two years earlier. Smartphone use is also rising, at 89%, up from 81% (2020) and 51% (2018). There is almost no change in social media use compared to the previous year, with 30% saying they are users (2020: 29%, 2018: 25%) and all companies continue to use email frequently. The trend is reversed for traditional communication channels. Only 60% frequently post letters, compared with 56% in 2020 and 71% in 2018, and faxes are used frequently by only 43% of all companies, down from 49% a year ago and 62% two years ago. The pandemic has accelerated changes in communication that began in recent years but the pace of digitalization is currently slowed by a lack of digital competence. Only 56% of respondents have the employees they need to drive the digitalization of business and administrative processes. A year ago, 72% of the companies still had sufficient digitally competent employees. Nevertheless, only 64% invest in the digital training and further education of their employees (down from 70% in the previous year). And only just under half of the companies (54%) have managements with the necessary digital competence to drive digitalization processes forward. Where digitalization is now gaining significant importance for companies and needs to be driven forward more strongly, the lack of expertise is more noticeable than ever.

The greatest hurdles that companies see for the digitalization of their own company are a lack of standards (64%) and excessively high data-protection requirements (63%). However, general legal regulations – such as the requirement for paper forms – also hinder digitization projects (47%), as do security concerns. For example, 61% of companies fear unauthorised access to sensitive company data, 57% cite IT security requirements that are excessively high from the company's perspective and 49% fear data loss. Finally, the costs involved are high: 57% complain of the need for too much investment, 55% lack the time, 42% need external advice and 39% see a general resistance to digitalization in the company. Digitalization and COVID-19 are two items that in combination drive the need to improve any financial decision making.

4.7. Critical perspective of digitalization

Digitalization and digitisation are frequently seen as bringing benefits to economy and society. As a researcher and individual, I am biased as I can see the benefits to my company brought through digitization of the business and without digitalisation this thesis would not have been possible. However, there are also critical perspectives that should not be omitted and considered. Any process that is fully digitized and runs automatically bears the risk of overreliance on fully automated process reducing the responsibility of staff for failures if these automatic processes fail (Afzaal, 2022). For SMEs in particular it is important to understand that items like professional judgment, professional expertise are changing due to technology. Digitalisation also creates new occupation opportunities, but at the same time threatens existing jobs and roles. Given the complexity and speed of digitalization and digital business models, there is a threat of a growing skills gap between workers with limited digital skills and recently hired digitally savvy employees (Nadkarni & Prügl, 2020). This can impact the overall organisational unity of an organisation.

Further, and this also links to strategy element of decision, digital communication channels like Twitter have become parts of the public. These tools enable external stakeholders to raise their voice and engage in open dissent with a company or a business practice (Maltseva et al., 2018). This can also be linked to digital rights and the need to monitor and ensure that a company complies with the respective rules in this context. Digitalization also leads to potentially faster conclusion drawing as only snippets of information can be consumed by individuals, resulting in faster and frequently unfounded decision making without considering sufficient details. This is also used to easily create and distribute fakes news through these new digital channels.

Digitalization also has the risk of creating a few monopolistic companies that control the market standards. Already a major power disparity between big tech companies and established companies can be observed (Trittin-Ulbrich et al., 2020). Other studies indicate that these tech companies make increased use of a low paid labour force without adequate worker's rights, frequently within precarious work environments. With the help of digitalization, these workers will be monitored and actively punished if they try to restore these rights in their workplace.

In addition, digitalization has been criticised for poor financial decision making with algorithms. Depending on the Algorithms deployed there can be gender, ethnic and cultural biases produced in the results. Digital technologies therefore can reproduce and amplify existing social and organizational inequalities (Trittin-Ulbrich et al., 2020).

Chapter 5: Data Analysis and results

Following the layout for the research model development, this chapter presents insights from the data analysis and results. First, the sample is defined, and the size of the sample justified. Key considerations in the development of the questionnaire are then examined to evidence robust research steps and external data and studies are presented as supporting evidence. The next chapter, Chapter 6, presents a discussion of the findings.

5.1. Sample description

General sampling is the statistical process of selecting a subset of a defined population of interest for the purpose of making observations and statistical inferences about that population (Taherdoost, 2016). Social science research is generally concerned with inferring patterns of behaviours within specific populations. It is not possible to study entire populations because of feasibility and cost constraints; hence, a representative sample from the population of interest needs to be identified for observation and analysis (Lakens, 2022). Although diverse in terms of its multiple dimensions (industry, location, ownership structure, access to senior management), the sample was difficult to recruit. Moreover, various external factors influenced access to senior managers during the data collection period. Nevertheless, the sample size was sufficient for data collection.

The qualitative data collection comprised 22 interviews conducted over the course of three years among SMEs in Germany. The initial set of interviews was completed by 2018 and another round of interviews was conducted and completed by early 2021. The interviewees all hold senior management roles in SMEs. The interview data were collected and filtered to eliminate unrelated and excessive information and focus on the key responses from the interview partners. The interviews were semi-structured, starting with a warm-up section containing general questions about the company, followed

by closed, structured questions around financial decision making, decision making concepts and methods with a range of preset answers, and, finally, a section of open questions and comments. The second round of interviews asked additional open questions regarding decision making and digitalization as well as the ongoing COVID-19 situation and how this was affecting their business. A local concentration of companies was avoided by using companies from various areas of Germany for primary data collection through the questionnaire. Economic strength in Germany varies between federal states. As a result, it is important to collect data from different regions for improved data quality. Therefore, data were collected from companies in the north, middle and south of Germany, particularly in the Hamburg area, the main Rhine region and the south Rhine. The majority of companies required at least two telephone calls as well as a letter requesting an interview prior to arranging and conducting the interview. A total of 18 companies said that they could help with the questionnaire but either stopped correspondence during the process or communicated that the senior management did not wish to continue with the questionnaire. The second round of interviews was particularly challenging as senior management were busy with the pandemic and companies were facing challenges to their very survival. All interviewees requested that responses were collected and analyzed anonymously. Two companies did not wish to report on revenue, while the average turnover for the remaining companies was 17.3 million euros for a full year. The average number of staff was 120, with the range varying from 15 to 250 members of staff. Putting both values in context, one outlier reported a turnover of only 28,000 euros per employee, while the average is computed at 132,000 euros. The outlier was undergoing a restructuring process at the time of the questionnaire. All the senior managers interviewed were male. This is typical for SMEs, in which the vast majority of senior management positions are occupied by white, male managers (Angler & Terpitz, 2019).

anonymity requested	100%
Average no. of staff	117
Average annual turnover in Euro million	17.3
gender of respondents	100% male

Table 5: Extract of sample

Source: Author

As respondents were male, it was not necessary to run additional analysis such as Mann-Whitney or Kruskal-Wallis tests on subgroup influences of gender (Singh et al., 2022) although, according to research by Singh et al. (2022), gender can influence data analysis and results.

5.2. Translation of interview data

Given the initial objective to target members of interest groups within German industry, the interviews were conducted in German and the responses translated into English. It was appropriate to conduct the interviews in German in order to promote participation amongst prospective participants in Germany. As accuracy of translation is a key criterion for cross-cultural research (Choi et al., 2012), the interviews were translated on the fly by the interviewer to ensure that the context of the relevant words was accurately conveyed. Following Temple & Young (2004), to achieve a good translation the initial translation should be carried out by a native speaker who is familiar with the subject and research process. However, translation is not purely concerned with language, but also with reflecting the culture in which the data were collected (Chen & Boore, 2010). It is common practice for entire transcriptions to be translated into English, and then analyzed as a dataset; however, some researchers suggest analyzing the data in the original language and translating the results afterwards (McKenna, 2022). The issues surrounding translation raise the question of

who should perform the translation. Chen and Boore (2010) suggest that for added rigour different people should perform each of the two processes (conducting and translating the interview). Ideally, those engaged in the translation should be familiar with the field of research and suitably qualified in conducting research to avoid potential bias (Abfalter et al., 2020). Depending on the research, the choice of translator may depend on the overall language proficiency of the research team members available (Piazzoli, 2015). In the context of this research project, I will conduct the interviews in German as the interviewees are German native speakers, so conducting the interviews in another language would have created another translation issue. I also translated the interviews as I understand the cultural background of the interviewees and am proficient in English, having lived in Ireland for over five years, studied at Trinity College and become a Certified Mediator with the Mediators Institute of Ireland and also a Chartered Accountant (ACCA).

5.3. Organizing the qualitative data from the interviews

Before the interviews started, I created a plan for how to approach and analyze the data. In the first step, the dataset was organized into a clear structure and readable format, ready for the NVivo tool to be used to analyze and interpret the data. The interviews were conducted in person by myself. It is important to note the majority of interviews had a defined time limit of 30 minutes. As a result, there was little time for warm-up discussion, and most interviewees asked to start with the questions straight away. This is not uncommon when meeting with senior managers who are time-constrained during the business day (Solarino & Aguinis, 2020). After asking the questions, I noted the responses in writing and followed up with the next question. On the open questions, follow-up questions were also asked to attempt to gather additional insights from the interviewees.

Following the interviews, I typed the answers and comments up in Word to allow the questionnaire's questions and respective answers to be imported to NVivo.

After uploading the information, the interview data were organized and coded in a five-step process. The codes were based on a list of pre-chosen key words, including "digitalization", "NPV", "strategy" and "project risk" that the interviewees were found to use frequently.

The coding table was then established. To improve and revise the code table, Nvivo features such as word cloud were used to identify key codes and themes from the raw interview data.

In the next step, each interview and each word, sentence or paragraph were coded using the respective coding table. Finally, the data were analyzed and the relevant information extracted. The overall process is depicted in summary below.

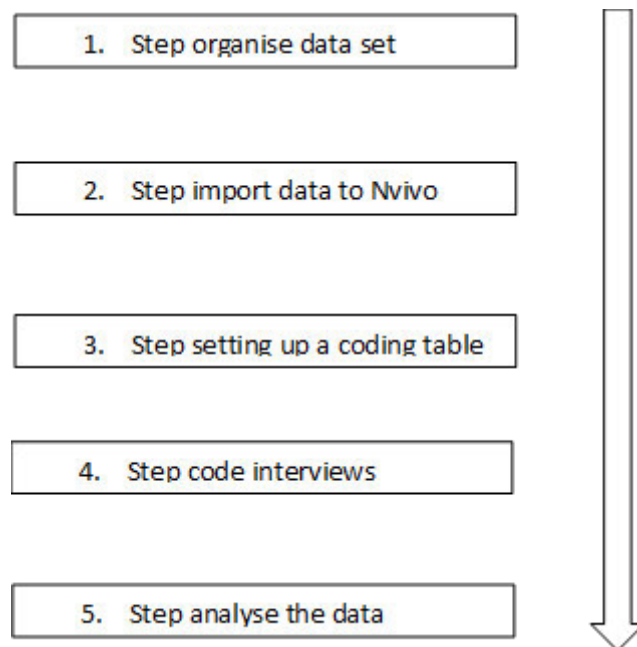


Figure 17: Organization of Nvivo data

Source: Author

It is important for the overall organization of the thesis that the research follows a robust scheme in terms of data analysis and organization as well as the presentation of interview data.

5.4. Organizing the quantitative interview data

In the interviews, the quantitative section of the questionnaire was preferred by interviewees as this part was completed quickly due to the predefined selection of answers. As stated earlier, time was of the essence in the interviews, as highlighted by many interviewees in advance. I transferred the answers given in the interviews from my handwritten notes to typed interview notes in Word and, from there, to Microsoft Excel. This programme was sufficient to analyze the quantitative data and produce graphs and extracts. Initially, I considered using EViews for quantitative analysis but, due to the limited data available, I also assumed Excel was deemed fit to provide the relevant statistical computations. Given the dataset, these quantitative data are used to provide additional context to the qualitative research and help interpret the findings within the given context. Overall, the data provided the setting and were results-driven. The dataset for each of the 22 respondents consisted of 17 responses to closed questions, six responses indicating agreement or non-agreement, 13 questions on creating the digitalization index and eight open questions within the context of the previous closed questions and questions on the digitalization index and further open questions.

5.5. Analyzing the qualitative interview data

The thematic content analysis of the semi-structured interviews follows a three-step process as suggested by Braun and Clarke (2006).

5.5.1. First consideration: Is the thematic content analysis within the scope of my research paradigm?

Thematic content analysis is a popular method in qualitative research, partly reflecting its independence from any particular theoretical approach or epistemology, thus offering researchers who position their work within either realist or constructionist paradigms a useful instrument for their analysis (Braun & Clarke, 2006). In the context of exploring voluntary participation, thematic analysis is useful because it enables the researcher to examine, from a constructionist methodological position, the meanings that people attach to their participation in the research project and the significance this has in their lives, including inner beliefs and settings within the professional work or, more broadly, their social construction of the research. At the same time, it enables the researcher to examine how these constructions may reflect the participants' perception of reality, the material or social contexts in which they live and work and the constraints and enablers that limit or expand their views. It allows the researcher to examine how people make meaning out of their professional experiences, and how they construct their social worlds through meaning-making, while retaining a focus on how these experiences are informed by their material experiences and contexts. The aforementioned items are a solid starting point within any pragmatist research project.

5.5.2. Second consideration: How to identify a theme?

Thematic content analysis is the process of identifying patterns and themes within a given interview dataset. It begins with data collection and continues throughout the processes of transcribing, reading and re-reading, analyzing and coding and interpreting the data. In reading and re-reading the transcripts, the focus remains on the research questions, as these guide the thinking about the data and what should be considered to be a theme. Braun and Clarke (2006), for example, maintain that a theme should capture

something important about the data in relation to the research questions, and represent some level of patterned meaning or response within the dataset. In repeated readings of the dataset, a theme will appear more than once but the frequency of instances does not automatically indicate that one theme is more or less important than another which appears in few instances across the dataset (Price & Smith, 2021). In qualitative analysis, the importance or significance of a theme is reflected in the extent to which it relates the theoretical position or overarching research questions.

5.5.3. Third consideration: How to present the themes

A key challenge when using qualitative interviews is how to report or represent patterns or themes identified within the dataset. One appropriate method of choice for many researchers is to use 'pseudo quantitative terms' to report the data. For example, Reay (2001, p. 39) writes "many of the working-class students..." and Meehan et al. (2000, p. 372) report on "for the majority of participants", while Crozier et al. (2008, p. 264) assert that "most parents said...". However, this depends on the size of the dataset: if there is only a small number of data items within a dataset (e.g. a small number of interviews), these terms may not be appropriate and, moreover, tell little about the relevance of a particular theme to the research questions (Braun & Clarke, 2006). If the dataset is small, it is preferable to provide a sense of the theme without reference to quantitative terminology. Braun and Clarke (2006) suggest describing a theme in detail, providing a rich description of it, and then presenting an interview extract to exemplify it. Reay and Ball (1997) similarly recommend presenting data extracts, "These are examples of a paradoxical theme..." (p. 92). Other examples of this approach to representing qualitative interview data (from research within sociology and education) can be found in Reay et al. (2009).

Following Braun and Clarke (2006), interpreting and representing data is a 'craft' that presents challenges and requires careful and reflexive consideration. This is time worth spending; thorough attention brings rigour

to the research project, and the analysis and interpretation of the data will reflect the epistemological and theoretical position of my own researcher perspective.

5.5.4. Case Study Analysis

A case study has become an important part of writing a doctoral thesis (Lee & Saunders, 2017). Case studies are especially important for theoretical frameworks that have insufficient real-world testing or where theory needs to be tested in the field. Conducting a case study requires rigorous research methods, with care to avoid potential biases due to personal involvement (Baldwin et al., 2022). Although a widely used method, it still lacks legitimacy as a social science research strategy, as it does not have well-structured and fully defined protocols defined by key literature (Yin, 2014).

The case study was conducted at a company where I am a managing director. The case study method is widely used by researchers interested in qualitative research and mixed methods research (Baskarada, 2014). Although case studies have been discussed extensively in the literature, little has been written about the specific steps to be used in conducting case study research effectively (Gagnon, 2010; Hancock, 2021). As no key literature could be identified recommending a specific approach, I decided to follow the guidelines provided by Rashid et al. (2019). As these were based on an IT project, they appear to be a good fit for this project and they take into account that management researchers frequently have only a limited repertoire of methodological approaches for conducting research and are primarily trained to use quantitative methods (Bazeley, 2015; Cameron & Molina-Azorin, 2011). As described by Rashid et al (2019), a key element of the case study is to maintain a formal document that captures the entire set of procedures involved in the collection and observation of empirical material (Yin, 2009). As defined by Yin (2009), a case study protocol should include (i) a research question, (ii) research methods, (iii) permission seeking, (iv) ethical considerations, (v) the

interpretation process, and (vi) criteria for assessment. In a qualitative study with an interpretive perspective, the involvement of the researcher in the interpretation of the collected material is crucial. Before the collection of empirical material, it is useful for the researcher to know the case and the participants who will be approached well. This ensures a smooth process and builds rapport between the researcher and participants. In this project, I, the researcher, hold a senior position in the company and know the participants. I act as researcher and document the case study. As outlined by Rashid et al. (2019), the case study is conducted within a safe environment for the participants and the case is clearly described as shown in Figure 18.

Case	Description	Location	Participants
Improved FAP model applied to an investment project	The improved FAP model applied to a proposed investment project in a new manufacturing line. The new production line will produce only new products with a new digitalised production printing methodology also requiring changed process for sales and administration as orders can be placed "just in time"	Klingenberg/ Main	Department leader

Figure 18: Case Study details

Source: Author

5.5.5. External data sources for research on digitalization

There is a growing body of research on digitalization, national levels of digitalization and now also intensified research on companies, largely since pressure from external events such as the COVID-19 pandemic has placed additional pressure on companies to advance faster with digitalization. As part of this research project, the progress of other research has been

monitored to gain additional insights and to check the results of this study against others. Research by Shuttleworth et al. (2022) shows that digitalization is seen as beneficial and that the pressure to become more digitalized as well as better prepared for Industry 4.0 is ever increasing. Hirsch-Kreinsen (2019), however, reports on a gap between expectation and reality, described as the “ironies of automation”. The author describes the phenomenon that technical systems are intended to simplify processes but are so complex that they can no longer be controlled, let alone remedied, by a single employee in the event of malfunction. This is a key issue to be considered in any decision making or appraisal process. Further, he describes that it is likely that the development and monopolization of expert knowledge will increasingly be linked to individuals in specific subareas and that the collaboration of these experts within a company will, therefore, become increasingly important in managing complex requirements in a targeted and efficient manner. At the same time, however, companies need not only experts in specific areas but also intrapreneurs with an overall understanding of business processes, that is, individuals with an entrepreneurial mindset, able to plan projects and workflows independently and coordinate their work with one another. The promotion of expert panels (i.e. Delphi Panels) is also growing.

A study by Werning (2020) on SME companies based in Germany’s largest state, North Rhine-Westphalia, provided additional insights into the current status of companies in terms of decision making and digitalization. Of the companies interviewed, 54.1% are defined as industrial or production companies, with the remainder described as industrial service companies and trade/craft companies. A total of 498 companies responded to the questionnaire (representing a 3.6% rate of response); 75.1% of respondents were the business owner or managing director, while 15.9% were managers with a budget function and 9% managers without a budget function. In this industry context, approximately 59% of managers report that they believe that their company does not have a highly advanced IT infrastructure. Further, it was found that on average 41%–60% of staff at these companies carry out their work with IT support, ranging from working with a computer

or having a smartphone to working with machinery that requires IT support. Only 0.7% of staff report that they carry out their work without any contact with IT. Overall, the computed index provides an average score of 4.6 for the industry of this region. This is an average result as the index scale is between 1 (low) to 10 (high). As North Rhine-Westphalia is the largest state within Germany and has the largest number of SMEs per capita, it offers a good indication of digitalization across Germany.

Chapter 6: Discussion

This chapter presents the findings from the questionnaire and provides a detailed analysis and presentation of these findings. In the first section, the findings from the questionnaire are discussed, while the second part discusses the case study. The conclusions of the research are presented in the next chapter.

6.1. Descriptive Statistics

All 22 interview partners asked for anonymity; thus, measures have been taken to ensure that anonymity is provided and data protection ensured. The sample size of 22 was below expectation as originally it was aimed to obtain 30 interview samples but due to the COVID-19 pandemic this was not possible. The overall interview partner sample of SME senior manager is shown in figure 19:

anonymity requested	100%
Average no. of staff	117
Average annual turnover in Euro million	17.3
gender of respondents	100% male

Figure 19: Descriptive statistics

Source: Author

The interview partner where all male and held the following senior management positions at their company as shown in figure 20.

decision maker level at company	
<i>owner</i>	4
<i>C-LEVEL</i>	13
<i>middle management</i>	5
<i>investment committee</i>	0
<i>other</i>	0

Figure 20: Decision maker level at company

Source: Author

Along with the type of company presented in figure 20, it is confirmed that at SMEs there are flat hierarchy, resulting in the fact that mostly there is no investment committee and only few middle management layers present. This is further reflected by the type of company as private company is the prevailing type in the data set as shown in figure 21.

type of company	
<i>public company (not traded)</i>	2
<i>private company</i>	20
<i>unlimited company</i>	0
<i>other</i>	0

Figure 21: Type of company

Source: Author

Out of these senior managers the majority is involved in digital transformation projects or in charge of driving digital transformation at their company.

involved in digital transformation	
<i>yes</i>	18
<i>no</i>	4

Figure 22: Involvement in digital transformation

Source: Author

6.2. Closed question findings

All companies involved in the research project are SMEs as defined in Section 2 and according to the EU definition of an SME. The average turnover of the companies ranges from 2 to 48 million euros, while 14 of the 21 companies have an annual revenue of up to 20 million euros. In terms of staff, the companies range from 15 to 240 employees, with an average of 118 members of staff. This is in line with other research stating that SMEs provide the majority of jobs and that SMEs tend to have a higher turnover-to-staff ratio than large corporates. In Germany, according to the state-owned KfW (2021), SMEs account for 42% of Germany's GDP and 56% of all jobs subject to social security contributions in Germany. In addition, the majority of SMEs employ around seven members of staff (KfW, 2021). As described in the literature section, decision making within SMEs takes place mostly at the owner level and SMEs have flatter staff structures due to their lower number of staff. In other interviews in the business segment, most interviewees are owners. However, in this research, only four out of 22 interviewees were owners, while 13 were C-level. However, on closer inspection, a further six of the interviews are direct relatives of the owner and therefore, potentially, future owners of the business. This also confirms the finding that 16 out of 22 interview partners are solely responsible for financial decision making. Those not in charge of decision making are all part of larger organizations within the SME space. Ownership structure also goes hand in hand with the type of company: 19 companies are privately held limited companies, while two take the legal form of public companies, but are not listed on a stock market. The majority of participant companies are within the general manufacturing space and produce machines or parts for machines used in various manufacturing companies.

In relation to the digitalization aspect of the research project, 81% of the interviewees responded that they were involved in digital transformation projects, while the budgets of such projects related to company size; only one company reported a project of more than 5 million euros, with the

majority of projects falling within a range of 500,000 to 1,000,000 euros, and the remaining below 500,000 Euro. Decisions for financial investments are taken at eight companies by investment appraisal teams. However, these companies are also the larger SMEs interviewed. For all other companies, decisions are taken mostly at owner level/C-level as the companies are much smaller in terms of employees and turnover, and decision power is more concentrated at this level. This aligns with the literature that found that decision making in smaller organizations is concentrated at owner level. On the question of investment appraisal committees, 66% of the companies in the dataset have no formalized appraisal policy. However, one larger SME also confirmed that they have no formalized investment appraisal policy but do have established an investment committee. However, 16 out of 22 interviewees believe their investment procedure could be improved, either by formalizing it or improving the process or technique relied upon to evaluate an investment. One of the key questions in financial investment is how the variables are defined and which variables are the key drivers of an investment decision. According to Frisell and Lorentzon (2015), the key considerations are ROI, interest rate and time. All the executives stated that they do not rely on one key variable but on a combination of variables; however, they appear to differentiate between hard and soft factors in terms of variables. As shown in Figure 23, the interviewees state that they consider variables such as digitalization and strategy but do not use these variables in any models applied for investment appraisal.

Key variable	# of mentioning
interest rates	14
time	16
risk	17
strategy	11
digitalization	4
other	
- competitive edge of investment (product or strategy)	2
- (positive) cash flow impact	1
- affordability	1
- creditworthiness	1
- technical feasibility of investment	1

Figure 23: Key variables financial decision making

Source: Author

As shown in the table above, the key considerations are risk, time and interest rates. However, interest rates between 2014 and late 2021 are at an all-time low – or even negative for sovereign states taking on debt – so it is surprising that this variable is still mentioned as a key criterion. Furthermore, interest rates are deductible in terms of accounting as they are cost items and, therefore, offer a certain form of tax shelter for businesses, independent of the company size (Ngozi & Emeka, 2022). There is scarce literature on this subject, but it is assumed that interest rates still have such importance as they are a key variable in any widely used or accepted model for investment appraisal analysis. Other items were mentioned as relevant variables for some companies, such as creditworthiness. If an investment is funded by debt, this is an external key variable, as a creditor will only provide the required finance if creditworthiness is proven. This question lies beyond the scope of this research project. Another factor is that an investment should provide a competitive edge for a product or strategy; in other words, these companies are looking for investments either by improving the efficiency of production of new products or through overall improvements in competitiveness.

Regarding the methods employed by the companies in this research, the vast majority work with the standard methods of NPV and IRR. Both methods are used by the companies primarily because they have long been relied upon and are easy to understand. Moreover, they are requested by financing partners as an appraisal method and, therefore, often have to be implemented (Bai & Zhao, 2022). NPV and IRR are dependent on similar assumptions and requirements and mostly depend on a specific discount rate and a defined time horizon to compute a present value. In the interviews, two larger SMEs stated they used cost-benefit analysis, while sensitivity analysis was also used by three companies, primarily to check for best, base and worst-case scenarios. The benefit/cost ratio is used alongside standard NPV by two companies. Overall, companies appear to prefer standard NPV and IRR models to more sophisticated models. The assumption is that the size of the company plays a role in using standard models; these are also often provided by standard ERP systems for analysis. More sophisticated models require additional staff and IT resources as well as technical expertise.

Large corporates started to introduce younger members – so-called “digital natives” – to their boards to demonstrate a willingness to transform and an awareness of digitalization and its various aspects. Some universities also started to offer digital entrepreneurial courses to support the increased demand for digitalization and “tech” requirements (Januchowski, 2022). In the SME space, this trend is yet to make an impact, mostly due to the small size of the typical SME. In the questionnaire, only five out of twenty-one responded that they have a “digital native” or senior manager in charge of digitalization at senior management level. At four of these five companies, the managing director sees themselves as digital natives or overseeing digitalization. Mostly, these managing directors are younger than their peers. They also stated that their products should become more interconnected, and they see digitalization as needed not only to improve processes or appraisal methods, but also to create new products or offer new services to create additional revenue streams. Of the group of five digital natives, four are also responsible for or involved in financial appraisal

at their company. In line with the small number of digital experts, none of the respondents had ever heard of the financial appraisal profile (FAP) model, perhaps because it is comparatively new and there was no need for companies to re-think their financial appraisal decision models. Interest rates have been favourable for companies over the past 15 years due to various stimulus packages and the lower interest rates set by central banks worldwide, making project appraisal easier as the denominator diminished over time. However, the interviewees mentioned other key considerations in investment decisions, including strategy, discount factors and project risk. Currently, in the investment appraisal models employed by the companies, strategy and project risk are not quantified or evaluated as part of the decision process. They are merely soft factors in the models currently used and are part of the overall consideration process for the respective decision-maker. Digitalization aspects were cited by seven companies as part of the decision process, while other factors were mentioned by four companies. Three companies include reputational matters in their thinking, mostly defined as environmental or social matters. ESG criteria also appear to be a potential key factor for a majority of companies in future decision making (Aldowaish et al., 2022).

Agility methods are a new development within organizations, first used within software development. They include solution improvements through collaborative efforts for self-organizing and cross-functional teams with customers or end-users (Collier, 2012). They have at their core an iterative development process. Organizations are starting to use agility methods for management and project development outside software development. The methods have attracted some criticism: Venkatesh and Rakhra (2020) find them inefficient, although their research focused on larger organizations. Cockburn (2010) noted that the agile method he has been credited for has weaknesses in terms of limited objectives, cognitive bias and adverse commercial interests. Despite these considerations, agile methods are widely adopted and are contextually similar to the FAP model's approach to investment appraisal. In this context, the interviewees responded that the larger companies surveyed also use agility methods. In total, eight

interviewees responded that agility methods form part of their organizational toolbox. The questionnaire, however, asked only whether they employed agility methods and did not ask in which area. It could be interesting to pursue this in a future round of interviews as agility methods could be an interesting starting point for an improved FAP model, due to similarities in approach.

In the third section of the questionnaire, the interviewees were asked to answer according to a preset scale from “strongly agree” to “strongly disagree”. Each question could only have one answer. The following table summarizes the results for each question.

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Do you think that financial decision making should be “digitalized”	7	9	1	4	0
Would you like to have the financial decision making improved within your organisation?	2	11	4	4	0
Do you think employing agility methods helps your organisation?	2	5	13	1	0
Do you think your organisation should improve the financial decision making?	1	11	8	1	0
Would you consider employing an improved financial appraisal and decision making model?	4	15	2	0	0
Do you think your current financial decision making framework is adequate for the challenges coming in terms of digitalization and industry 4.0?	2	8	9	2	0

Table 6: Scaling question results

Source: Author

None of the interviewees responded to any of the questions with “strongly disagree”. In this type of question set, interviewees tend to answer questions positively rather than disagreeing. Research by Tick et al. (2022) confirms this finding. Overall, the respondents see and agree with the questions stated and agree that there is a general need for improvement. On the digitalization of decision making, in particular, the respondents agreed that financial decision making should be digitalized. On company-related questions, there was also positive momentum on potential improvements. With regard to the question of agility, this attracted strongly positive answers from two larger SMEs, while the majority elected a neutral position.

The digitalization index comprised six variables. Each variable could be given only one response. The variable affordability was a scaled question, while the remaining variables were dependent on each company’s individual situation.

6.3. Digitalization index variables

6.3.1. Affordability

Like any investment, “price” is a crucial criterion for identifying the project cost. In terms of affordability and digitalization, it is essential to identify the price, especially within SMEs which usually have tight cost regimes. Only two companies invested heavily in digitalization projects. The majority of these projects are not simply upgrading IT infrastructure and computers but include also improvements to machinery and production equipment as well as adding digital services. The cost itself is, therefore, not restricted solely to IT infrastructure but includes investment in any relevant digital aspect. The majority of companies invest up to 50,000 euros per annum and focus mostly on improving IT infrastructure, upgrading computer systems or acquiring new software licences. This finding is in line with 2019 research

by the US research institute CompTIA, which states that the average SME invests between \$10,000 and \$50,000 (CompTIA, 2019).

	€0 - €50,000	€50,001 - €250,000	€250,001 - €500,000	€500,001 – €1,000,000	More than €1,000,001
How much does your company invest in digitalization projects per annum	11	5	3	0	2

Table 7: IT-Investment spending

Source: Author

A total of 11 respondents stated that they also set quantitative targets for digitalization investment, either in the form of cost savings or benefit increases. Expected savings are up to 50,000 euros for seven of these companies, while four require savings or benefits of up to 250,000 euros. Savings and benefits are not estimated on an annual result but on the total project saving or benefit.

6.3.2. Human Capital

A critical element within organizations is the human capital available. Either relevant and sufficient knowledge is available or additional training and qualification are required. Comparing the age of the average SME employee to digitalization needs, it becomes clear that there is a need for training and qualification to allow all staff members to adapt to digitalization. In absolute terms, the average spending per staff member for training and qualification is 367 euros per annum; however, the number is skewed as seven companies, or about one-third of respondents do not invest in staff training. The smaller SMEs, in particular, have no training budget. However, only six companies have no budget allocated for IT training and the remainder offer, on average, one day of mandatory training per annum. Changes in the IT

environment involve both technical and organizational changes. Investment in human capital also depends on the status of employees, as two of the companies do not invest in IT staff qualification, while four have outsourced their IT departments, and two still provide training for staff in IT knowledge.

6.3.3. Usage

For the participant group, on average one-third of all employee tasks were internet related. This implies that workers on the production floor also have internet-related tasks, frequently connected to the maintenance of machinery or support from remote service personnel for the machinery and production lines. It was also reported that over 80% of all company telephones are smartphones that allow internet access to connect with colleagues, clients, business partners or other services, including controlling machinery and remote production. The findings are similar to those of Caniels et al. (2015), who found that the majority of small business owners have yet to take advantage of the internet to advance their businesses. Moreover, Yodle (2013) found that 52% of US SMEs have no website or do not use internet technology to gather information from existing or potential customers. A more recent study from the Institute of Deutsche Wirtschaft (2018) found that only 27% of German SMEs have a high or very high degree of IT usage (Schöpfer et al., 2018).

6.3.4. Infrastructure reliability

As well as internet usage, the infrastructure needs to offer reliability and stability to allow for digital improvements. On average the participating companies invest 412 euros per employee in IT infrastructure, far below the average of 1200 euros found by Schüle and Murnleitner (2020). Ten companies reported no infrastructure failures in the past 12 months, while four companies had one relevant failure and seven had other failures. The

type of failure was not asked, but the companies would only have reported a severe failure.

6.3.5. Network access

The questionnaire found that approximately 92% of staff members have access to the company network and that 82% have company phones. The difference is accounted for by some companies offering “bring your own phone” policies. Companies frequently offer only a specific company phone model and staff may, therefore, prefer to use their private phone also for work.

6.3.6. Capacity

Improving the digitalization of a company requires that company to have sufficient network access speed and broadband capacity. In particular, digitalization projects for Industry 4.0 require fast speeds and broadband width including permanent online connections. IOT devices require stable communication and interaction ("Industrie 4.0 braucht 5G", 2019). The most recent standard for communication is 5G, which is currently rolled out across Europe. Narrow-band data transfers from sensors in large numbers, high-volume transfers to the local cloud for later analysis, time-critical control tasks in robotics, AI-supported image analysis and machine learning via edge computing – all these run in parallel with voice telephony under 5G and future developments of the standard will be made available via software updates of the existing infrastructure. All companies in the questionnaire had broadband speeds of at least 100mbit/second, while approximately 50% had minimum speeds of 1Gbit/second and the largest company in the dataset had a speed of 10Gbit/second available across the company. Only one company reported limiting capacity at certain times, and this was after hours for their office workers as part of a workers' council agreement with

the owner to allow staff to relax and not receive company communications after hours.

6.4. Qualitative Findings

In the next part of the questionnaire, open questions were asked, to provide evidence of the need for an improved financial investment model, as outlined in the methodology section (Chapter 3). The initial coding process was conducted by reading and re-reading the transcripts and questionnaires to identify relevant words. In the initial identification of words and themes, the focus was defined as outlined in the research objectives. The initial themes and key codes were “digitalization”, “financial improvements” and “decision making”. Following these three primary themes, the questionnaire responses were re-read and the coding further refined with another iteration, yielding further findings, especially around the decision making process and digitalization. After this stage, the main groups of nodes were defined as shown in the figure below. The initial temporary codes were defined as preliminary codes, further refined for the final code. The guidelines for the coding process are as described in the methodology section. The initial codes were derived from the analysis function of NVivo, which yielded a weighted percentage rate for the words most frequently found in the transcript. It should be noted that the analysis for word count excluded irrelevant words such as “also” and “and” that were not identified as key for this project. The top ten most frequently mentioned relevant words were as follows, with percentage weighting:

word	Number of occurrences	weighted percentage in %
digitalisation	139	2.29%
decision	123	2.03%
factors	119	1.96%
appraisal	107	1.76%
making	106	1.75%
business	102	1.68%
financial	98	1.61%
benefits	83	1.37%
investment	69	1.14%
strategy	57	0.94%
digital	53	0.87%
corona	44	0.72%

Figure 24: Coding results

Source: Author

The importance of words and themes increases by the number of key words mentioned in the text as demonstrated by a higher percentage share of total text (Johnson & Waterfield, 2004).

Using NVivo's visualization method, the concentration of the words identified above is shown in a word cloud. This, however, includes words that have been removed from the theme identification process.

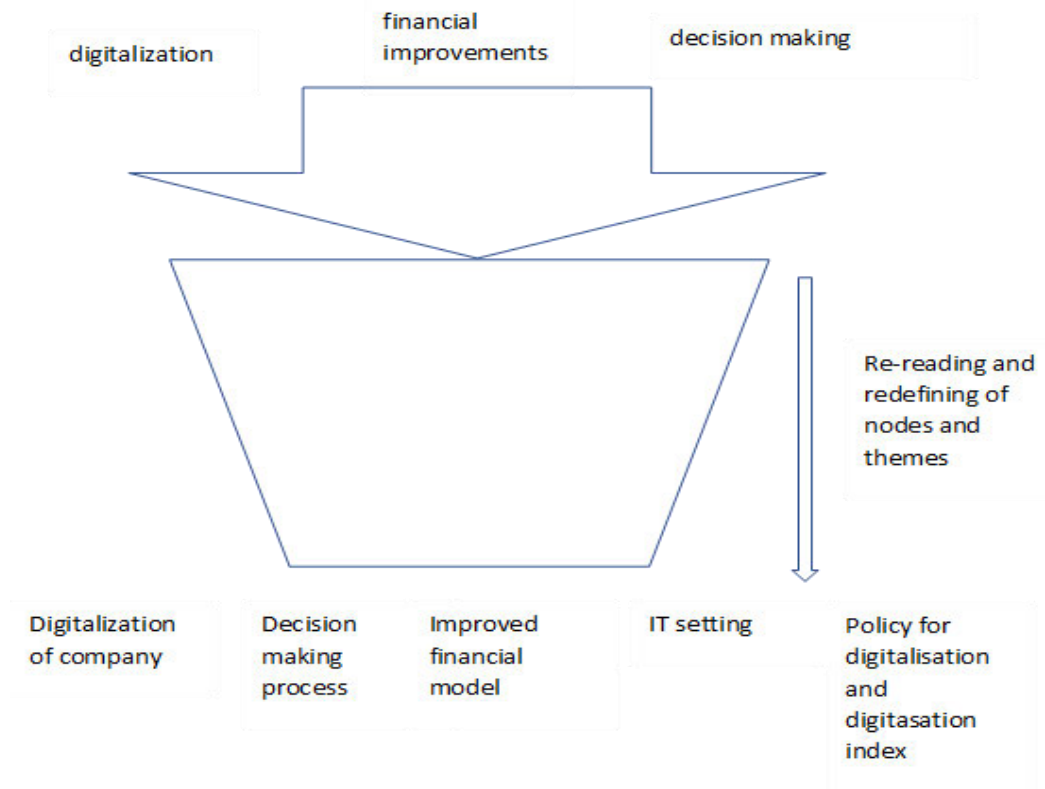


Figure 26: Word filter

Source: Author

As a result, the high-level key codes were identified and set as master nodes for a further coding process. Further detailed nodes were created under these five master nodes. For the coding itself and theme identification, the various automatic visualization and analysis tools provided by Nvivo were used to confirm the themes identified. As defined by Gibbs (2018), “coding is a way of indexing or categorizing the text in order to establish a framework of thematic ideas about it”.

During the coding process, it came apparent that in theory the interviewees realize and are fully aware of changes in the real world and the importance of digitalization and improved financial appraisal. Yet, the responses are ambiguous in that the majority of companies do not yet have sufficient resources in place for digitalization, nor have they adopted a revised, improved financial decision model. Moreover, by the second round of interviews, the situation had changed: the first interviews were conducted in

2019, pre-COVID. By 2020, the world had changed, and business models stress tested by the virus remained under severe pressure for a majority of companies as the pandemic continued. Alongside the threat of the virus and staff being placed in quarantine, concerns increased about the supply of raw materials or extended lead times for required resources.

From the dataset itself, it was clear that there is an increasing change in the perception of digitalization and the need to consider employing more advanced models of financial appraisal to support improved and informed decision making by including additional factors as identified by this research project.

6.5. Categories

The following categories were defined based on the first analysis of the interviews. There were five categories found, which are:

- Digitalization aspects
- Financial decision making
- Strategy mix
- Risk (interest related)
- IT utilization

These four categories were identified using Nvivo and the process of thematic content analysis before. Based on the themes identified the analysis of the data will be deductive qualitative and inductive qualitative (Mayring, 2016; Kuckartz, 2012). However, it should be noted that even with the most rigour applied the definition of categories could be biased by the research.

6.6. Discussion of findings from the qualitative analysis

To bring the responses from the previous section into the context of the research and to introduce personal perspectives, open questions were then asked on the items. Most companies do not have a formal investment appraisal team, as identified before. Of those that do have such a team, only one reported a set interval for meetings – “The investment appraisal team meets once a month”, which is also supported by the larger organization of this company. Larger organizations offer additional resources for improved governance and structure than SMEs, where a wide range of tasks is concentrated on a smaller number of staff (Taschner, 2012). The above analysis centers on the quantitative aspects of the companies under review.

6.6.1. Research questions and respective findings

1. Is there a need in German SMEs to integrate digitalization in their decision making process?

In the questionnaire, the companies confirmed that digitalization had affected their business. Not only were they affected by the need to improve and invest in technology but also by the changes and improvements required in sales, competition, products and training needs. One company stated:

It [Digitalization] is heavily affecting our business and markets. Competition. E-commerce and improved connectivity for our products and additional services provided and charged to clients offer additional business and revenue streams.

Digitalization is not only a challenge, it can also provide opportunities in sales, improve organizational efficiency or make the company more attractive to potential staff looking for a modern workplace, as summarized in this response:

In every aspect, our product is digital printing. So for our product itself and production digitalization is a key element. We also include our product developer team as digital experts as they need to build on the computer the structure and surface of another material to be printed on the product. Our sales teams work with e-commerce tools and every member of staff is connected to the company network by laptop or mobile phone.

All companies recognized the importance of digitalization due to the scale and impact it brings, as well as other potential advantages, unique for each company. Digitalization is a game-changer for some established companies needing to adapt to a more digitalized world.

2. How can an improved FAP model contribute to improved decision making at German SMEs?

On the question of whether digitalization is integrated into the decision making process, this is not yet the case. Companies still depend heavily on existing quantitative research methods such as NPV and IRR. However, the need to consider digitalization in decision making and financial-appraisal processes was known and established among the interviewees. One challenge in this respect is that education on more advanced financial appraisal technologies is scarce within the organizations, but the willingness to adopt new methods exists. A key consideration for one company is:

Trying to find the right model and variables to fit and reflect planned investment adequately and combine with digitalization.

Others have established that they not only need to adopt a new, improved model but also require a change in perspective, education and qualifications, which may require new talents. For SMEs, this may be a greater challenge than for large corporates. Moreover, the location of a company may also hinder its ability to improve financial decision making with digitalization:

Upfront investment costs and retaining qualified staff as well as training staff – this is a real challenge for a company, particularly one like us, an hour away from a larger city. Talent acquisition is challenging.

Without a systematic approach and user-friendly model, it may be difficult to improve financial decision making.

In political and economic analyses, the next “industrial revolution” is expected to be based on digitalization. In Germany, this is summarized in the term Industry 4.0, defined by digital transformation consulting firm I-Scoop, in 2017, as “a name for the current trend of automation and data exchange in technologies, including cyber-physical systems, the Internet of things, cloud computing and cognitive computing and creating the smart factory”. The range of definitions is wide, as every company creates its own definition. One respondent felt that digitalization also helps to address other relevant factors such as ESG.

Providing benefits to improve the connectivity of machinery, products, customer and supplier. Also considering ESG criteria to improve investment quality and social responsibility.

Another respondent saw improvements in various company-relevant items from production to sales and overall efficiency improvements, namely cost savings:

Connecting the production lines with client needs. Ideally the client orders online and production is done automatically with no need for additional staff intervention.

and

Reduction in costs and additional savings, but also threats for companies that do not invest and improve.

3. How to define digitalization and its benefits for a German SME?

As mentioned before there was clear evidence from the questionnaire and the respondents that digitalization offers various benefits. The benefits for each company may vary in the senior management's individual perceptions as well as in the definition of benefits. To quote from one respondent, who defined benefits of digitalization for his company as follows:

Digitalization is an important matter for us. We define digitalization mostly along the production line and the automatization of processes. If we can achieve optimization in the production line or relevant cost savings, these are benefits of digitalization for me. Improving communication with clients, suppliers and external partners is also a benefit, but I would not regard email or mobile phone as digitalization benefits, these are rather computerization benefits in my opinion.

Besides the vast majority of positive voices in the context of digitalisation and respective benefits, there were also other comments. There was also a

critical voice on digitalization and improved decision making. As one responded stated that:

Digitalization is praised as an important and relevant and some might also say as the next industrial revolution. I can only say this for my business, but I feel that there is still a long way to go to say that digitalization will bring substantial additional benefits. I still think that in sales it is a people business, and it is about quality and price. I do compare digitalization to my new Audi car. It offers a lot of additional features, however, out of the 10 assistance systems offered in the car I only use the parking assistance system and switch of the other systems as they are annoying to me.

This statement demonstrates that there is also critical viewpoints on the advantages of digitalization. In the theme identified as digitalization this respondent was the only one addressing his personal beliefs in terms of digitalization. In contrast to his own opinion, he responded in the theme identified as strategy mix that:

As mentioned, before I do not think of digitalization as new industrial revolution, but I rather see it as another business opportunity or stream to reduce business risk by adding another [digital] sales channel and way to increase communication through additional channels with supplier, clients and other business partner.

This ambivalent statement confirms that there are not only positive assumptions around digitalization, but also critical viewpoints.

4. How to integrate digitalization into an improved FAP model?

Following the definition of digitalization and its benefits, the question remains on how to integrate digitalization in an improved FAP model. Following the statements made by the respondents in the questionnaire there are two key elements for the integration. Digitalization should be easy to define and understand and easy to integrate. This is confirmed by a statement of respondents:

In our organization it is important to ensure that we use standardized and well-defined processes. This also includes financial decision-making. We have a check list we are following, besides an NPV calculation. For an improved financial decision-making model, it is required to be able to adopt a similar scheme we can use and rely on, even if the steps until the final decision may take a little longer.

In the same direction another comment was made by another senior manager:

I have a long experience with integrating and combining various methods to improve our decision making. For me this is like the Kaizen philosophy that was introduced to our company about 20 years ago. We are used to continuous improvement and for us we only need a some initial guidance and we will manage to also include digitalization within our financial decision making process.

5. How to practically apply the improved FAP model within a German SME?

This comes back to the general question and reason for this research project. The practical application of an improved financial decision making

model is required to get the attention of senior managers. In the senior management world key considerations are time, value and money. In terms of an improved FAP model it will take more time to reach a conclusion with the FAP model compared to a singular approach with an easy NPV calculation. In the two other terms defined as value and money the FAP model can demonstrate its strength in theory. For practitioners to convince that a new digitalized model to them works they need to either see it themselves or the need references or existing use cases (Westerman et al., 2017). A respondent summarized this issue as follows:

Overall, I think it is very interesting to see that there are new decision making models being promoted and tested. For there is only question relevant: has the improved model been tested and who [at which firm] the model was tested. Of course, if a competitor can be named or a large company uses this model it is more attractive to me to also look into this new model. If it has not been tested and no references that I know of can be presented I am not really interested to invest time into understanding the model.

6. What are the key considerations for an improved FAP model ?

Financial decision making as a theme of relevance combined with the question of improved decision making, which is also related to the identified theme of risk, resulted in the following statement by a respondent:

We relied on NPV calculations to date together with our gut feeling for any financial decision-making. This gut feeling was mostly based on feelings around future development of company or potential risks arising from the investment project.

As stated by the respondent with the description of gut feeling, is the interpretation of instinctive feelings, intuition, beliefs that are frequently associated with decisions without rational underpinnings (Holzer, 2022). As outlined by Holzer (2022), feelings or emotions do not originate in the gut but are generated in the brain. As a result, these emotions originate from the brain and are not based on rational and scientific results, but rather based on emotions. On the question of further specifying what the respondent requires for financial decision making he replied:

If we can easily define, compute and analyze gut feeling in a similar manner as we do with NPV calculation we will consider to include this in our investment decision making. Especially, if it is so easy to compute and understand as the normal NPV calculation.

Further for the respondents it was important to mention that they prefer an easy computation and analysis for additional variables, while the majority expressed interest in the addition of further variables to the decision making process. This leads also to the consideration of how to integrate digitalization within an improved FAP model.

In previous model developments it was important to ensure that despairing indices can be combined and work together well within a newly developed or improved model.

6.7. Combination of despairing indices within the FAP model

As part of the analysis and discussion of the proposed improved FAP model it is important to note that the pre-digitalized FAP model includes three different areas of analysis and reaches as summary judgement based on

the outcomes for each area. With another (fourths) area complexity of the FAP model increases once more. Like the challenges faced by Mastrandrea et al. (2011), that various independent variables increase difficulty of analysis and uncertainty in the outcome. To reduce uncertainty in the FAP model it is important to evaluate each index with the same set of information in regard to a well-defined financial investment project. Each stream is evaluated based on the same defined project and therefore the level of uncertainty is reduced as well as relying on the same group of people judging the project in the various aspects. As also found by Mastrandrea et al. (2011), that there is still an ongoing debate about the ideal theoretical and empirical foundation for model types as there is no general consensus. In terms of this project, the researcher's standpoint is that the FAP model has not yet widely used and accepted to have sufficient data collected on the actual validity or non-validity of the model and as a result is being accepted as working with the various indices until its non-validity is confirmed. In this context also the "Ockham's razor method" proposes that if a model explains the empirical phenomena using less and/or specific assumptions or parameters than other models it can be deemed preferable and accepted (Danek et al., 2022).

6.8. Case Study

The results from the study provided evidence for the need to devise a new approach to improve financial decision making. These findings were then implemented in a case study in a company that took part in the questionnaire. The company manufactures high-quality technical ceramic products and develops its own machine pieces for production. It is a typical SME with revenue of approximately 12 million euros and 105 employees. Its products are sold worldwide, and the financial appraisal instrument relied upon to date is solely the NPV calculation. I had full access to all company resources due to my position as a senior manager with the holding company. The case study team comprised five people, who were the

factory's key staff, leading each of the following departments: production, procurement, accounting, sales and controlling. The case study team contained two male and three female leaders with an average age of 51. The age of senior managers in SMEs, irrespective of when the company was founded, is frequently over 50 years (Zhou et al., 2022). No steps were taken to redress gender imbalance, as women were overrepresented in the case study team and all team members participated voluntarily in the case study.

The case study was conducted during August 2020, while the company's production was stopped for the summer break. August was chosen as the ideal time due to lower activity and the availability of the required staff to support the study. The initial set-up included a meeting on 4 August 2020 to brief the project team members on background and set-up. Avoiding potential bias conflicts, I took on the role of observer and provided the materials and explanations required for the case study and the financial project. The project was to evaluate an upgrade for one production line to offer digital printing for products, with an investment volume of approximately 500,000 euros, an expected lifetime of 10 years, scrap value of 10,000 euros and compound rate of 4%. The expected cash inflow from the project was estimated to be 3,500,000 over the project timeline. Staff were represented by the head of production, head of sales, head of finance, workers' council representative, head of purchasing and the managing director, who formed the investment appraisal committee. It is important that the committee represent a range of perspectives within an organization. This was also welcomed by the project members as one member stated:

It is the first time that he (as the production manager) discusses the investment in a new production line with the head of purchasing and the head of sales. It is very interesting to see what their opinion is on the proposed project and what is the possible outcome of this meeting.

To better reflect the reality of projects, there was an option to abandon the project. In the vast majority of financial appraisal projects, this is not included in the calculation as an option; however, reality shows that it would be wrong to assume that all projects calculated with a positive NPV will result in a positive return to the company (Ren, 2022) and the appraisal team estimated that within the first three years it would be possible to abandon the project if unsuccessful and failing to meet expectations. In the estimation of the NPVP, it was further assumed that if the average discounted abandonment value is greater than 30% of the original investment amount (project value) the value would be categorized as “high”; if the value is between 30% and 15% it would be “medium” and values below 10% are regarded as “low”. In the following, the various variables are computed, starting with the basic elements of the FAP model.

6.8.1. Estimation of the NPVP (cost of capital)

As outlined by the FAP model, the NPVP is defined by an initial outline of cashflow as defined by the financial appraisal committee. In the first step, the team arrives at a consensus for a realistic discount factor. The discount factor was estimated to be 4%, defined as the mid-point between the rate of refinancing cost of 3% and the expected return on investment of 5% by the holding company. The scrap value is expected to be realized in the last year and is added to the expected cashflow. As stated in the assumptions, the abandonment value is estimated for the first three years of the project as the appraisal team decided that it would become clear within this timeframe whether the project would provide benefits or have to be cancelled. In the following table, the financial setting of the project is computed in the NPVP calculation.

Project NPVP calculation in EUR						
Year	Net cash inflow	discount factor 4%	present value of net cash inflows	cumulative present value	abandonment value	discount value
1	200.000,00	0,96154	192.307,69	192.307,69	200.000	192.307,69
2	400.000,00	0,92456	369.822,49	562.130,18	180.000	166.420,12
3	400.000,00	0,88900	355.598,54	917.728,72	90.000	80.009,67
4	400.000,00	0,85480	341.921,68	1.259.650,40		
5	400.000,00	0,82193	328.770,84	1.588.421,24		
6	400.000,00	0,79031	316.125,81	1.904.547,05		
7	400.000,00	0,75992	303.967,13	2.208.514,18		
8	400.000,00	0,73069	292.276,08	2.500.790,26		
9	400.000,00	0,70259	281.034,69	2.781.824,95		
10	100.000,00	0,67556	67.556,42	2.849.381,37		
total	3.500.000		2.849.381,37			438.737,48

Table 8: Project NPVP calculation

Source: Author

The calculated NPV indicates a clear positive benefit to the company, calculated as the cumulated present value of net cashflows of 2,849,381.37 euros less the project cost of 500,000 euros, resulting in a positive NPV of 2,349,381.37 euros. As shown in the questionnaire, for the majority of companies this would be the only calculation and a clear go-ahead would be given, as the NPV is strongly positive. To check for further insights on the potential result, the following items have also been calculated:

Net present value	2.349.381,37
Abandonment value classification	29,25% => medium
Discounted payback	5,68
Discounted payback index	5,70
Marginal growth rate	19,01%

Figure 27: NPV Case study

Source: Author

The figures confirm that from a financial perspective the project will receive a clear go-ahead from the finance team. A discounted payback index of 5.70 indicates that the project will recover its expected cost 5.70 times. Moreover, the abandonment value classification is just short of being in the “high” territory and confirms that the project is cashflow positive for the company. However, the calculation of the NPVP and other metrics demonstrate the potential danger of relying on a single metric. A significant finding of this research project is the strong indication of an overreliance on NPV, while other (more) modern methods are not considered in the analysis. It was also commented by the Head of Sales, that:

It is very interesting to see that I now understand what this present value method is all about. Until now, I assumed that when making investment decisions, you only calculate how high the possible sales proceeds are compared to the expected costs, and not that you still have to discount these values with a reference interest rate and also make sure that the estimated cash flows including the scrapping value are discounted at the end.

6.8.2. The project risk profile

For the company in the case study, any project comes with risk. The company is in a niche market, producing high-quality, technical ceramic

tiles. Despite its niche position, the competition is strong and, therefore, any decision for a new project is important, and brings inherent risks for the company's future development. As a result, the company could be described as a risk-averse organization. In the context of any risk-oriented investment project, an assessment of the strengths and weaknesses of the investment activities of the enterprise are a prerequisite for the risk assessment. Research by Bondarenko et al. (2022) has found similar risk aversion within SMEs in Ukraine.

Measuring risk is important but brings difficulties. An assessment of risk may be subjective, depending on the individual's situation and inner beliefs, or biased (Patent, 2022). To overcome the individual perspective, the FAP model attempts to arrive at a consensus estimate through the various views and estimates provided by each appraisal team member involved (Lefley, 2018). Further, a corporate risk scale was introduced with a scale from 0 to -10, where -10 represents the highest risk and 0 the lowest risk a company is willing to take. In this context, the consensus defines a risk area index within the project risk profile. The appraisal team decided to accept a corporate risk threshold of 6. Furthermore, this risk area index was weighted by assumptions taken by the team by assigning a probability of occurrence to the consensus risk. As in theory, each company has its own unique level of risk acceptance, resulting in individual corporate risk thresholds (Lefley, 2015). In the case study, the company decided to involve the middle management and department heads, as outlined in the introduction to the case study. In the analysis and computation of the project risk profile, each manager is responsible for identifying key elements of risk for their own area. As a group it is the team members' responsibility to determine the consensus risk value, similar to the Delphi protocol in the literature which represents any anonymous expert panel (Vorstenbosch et al., 2022). In this case study, the head of finance was appointed as facilitator, to moderate the project risk-profile calculation in case of dispute or failure to reach a common position. This fact was commented by the Head of Finance:

So far, investment decisions have been largely conditioned by my NPV calculation and the financial assumptions made. In this investment decision, however, the financial criteria are only one of several important decision variables. I am therefore pleased to be involved in the consensus building for these new variables and to be effectively part of the new decision making process.

In the next step, each member of the appraisal team was given a paper to identify the major risks and allot a probability and potential impact value for each risk identified. In the next stage, these items were shared with the group. The appraisal team discussed the elements based on their personal knowledge and experience, taking the opportunity to rethink and revise the estimated values and risks to improve their predictions, reduce differences and aggregate similar items. In the next stage, these risks were evaluated by the appraisal team to reduce potential risk exposure. The main target was to manage the risks identified by reducing the probability of their occurrence and the level of their impact. The level of minimized risk given a risk value for the calculation of the project risk profile is relevant here. If there were outliers, the appraisal team members who gave values in the upper or lower quartiles were asked to justify and potentially rethink their position. It was the task of the facilitator to moderate this process until a common and acceptable consensus was achieved. Each appraisal team member had the chance to change their position and the values they assigned in terms of risk. Following this exercise, the aggregated risk values for probability and level of impact were calculated using the weighted average. The literature supports a weighted average approach as it can improve assessment quality by aggregating the opinions of individuals as probability distributions; thus, a common consensus value is derived from the various expert views (Merkhofer, 1987). Alongside the technical merits of this approach, corporate and team spirit are strengthened compared to an individual decision (Schippers & Rus, 2021). While team members may influence each other in their decisions, the consensus approach and

weighting of the results will reduce biased views, resulting in a more unified corporate risk approach (Lefley, 2015). Especially for the Head of Sales it was an important experience to be part of the investment decision making process:

I was previously a little irritated by the question of whether I would like to be involved in the decision making process for an investment in a new production line. However, I must say that I find it very refreshing and also helps me to better understand the perspective of the other department managers and to achieve a goal together.

In the calculation of risk values, each appraisal team department agreed to identify two key risk areas, totalling 10 identified major risk areas. Each department leader assigned a probability of occurrence between 0 and 1 and a disutility impact value between 0 and 100, where 100 represents the highest disutility impact and 0 the lowest. Following a team discussion facilitated by the moderator, final values were agreed and the probability index with the disutility impact value multiplied to achieve the risk value for each identified risk. Especially the head of purchasing department lead the discussion around calculation of risk and commented:

I have sometimes asked myself why I was asked to buy certain products from certain suppliers, even when I thought that I might get better price for similar quality with another supplier. However, following the discussion and also better understanding the various moving parts and reasoning of other departments, it helps to also think about associated risks involved in the investment decision to be taken. Approaching this in a structured way, that also I can understand with the dimension of probability and utility impact is a good concept, while I still need further insights on the calculation, while I can see that the maths itself is not overcomplicated.

For each risk area, these values were totalled and the risk area value calculated:

$$\frac{\text{computed importance rating}}{\text{corporate risk threshold}} X - \text{Total number of risks identified}$$

Figure 28: Formula: Risk threshold

Source: Author

The results of the computation are shown in Table 9.

Calculation of risk values			
Risks identified by department	Probability of risk occurrence (0-1)	Utility impact value (0-100)	Importance rating/risk value
Sales and marketing			
competition	0,1	12,54	1,254
increased cost of sales	0,21	8,3	1,743
computed importance rating			2,997
risk area risk value			-4,995
production			
production delay	0,25	30,42	7,605
unforeseen complications	0,11	15,8	1,738
computed importance rating			9,343
risk area risk value			-15,572
human resources			
staff changes	0,04	3,83	0,1532
staff know-how	0,09	8,16	0,7344
computed importance rating			0,8876
risk area risk value			-1,479
purchase department			
resources availability	0,15	10,98	1,647
cost increase of new raw material	0,22	7,92	1,7424
computed importance rating			3,3894
risk area risk value			-5,649
workers counsel			
increased staff workload	0,04	2,63	0,1052
overwhelming staff with new tasks	0,05	5,44	0,272
computed importance rating			0,3772
risk area risk value			-0,629

Table 9: Calculation of risk values

Source: Author

The final step in the computation of the project risk profile is to identify the highest risk area level, which is determined to be the project's risk area index. Table 10 shows a summary of the various risk areas defined. The maximum risk has been identified in the production area and, therefore, the project risk area index is -15.57.

Risk areas (Departments/areas of responsibility)	risk value/profile
Sales and marketing	-5,00
production	-15,57
human resources	-1,48
purchase department	-5,65
workers counsel	-0,63
Project risk area index	-15,57

Table 10: Risk value profile

Source: Author

6.8.3. The strategic index

As stated previously and shown in the questionnaire results in Chapter 4, senior decision-makers in German SMEs are aware that strategy plays an important role in their appraisal analysis when considering their decision making process. In reality, however, hardly any companies quantify or consider strategic elements in their appraisal method. The strategic index offers a structured analysis of a project's strategic benefits from corporate and management perspectives. The results of such analysis are represented in a project strategic score value for each identified strategic benefit. The strategic index is then computed by applying a corporate ranking to the project strategic score value to arrive at a unique strategic index for the project. The project strategic score value, or strategy index, is based on a quasi-Delphi approach. Experts are asked to provide their own key assumptions and views and these are discussed among other experts

with diverse backgrounds and further refined until a consensus decision is reached.

In the first step towards arriving at the strategic index, the initial screening is performed and documented in the protocol. Lefley (2015) suggests that this is conducted by the financial appraisal team for SMEs. In larger organizations, the guidance would be set by corporate management. The financial appraisal team identifies and ranks the strategic benefits, with a rating of 10 representing the highest level of benefit. This is similar to the NPVP calculation steps before moderation by an unbiased facilitator helped reach a consensus and aligned the appraisal team members in full agreement on the identified benefits. As one case study participant confirmed:

Reaching a consensus is quite a challenge but focusing on a certain decision to be taken and anchoring the decision making around objective matter, I am pleasantly surprised that I and my colleagues are eager to work together on getting to the result and resolve if the investment as proposed should be done or if it should be rejected.

In the financial appraisal team, the members identified five key strategic benefits (increased flexibility, new products, internal production logistics improvements, environmental improvements, and improved staff know-how). In their discussion, the appraisal team established a ranking and decided on the magnitude for each key benefit of the project. As the team identified only a small number of relevant key strategic benefits, they decided to assign only whole numbers in ratings. In larger corporates, with larger project volumes, corporate ratings are calculated by a pairwise matrix using a geometric average. The facilitator noted the responses in the protocol and prepared the calculation using a pairwise matrix and geometric average calculation. At the same time, the management decided on the normalised weights to be applied for each benefit, totalling 100%. As one

project team member noted, the need for a facilitator was critical to reaching consensus:

At the beginning, when the project and the meeting were introduced, I thought that a moderator is not necessary, because we will agree as colleagues. However, I must say that it was right to use a moderator to make sure, because the discussions and different opinions were sometimes and especially (in the strategy discussion) very far apart and a consensus was sometimes more difficult to achieve.

Key strategic benefits identified	(a)					(b)	(a)*(b)		
	Production	Sales and Marketing	Personnel (workers council)	Purchase	Transport	Agreed PSSV	normalised weights	SI Index calculation	
increased manufacturing flexibility	8,2	5,1	3,6	2,8	4,7	8,2	30%	2,5	
new products	6,4	7,8	4,1	6,7	2,8	6,7	15%	1,0	
internal production logistics improvements	4,7	2,7	5,1	4,9	7,1	5,1	10%	0,5	
environmental improvements	2,9	8,1	7,4	6,6	5,8	7,4	20%	1,5	
improved staff know-how	6,8	6,4	5,7	7,2	4,1	4,1	25%	1,0	
Total									6,5

Table 11: Strategy value profile

Source: Author

A project strategic score value (PSSV) of 6.5 was computed by the facilitator based on the values agreed by each head of department and the financial appraisal team (see table 11). Overall, the strategic index is the weighted average of the strategic score values agreed by the team and the rankings given. To put the strategic index into context, the result is an above-average score value on a scale from 1 to 10.

6.8.4. Digitalization Decision Support Index

The digitalization of companies and the economy has attracted increasing attention in research. A recent study by Tick et al. (2022) found that the benefits of digitalization for SMEs are generally recognized and acknowledged today and digitalization is typically seen as essential in a rapidly and constantly changing business environment. Yet the level of digitalization is still below expectations, especially among SMEs. According to a CompTIA (2019) study, average investment in digitalization for SMEs ranges between \$10,000 and \$50,000 per annum. For an SME, this is a relevant investment or ongoing cost and, therefore, needs to be reflected within the decision making model.

On the digitalization index, the financial appraisal team was first asked to identify the most important elements within the six overarching dimensions to measure digitalization within the company. The company manager was selected to facilitate the discussion on affordability, infrastructure investment, network access, capacity, usage and human capital. As each company is in a unique situation, the importance of each factor and sub-factor differed for each of them. To include this within the index, the factors identified were ranked as useful (a), ease of use (b), facilitating conditions (c) and peer/competitor pressure (d). The team needed not only to reach a consensus on the activities but also on the ranking of each variable.

Following initial discussion, the team identified and agreed on the five most important aspects in the six categories of digitalization. Each category contained five key activities. In the discussion, variables were identified that could be placed in more than one category. In these cases, the facilitator asked for a vote to decide which category the item should be placed in. Intensive discussions took place around each key variable for each category and the facilitator was required to step in and facilitate to reach a consensus on each category variable. There was an intensive discussion on this subject, which was commented on by the head of procurement as follows:

It was very difficult in places to bring the individual positions together. The moderation of the Head of Finance was essential in order to achieve a result. Especially considering the time required for the meeting, which lasted almost 5 hours.

The variables defined by the team are presented in Figure 29.

Affordability

Upfront cost of digitalisation efforts
Follow-up cost of digitalisation improvements
Potential cost reduction over time
Purchase of material and external services
financing of investment

Human Capital

sufficient staff know-how
additional staff required
participation of staff
changes to workload and/or processes
being permanent online requirement

Usage

limitation to usage by time
accessibility by staff
increased internet related tasks
increased accessibility of company data (ie smartphones, laptop)
working from home

Infrastructure reliability

security matters
investment in new IT hardware
improved IT infrastructure
management of Infrastructure
failure safety

Network access

providing company phones to staff
remote access to company server
access limitations for staff
company laptops for staff
authorisation levels

Capacity

speed of company network
access limitations
data retention on server/cloud system
cloud synchronization
user limitations

Figure 29: Digitalization variables

Source: Author

After establishing the initial key variables, each appraisal team member was asked to rank each activity presented in figure 29 from 1 to 10 for usefulness, ease of use, facilitating conditions and peer/competitor pressure. As the financial appraisal team comprised five people, the maximum rating is 50 for each activity factor. By totalling for each activity, the sum of ratings for each variable, the level of digitalized data-management process is computed, as shown in Table 12.

	totalling sum of ratings for each activity				sum of ratings per variable	
	useful	ease of use	facilitating conditions	peer/competitor pressure	Total	
Affordability						
Upfront cost of digitalisation efforts	14	13	39	41	107	
Follow-up cost of digitalisation improvements	17	9	32	36	94	
Potential cost reduction over time	36	29	32	37	134	
Purchase of material and external services	41	30	32	36	139	
financing of investment	12	14	18	50	94	
Human Capital						
sufficient staff know-how	38	22	37	29	126	
additional staff required	22	25	34	42	123	
participation of staff	50	34	43	40	167	
changes to workload and/or processes	18	38	43	36	135	
being permanent online requirement	24	15	19	19	77	
Usage						
limitation to usage by time	18	22	37	17	94	
accessability by staff	24	35	45	33	137	
increased internet related tasks	17	13	22	26	78	
increased accessability of company data (ie smartphones, laptop)	34	42	16	33	125	
working from home	42	41	39	44	166	
Infrastructure reliability						
security matters	41	13	32	38	124	
investment in new IT hardware	21	34	29	38	122	
improved IT infrastructure	23	11	36	29	99	
management of Infrastructure	23	22	25	21	91	
failure safety	36	41	33	28	138	
Network access						
providing company phones to staff	29	11	34	40	114	
remote access to company server	27	34	36	32	129	
access limitations for staff	22	19	42	9	92	
company laptops for staff	23	38	15	20	96	
authorisation levels	38	14	19	10	81	
Capacity						
speed of company network	41	23	43	38	145	
access limitations	15	22	19	16	72	
data retention on server/cloud system	36	32	38	34	140	
cloud synchronisation	20	25	32	28	105	
user limitations	22	13	27	21	83	

Table 12: Digitalization variables results

Source: Author

To compute the digitalization index, the five activities with the highest values were identified. The highest values are relevant to identify the five key variables as weighted by the appraisal team. The result is presented in figure 30.

	useful	ease of use	facilitating conditions	peer/competitor pressure	Total
Purchase of material and external services	41	30	32	36	139
data retention on server/cloud system	36	32	38	34	140
speed of company network	41	23	43	38	145
working from home	42	41	39	44	166
participation of staff	50	34	43	40	167

Figure 30: Five key digitalization variables

Source: Author

The activities listed in Figure 29 were identified by the team as the most important of the key activities discussed and were further used to estimate the degree of digitalization for these activities in Figure 30.

The degree of digitalization is categorized by three levels as shown in table 13 below depending on company activities. The degree of digitalization describes the level of digitalization of data collection, which can be either manual, semi-automatic or fully automated. Level 1 is the degree of least digitalization, while Level 3 represents the level of fully automated and digital for an activity at the company. Level 2 represents stage inbetween, where some automation and digitalisation is achieved, while some manual work is still required.

Degree of digitalization	Method of data acquisition	Type of data entry	How is data analysed	Reporting process
Level 1	Manual data collection	on paper	on paper	on paper
Level 2	digitized collection requiring user interpretation	digitized manually	partially manually with software support	digitized but with manual adjustments
Level 3	digitized collection requiring without user interpretation	digitized automatically	fully automatically with software	automated

Table 13: Degree of digitalization

Source: Author

After these key variables were estimated in the next step, the degree of digitalization was discussed. To this end, the appraisal team estimated on a consensus basis the degree of digitalization as defined in Table 12. Each of the five key activities is set against each level of digitalization. A five-point Likert scale is used, with 1% to 20% representing the most manual processes and 81% to 100% representing the mostly fully digital/automatic

processes. The appraisal team members were required to decide on the level of digitalization for each key activity. In terms of finding a consensus, this was the most challenging part, as opinions on the categories and levels of digitalization varied and the facilitator was asked to moderate each item. The head of controlling summarizes these as follows:

Each department head fought for their position and tried to achieve the right result from their perspective. In the end, however, consensus decisions must be made among the executives with clear alignment to the different variables and the business goals, and of these, essentially, the question using the decision model and associated process. In the end, a value must emerge that defines in black and white the decision for or against the project.

The appraisal team identified the “speed of the company network” as the most digital/fully automated level of digitalization, while “purchase of material and external services” was identified as the least digital/automated activity. For calculating the overall degree of digitalization, the degree of digitalization is multiplied with the five-point likert scale result. The sum of the total level of digitalization for the selected activities was totalled. The maximum value of the degree of digitalization in this case was 150, as for each weighting of the degree of digitalization multiplied by each key variable the maximum value was computed as 150. At 150, the highest level of digitalization would have been achieved by the company and, respectively, the investment decision. The results are presented in table 14.

	degree of digitalization	Five points likert scale					Total value of degree of digitalization
		1	2	3	4	5	
		1-20	21-40	41-60	61-80	81-100	
Level 1 degree of digitalization	Purchase of material and external services	1					1
	participation of staff	1			4		4
	working from home	1		3			3
	speed of company network	1	1				1
	data retention on server/cloud system	1					0
Level 2 degree of digitalization	Purchase of material and external services	2	2				4
	participation of staff	2	1				2
	working from home	2	2				4
	speed of company network	2					0
	data retention on server/cloud system	2	1				2
Level 3 degree of digitalization	Purchase of material and external services	3		3			9
	participation of staff	3					0
	working from home	3					0
	speed of company network	3				5	15
	data retention on server/cloud system	3			4		12
Total degree of digitalization						57	

Table 14 Degree of digitalization

Source: Author

The last step of the digitalization decision support index computes a score for each activity taking the sum of the activities multiplied by the degree of digitalization, and resulting in an index of 57, as shown in Table 14. As the maximum output for the sum of activities multiplied with the maximum degree of digitalization could be 150. By dividing the result of 57 by the maximum output of 150 an index of 38 has been computed.

Based on the index construction and interpretation for this project, the score scale ranges from “mostly analogue and manual” for scores up to 30, “a blend of analogue and manual and digital and manual” for scores up to 60, “completely digital and manual” for scores up to 90, a “blend of digital and manual and digital and automated” for scores up to 120 and, finally, “fully digital and automated” for scores up to 150. Therefore, the digitalization index gives the company a rating of “a blend of analogue and manual and digital and manual”. Interpreting this result requires that the company needs to work on its digitalization and automation processes further and invest in additional digitalization projects. Furthermore, the investment in the new production line will bring some digitalization benefits, albeit only minor ones.

6.8.5. Conclusion of case study

For this company, this case study is novel: it was the first time that the company management had come together with the heads of the relevant departments to work on a case study and a financial investment decision. The initial proposal to review this important investment in a new production line as a team, relying on a new and more comprehensive financial appraisal method, was met with some initial resistance. However, due to the management's approval and guidance to review the project with a view to reaching consensus and involving all the relevant decision-makers, not only were decision making processes on this particular project improved, but a positive example was provided of involving additional stakeholders from the company. Furthermore, the new element of the improved FAP model, the digitalization decision support index, provided additional helpful insights on the degree of digitalization and the need to further investigate the level of digitalization and its various aspects. However, this is now a follow-up project for the newly established financial appraisal team at the case study company.

The results from the improved FAP model with the digitalization decision support index, provide sufficient support for the project with the following overall results:

The NPVP provides a strong positive vote for the project with a positive NPV and fast repayment cashflows generated from the project. The project risk index is estimated at -15.75, also a positive result as the project risk at this level is defined as existing but manageable by the company from the individual risks defined by the consensus decision panel. The project scored 6.5 on the strategy index, which also provides support in favour of the project as it is in line with the company's overall strategy. Lastly, the digitalization decision support index showed that the key digitalization aspects defined are currently "analogue and manual and digital and manual" with a score of 38. This implies a further need to improve digitalization

efforts; as a result, the project also gains approval from the digitalization angle.

The case study participants worked very well together and when the discussions became too intense, the moderator intervened neutrally and objectively. However, there were also two critical voices from participants who stated the following at the end of the meeting:

Meeting and working together on taking an important decision for the company and its future investment in the production line was a good experience. However, I have to say that the meeting from my point of view took too long and sometimes it was a challenge to follow the various index calculations and the need to structure and decide on certain elements of the various indices.

Another participant commented in the same direction.

I think it would be easier if we could do the whole thing with a software or questionnaire programme that does all the consensus calculations in the sense that the items that were ranked highest or mentioned most often are automatically assigned as key variables and the software does all the tricks to come up with the values for the different indices. I enjoyed the exercise, but I'm not sure I would want to participate in such a long, almost all-day session on a financial investment decision again. This could be done in a different way or get people's input through a different process that each participant can start at their own discretion and pace, perhaps working from their home office.

In pre-existing literature, the FAP model has been applied to an IT appraisal process in Czech Republic (Lefley, 2015). As outlined in literature section there is only little literature on actual application of the FAP model available and does not include additional index factors. As a result, there is little insights on the FAP model being applied in reality and tested for applicability in various scenarios. Testing the model with an actual real world use case demonstrates the adoptability of the model potentially further improvements going forward by incorporating additional factors or also modifying the digitalization index by incorporating cost risk and other factors relevant for digital transformation. It is important to understand that the case study is not seen as an isolated case. Future investment appraisal projects are planned to be conducted with the same set-up and methodology. Moreover, working on the digitalization index by incorporating additional angles like cost of digitalization or risks of digitalization. Besides the digitalization factor, also the applicability of the project risks, NPV and strategy index could be revisited.

Overall, the various angles provide sufficient support for this particular project; however, another project may not yield such a clear result; therefore, the application of this improved financial appraisal method should also include a clear structure and efficient and transparent processes. The project appraisal team should always consider a comprehensive approach, seek to avoid biased or manipulated decision making and document the key elements and decision basis sufficiently in a protocol. A key element is also to ensure that the team members are bought in into the project and working together.

6.9. Discussion of research questions and meeting the research objectives

This section addresses the research questions and is concerned with the overall research results of this project.

6.9.1. Research Objective 1

RO1: To investigate how German SMEs integrate aspects of digitalization into their current financial decision making processes.

This section places the findings of the research project in the context of RO1, that is, how German SMEs integrate digitalization into their current financial decision making processes. As outlined in the literature section, digitalization is not a clearly defined term. Depending on the field of the literature, it may refer to automation, use of cloud systems or working with the latest (virtual) technologies. The lack of definition highlights the need to structure and define digitalization at a company level and to identify the relevant digitalization aspects driving the company's success. It was key in this project to define digitalization well and choose the most appropriate and relevant methods to define and analyse the data and draw accurate conclusions based on the analysis. In the initial steps, the focus was on using quantitative data to match and validate the findings in terms of digitalization. The literature does not provide unanimous evidence of the positive productivity effects of digitalization. The majority of studies use rankings based on arbitrary variables such as broadband speed to estimate digitalization, which does not necessarily provide any insights into the level of digitalization either of an economy or a business (Lynn et al., 2022). Depending on the business sector, a digital divide may be identified in the literature, supporting the notion that certain digitalization variables have no impact on business development (Ford, 2018). The questionnaire was therefore construed to rely not solely on these established variables from the literature. The results from the questionnaire are clear, especially as regards digitalization, as outlined in the table below showing the responses on the importance of digitalization:

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Do you think that financial decision making should be “digitalized”	7	9	1	4	0
Would you like to have the financial decision making improved within your organisation?	2	11	4	4	0
Do you think employing agility methods helps your organisation?	2	5	13	1	0
Do you think your organisation should improve the financial decision making?	1	11	8	1	0
Would you consider employing an improved financial appraisal and decision making model?	4	15	2	0	0
Do you think your current financial decision making framework is adequate for the challenges coming in terms of digitalization and industry 4.0?	2	8	9	2	0

Table 15: RO1 questionnaire results

Source: Author

From the questionnaire evidence, it appears that digitalization is an important aspect of decision making at all the companies that participated in the questionnaire.

The discussion of the data has led to a few key summary findings regarding Research Question 1:

- Managements see clear benefits from digitalization, not only in improving company organization and efficiency, but also in potential additional revenue streams (see data section).
- The need to improve financial decision making is recognized; senior managers generally perceive a need to consider digitalization aspects in their decision making around financial investments. The questionnaire shows clear evidence that external factors such as

COVID-19 have had a strong facilitating profile on aspects of digitalization and the need to include the latter in decision making processes (see data section).

- Senior managers at German SMEs are aware that digitalization is an important aspect of the future development of their companies and can bring benefits, but comes at a cost with additional investment needs (see data section).

In the case study the analysis of the digitalization index provided important insights on the company's level of digitalization. In this case the level reported is low and requires the company to invest further in improving its digitalized footprint. Further the digitalization index supported the investment appraisal as the new manufacturing line would also provide digitalization benefits to the company. As a soft factor and also mentioned in the quotes the discussions around the FAP model factors helped to promote a better understanding in terms of digitalization for the key staff members participating in the investment appraisal exercise.

This confirms the findings of other recent studies in the context of digitalization; in particular, the pressure from authorities to allow remote working during the pandemic and the restrictions imposed on travel forced managements to act (Haarmeier, 2021). Digitalization not only drives improvements in processes and productivity; it is also used to automate and create savings as well as new revenue streams. In this context, it is important for SMEs to focus on the most appropriate individual digital tools to be able to plan their investments over a longer period to grow revenue, increase efficiency or reduce costs. The identification of future-proof technologies is also of fundamental importance in order to remain competitive in the long term. As described by Fenn and Raskino (2008), every technology goes through a hype cycle. In terms of digitalization, we are currently in the phase of realizing the useable benefits. The concept developed by Fenn and Raskino (2008) is depicted with my input in Figure 31.

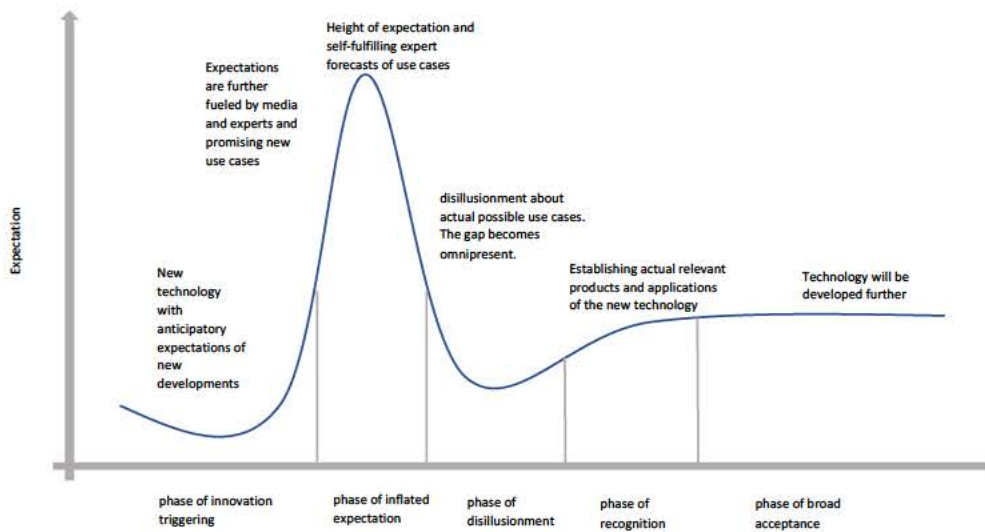


Figure 31: Technology cycle

Source: prepared by author, based on Fenn & Raskino (2008)

6.9.2. Research Objective 2

RO2: To explore the extent to which digitalization can be incorporated into the FAP model as a means of enhancing mainstream financial decision making models for German SMEs and how expanding the FAP model will contribute to knowledge.

This question can be broken down into two parts: first, how the existing models can be extended and, second, whether the FAP model can be extended to improve decision making and contribute to knowledge. At the start of the project, the developer of the original model was contacted and informed that an extension of the FAP model was planned; they confirmed that the model had not yet been extended with a digitalization factor and that this could be a potential contribution to knowledge. As outlined in the literature section and the findings regarding RQ1, there is very limited literature on digitalization in the context of improving financial decision making. To date, no similar model or approach could be identified, evidencing a gap in the literature. From the deconstruction of the elements

of the FAP model, the development of the digitalization index can be seen as a relevant additional factor to improve financial decision making. Certainly, the general over-reliance on one-dimensional models in German SMEs presents a challenge, as confirmed by the findings from the questionnaire and the literature. Conversely, the questionnaire provides strong evidence that the vast majority of senior managers are aware of the need for digitalization and confirm that this factor is considered to some extent during the decision making process, but generally only as a soft factor or positive side-effect within the overall process. Further evidence gathered indicates that the aforementioned need to consider digitalization within the financial appraisal is becoming more pressing. One external factor is the COVID-19 pandemic, which placed digitalization on the agenda of every company worldwide, forcing companies to invest in and review their IT infrastructure. Moreover, the digitalization index provides additional insights into a company's current digital position, defining the degree to which it relies on manual or automatized processes. Without a clear understanding of a company's IT spend and digitalization position, no significant improvement can be achieved; the company first needs to understand its own position. Any investment in new machinery or equipment today also becomes a question of IT and digitalization, as well as involving a review of current established processes. From the questionnaire and literature, as mentioned before, there is evidence that companies are becoming aware of the need to invest in IT and also to consider the overall digitalization of the business, processes and investments, thus recognizing the need to include digitalization in their investment decision making.

The improved FAP model contributes to knowledge by providing insights from German SMEs that have so far not obtained by another research. Also, the improved FAP model has been applied for the first time within a case study at a German SME. The original FAP model was developed about 20 years ago but has so far not been in use by a large number of companies. Further since it was initially developed companies have become more exposed to digitalization and automatization and as a result also, ideally,

should include digitalization aspects in a more integrated financial decision making.

Relating the findings from the questionnaire to the case study the digitalization index construction worked well in a real-world application. However, the issue of the complexity of construing the digitalization index as well as the other indices of the FAP model are time consuming. As previously stated in 6.9.1 the discussions while preparing the FAP model indices allowed the case study participants to reflect on their positions and also helped improved understanding of digitalization as well as the position of other department leaders in this context. The extension of the FAP model with a digitalization index helps the case study company to improve its own digitalization level going forward by utilizing the insights gained from the investment appraisal process.

Following the financial crisis of 2007/2008, regulators started to require banks and other financially regulated entities to adopt new models, such as value-at-risk models to estimate and improve the analysis of financial risk (McCullagh et al., 2022). Similarly, digitalization plays an increasing role in financial decision making, and models such as the FAP model will need to be improved with a digitalization index. The development of the FAP model followed a Delphi approach in terms of strategy and project risk index computation. A similar approach has been used in the creation of the digitalization index. As a result, in terms of both methodology and theory, the digitalization index fits the existing approach of the FAP model. Moreover, while the FAP model has not been limited by specific dimensions or factors, it is complex and time consuming to update it as an improved decision making and appraisal model. Therefore, it seems beneficial to assess the three indexes at the same time, and the case study has shown that digitalization – as a fourth dimension of the revised FAP model – is a factor of equal importance to project risk, strategy and the NPV calculation.

6.9.3. Research Objective 3

RO3: To develop a practical application of the FAP model within German SMEs by integrating digitalization alongside its current, traditional decision making approach, for a post-digitalized decision making environment.

RQ3 is also divided into two sections. The first part is concerned with the analysis of post-digitalized decision making and the second with the possible extension of the FAP model. The data shows a need to consider digitalization and a post-digitalized decision making environment. This is caused in part because the evolution of business and unforeseen global pandemic placed digitalization on every company's agenda and, in part, by pressure from peers to improve digitalization and to consider digitalization aspects in any investment decision, particularly because technology and interconnectivity play an important role in any investment in machinery or equipment. As the case study has demonstrated, the FAP model, combined with a digitalization index, provides additional insights into the company and helps to identify needs and areas of improving digitalization. The case study helped to improve the company and the participants to better understand their own level of digitalization, or better the need of improving digitalization of the company and processes to improve decision making further to move to a great degree of informed decision making supported by an improved FAP model. A post-digitalized decision making is important for an ever-increasing digitalized business environment. Without digitalization considerations in financial decision making, especially at industrial companies, it may result in wrong investment decisions as digitalization as a key variable has not been considered. In the case study the digitalization element also provided clear insights on the need of the company to improve its digital readiness. SMEs in particular are vulnerable to changes in the business environment and promoting an improved FAP model for SMEs will help them to make better informed financial decisions in the future. In comparison, large organisations can dedicate many more resources to financial decision making and often have more choices in terms of financial

decision making than an SME. By utilising an improved FAP model, German SMEs can also improve their financial decision-making and better compete against other companies. Furthermore, improved financial decision-making is more important for SMEs than for large companies, because if the investment goes wrong or the benefits, efficiencies or improved automation and digitalisation do not materialise, this could be more life-threatening for an SME than for a large company, which can more easily cope with 'wrong' decisions.

In addressing this research objective, the time at which the FAP model was constructed needs also to be considered. Digitalization then played a less important role than it does in today's world. Its key elements were compiled to create a financial appraisal model that also considered the dimensions of strategy and project risk. All three dimensions are independent of one another and the FAP model weights them equally. This is important as it allows the introduction of another equally weighted dimension, offering similar advantages.

6.10. Final conceptualization of the improved FAP model

As outlined in the previous sections of initial conceptualisation and the need for an improved FAP model the FAP model requires improvement to adopt to a new key variable/category, which is digitalization. The initially defined improved FAP model has been tested in the case study and evidence from the questionnaire has shown that there is a need to consider digitalization aspects for financial decision making. There has been no change to the existing categories of the FAP model as these appeared, also in the case study, as relevant and important to measure. Considering the research objectives from the initial conceptualisation considerations evidence was provided by the case study on the practicability and usability of a digitalization dimension for an improved decision making model. The

method of construing the digitalization index also was practically tested in the context of the case study. The digitalization index has twofold implications on the improved FAP model. It provides insights on the current stand of the company in terms of the level of degree of digitalization of the company. As outlined in literature digitalization is a key element for SMEs, but companies frequently fail to understand their own level of digitalization. Digitalization is not about providing staff with the latest IT equipment; it is more about digitalizing processes and digitize workstreams. To work on this each company, need to understand their level of digitalization and the relevant aspects or areas that need to be digitized. The digitalization index provides a first review of the importance of digitalization aspects where the department leaders need to think and agree on the five key digitalization items. By compiling the digitalization index until the end, the index provides a weighted result of the digitalization reality of the company. It also provides insights if the investment decision under review adds digitalization value.

The improved FAP model also requires bringing an investment appraisal team together that has to discuss the investment from the four perspectives of the improved FAP model. From an organizational perspective this also increases accountability and level of responsibility of each individual key staff member of the appraisal team. Further the improved FAP model application requires the facilitator to ensure that all steps and documentation of the consensus decisions taken along the process of deriving at the final outcomes for each variable are in the required form, to allow coming back and checking and reviewing previous decisions. The improved FAP model is also offering a more democratic approach to financial decision making compared to one dimensional financial appraisal models.

In the final design of the improved FAP model it was intended to keep the model concept rather simple to understand and as a result also easier to promote. The latter is an important matter to gain further acceptance in the industry on promoting improved financial decision making. In the final conceptualisation the improved FAP model is shown in figure 32 below.

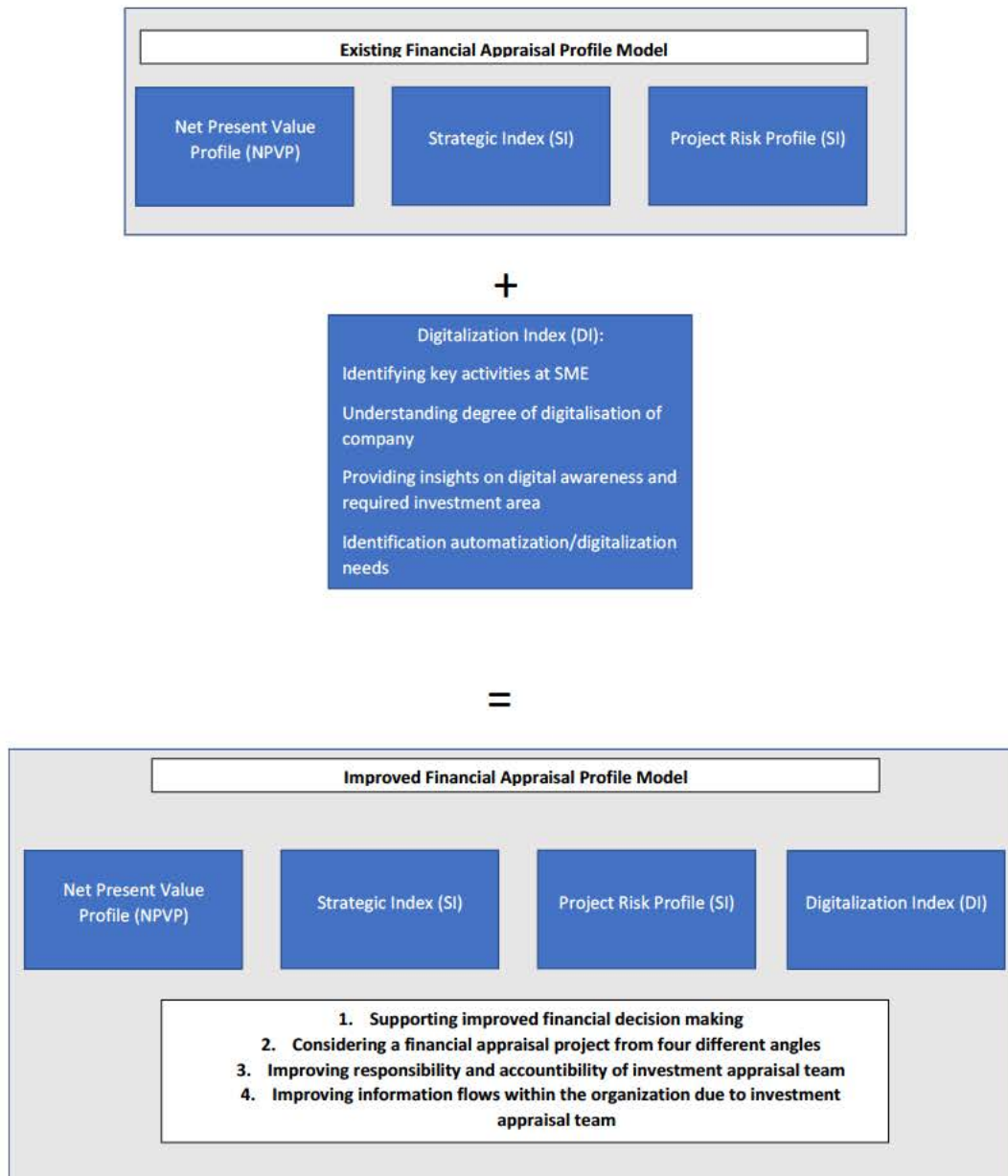


Figure 32 Improved FAP model concept

Source: Author

Applying the improved FAP model to SME companies, as outlined in the previous sections it is important to note that the model is understood by the decision maker at SME companies. As a result, it is required to understand that for an applicable model for German SMEs it needs to be easily understood as stated before, but also adds value and is intuitively understood. In contrast to large companies, resources constraints are

limiting factors at SMEs and therefore require that an improved FAP model is accepted by German SMEs that it does not overstretch an SME on preparing the financial investment appraisal and financial decision making. By presenting the model with four easy-to-understand variables and a clear process to determine the result and outcome for each indice it does not create an artificial barrier preventing application. The FAP model is therefore predestined to be applied by SME companies, as the key staff is easier together and to discuss and take decisions, while large organizations are often spatially dispersed. Further in SME organisations the understanding for other departments and roles is frequently greater as there are fewer layers and people working in a company.

Chapter 7: Conclusion

7.1. Introduction

This chapter concludes the research project and describes the contributions to knowledge, practice and methodology, before assessing these contributions. It is followed by the final chapter, which describes the limitations of this project and identifies potential future research.

The research has contributed to creating an improved financial decision making model for SMEs including a digitalization index. However, its use is not limited to SMEs; the model can also be applied by large corporations looking to improve their decision making and include digitalization and other key variables in their decision making models. Digitalization, now a key element of the next decade of business development, can support improved organizational decision making. The basis of the digitalization index is a reliable estimation of the digitalization status of an organization and the ranking of digitalization aspects for a project.

This model will explicitly help companies to determine where their own organization stands and degree of digitalization and what measures it should take to achieve a best practice or industry excellence investment appraisal level. The improved FAP model can be applied to organizations in the relevant industry.

7.2. Review and overview of the research

Chapter 1 provided an overview and definition of the research problem and research questions. Financial appraisal, decision making and digitalization are aspects of investment decision making in any company. Various studies have addressed the digitalization status of countries, but few have focused on digitalization efforts at a company level. Moreover, financial decision

making takes place mostly at owner or senior management level and is widely based only on a quantitative NPV or similar analysis; other factors such as company strategy, project risk or digitalization play no significant role in the decision making process. The chapter introduced the concept of the FAP model and key considerations in terms of digitalization and defined the limitations and ethical framework of the project.

In the next chapter, the literature review revealed gaps in the literature on financial decision making processes as regards an improved FAP model. While the literature extensively covered quantitative financial decision models and digitalization analysis methodologies, no financial decision making model was found to combine digitalization aspects with financial decision making. This chapter laid out the research paradigm and foundations for the research project and reviewed the literature on the unique German SME market. While literature was found that promotes improved financial decision making models, none promoted the inclusion of a digitalization variable or perspective in a revised model.

The literature review continued on the need for development, finding that improved financial decision making initiatives can only contribute if the adoption and successful implementation of such initiatives is directly aligned with staff involvement and facilitators to promote improved decision making. Moreover, staff must be able to adapt to and adopt digitalization within the improved model. In this thesis, the interaction and involvement of key staff are vital in promoting and achieving relevant decision making and digitalization awareness in a company.

Chapter 2 also examined the literature on the relationship between digitalization and organizational change, demonstrating that contemporary organizations are intertwined with technology. We cannot understand organizations without understanding the technology, since digitalization and organizational contexts have transforming effects on one another.

This chapter further outlined the philosophical assumptions underpinning this research, corresponding to the epistemological and ontological

assumptions of pragmatic research, as the aim was to achieve a better understanding of the interplay between financial decision making and digitalization at the organizational level in the context of German SMEs. As detailed in Chapter 6, a case study was conducted at a German SME to gain rich insights into the process and the theoretical and practical results of the improved FAP model.

In Chapter 3 the research design and data collection techniques employed in the fieldwork were presented, together with the reasoning for the questions and organization and design of the questionnaire. The questionnaire design followed the methods suggested by the Pew Research Center (2019), and a qualitative approach, with limited closed questions in the questionnaire, was employed due to the research paradigm of pragmatism. The last part of this chapter explained the case study design.

The research model development was described in Chapter 4, revealing the importance of an improved FAP model and taking into consideration the COVID-19 pandemic. Although the pandemic posed difficulties for research, it highlighted the need for change in German SMEs, as lockdowns in 2020 required companies to consider their digitalization levels in the context of how to continue operations. Following the pandemic, central banks have started to raise interest rates; the lengthy period of cheap money is over, resulting in the need for organizations to consider rising interest rates and digitalization in their decision making models.

Chapter 5 discussed the organization of the data as well as the need to consider the interview language, nuances of tone and language, and translation from German to English. Further samples were described and analysed, leading to the discussion presented in Chapter 6 which initially focuses on the case study. The case study introduces the theoretical element of the research including the digitalization index developed and put into practice at a German SME. The chapter concludes with an analysis of the case study and provides responses to the overarching three research questions.

Theoretical and practical contributions to knowledge are presented in Chapter 7 and suggestions for further research offered in Chapter 8.

7.3. Contribution to knowledge

Both the theoretical and empirical findings contribute to an understanding of the interplay between the digitalization of decision making and the development of an improved financial decision making model. This research project also contributes to our understanding of how SMEs in Germany can improve their financial decision making and the status of financial decision making in these companies. Especially, by providing a model to understand that could be applied to better understand the companies own level of digitalization. Allowing an organization to better understand its need of advancing with the digitalization of its business adds value.

The findings of the case studies suggest a gap in the knowledge on combining digitalization and financial decision making, and improving financial decision making. With COVID-19, this gap became more evident as companies had to start to re-think their digitalization status. To ensure the survival of their companies in the pandemic, they were forced to re-think decision making processes and allocate resources efficiently.

Other factors in improved financial-decision models include digitalization advancements, collaborative decision making within the organization and the use of expert panels in decision making, which help the organization to promote the decision. Within organizational theory, this is a key step towards a more collaborative organizational structure. The likelihood that a project will be adopted and analysed through the improved FAP model increases when the interest of various departments and the support of key staff are gained.

The application of the improved FAP model and theoretical grounded theory supported the analysis of the findings of the case study. The four

dimensions of the FAP model (finance index, strategy index, project risk index and digitalization index) measure the key elements of an organization. These key elements should not be seen as final and set, potentially these variables are developed further or refined further to fit a changing purpose.

Some research has been conducted on digitalization, decision making and the development of improved financial decision making models. Notably, Lefley (2015) has worked on improving the acceptance of the existing FAP model. Research on digitalization has improved exponentially in the past two years, due to COVID-19, while improved financial decision making models, like a multiple-criteria decision making model for investment decisions using data mining techniques as proposed by Cheng et al., (2021), have been developed. However, the combination of an improved financial decision making model and a digitalization index perspective has not yet been developed and studied.

Despite studies on improved financial decision making initiatives in larger organizations with greater resources of staff and money, none focusing on German SMEs concentrate on the interplay between digitalization and the development of an improved financial decision making model.

7.4. Contribution to practice

This study strongly suggests that every organization should be aware of its current level of IT and understand digitalization. While most companies are already aware of digitalization, its full potential is not yet utilized, especially in terms of financial appraisal. German SMEs centre their decision making on either purely quantitative models such as the NPV or a key decision-maker following their gut feeling or own reasoning. As described in this thesis, there is a need to improve decision making and financial appraisal processes, shifting from a one-way process to an integrative one that includes additional key variables and includes input and expert knowledge from various angles of the organization.

One of the practical contributions of this research is the detailed insight provided by the case study at a German SME. The case study reveals that the level of digitalization in an organization is key to decision making. Further, bringing heads of department together as project team members and helping to promote each other's understanding and rationale brings additional insights and promotes acceptance of the project within the organization.

This implies that, for the effective implementation of an improved FAP model, emphasis should be placed on the importance of understanding the contexts of work, task and organization. This will increase acceptance of the new project and, hopefully, lead to its successful realization. The case study also reveals that key staff members and managers need to acquire new negotiation and communication skills to arrive at a consensus decision. Another practical contribution is the promotion of the digitalization index and the recommendation that every organization should review its current strengths and weaknesses in digitalization.

The contribution of this research is to understand, based on theoretical assumptions, how a newly improved FAP model can help German SMEs to improve their potential. To this end, the due process model can be used as a practical tool.

7.5. Methodological contribution

The main methodological contribution of the research is the combination and application of concepts from the FAP model and the digitalization index to develop an improved financial decision making model.

Disciplinary advances are dependent on two interlinked pillars: refinements in theory and refinements in methods (Bergh et al., 2022). Numerous studies provide insights or guidance on methodological contribution, but the key question remains of what exactly constitutes a methodological

contribution. The grid in Figure 32 has been developed to support evidence of a methodological contribution (Bergh et al., 2022), defined as achieved if a large audience has been reached with a rigorous exchange. A research project published by Gioia et al. (2012) reached over 7,500 citations and, therefore, is regarded as a significant methodological contribution.

		<i>Potential Audience</i>	
		Limited	Large
<i>Extent of Change</i>	Major	<p><i>Modest Methodological Contribution:</i></p> <p>The methodological contribution offered needs to be accompanied by a substantive contribution to merit publication in a leading journal</p>	<p><i>Major Methodological Contribution:</i></p> <p>The methodological contribution dramatically changes practice as reflected in indicators such as citations and follow-up articles</p>
	Minor	<p><i>Minor Methodological Contribution:</i></p> <p>The method contribution offered is meaningful, but it only fosters minor changes within a fairly small body of work</p>	<p><i>Incremental Methodological Contribution:</i></p> <p>The methodological contribution matters to a large group of scholars, but it leads to only minor adjustments in practice</p>

Figure 33: Definition of methodological contribution

Source: Bergh et al. (2022)

In terms of this research project, no relevant citation is yet known. Defining methodological contribution solely by the number of citations may not be a good measure of quality. Therefore, the definition of MacKenzie et. al (2016) is relied upon, whereby a relevant contribution to methodology is provided by following a clear structure in research and providing new insights. These can be new or improved practical developments.

A further methodological contribution lies in the experience gained through the application of the improved FAP model within a case study at a German SME and the interpretive approach and techniques applied for data

collection. This experience may be useful for other studies on the adoption and use of initiatives related to the FAP model in other organizations in Germany and other countries.

Finally, a methodological contribution relates to the appropriateness of applying the revised and newly developed theoretical concepts and theories in other contexts. With the introduction of a model to measure digitalization and improve decision making, and the provision of guidance on the practical and methodological application of the revised model, a methodological contribution has been made.

7.6. Assessing the contribution

Returning to the issue raised in the first part of the methodological contribution, the overall question remains of what constitutes a theoretical contribution and how to assess the contribution made. Whetten (1989) describes four key areas to assess the contribution of a research project:

- What? What factors and concepts should be included in the explanation of the contribution? For this purpose, two criteria are taken into account: comprehensiveness – the inclusion of all the relevant factors, and parsimony – excluding those that have little role to play in improving the understanding of the contribution.
- Why? Why select certain factors? What are the underlying assumptions of the theory or model? The logic of the proposed conceptualization should be of interest to other researchers.
- Who, where and when? These enquiries define the boundaries for generalization.
- How? After identifying the factors and concepts that constitute the contribution, the researcher should reflect on how these factors are interrelated.

A set of questions based on Whetten's framework above is used to evaluate the theoretical contribution of this research study.

7.6.1. Contribution to current knowledge

Which new elements does this study provide? Does this study make a significant contribution to current thinking?

The contribution of this study is achieved on three levels. Firstly, the review of the relevant literature connects improved financial decision making and digitalization in the context of German SMEs. Secondly, the contribution lies in the empirical insights provided by the expert interviews and the case study conducted within the refined framework with an improved FAP model. Moreover, the integration of the digitalization index increases understanding of the interplay between digitalization and improved decision making and the digital awareness of a company. Thirdly, the description of the improved framework and the data techniques applied in this study may help other researchers conducting similar studies in other organizations. In addition, the first section of the digitalization index development allows a company to reflect on its current digitalization status and increases awareness of its current digitalization processes.

7.6.2. Influence of FAP model on future appraisal at German SMEs

Is it likely that the revised FAP model will change how German SMEs appraise their investment decisions?

On the assumption that companies are willing to rethink and improve their organizational and economic approaches to investment appraisal, the revised FAP model and the case study can be used as practical tools to guide the application of the model. The positive impact of the improved FAP on financial appraisal at German SMEs needs to be communicated and further promoted. One way is to promote the improved FAP model by

publishing future works on the FAP model in relevant papers. Another way is to promote it from the practitioner side and work with consultants to apply the improved FAP model at companies that are looking forward to improving financial appraisal. As outlined before the improved FAP model also helps to add value to organizational development as it increases responsibility and accountability to key staff members as they are part of the development of the financial appraisal process and can bring their views, inner beliefs and values to the decision making process. The improved FAP model, as demonstrated in the case study, can be actually applied to a German SME and can help improve financial decision making at SMEs with techniques that are otherwise only available to large companies due to limited resources at SMEs.

This research project also has implications in terms of building new skills and knowledge for users, managers and the organization as a whole. Lastly, it promotes a new approach in terms of investment appraisal towards a more comprehensive model than the traditional, purely quantitative NPV models, or decisions taken by the owner or managing director alone.

7.6.3. Selection of key factors

Why? Why select certain factors, such as digitalization, as key variables?

Digitalization and the use of modern IT technology have been important for any company since the arrival of email and the automation of processes in production and administration led to efficiency gains and cost reductions. Recently, due to the COVID-19 pandemic, this shift was accelerated as every company in Germany was forced either to adopt quickly to the situation or close their business due to uncertainty. This resulted in a range of initiatives and studies launched with organizations and communities with the main purpose of better understanding the status of digitalization within organizations as well as what was needed to improve this status. Empirical studies were mostly less detailed than this study, which is based on

interviews with key decision-makers at German SMEs. It was important to conduct the interviews in the context of German SMEs to achieve a better understanding of the processes involved in adopting and using investment appraisal and digitalization initiatives in this backbone of the German economy, of interest to various scholars, especially in the field of economics. This study emphasises the importance of local context in the adoption and use of digitalization and improved financial appraisal models and, thus, contributes to the discourse on a new approach to implementing improved financial decision making initiatives in German companies.

7.6.4. Quality of research

Quality of research? Does the research work reflect seasoned thinking, conveying completeness, thoroughness and logical reasoning?

Overall, the research problems, and the results of the case study, provide additional insights and perspectives. The various research approaches and methods were discussed in Chapter 3 (methodology) and the interpretation of the results in Chapter 5, together with analysis from various perspectives. The research paradigm and theoretical concept of “pragmatism” provided the required methodology and interpretation possibilities. The last chapter of the thesis is used to review the research, the research questions and the contributions made by the research project, indicating thoroughness and reflection.

7.6.5. Reasoning and interest of research topic

Why? What is the reasoning behind the topic of the research project, and is the topic of interest for scholars and practitioners?

As outlined previously, digitalization is key for every decision-maker and every German SME. In this context, the pandemic was a facilitator of

digitalization, forcing companies to assess their digitalization status. Furthermore, central banks lowered interest rates to an absolute minimum, resulting in adverse investment appraisal analyses if market interest rates were used in quantitative investment appraisal methods. Re-thinking financial appraisal methods allow to improve financial decision making. Especially, in a business world that becomes more risk averse improved financial decision making is of increased relevance.

To this end, it was important to conduct this research project in the context of digitalization and German SMEs in order to contribute to a better understanding of and improvements in financial decision making.

7.6.6. Methodology and supporting evidence for improved FAP model

How so? Are the underlying methodology and supporting evidence for an improved FAP model compelling?

Chapter 1 presented the research problem and promoted various aspects of an improved financial decision making model including a digitization factor. In Chapter 2, the literature on the FAP model, digitalization and financial appraisal techniques and models, and their underlying theories, were discussed. Chapter 3 discussed the various social theories, and factors to be considered were identified. This led to the choice of a pragmatic approach and case study design for this research project. In Chapter 5, the framework for the analysis of the interplay between digitalization, financial decision making and the development of the improved FAP model was described, based on the interpretation of the results of the case studies presented in Chapter 4. The research conclusions presented in Chapter 6 were therefore drawn from a solid base of evidence.

7.6.7. Interviews and research group

Who, where and when? Reasoning for the interviews and the respective research group

As outlined in Chapter 1, the SME sector is the backbone of the economy in Germany and the vast majority of the population is employed within this sector. Research in this sector is relevant for SMEs, scholars and politicians and will help to improve effectiveness and provide additional insights. The interviewees were selected either through personal contacts or third parties who facilitated such contact. As outlined in Chapter 3, interviews were selected as a method based on the criteria described to fit the research purpose. The results of the research project are relevant to other companies and organizations outside the typical definition of an SME.

7.7. Research limitations

As with every study, there are limitations to this research, principally concerning the participants' interest in the subject and the availability of interview partners from the selected scope of the study.

Initially, the target number of interview participants was set at 35. The participants are senior financial decision-makers in German SMEs. A larger sample would probably have enhanced the reliability of the research; however, no uniform suggestions are made by the literature on sample size. In statistics, a sample size of 30 is often seen as large and representative but Sekhar et al. (2013) suggest that there is no definitive number for sample size and a smaller sample can also be representative. Following the first contact with the selected interviewees, the overall response rate stood at 22 participants.

Further justification for the sample size is provided by Green and Thorogood (2003), who found that the experience of most qualitative researchers conducting an interview-based study with a specific research question is

that little new relevant information is generated after interviewing 20 people. This is confirmed by Baker and Edwards (2012), who suggest that the consensus among interview methodologists on how many interviews a researcher should conduct is “it depends”. Moreover, research by Deterding and Waters (2018) for an empirical test suggests that as few as 12 interviews may reach an acceptable degree of saturation. A similar number is given by Elmholdt et al. (2021).

Research by Lakens (2022) found six types of justification for sample size as outlined in Figure 33. Those applicable in this case are resource constraints and heuristics as outlined above. The resource constraints were mainly due to the nature of interviews, while the heuristic limitations were based on the literature findings, accepting an interview sample size of 20 and greater.

Type of justification	When is this justification applicable?
Measure entire population	A researcher can specify the entire population, it is finite, and it is possible to measure (almost) every entity in the population.
Resource constraints	Limited resources are the primary reason for the choice of the sample size a researcher can collect.
Accuracy	The research question focusses on the size of a parameter, and a researcher collects sufficient data to have an estimate with a desired level of accuracy.
A-priori power analysis	The research question has the aim to test whether certain effect sizes can be statistically rejected with a desired statistical power.
Heuristics	A researcher decides upon the sample size based on a heuristic, general rule or norm that is described in the literature, or communicated orally.
No justification	A researcher has no reason to choose a specific sample size, or does not have a clearly specified inferential goal and wants to communicate this honestly.

Figure 34: Justification

Source: Lakens (2022)

Aspects of digitalization may change in the future and the variables used in construing the digitalization index may be changed due to changes of importance in the weightings of variables, which are also subject to current estimates.

Moreover, the FAP model itself is relatively unknown by business practitioners and currently not applied by any business as a tool for ongoing financial decision making. As it is currently only used by a minority of academic researchers, it may not be a good fit for a business, even if improved by a digitalization index. This evaluation, however, does not form part of this thesis.

In some cases, participants may refuse to speak negatively of their organizations and their current approach to financial decision making, resulting in skewed results and findings. I ensured that such cases were identified and mitigation measures employed.

The research findings could be biased towards a certain SME sector and may not be generalizable to all organization sizes. This is based on the large %age of automotive SMEs within the German SME sector.

In applying and understanding a new model, it is recognized that a learning period of several months is needed before a new appraisal process is established within an organization. The thesis did not take this delay into consideration nor the aspects of cultural change involved in the change management process.

As stated above, the study is limited to German SMEs as I have substantial experience in this area. Large companies have different drivers from SMEs. The study is further limited to Germany due to the importance of SMEs in the German economy and their role as major employers in Germany. The study is not limited to any specific industry to avoid limiting the results, and the improved FAP model should be as generic and widely acceptable, not limited to any particular industry sector.

Chapter 8: Further research

This study is limited by its research questions and, thus, may have omitted certain aspects associated with the existing research setup. It may also be limited by its time frame, in relation to the primary data collection during the pandemic. As a result, the interviewees were contacted again after the initial interviews and the majority had another round of interviews. Moreover, the research was limited to a small number of interviews and certain regional clusters of companies. A larger interview base and the inclusion of large corporations may result in different findings. Therefore, all these possible limitations call for further research not bound by the limitations presented above.

Alongside digitalization another key criterion on companies' agendas worldwide is ESG. Large corporations already prepare a dedicated ESG report with their annual financial statement and are starting to consider ESG criteria in the context of investments and decision making. As a soft factor, ESG is ripe for further revision and could be included in an improvement of the FAP model. There are a number of gaps in our knowledge around the further development of the FAP model that follow from our findings, and would benefit from further research, including a realist evaluation to extend and further test the theory and model developed here:

1. More methodological work is needed on how to robustly capture the impact and outcomes of the model in research, including further economic analysis and an exploration of its impact and applicability for businesses.
2. It would be useful to modify and test the model for other industries, including large corporations, which frequently have more resources available, allowing a more complex improved financial decision model to be employed.
3. The existing FAP model could be expanded, besides the digitalization index, with an ESG factor/index to further improve decision making.

4. It would also be helpful to capture qualitatively the experiences and perspectives of companies who have had mixed or negative experiences with the FAP model, since they may be less likely to volunteer to participate in research such as this. Similarly, further research might explore the disadvantages of the models to enable further improvements going forward.

Appendix I – Questionnaire samples

Questionnaire: Improving financial decision-making within German manufacturing SME's by incorporating digitalization within an expanded FAP model.

University of Gloucestershire
Matthias Herrmann
DBA Candidate

Part A	
Name	
Company	
Position	
Company Adresse	
E-Mail	
Phone	
Fax	
Anonymity	yes
Company turnover	13 million
Number of employees	105
Part B	
Are you in charge of financial decision making?	Yes X No <input type="checkbox"/>
Who has the decision-making power on investment appraisal?	Owner <input type="checkbox"/> C-level X Middle management <input type="checkbox"/> Investment committee <input type="checkbox"/> Other <input type="checkbox"/> _____
What type of company is this?	Listed company (AG,SE etc.) <input type="checkbox"/> Private company X Unlimited company <input type="checkbox"/> Other <input type="checkbox"/> _____
Have you been involved in a digital transformation project/ digitalization project within your firm?	Yes X No <input type="checkbox"/>
Indicate the largest size of financial project you have evaluated:	€0 - €200,000 <input type="checkbox"/> €200,001 - €501,000 <input type="checkbox"/> €501,001 - €1,000,000 X; € 1,000,001 – 5,000,000 <input type="checkbox"/> More than €5,000,001 <input type="checkbox"/>
Does your organization have a formal investment appraisal team?	Yes X No <input type="checkbox"/>
Is the investment appraisal process formalized in a policy or written work instruction?	Yes x No <input type="checkbox"/>
Does your investment appraisal process also include qualitative aspects/implications of the investment?	Yes x No <input type="checkbox"/>
Could your existing investment appraisal procedures be improved?	Yes x No <input type="checkbox"/>
What key factors to your take into account in your investment decision?	Interest rates <input type="checkbox"/> Time X

	Risk X Strategy X Digitalization <input type="checkbox"/> Other X creditworthiness																		
What is the preferred method of financial decision making in your company? <u>Analytical methods</u> Net Present Value Method (NPV) Discount rate Internal Rate of Return (IRR) Benefit / Cost ratio (BCR) Payback and Discounted payback Sensitivity analysis Scenario analysis Switching values Distributional Analysis <u>Economic appraisal techniques</u> Cost benefit analysis (CBA) Cost Effectiveness Analysis (CEA) Cost Utility Analysis (CUA) Multi Criteria Analysis (MCA)	Sensitivity Analysis and IRR																		
Does your company have a "digital native" or assigned a senior manager being in charge of "digitalization"	Yes X No <input type="checkbox"/>																		
Is the "digitalization" expert part of the financial appraisal process?	Yes X No <input type="checkbox"/> Our company does not have an appraisal process <input type="checkbox"/>																		
Have you heard of the financial appraisal profile model (FAP model?)	Yes <input type="checkbox"/> No X																		
Would you consider the following factors as relevant for your decision making process? Strategy Project Risk Digitalization factors Discount factors Other key factor, if yes what factor _____	Yes X No <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes X No <input type="checkbox"/> Yes x No <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/>																		
Does your organization employ agility methods	Yes x No <input type="checkbox"/>																		
Part C																			
	<table border="1"> <thead> <tr> <th></th> <th>Strongly Agree</th> <th>Agree</th> <th>Neutral</th> <th>Disagree</th> <th>Strongly disagree</th> </tr> </thead> <tbody> <tr> <td>Do you think that financial decision-making should be "digitalized"</td> <td></td> <td>X</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Would you like to have the financial decision-making improved within your organization?</td> <td>X</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Do you think that financial decision-making should be "digitalized"		X				Would you like to have the financial decision-making improved within your organization?	X				
	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree														
Do you think that financial decision-making should be "digitalized"		X																	
Would you like to have the financial decision-making improved within your organization?	X																		

Do you think employing agility methods helps your organization?	X				
Do you think your organization should improve the financial decision making?		X			
Would you consider employing an improved financial appraisal and decision-making model?		X			
Do you think your current financial decision-making framework is adequate for the challenges coming in terms of digitalization and industry 4.0?	X				
Part D "Digitisation Index"					
Affordability					
How much does your company invest in digitalization projects per annum	€0 - €50,000 <input type="checkbox"/> ; €50,001 - €250,000 <input checked="" type="checkbox"/> ; €250,001 - €500,000 <input type="checkbox"/> ; €500,001 - €1,000,000 <input type="checkbox"/> ; More than €1,000,001 <input type="checkbox"/>				
Does your company set quantitative targets to be achieved ie. savings or investment return per annum in absolute terms?	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> If yes, please indicate amount: €0 - €50,000 <input type="checkbox"/> ; €50,001 - €250,000 <input type="checkbox"/> ; €250,001 - €500,000 <input type="checkbox"/> ; €500,001 - €1,000,000 <input type="checkbox"/> ; More than €1,000,001 <input type="checkbox"/>				
Human Capital					
Training, education per employee in absolute terms	one day a year (8h)				
Annual hours invested in IT qualification	100				
% of IT employees in work force	3				
Usage					
% of internet related tasks per employee on average	15				
Smartphones as company phones %	50				
Infrastructure reliability					
Investments per employee in absolute terms	1000				
Total failure of IT systems in last 12 months	No <input type="checkbox"/> Yes <input checked="" type="checkbox"/> If yes: once <input type="checkbox"/> twice <input type="checkbox"/> more often <input checked="" type="checkbox"/>				
Network access					
Number of workplaces with a PC in absolute terms	32				

Number of company phones in absolute terms	30
Capacity	
Speed of network access in mbit	250mbit
Any access limitations?	Yes X if yes at certain times ? only for work No <input type="checkbox"/>
Part E "Open questions"	
How often does the formal investment appraisal team meet?	Once a year and on demand
To what extent is your business affected by digitalization and information technology advancements?	Strongly, business needs to adjust to sales and production improvements
How do you evaluate capital investment proposals?	Future proceeds and/or cost savings
What evaluation techniques are used by your company?	IRR, NPV and sensitivity analysis
If no evaluation, how is investment decision taken?	Company decision
What do you think are the challenges around digitalization and investment decision-making?	Cost and benefits sometimes are not clear upfront
What qualitative considerations are you considering on financial decision-making?	Achieving overall company mission targets
Digitalisation and improved manufacturing methods are branded as "industry 4.0". What do you understand under the term "industry 4.0"	Improved manufacturing process and technology
Additional comments:	
<ul style="list-style-type: none"> - Digitalisation affects the business and financial decisions are key, in particular for a company with financial difficulties. 	

Do you think Corona has any implications on your financial decision making and digitalisation?

Yes, Corona affects our financial decision-making. We have relied on our existing business model with sensitivity analysis and IRR. However, at the moment we have to secure financing to survive the corona crisis. We have sought KfW backed corona loans, but not sure if we will get financed by this and therefore use Kurzarbeit to reduce our cost basis, while trying to stabilize our sales and business. The decision making at the moment is less driven by optimizing, more by surviving mode. Digitalisation efforts have also been increased to allow our staff, where possible to work remote. For those investments we went for them not considering or running a decision or appraisal model before as we simply had to make the investment.

Do you think digitalisation brings benefits?

Clearly yes, with increased digitalisation we can optimize our business. We can strengthen our processes, while at the same time automate a lot of items and ideally save on headcount for repetitive work going forward. Tile business is a low margin business; therefore, it is important to be well-informed about the products and have processes that work. Moreover, digitalisation assist us to be closer to our business partners and sales agents. We are in close contact and think about e-commerce to support our business and create another sales channel. Digitalisation also means that our machinery in the factor can report on maintenance needs or other important metrics to improve production.

Do you plan to update the investment appraisal policy due to the current situation?

Yes, we include the current challenges as part of emergency plans to have some sort of guidance from the learnings going forward.

Why do you think time, strategy, risk and creditworthiness are the important factors and do you also consider other factors?

Any project appraisal requires the element of time and risk. Without risk no reward, there is nothing like a free lunch. This also goes hand in hand with strategy. Our overarching target is to improve our business and make the company profitable. Therefore, we need to also include strategy to measure our steps until we achieve this result. In the meantime, we are also considering creditworthiness as our banks are constantly rating and reviewing our sales and business updates.

Why do you rely on sensitivity analysis and IRR as appraisal methods?

Sensitivity analysis and IRR are our main methods as we are steering the business by various variables that have implications on sensitivity. This also helps to create certain scenarios to identify decisions that need to be taken. The IRR method is measuring the minimum rate we need to achieve to reach a certain contribution rate at which our business is profitable.

Have you used any other analytical method?

We also used an NPV model before and if required by banks we also can provide this information, but for financial decision-making it does not play an important role for us.

Have you ever considered economic appraisal techniques?

Yes, we have as the group used to have such models like EVA as long as the holding company was listed. Since delisting of the group for our operation with Klingenberg we do not use an economic appraisal model.

Would you consider a more sophisticated model if required?

Certainly, the better it is integrated with our ERP the better. If the sophisticated model should add benefits or bring additional insights to improve and optimize our financial decision making. If we can also quantify the digitalisation as mentioned in our research project, this could also help to support our business model and development, while also quantifying the digitalisation aspects. I think digitalisation and interconnection plays an ever-increasing role, together with connectivity with our customers, that could directly access our warehouse data and order by an e-commerce platform instead of making calls and sending emails.

Would you consider a digital native?

I would see myself as digital native as digitalisation improvements can only be made if the company leader supports and facilitates such change.

What do you think about an improved financial decision-making model?

Ideally, it should be a simple model and not requiring binding additional resources in administration. Aside from that our company drives for continuous improvements and this includes also changes from time to time to improve and optimize our business.

Do you think strategy, reputation and digitalisation add benefits as additional factors for an appraisal model?

Strategy is a key element, without a strategy, or a plan how I like to say is important to follow a plan. Reputation is important as our business is challenged by competitors worldwide. We benefit from high social and environmental situation in Germany, but we are constantly challenged and therefore we build on our reputation as a quality driven company that helps support our company targets and sales. Worldwide sales also require being connected to our clients, agents and business partners to support sales and leading the way.

Questionnaire: Improving financial decision-making within German manufacturing SME's by incorporating digitalization within an expanded FAP model.

University of Gloucestershire
Matthias Herrmann
DBA Candidate

Part A	
Name	
Company	
Position	
Company Adresse	
E-Mail	
Phone	
Fax	
Anonymity	yes
Company turnover	undisclosed
Number of employees	60
Part B	
Are you in charge of financial decision making?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Who has the decision-making power on investment appraisal?	Owner <input type="checkbox"/> C-level <input checked="" type="checkbox"/> Middle management <input type="checkbox"/> Investment committee <input type="checkbox"/> Other <input type="checkbox"/> _____
What type of company is this?	Listed company (AG,SE etc.) <input type="checkbox"/> Private company <input checked="" type="checkbox"/> Unlimited company <input type="checkbox"/> Other <input type="checkbox"/> _____
Have you been involved in a digital transformation project/ digitalization project within your firm?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Indicate the largest size of financial project you have evaluated:	€0 - €200,000 <input type="checkbox"/> €200,001 - €501,000 <input type="checkbox"/> €501,001 - €1,000,000 <input checked="" type="checkbox"/> € 1,000,001 – 5,000,000 <input type="checkbox"/> More than €5,000,001 <input type="checkbox"/>
Does your organization have a formal investment appraisal team?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Is the investment appraisal process formalized in a policy or written work instruction?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Does your investment appraisal process also include qualitative aspects/implications of the investment?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
Could your existing investment appraisal procedures be improved?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
What key factors to your take into account in your investment decision?	Interest rates <input type="checkbox"/> Time <input checked="" type="checkbox"/>

	Risk <input checked="" type="checkbox"/> Strategy <input checked="" type="checkbox"/> Digitalization <input type="checkbox"/> Other <input checked="" type="checkbox"/> product competitive edge																		
What is the preferred method of financial decision making in your company? <u>Analytical methods</u> Net Present Value Method (NPV) Discount rate Internal Rate of Return (IRR) Benefit / Cost ratio (BCR) Payback and Discounted payback Sensitivity analysis Scenario analysis Switching values Distributional Analysis <u>Economic appraisal techniques</u> Cost benefit analysis (CBA) Cost Effectiveness Analysis (CEA) Cost Utility Analysis (CUA) Multi Criteria Analysis (MCA)	NPV and IRR																		
Does your company have a "digital native" or assigned a senior manager being in charge of "digitalization"	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>																		
Is the "digitalization" expert part of the financial appraisal process?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Our company does not have an appraisal process <input type="checkbox"/>																		
Have you heard of the financial appraisal profile model (FAP model?)	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>																		
Would you consider the following factors as relevant for your decision making process? Strategy Project Risk Digitalization factors Discount factors Other key factor, if yes what factor: reputation	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>																		
Does your organization employ agility methods	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>																		
Part C																			
	<table border="1"> <thead> <tr> <th></th> <th>Strongly Agree</th> <th>Agree</th> <th>Neutral</th> <th>Disagree</th> <th>Strongly disagree</th> </tr> </thead> <tbody> <tr> <td>Do you think that financial decision-making should be "digitalized"</td> <td style="text-align: center;">X</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Would you like to have the financial decision-making improved within your organization?</td> <td></td> <td style="text-align: center;">x</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Do you think that financial decision-making should be "digitalized"	X					Would you like to have the financial decision-making improved within your organization?		x			
	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree														
Do you think that financial decision-making should be "digitalized"	X																		
Would you like to have the financial decision-making improved within your organization?		x																	

Do you think employing agility methods helps your organization?	X				
Do you think your organization should improve the financial decision making?		X			
Would you consider employing an improved financial appraisal and decision-making model?	X				
Do you think your current financial decision-making framework is adequate for the challenges coming in terms of digitalization and industry 4.0?		X			
Part D "Digitisation Index"					
Affordability					
How much does your company invest in digitalization projects per annum	€0 - €50,000 <input type="checkbox"/> ; €50,001 - €250,000 <input type="checkbox"/> ; €250,001 - €500,000 <input checked="" type="checkbox"/> ; €500,001 - €1,000,000 <input type="checkbox"/> ; More than €1,000,001 <input type="checkbox"/>				
Does your company set quantitative targets to be achieved ie. savings or investment return per annum in absolute terms?	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> If yes, please indicate amount: €0 - €50,000 <input checked="" type="checkbox"/> ; €50,001 - €250,000 <input type="checkbox"/> ; €250,001 - €500,000 <input type="checkbox"/> ; €500,001 - €1,000,000 <input type="checkbox"/> ; More than €1,000,001 <input type="checkbox"/>				
Human Capital					
Training, education per employee in absolute terms	8 hours pa				
Annual hours invested in IT qualification	8 hours pa				
% of IT employees in work force	20				
Usage					
% of internet related tasks per employee on average	80				
Smartphones as company phones %	100				
Infrastructure reliability					
Investments per employee in absolute terms	500				
Total failure of IT systems in last 12 months	No <input checked="" type="checkbox"/> Yes <input type="checkbox"/> If yes: once <input type="checkbox"/> twice <input type="checkbox"/> more often <input type="checkbox"/>				
Network access					
Number of workplaces with a PC in absolute terms	55				

Number of company phones in absolute terms	55
Capacity	
Speed of network access in mbit	1 Gbit
Any access limitations?	Yes <input type="checkbox"/> if yes at certain times ? No X
Part E "Open questions"	
How often does the formal investment appraisal team meet?	Never sofar
To what extend is your business affected by digitalization and information technology advancements?	In every aspect, our product is digital printing. So for our product itself and production digitalization is a key element. We also include our product developer team as digital experts as they need to build on the computer the structure and surface of another material to be printed on the product. Our sales teams works with ecommerce tools and every member of staff is connected to the company network by laptop or mobile phone.
How do you evaluate capital investment proposals?	Future income and income streams, as our business is cashflow driven as we see our self as a startup company
What evaluation techniques are used by your company?	Driven by our parent company, we use NPV, however we also use for minor decision items different key elements. These also consider items like potential future additional sales.
If no evaluation, how is investment decision taken?	If an ad-hoc decision is required, this is done by a team during a meeting or by the managing director to both approve. Generally, however, decisions are taken at a manager meeting together with the investment committee of the parent company.
What do you think are the challenges around digitalization and investment decision-making?	Upfront investment cost and retain qualified staff as well as train staff. This is a real challenge for the company particular like for us the company is 1 hour away from a larger city. Talent acquisition is challenging.
What qualitative considerations are you considering on financial decision-making?	Future business and expanding product market share and improve cost structure and client communication
Digitalization and improved manufacturing methods are branded as "industry 4.0". What do you understand under the term "industry 4.0"	Connecting the production lines with client needs. Ideally the client orders online and production is done automatically and no need for additional staff interference.
Additional comments:	
Interviewee: The digital natives are I and my Co-MD of the company.	
Digitalisation is a key aspect for our company and to improve financial decision making can help to improve the company growth further. However, all key decisions need to be approved by the investment committee of the parent company. Surely, an additional investment approval system could help to convince the parent company decision taker to follow the managing directors' suggestions for investment.	

Do you think Corona has any implications on your financial decision making and digitalisation?

It has various implications on one side our project sales deteriorated while sales in residential area increased, due to people staying home and fixing homes and carrying out work at home. On financial side, corona has implications, but we see ourselves as pretty stable as we are an established family-owned company with low external financing. Our projects are by majority financed from actual cashflow and equity. Digitalisation at our company is not driven by Corona, like with many of our competitors. We have been developing our manufacturing processes already considering industry 4.0. Part of our company's success is certainly that we are focused on digital optimisation of our processes and production steps.

Do you think digitalisation brings benefits?

I not only think it will bring benefits in the future. It does deliver positive results already now for us. Without our early focus on manufacturing improvements and cost efficiency we would be in a worse position and like competitors only start now to think about investments when everyone else is looking for IT investments. We have this competitive edge already and continue to develop this further.

Do you plan to update the investment appraisal policy due to the current situation?

Yes, we will include pandemic situations in our investment appraisal policy. I don't think we will face another pandemic like this one now in the next 100 years, but we might have to face local pandemic situations as before. For us this is an element of consideration as we supply our products worldwide.

Why do you think strategy and risk are the important factors and do you also consider other factors?

As said, for us strategy and forward thinking is a key consideration of our general decision making process. Similar for financial decision making we try to evaluate what will happen in the future and what trends we will follow or foresee in our market sector. Forward looking thinking always comes with a level of uncertainty and uncertainty is risk. We try to appraise the level of risk, without the willingness to take risk the growth and business growth is very limited. We define for us certain level of risk capacity and risk acceptance. Besides that, we have good reputation caring for our workforce and staff and we also consider this in our business planning as we like to be a relevant employer in the future.

Why do you rely on IRR as appraisal methods?

We are steering our business model with expected return rates and therefore for investment appraisal we use IRR. As mentioned, before we are a family owned business and we care about return, but it is not the absolute factor of measuring our business as we are not a listed company that is thinking in quarterly reports.

Have you used any other analytical method?

We also use NPV from time to time.

Have you ever considered economic appraisal techniques?

Yes, we also use cost benefit analysis for new products as we not only think about pure IRR rates. Especially when we introduce a new product and need to check if the product will be profitable and if not at the first go, we need to think about where to tweak the product calculation to make the product work for us. I think with a more comprehensive approach like CBA we can define the product and its life cycle better compared to a simple IRR calculation.

Would you consider a more sophisticated model if required?

If it provides additional insights and can fit with our business segment and is also easily to be handled. As you mentioned your research will bring benefits to SMEs on digitalisation, this is something we like to consider as we see ourselves as a leader in digitalisation of our manufacturing processes. I believe we could utilize an improved model incorporating digitalisation as a factor as this would be relevant for us. But the more sophisticated model should still be easy to fill with data, analyse and to understand.

Would you consider a digital native?

Yes, but I see myself as the board member that is a digital native and helping the organisation to facilitate digitalisation projects in the company. Not only in my company, also at home we rely a lot on smart home features, and I can instruct the heating and AC remotely or check if the home is secure from anywhere in the world, therefore I consider myself as a digital native, even if I cannot program a single line of programming code.

What do you think about an improved financial decision-making model?

Like before, I think it can aid a lot of issues that are currently not covered by a "classical" financial decision making model. It would, however, potentially need someone who pushes for such a model as I think most SME companies financial decision making models are the models that are requested by the banks.

Do you think strategy, reputation and digitalisation add benefits as additional factors for an appraisal model?

We already consider these factors in our financial decision making, but not as quantitative inputs as we cannot quantify such factors, however, if that is possible in the future we might add such factors also in a quantitative decision model for our business and finance decisions. Overall, I think these factors are more relevant for business decision-making and not only finance decision making. I think for pure financial decision making interest rates and other factors might be more relevant, but bringing a business appraisal and financial investment appraisal model together this has huge potential for general decision making within a business.

Do you think it is important to have a digital native as part of the executive management team?

Yes, I see myself and my co-MD as digital natives. Our business and production is mostly automatic and relies on a strong IT and digitalisation of our processes. Without having the mind-set of a digital native, our company and products would not be successful. But I need to say that we do not use any IT or digitalisation consultants as I have strong view that also the concepts being sold by large consulting firms are not worth to be considered as they mostly recycle ideas and drop buzz words. We are really looking towards the details. I go one step further I think a digital native should at least be able to write one programming language to be allowed to refer to him as a digital native.

I understand from your comments that you are think highly of digitalisation and already orient your investment decision on actual digitalisation aspects. From your perspective how should the ideal investment decision making process look like including digitalisation aspects?

Good question. Ideally the process should be easy, straight forward and applicable. It should not be a process with too many iterations and having to many people involved as with every additional view it gets difficult to align everyone on taking one decision. I understood that your improved FAP model is based on an expert panel. Intuitively I would not go down this road. I think investment decision

making should only sit with senior management and the finance team. Of course considering the comments by the respective departments asking for an investment, but overall I think departments like production should not be included in the decision making as they will only represent their view from a production perspective not from an overall company improvement aspect.

In the improved FAP model it is a key requirement to reach a consensus among the participants, with the help of a moderator. Would that be helpful from your perspective?

I don't know. I think it is a challenge if you have senior department manager that are used to only represent their department and fight for their own budgets. In my experience also having worked in a large corporate before, I think it is a challenge and for sure the decision making process would take much longer as it currently does. We can take an investment decision in one meeting among managing director and the head of finance. For very large investments we need to involve our parent company, which is rather a formality than actual challenging our investment decision making. I really doubt we can take better decisions if we discuss all day with various department managers involved.

Certainly, there is guideline and guidance required for applying a new investment decision making process. You also mentioned that for some decisions you need to involve the parent company. Could you please specify further what type or volume requires approval by the parent company?

We need to involve our parent company on any real estate transaction and if investments above five million euro. We tend to inform our parent company management on quarterly reports about ongoing investments and decisions taken. To date, since I joined the company we have not seen that a decision by myself or my co-managing director has been challenged or was denied. I think this will not happen as long as we deliver two digit growth rates pa and the company continues to grow and develop our business.

Questionnaire: Improving financial decision-making within German manufacturing SME's by incorporating digitalization within an expanded FAP model.

University of Gloucestershire
Matthias Herrmann
DBA Candidate

Part A	
Name	
Company	
Position	
Company Adresse	
E-Mail	
Phone	
Fax	
Anonymity	yes
Company turnover	2,5 Mio Euro
Number of employees	90
Part B	
Are you in charge of financial decision making?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Who has the decision-making power on investment appraisal?	Owner <input type="checkbox"/> C-level <input checked="" type="checkbox"/> Middle management <input type="checkbox"/> Investment committee <input type="checkbox"/> Other <input type="checkbox"/> _____
What type of company is this?	Listed company (AG,SE etc.) <input checked="" type="checkbox"/> Private company <input type="checkbox"/> Unlimited company <input type="checkbox"/> Other <input type="checkbox"/> _____
Have you been involved in a digital transformation project/ digitalization project within your firm?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Indicate the largest size of financial project you have evaluated:	€0 - €200,000 <input type="checkbox"/> €200,001 - €501,000 <input type="checkbox"/> €501,001 - €1,000,000 <input checked="" type="checkbox"/> € 1,000,001 – 5,000,000 <input type="checkbox"/> More than €5,000,001 <input type="checkbox"/>
Does your organization have a formal investment appraisal team?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
Is the investment appraisal process formalized in a policy or written work instruction?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
Does your investment appraisal process also include qualitative aspects/implications of the investment?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Could your existing investment appraisal procedures be improved?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
What key factors to your take into account in your investment decision?	Interest rates <input checked="" type="checkbox"/> Time <input checked="" type="checkbox"/>

	Risk x Strategy x Digitalization x Other <input type="checkbox"/> _____				
What is the preferred method of financial decision making in your company? <u>Analytical methods</u> Net Present Value Method (NPV) Discount rate Internal Rate of Return (IRR) Benefit / Cost ratio (BCR) Payback and Discounted payback Sensitivity analysis Scenario analysis Switching values Distributional Analysis <u>Economic appraisal techniques</u> Cost benefit analysis (CBA) Cost Effectiveness Analysis (CEA) Cost Utility Analysis (CUA) Multi Criteria Analysis (MCA)	NPV and IRR				
Does your company have a "digital native" or assigned a senior manager being in charge of "digitalization"	Yes X No <input type="checkbox"/>				
Is the "digitalization" expert part of the financial appraisal process?	Yes <input type="checkbox"/> No x Our company does not have an appraisal process x				
Have you heard of the financial appraisal profile model (FAP model?)	Yes <input type="checkbox"/> No x				
Would you consider the following factors as relevant for your decision making process? Strategy Project Risk Digitalization factors Discount factors Other key factor, if yes what factor _____	Yes <input type="checkbox"/> No x Yes <input type="checkbox"/> No x Yes <input type="checkbox"/> No x Yes <input type="checkbox"/> No x Yes <input type="checkbox"/> No <input type="checkbox"/>				
Does your organization employ agility methods	Yes <input type="checkbox"/> No x				
Part C					
	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Do you think that financial decision-making should be "digitalized"	X				
Would you like to have the financial decision-making improved within your organization?		X			

Do you think employing agility methods helps your organization?			X		
Do you think your organization should improve the financial decision making?		X			
Would you consider employing an improved financial appraisal and decision-making model?		X			
Do you think your current financial decision-making framework is adequate for the challenges coming in terms of digitalization and industry 4.0?		X			
Part D "Digitisation Index"					
Affordability					
How much does your company invest in digitalization projects per annum	€0 - €50,000 <input type="checkbox"/> ; €50,001 - €250,000 <input type="checkbox"/> ; €250,001 - €500,000 <input type="checkbox"/> ; €500,001 - €1,000,000 <input type="checkbox"/> ; More than €1,000,001 X				
Does your company set quantitative targets to be achieved ie. savings or investment return per annum in absolute terms?	YES <input type="checkbox"/> NOx If yes, please indicate amount: €0 - €50,000 <input type="checkbox"/> ; €50,001 - €250,000 <input type="checkbox"/> ; €250,001 - €500,000 <input type="checkbox"/> ; €500,001 - €1,000,000 <input type="checkbox"/> ; More than €1,000,001 <input type="checkbox"/>				
Human Capital					
Training, education per employee in absolute terms	2500				
Annual hours invested in IT qualification	15				
% of IT employees in work force	20				
Usage					
% of internet related tasks per employee on average	50				
Smartphones as company phones %	100				
Infrastructure reliability					
Investments per employee in absolute terms	350				
Total failure of IT systems in last 12 months	No x Yes <input type="checkbox"/> If yes: once <input type="checkbox"/> twice <input type="checkbox"/> more often <input type="checkbox"/>				
Network access					
Number of workplaces with a PC in absolute terms	90				

Number of company phones in absolute terms	90
Capacity	
Speed of network access in mbit	1Gbit
Any access limitations?	Yes <input type="checkbox"/> if yes at certain times ? _____ No x
Part E "Open questions"	
How often does the formal investment appraisal team meet?	Upon new acquisitions or investments proposed by a managing director
To what extend is your business affected by digitalization and information technology advancements?	It drives our business, we invest in IT and manufacturing companies that want to digitalize their business
How do you evaluate capital investment proposals?	Based on NPV and business plans and future benefits expected, also
What evaluation techniques are used by your company?	NPV, IRR as per banks request
If no evaluation, how is investment decision taken?	
What do you think are the challenges around digitalization and investment decision-making?	Trying to find the right model and variables to fit and reflect planned investment adequately and combine with digitalization
What qualitative considerations are you considering on financial decision-making?	Future growth and business
Digitalization and improved manufacturing methods are branded as "industry 4.0". What do you understand under the term "industry 4.0"	Providing benefits to improve connectivity of machinery, products, customer and supplier. Also considering ESG criteria to improve investment quality and social responsibility.
Additional comments:	
The interview has been interrupted a few times due to Sandy Möser receiving various calls during the meeting. Resulting in a few minor interruptions	

Do you think Corona has any implications on your financial decision making and digitalisation?

This is our core business affected by Covid-19. In our case positively as we strive for digitalisation and therefore operate an IT center in India to help other companies to improve their business model and also decision making by utilizing digitalisation.

Do you think digitalisation brings benefits?

Absolutely, our company fully focuses on digitalisation and how to utilize digitalization, including AI and IoT to improve decision making. This also includes additional investments in digitalisation, especially manpower.

Do you plan to update the investment appraisal policy due to the current situation?

No, we think our existing investment appraisal policy is adequate for the current situation.

Why do you think risk, time, strategy and digitalisation are the important factors and do you also consider other factors?

For us these are the relevant factors, but we also consider ESG criteria recently, but these are not quantified, but rather qualitative aspects.

Why do you rely on NPV and IRR as appraisal methods?

As we also invest in IT companies to acquire additional knowledge, for a business plan evaluation the NPV and IRR seem to be the best fit for investments and analysing business plans and future benefits of an investment.

Have you used any other analytical method?

Not yet, we believe the existing methods are adequate.

Have you ever considered economic appraisal techniques?

I have not heard of this method yet.

Would you consider a more sophisticated model if required?

Ideally, if it can model our business exactly to support improved decision making, yes, absolutely. However, our business is rather complex and therefore I think a basic and easy to understand and communicate model like classic NPV or IRR calculation are still the models of choice.

Would you consider a digital native?

We have a digital native at board level, he is also in charge as CTO for the company to further develop the business and IT matters.

What do you think about an improved financial decision-making model?

I think everything that can be optimized should be optimized.

Do you think strategy, reputation and digitalisation add benefits as additional factors for an appraisal model?

Yes, digitalisation and strategy are relevant items for us, but we also started to consider ESG criteria as a soft-factor recently.

You mentioned before that you think ESG criteria are important and also you think that these are also relevant criteria to include in your investment decision appraisal?

I am also serving at the supervisory board of a listed company , which has recently established an ESG report. As part of this report, we had a consultant advising us on the reporting. The consultant suggested to include ESG aspects in our investment decision going forward as he said that banks also consider ESG criteria for lending decisions going forward and or ESG help to get better pricing and conditions if certain ESG targets have been set and reported.

In the current model I develop besides NPV, project index and strategy index, also digitalisation index is included, would you potentially going forward also expect that a further improved model including an ESG index would benefit your investment decision?

I think so. So far as mentioned before we rely on NPV calculations. We are aware that other models could also be used, and I know from the last investment that was financed by a bank. I remember that the bank also asked us in the credit approval processes about our future investments in IT and if we plan to measure and reduce CO2 consumption in our production. At the moment we of course will invest in IT to replace our outdated ERP system, but we have no plans to measure CO2. I heard from an other company that they get cheaper financing if they reach a certain target in terms of CO2 reduction. I don't know the details.

Coming back to the digitalisation index, what is your view on introducing the model I presented and would you be interested in testing the next investment decision by an improved FAP model?

I think we could try. But the model and processes should be easy to apply and straight forward as our finance department does not have the capacity to spend weeks on understanding a new investment concept. We are already under pressure due to limited capacity in the finance team. If the investment decision can be done by a computer software would be even easier, so that all stakeholder, as I understood from your initial explanation, need to provide input it would be helpful if this could be done by a few clicks in a software.

Based on your comment on new acquisitions, besides already mentioned methods, what are contributing elements of the final investment decision making from your point of view?

I think it is also about having a positive (gut) feeling about the potential investment. At the end of the day figures are figures and we cannot plan for anything in advance. But I think also considering the potential future development in terms of digitalization, is an element we already consider to some extent, even if we do not actually calculate or quantify it or its potential impact.

Appendix II – Sample Emails

Matthias Herrmann

Von: Matthias Herrmann <matthias.herrmann@...>
Gesendet: Montag, 24. Februar 2020 17:36
An:
Betreff: Re: Anfrage Meeting für Umfrage DBA These

Hallo Herr F

Vielen Dank. Ich sende Ihnen gerne eine Einladung für einen Zoom Call für Freitag, 11 Uhr zu. Anbei sende ich Ihnen den Fragebogen zu. Ich denke es werden sich noch weitere Fragen im Gespräch ergeben.

Ich freue mich auf das Gespräch und danke Ihnen für Ihre Unterstützung.

Beste Grüße
Matthias Herrmann
Tel. [REDACTED]

[Get Outlook for iOS](#)

From:
Sent: Monday, February 24, 2020 11:17 AM
To: Matthias Herrmann <matthias.herrmann@...>
Subject: AW: Anfrage Meeting für Umfrage DBA These

Hallo Herr Herrmann,

Ja, bitte senden Sie mir den Fragenkatalog vorab zu. Ich könnte Ihnen diese Woche am Donnerstag oder Freitag vormittags anbieten für ein max. 1h Gespräch zwischen 10 Uhr und 11 Uhr. Würde dies bei Ihnen passen? Bitte senden Sie die Fragen vorab.

Mit freundlichen Grüßen / With kind regards,

Von: Matthias Herrmann <matthias.herrmann@...>
Gesendet: Freitag, 21. Februar 2020 21:08
An:
Betreff: Re: Anfrage Meeting für Umfrage DBA These

Hallo Herr

Vielen Dank für die positive Rückmeldung. Ja, die Umfrage ist anonym. Ich sammle zwar Daten zu allgemeinen Informationen zu den befragten Unternehmen, diese werden aber auf Wunsch vollständig anonymisiert. Ideal wäre ein persönliches Treffen, aber sofern dies nicht möglich ist, können wir auch eine Videokonferenz über z.B. Teams oder Zoom durchführen. Den Fragebogen würde ich gerne direkt mit Ihnen im Gespräch durchgehen. Dieser umfasst allgemeine Fragen zum Unternehmen und Prozessen, sowie Finanzentscheidungen und Methodiken so wie offene Fragen zu verschiedenen Bereichen. Insgesamt dauert das Interview ca. 1 Stunde. Ich verstehe aus Ihrer E-Mail, dass Sie gerne vorab den Fragebogen einsehen können, ich kann Ihnen anbieten die allgemeinen Fragen im Fragebogen zu zusenden. Es gibt dann sicherlich noch weitere Fragen, die sich im Gespräch ergeben.

Ich bin die nächsten beiden Wochen gut verfügbar und es würde mich freuen, wenn wir hier einen Termin finden könnten. Gerne dürfen Sie einen Vorschlag machen und ich richte mich nach Ihnen.

Ich wünsche Ihnen ein schönes Wochenende

Beste Grüße
Matthias Herrmann
Tel. [REDACTED]

[Get Outlook for iOS](#)

From:
Sent: Friday, February 21, 2020 2:57 PM
To: Matthias Herrmann <matthias.herrmann@...> <...>
Subject: AW: Anfrage Meeting für Umfrage DBA These

Hallo Herr Herrmann

Danke für Ihre E-Mail. In der Tat hat Herr [REDACTED] mit mir gesprochen. Er hat nur positiv von Ihnen und Ihrem Projekt gesprochen. Er hat mir auch zugesichert, dass die Umfrage anonym durchgeführt wird, ist das richtig? Mir ist es wichtig, wenn ich über meine Firma und Prozesse spreche, dass entweder vorab ein NDA unterschrieben wird oder, dass die Anonymität gewahrt wird. Gerne kann ich Sie bei Ihrem Projekt unterstützen. Wie ist der von Ihnen gedachte Prozesse? Senden Sie mir den Fragebogen zu und ich fülle diesen aus, oder sollen wir einen Call ansetzen und ich gehe mit Ihnen die Fragen durch?

Mit freundlichen Grüßen / With kind regards,

Von: Matthias Herrmann <matthias.herrmann@...>
Gesendet: Montag, 20. Januar 2020 09:29
An:
Betreff: Anfrage Meeting für Umfrage DBA These

Sehr geehrter Herr

Mein Name ist Matthias Herrmann und ich bin, ebenso wie Sie, Geschäftsführer eines mittelständischen Unternehmens. Ich habe Ihren Kontakt von Herrn [REDACTED], einem gemeinsamen Bekannten. Herr Hussmann hatte mich informiert, dass er Sie auch bereits angesprochen hat bezüglich meiner These. Meine Promotionsarbeit befasst sich mit der Verbesserung von Entscheidungsfindung im Investitionsbereich unter Berücksichtigung von verschiedenen Variablen und darunter auch Digitalisierung als mein Schwerpunkt. Gerne möchte Ich Ihnen meine Forschung und das Modell darstellen und Sie auch gerne bitten aktiv zur Entwicklung beizutragen, wenn Sie mir die Möglichkeit geben mit Ihnen ein Interview über ca. 1 Stunde zu führen.

Mit freundlichen Grüßen

Matthias Herrmann

Tel. [REDACTED]

[Get Outlook for iOS](#)

Matthias Herrmann

From: Matthias Herrmann <[matthias.herrmann@r...le](mailto:matthias.herrmann@r...)>
Sent: Freitag, 15. Februar 2019 11:24
To: <...>
Subject: RE: Vorstellung und Termin

Hallo Herr ...

vielen Dank. Ich bestätige den Termin und sende Ihnen eine Einladung für den Kalender. Ja, das Interview ist vertraulich und ich kann Ihnen Anonymität zu sichern. Ich kann Ihnen auch mitteilen, dass dies bisher von allen Interviewpartnern gewünscht ist. Ich freue mich auf das Gespräch. Den Fragebogen würde ich Ihnen gerne erst zeigen, wenn wir sprechen. Ich würde Ihnen dazu einfach gerne den Prozess und Hintergrund der Fragen erläutern, bevor wir in den Fragebogen einsteigen.

Sollten sich in der Zwischenzeit Fragen ergeben, können Sie mich gerne jederzeit unter meiner privaten Telefonnummer (0171/ 962 362 2) erreichen oder mir einfach eine Email schreiben.

Vielen Dank und ich freue mich auf das Gespräch

Mit freundlichen Grüßen
Matthias Herrmann
Tel. [REDACTED]

From: <...>
Sent: Thursday, February 14, 2019 1:08 PM
To: Matthias Herrmann <[matthias.herrmann@r...e](mailto:matthias.herrmann@r...)>
Subject: RE: Vorstellung und Termin

Hallo Herr Herrmann,

ich würde eher dazu tendieren am Ende der vorgeschlagenen Woche zu treffen. Wie wäre es mit Freitag, 26 April 2019 um 11 Uhr? Sie sagten, dass das Interview für Ihre These vertraulich ist, richtig? Senden Sie mir den von Ihnen genannten Fragebogen vorab zu?

Mit freundlichen Grüßen

From: Matthias Herrmann <[matthias.herrmann@r...>](mailto:matthias.herrmann@r...)>
Sent: Donnerstag, 14. Februar 2019 10:19

To: <...>
Subject: Vorstellung und Termin

Sehr geehrter Herr ...

wie telefonisch besprochen, möchte ich gerne einen Termin mit Ihnen vereinbaren, um über mein Projekt und These zu sprechen. Ich habe verstanden, dass Sie aktuell einen Termin im April, nach Ostern, vorschlagen in Person vorschlagen. Aufgrund der Kürze von Frankfurt zu Ihnen, ist für nur wenig Vorlauf notwendig und ich schlage daher gerne vor, dass Sie mir einen Termin in der Woche, ab dem 23. April vorschlagen. Das ist die Osterwoche. Ich bin in dieser Woche zeitlich flexibel und richte mich nach Ihnen.

Mit freundlichen Grüßen
Matthias Herrmann
Tel. [REDACTED]

Appendix III – NVivo Coding sample

Company details

Decision maker

C-level

decision committee

Owner Founder

Investment method

Benefit ~ Cost ratio (BCR)

Cost benefit analysis (CBA)

Cost Effectiveness Analysis (CEA)

Cost Utility Analysis (CUA)

discount factor model

economic appraisal technique

EVA

internal rate of return

economic appraisal technique

NPV

sensitivity analysis

type of company

Listed company

private company

unlimited company

Covid-19

adverse effects

digitalisation

financial decision making

liquidity issues, focus on company survival

no benefits digitalisation

what benefits digitalisation

Financial decision making process

agility methods employed

digitalisation expert

FAP Model

Formal appraisal done

improvement of policy planned

investment policy in effect

no new policy adequate

other factors (digitalisation, others)

Type of strategy

digitalisation of company

benefits through digitalisation

business model

Cost
decision making
digitalisation benefits
Infrastructure
People

Digitalization Index

Affordability
capacity of network
Human Capital
Infrastructure reliability
network access
Usage
Digitalization
Mobil phone
Computer
Automatization

Improve financial model (like FAP or other)

easy to use and implement
not relevant improvement
NPV
project risk
relevant improvement
reputation
staff challenge
Strategy

Investment method variable

interest
other factors (environment etc.)
risk
strategy
time

IT Environment

Financial investment
in the progress of upgrade
old infrastructure (failures etc.)
State of the Art Infrastructure
policy for digitalisation

Strategy mix

Strategy
Approval
Company policy
Strategy definition
Type of strategy

Risk matrix

Risk of shift in interest rates
Risk of wrong decision making

IT utilization

IT spend - investments
IT usage – speed - availability

Appendix IV – NVivo coding and theme analysis sample

Bearbeiten Kodierfeld      



Do you think Corona has any implications on your financial decision making and digitalisation?

It has various implications on one side our project sales deteriorated while sales in residential area increased, due to people staying home and fixing homes and carrying out work at home. On financial side, corona has implications but we see ourselves as pretty stable as we are an established family owned company with low external financing. Our projects are by majority financed from actual cashflow and equity. Digitalisation at our company is not driven by Corona, like with many of our competitors. We have been developing our manufacturing processes already in light of industry 4.0. Part of our companies success is certainly that we are focused on digital optimisation of our processes and production steps.



Do you think digitalisation brings benefits?

I not only think it will bring benefits in the future. It does deliver positive results already now for us. Without our early focus on manufacturing improvements and cost efficiency we would be in a worse position and like competitors only start now to think about investments when everyone else is looking for IT investments. We have this competitive edge already and continue to develop this further.



Do you plan to update the investment appraisal policy due to the current situation?

Yes, we will include pandemic situations in our investment appraisal policy. I don't think we will face another pandemic like this one now in the next 100 years, but we might have to face local pandemic situations as before. For us this is an element of consideration as we supply our products worldwide.



Why do you think strategy and risk are the important factors and do you also consider other factors?

As said, for us strategy and forward thinking is a key consideration of our general decision making process. Similar for financial decision making we try to evaluate what will happen in the future and what trends we will follow or foresee in our market sector. Forward looking thinking always comes with a level of uncertainty and uncertainty is risk. We try to appraise the level of risk, without the willingness to take risk the growth and business growth is very limited. We define for us certain level of risk capacity and risk acceptance. Besides that we have good reputation caring for our workforce and staff and we also consider this in our business planning as we like to be a relevant employer in the future.



Why do you rely on IRR as appraisal methods?

We are steering our business model with expected return rates and therefore for investment appraisal we use IRR. As mentioned before we are a family owned business and we care about return, but it is not the absolute factor of measuring our business as we are not a listed company that is thinking in quarterly reports.



Have you used any other analytical method?

We also use NPV from time to time.



Have you ever considered economic appraisal techniques?

Yes, we also use cost benefit analysis for new products as we not only think about pure IRR rates. Especially when we introduce a new product and need to check if the product will be profitable and if not at the first go, we need to think about where to tweak the product calculation to make the product work for us. I think with a more comprehensive approach like CBA we can define the product and its life cycle better compared to a simple IRR calculation.



Would you consider a more sophisticated model if required?

If it provides additional insights and can fit with our business segment and is also easily to be handled. As you mentioned your research will bring benefits to SMEs on digitalisation, this is



Appendix V – Briefing Case Study



BRIEFING

Liebes Klingenberg Team,

wie mit den einzelnen Leader besprochen, werden wir am 04. August 2020 eine sogenannte Fall-Studie zum geplanten Investment in eine neue Produktionsanlage durchführen. Dies ist das erste Meeting dieser Art und daher bitte ich euch, dass alle für das Meeting ab 10 Uhr ganztätig zu Verfügung steht. Entsprechend bitte ich euch, dass ihr eure Stellvertreter informiert, dass diese den Betriebsablauf sicherstellen. Der Betriebsrat ist auch informiert. Der Ablauf ist wie folgt:

1. Es gibt eine kurze Zusammenfassung zum Invest
2. Es wird das Konzept und der Ablauf vorgestellt und das Ergebnis der betriebswirtschaftlichen Analyse (Barwertberechnung/NPV)
3. Es wird ein Moderator gewählt, welcher die Rolle eines Mediators einnimmt
4. Das Ergebnis wird am Ende definiert, um die Entscheidung zum Invest entweder zu bestätigen oder abzulehnen.

Ich werde als neutraler Beobachter teilnehmen und die Ergebnisse und Diskussionen mitschreiben. Es werden keine persönlichen Daten (außer der Teilnahme als Leader und für welchen Zuständigkeitsbereich) erhoben. Die Teilnahme ist nicht verpflichtend, jedoch bietet diese die Chance an der aktuellen großen Entscheidungsfindung teilzuhaben. Das Ergebnis und der Prozess wird weiterhin aufgeschrieben und wie bekannt für mein Forschungsprojekt genutzt.

Ich freue mich auf das Meeting und bin gespannt welches Ergebnis ihr gemeinsam erarbeitet.

Mit freundlichen Grüßen

Matthias Herrmann
Geschäftsführer

TRANSLATION OF CASE STUDY BRIEFING

BRIEFING

Dear Klingenberg Team,

As discussed with the individual leaders, we will be holding a so-called case study on the planned investment in a new production facility on 04 August 2020. This is the first meeting of its kind and therefore I ask you all to be available for the meeting from 10am all day. Accordingly, I ask that you inform your deputies to ensure that the meeting runs smoothly. The works council has also been informed. The procedure is as follows:

1. there will be a short summary of the investment
2. the concept and procedure are presented, and the results of the business analysis (net present value/NPV) are presented
3. a moderator is chosen who takes on the role of a mediator
4. the outcome will be defined at the end to either confirm or reject the decision to invest.

I will participate as a neutral observer and take notes of the results and discussions. No personal data (other than participation as a leader and for which area of responsibility) will be collected. Participation is not compulsory, but it is a chance to be part of the current big decision making. The outcome and process will still be written up and used for my research project as known.

I look forward to the meeting and am excited to see what outcome you will come up with together.

With kind regards

Matthias Herrmann

Managing Director

Appendix VI – Evidence of English language skills



Member

This is to certify that

Matthias Herrmann

was admitted a member of the Association
on 10 June 2021

Given under the Seal of the Association
on 21 May 2022



President

Deputy President

Secretary

Association of Chartered Certified Accountants

This certificate remains the property of ACCA and must not in any circumstances be copied, altered or otherwise defaced.
ACCA retains the right to demand the return of this certificate at any time and without giving reason.

Think Ahead 

01233765

2735895

THE MEDIATORS' INSTITUTE OF IRELAND

AWARDS

Matthias Herrmann

a Practising Certificate

FOR THE PERIOD

01.01.2023

to

31.12.2023



A handwritten signature in blue ink, appearing to read 'Diana Blawie', is written over a horizontal line.

A handwritten signature in blue ink, appearing to read 'Bee Casey Murray', is written over a horizontal line.

DIRECTOR

01.01.2023

DATE

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