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DOCTORAL (Ph.D.) DISSERTATION

Dipl.-Ing. Wolfram Irsa, CFPIM, CIRM, CSCP

University of Sopron

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Joint Cross-Border PhD Program

Analysis of Overhead Costs Management in Companies

Doctoral (Ph.D.) Dissertation

Written by:
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Supervisor:
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Dissertation to obtain a Ph.D. degree

Written by:

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Prepared by the University of Sopron

István Széchenyi Economics and Management Doctoral School

within the framework of the International Economy and Management Programme

Supervisor:

Prof. Em. Dr. Székely Csaba, DSc

The supervisor has recommended the evaluation of the dissertation be accepted: yes / no

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supervisor signature

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1. Judge: Dr. _____ yes /no _____

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Chairperson of the Judging Committee

Qualification of the Ph.D. degree: _____

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Abstract

The development of overhead costs management is becoming more and more important as the percentage of overhead costs on the overall costs is constantly rising. The last 15 years have demonstrated the awakening of several advanced methods and tools for overhead costs management. They have in common the notion of understanding the utilization of overhead better. This dissertation investigated the current state of overhead costs management with a sample of 20 companies in Austria, Hungary, and Slovakia. A qualitative approach was applied in a multi-case study, which unveiled the significance of overhead costs management with the increasing trend of importance. The findings were supported by quantitative analysis, within the samples, income statements, and external data. The effort reflected current innovations using the digitalization of processes. The findings showed that (1) the majority of the companies indicated that digitalization heavily impacts overhead costs; (2) all expressed their dissatisfaction with the tools currently used; and (3) the majority cited that usability and speed are the predominant factors for successful overhead costs management. The findings were challenged against the BACH database system of the European Committee of Central Balance-Sheet Data Offices. It embedded the findings of the sample into a broader context of the countrywide database by identifying overhead as an imprecise term. The analysis and the subsequent synthesis delivered three theses: (1) the perception that digital competence enables overhead costs management; (2) the persuasion that competencies are insufficient; and (3) there are prerequisites for success in overhead costs management, primarily usability and speed. The scientific novelty of the thesis lies in the first qualitative research of the overhead costs situation in the sectors manufacturing and transportation/storage with companies in Austria, Hungary, and Slovakia for the time period of 2008 to 2017. The dissertation concludes with several recommendations for academia, businesses, and research.

Keywords: Digitalization, Organizational Behavior, Overhead costs Management

JEL Classification: D23 Organizational Behavior • Transaction Costs • Property Rights, O14 Industrialization • Manufacturing and Service Industries • Choice of Technology, O33 Technological Change: Choices and Consequences • Diffusion Processes

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Kurzfassung

Die Entwicklung des Gemeinkostenmanagements wird immer wichtiger, da der Anteil der Gemeinkosten an den Gesamtkosten ständig steigt. In den letzten 15 Jahren wurden fortschrittliche Methoden und Werkzeuge für das Gemeinkostenmanagement entwickelt. Allen gemeinsam ist der Gedanke, die Nutzung der Gemeinkosten besser zu verstehen. Die Dissertation untersuchte den aktuellen Stand des Gemeinkostenmanagements an einer Stichprobe von 20 Unternehmen in Österreich, Ungarn und der Slowakei. Mit einem qualitativen Ansatz durch eine Multifallstudie wurde die unveränderte Bedeutung des Gemeinkostenmanagements mit zunehmender Brisanz aufzeigt. Die Ergebnisse wurden durch quantitative Analysen innerhalb der Stichprobe, von ausgewählten Geschäftsberichten und durch externe Daten gestützt. Die Ergebnisse zeigten, dass (1) die Mehrheit angibt, dass sich die Digitalisierung stark auf die Gemeinkosten auswirkt; (2) alle äußerten ihre Unzufriedenheit mit den derzeit verwendeten Werkzeugen, und (3) die Mehrheit führte an, dass Benutzerfreundlichkeit und Geschwindigkeit die vorherrschenden Faktoren für ein erfolgreiches Gemeinkostenmanagements sind. Die Ergebnisse wurden mit dem BACH-Datenbanksystem des Europäischen Komitees der zentralen Bilanzdatenbanken in Kontext gesetzt. Die Analyse und die daraus folgende Synthese lieferte drei Thesen: (1) Wahrnehmung, dass digitale Kompetenz das Gemeinkostenmanagement ermöglicht; (2) Überzeugung, dass die Kompetenzen unzureichend sind; und (3) es gibt Voraussetzungen für ein erfolgreiches Gemeinkostenmanagement, vor allem Benutzerfreundlichkeit und Geschwindigkeit. Der wissenschaftliche Neuwert liegt in der ersten qualitativen Untersuchung der Gemeinkosten-Situation in den Sektoren Fertigung und Transport/Lagerung mit Unternehmen in Österreich, Ungarn und der Slowakei im Zeitraum 2008 bis 2017. Die Dissertation schließt mit mehreren Empfehlungen für Wissenschaft, Wirtschaft und Forschung ab.

Schlüsselwörter: Digitalisierung, Organisationsverhalten, Gemeinkostenmanagement

JEL Klassifikation: D23 Organizational Behavior • Transaction Costs • Property Rights, O14 Industrialization • Manufacturing and Service Industries • Choice of Technology, O33 Technological Change: Choices and Consequences • Diffusion Processes

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List of abbreviations

ABC	Activity-based costing
AC	Analytical category
AI	Artificial intelligence
a.k.a.	also known as
AR	Augmented reality
b	Billion
B2B	Business-to-business
B2C	Business-to-consumer
BACH	Bank for the Accounts of Companies Harmonized
CAM	Computer aided manufacturing
cf.	cōnfer (lat.), compare
CI	Critical incident
CNC	Computer numerical control
COGS	Cost of goods sold
CPPS	Cyber physical production system
Dipl.-Ing.	Diplomingenieur (germ.)
EAT	Earnings after tax
EBIT	Earnings before interest and tax
EBT	Earnings before tax
ECCBSO	European Committee of Central Balance-Sheet Data Offices
EDI	Electronic data interchange
e.g.	exemplī grātiā (lat.), for the sake of an example
ERP	Enterprise resource system
ESCB	European System of Central Banks
EU	European Union
F	Finding
F&A	Forschung und Entwicklung (germ), Research and development
GAAP	Generally Accepted Accounting Principles
GDP	Gross Domestic Product
germ.	German
H	Hypothesis

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List of abbreviations (continued)

IFRS	International Financial Reporting Standards
Ing.	Ingenieur (gem.)
hun.	Hungarian
I4.0	Industry 4.0
i.e.	id est (lat.), that is
IOT	Internet of things
k	Kilo, short for thousand, 10^3
lat.	Latin
log.	Logistics
m	Million, 10^6
MRO	Maintenance, repair, operative
MSc	Master of Science
OEM	Original equipment manufacturer
OH	Overhead
PKR	Prozesskostenrechnung (germ.)
PO	Purchase order
R	Pearson correlation coefficient
R&D	Research and development
RQ	Research question
SAAS	Software as a service
SCM	Supply chain management
SME	Small and mid-size enterprises
SWOT	Strengths, weaknesses, opportunities, threats
TCM	Total cost management
TCT	Transaction cost theory
TD-ABC	Time-driven activity-based costing
transp.	Transportation
VUCA	Volatility, uncertainty, complexity, ambiguity
WIP	Work in process
Z	Zetta, 10^{21}

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CHAPTER 1

INTRODUCTION AND BACKGROUND

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1 Introduction

This dissertation seeks to explore the phenomenon of how businesses deal with the increasing importance of overhead costs management in the advent of innovations driven by digitalization. Digitalization is the process of employing digital information and technologies in order to transform them into business operations. It is the use of digital technologies to potentially change a business model and provide new revenue and value producing opportunities. Conversely, digitization is the process of changing from analog form to digital; it refers to taking analog information and encoding it into zeroes and ones so that computers can store, process, and transmit information.

The purpose of the dissertation is to explore with a sample of companies their perceptions of and why they believe that overhead costs management is important and how they successfully manage the development of overhead costs, triggered by the innovations of digitalization. It was anticipated that the knowledge generated from this inquiry would create new insights and so inform the academic community and business leaders on the impact of contemporary capabilities. The dissertation employed qualitative multi-case study methodology with quantitative statistical description to portray the phenomenon under investigation. Participants of the dissertation included a purposefully selected group consisting of 20 companies from seven different industries in Austria, Hungary, and Slovakia, who had an impressive economical track record as world market leaders in their fields.

This chapter introduces at its beginning the background and context that frames the dissertation, then follows with the problem statement, the statement of purpose, and the associated research questions. Also included in this chapter is the discussion about the research approach, the researcher's hypotheses, and the underlying values for conducting research. This chapter concludes with a summary of the proposed rationale, significance, and structure of the dissertation.

1.1 Background and context

Cost management has always been important for companies. Since the financial crisis in the year 2008, which turned into an economic crisis for many companies, the successful management of costs became even more important. The overhead costs, which are mostly fixed costs from a structural point of view and indirect costs from an accounting point of view, become more significant due to several reasons. There is the issue of inflexibility of scaling

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overheads quickly up and down as required in dynamic markets. Further, the reduction of overhead is a delicate process as it often means reducing the headcount. Even if lay-offs can be avoided, the reduction of overhead costs is a significant change which means abandoning well-established routines (e.g. so far unaccounted services need then a precise recording of the service to a sellable cost object). Miller and Vollmann (1985) displayed numbers from the mid-19th century up until the mid-1980s, showing a continuous increase of overhead costs.

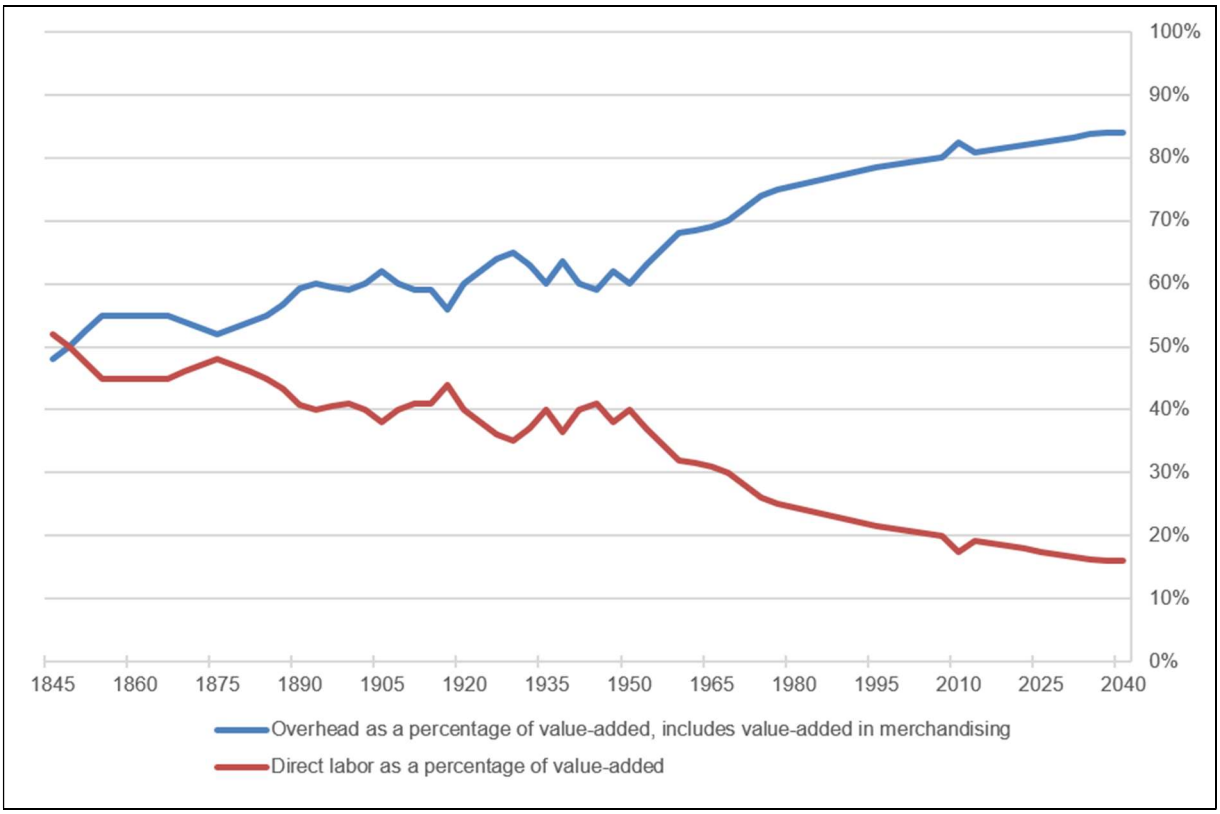

Figure 1: The increase of overhead costs in a long-term perspective

Source: Miller and Vollmann, 1985; supplemented with data from own research

Miller and Vollmann (1985) stated that the continuing surge of overhead is immanent due to the ongoing automation of business processes. Figure 1 shows an increase of overhead from 50% in the middle of the 19th century to roughly 85% 190 years later as a percentage of value added. The data stem from the North American Manufacturing Futures Survey and used as a research method a survey with more than 200 respondents from just as many different business units; the typical job description of the respondents was vice president of operations. The survey was repeated in the subsequent years with respondents from Asia and Europe, which supported the original results. The scientific value of the survey appears questionable as there is ambiguity within the understanding of the term *overhead* over such a long period of

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time. Nevertheless, the survey and the publication disclosed for the first time the long-term dynamics of the topic and stimulated awareness for systematic research. As of now, the trend indicates that overhead will still continue to slightly rise. Consequently, the direct labor will decrease.

1.2 Problem statement

Research indicates that a compelling number of businesses are wondering how the changing environment caused by digitalization in the last years will impact their capability to successfully manage overhead costs. Hence, despite their fortunate past and their serious investment of time and money to understand upcoming innovations, these businesses face uncertainty concerning their future existence. In fact, uncertainty is just one element of four, which are known as VUCA. VUCA stands for volatility, uncertainty, complexity, ambiguity and describes the dynamics in digitalized markets. There is little information about how to successfully handle this phenomenon (Hernández-Santibáñez & Mastrolia, 2019).

1.3 Statement of purpose and research questions

The purpose of the dissertation was to explore with 20 businesses their perceptions of how they manage overhead costs in the advent of business processes digitalization. It is anticipated that more informed decisions could be made by current businesses, academic scholars, and prospective business founders based upon the results of this study. The dissertation should enable a better understanding of the needs of the businesses, the challenges and issues they face, and the academic foundation based on theories and concepts. To shed light on the problem, the following research questions were addressed:

1. How does the digitalization of processes impact the management of overhead costs?
2. What are the limitations of the current approaches of the management of overhead costs in respect to methods and tools? If there are limitations, what can be done to overcome them?
3. In general, what are the prerequisites for the successful management of overhead costs?

Each research question (RQ) stands independently for itself. Nevertheless, there are links between them. In order to first understand the ramifications, it makes sense to place the first RQ at the top of the list. Following, the second RQ addresses the internal details. Finally,

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the third RQ asks for overall prerequisites in order to succeed in the field of overhead costs management, which offers a universal perspective.

1.4 Research approach

I began with studying the perceptions and experiences of 20 participants from 20 different enterprises in seven different industries. The participants were drawn from a pool of potential candidates and had successfully demonstrated their capabilities in the industry over a period of 10 to 15 years. They had been challenged with ongoing changes due to digitalization and the impact on overhead costs. The investigation of the dissertation followed the tradition of a multi-case study using qualitative research methods as well as descriptive statistics using quantitative research methods.

In-depth expert interviews prepared with a survey were the primary methods of data collection. The interview process began with two pilot interviews. After fine-tuning the process and procedures, the information gathering began. The information – collected by means of 20 individual interviews and a focus group meeting – consequently formed the foundation for the overall findings of the dissertation. A pseudonym identified each interviewee with a participant code; all interviews and focus group statements were recorded and transcribed word for word. Further, the participants completed critical incident reports in order to root the findings emanating from the in-depth expert interviews in a practical context, rich with specifics. The answers were safe guarded with quantitative statistical analysis based on the survey using Likert scales. In order to challenge the results in a broader context, I performed an income statement analysis using data from the enterprises and the BACH database (European Committee of Central Balance-Sheet Data Offices, 2020) from the EU.

1.5 Unit of analysis

The dissertation used unit of analysis to design the data gathering from the informants (i.e. unit of observation) and to measure concepts within the subject matter. The unit of analysis specifies the research object concerning the level of investigation and the specific data. It is the major entity for analyzing the data and composing the synthesis. The different levels might be groups, institutions, nations, organizations, and people. It enables the proper focus, builds on the research approach, and leads to the coherent hypotheses. The unit of analysis cascaded from country to individual level as illustrated in Figure 2.

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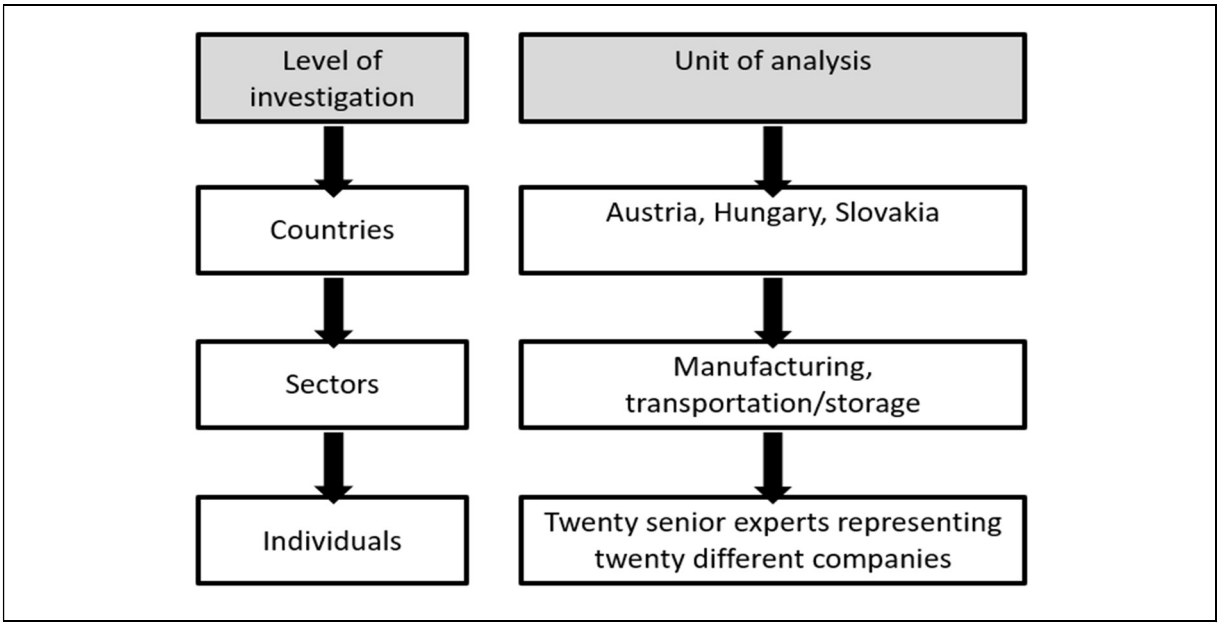

Figure 2: Unit of analysis for the dissertation

Source: Own depiction

Figure 2 explains the systematic breakdown of the levels of investigation with the corresponding unit of analysis. It starts at the country level for Austria, Hungary, and Slovakia. The next level is sectors comprising of manufacturing and transportation/storage. The bottom level addresses on an individual basis twenty different senior experts from twenty different companies (i.e. unit of observation). Their qualitative views, supported with the quantitative data from their companies, formed the foundation of the dissertation from an analytical point of view. For the syntheses, the same units of analysis were used. The three theses in Chapter 6 are based on the levels of investigation.

1.6 Hypotheses

Based on my experience and background as an academic scholar, three hypotheses were made regarding the dissertation. The previously mentioned problem with the statement of purpose and the research questions trigger the hypotheses, which are supported by context and conceptual framework explained in 2.6.

First hypothesis: Innovation (e.g. digitalization) drives the percentage of overhead costs continuously upwards. This hypothesis is based on the long-term observation of Miller and Vollmann as a secondary source. Additionally, primary sources utilized in the dissertation serve as a data pool to respectively verify or falsify the hypothesis. The momentum of the long-term

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trend indicates a growing importance. Nevertheless, thoroughly scientific research may discover unknown side effects.

Second hypothesis: The surge of digitalization has an impact on related methods and tools. This hypothesis is based on the rapid increase of data volume over the last five years. Further, there are indications that the so-called fourth industrial revolution disrupts current business models by means of digital tools, which enable low barrier market entrance for agile – often still small – companies. It seems worthwhile to find out if this general trend is confirmed in the geographical/industrial scope of the dissertation.

Third hypothesis: Digitalized services have a direct effect on overhead costs. This hypothesis premises the notion that services cannot be stored, but rather must be present when needed. Moreover, digitalized services require a sophisticated infrastructure as a backbone which includes skilled labor, software, office buildings with integrated computer infrastructure, based upon a compelling business idea with viable processes. Initial indications suggest a strong link between digitalized services and overhead costs. However, it is hypothetically possible that digitalized services account directly for the cost object and therefore avoid overhead costs, which is explained in the literature review under 2.2.

The three hypotheses revolve around something unknown with overhead costs, digitalization, and services – with interactions between them and further unknown elements. All are based on real-life observation of industrial practices in Austria, Hungary, and Slovakia. The dealing with the hypotheses requires academic groundwork as well as empirical data.

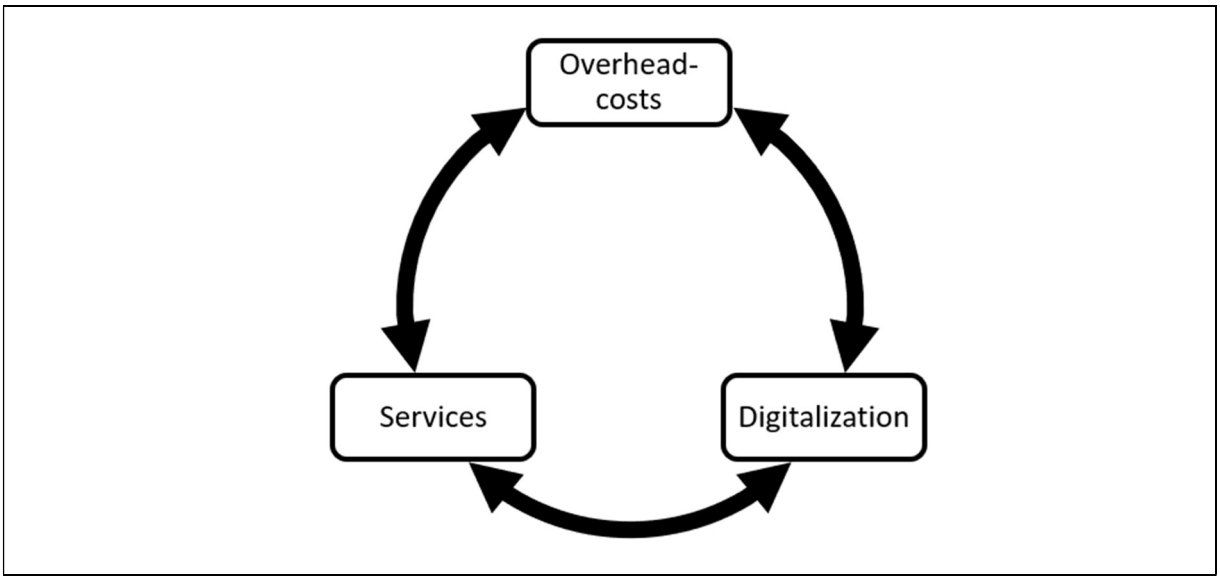

Figure 3: Hypotheses in the dissertation

Source: Own depiction

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Figure 3 depicts the interrelation and interactions of the hypotheses. The sequence of the hypotheses is purposefully selected. It assumes that first, innovation is the wellspring of all advancement of mankind, in general, and for enterprises, specifically. It is associated with a price tag, called overhead cost. Once the foundation is determined with this premise, the second hypothesis uses the observation of the dominance of digital processes, called digitalization. Finally, the third hypothesis builds on the previous two with the notion that overhead costs and digitalization require a vehicle of delivery, called services.

1.7 The underlying values for conducting the research

I recognized that the same skills that are valuable in providing insight could serve as a liability, biasing my judgement regarding research design and the interpretation of findings. In addition to my assumptions and theoretical orientation being made explicit at the outset of the dissertation, I remained committed to engaging in ongoing critical self-reflection by reading topic-related publications and in-depth debates with academic advisors and professional colleagues. Furthermore, procedural safeguards applied triangulation of data sources, triangulation of methods, and perpetual reliability checks with colleagues in order to address my subjectivity and to strengthen the credibility of the research.

1.8 Rationale and significance

The rationale for the dissertation stemmed from my desire to uncover ways to help businesses manage their overhead costs better based on a solid academic framework. Moreover, it seemed advantageous - as industries are barely able to manage the digital integration of business processes - to display this essential aspect of Industry 4.0 laid out in Chapter 2. These businesses may be current world-market leaders, promising newcomers, solid incumbents, or those who are struggling to succeed.

A better understanding of how to manage successful overhead costs may not only reduce the number of insolvent companies, but also increase the potential for a greater number of European companies succeeding in the global marketplace. Smart management of overhead costs may not only yield businesses with more opportunities to succeed, but also has the potential to benefit society at large by fostering and advancing the overall living standard.

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1.9 Structure of the dissertation

The dissertation is organized as follows: Chapter 1 includes the introduction, which contains background and context, the problem statement, the statement of purpose and the research questions, the research approach, the hypotheses, a section about the underlying values, and the rationale and significance of the research. Chapter 2 contains the literature review with the focus on classification of costs, overhead costs management, transaction cost theory, Industry 4.0, a summary of the literature review and the applied conceptual framework. Then, Chapter 3 explains the research methodology, which provides the rationale for qualitative and quantitative research, multi-case study methodology, the research sample, the approach of the income statement analyses, the methods for data collection, analysis and synthesis, issues of trustworthiness, the constraints of the dissertation, and a summary of the chapter. Chapter 4 includes the presentation of the findings, which portrays the metadata of the dissertation, the outcome of the various data collection methods, three distinguishable findings, itemized income statement analyses and a chapter summary. Chapter 5 delivers the interpretation and synthesis of the findings, revisits the hypothesis for verification or falsification respectively, challenges the results against the BACH database system, and provides a summary of the interpretations. Finally, Chapter 6 summarizes with the conclusion, scientific novelty value, multiple recommendations with the focus on formulating three theses, the contribution to the scientific community, and recommendations for academics, businesses and future research. At the end, the bibliography of the used sources and appendices are provided.

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CHAPTER 2

LITERATURE REVIEW

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2 Literature Review

2.1 Overview of literature review approach

The purpose of this research was to explore 20 businesses' perceptions on how the management of overhead costs has evolved over the last 10-15 years. In particular, I aspired to understand how the experiences of these businesses had influenced their capabilities to develop methods and tools. In order to successfully realize the dissertation, it was necessary to conduct a thorough review of current literature. This review was perpetual throughout the phases of data collection, data analysis, and the synthesis in the dissertation.

The thorough review explored the interrelation of the experiences of participants and the theoretical resources that they perceived were available to them. From this perspective, two major bodies of literature were comprehensively reviewed: (a) the evolution of overhead costs management and (b) the impact of make-or-buy decisions explained by the transaction cost theory. The review of the literature on evolution of overhead costs management provided an understanding of the application, context, historical background, ramifications, and rules under which businesses must account their costs in order to succeed in a competitive and often global environment. Transaction cost theory is reviewed to provide the context for understanding what type of governance, knowledge, skills, and strategies were identified concerning make-or-buy decisions. Making or buying a product/service impacts how the accounting information systems records the cost for these activities. Both bodies of literature set the groundwork for the understanding of the overhead costs structure and what factors play an important role in managing it.

To perform the selected literature review, I utilized several information sources, including monographies, professional journals, dissertations, conference proceedings, company reports, internet resources, and periodicals. These sources were accessed through DBIS, EBSCOhost, MENDELEY Elsevier, ProQuest, and SCOPUS. Although the literature review began early in the dissertation process, there was no specific delimiting timeframe applied regarding when it is the right point in time to conduct the search. On the contrary, the search was an ongoing effort on an as-needed basis. Because of the nature of the two bodies of literature reviewed, the historical context was considered equally significant, and therefore a discretionary criterion. It allows the investigation in a timeframe of many years to endow the inclusion of substantial and relevant material.

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Throughout the review, I attempted to detect important gaps and inadvertencies in distinct segments of the literature as and when they became perceivable. Further, relevant issues were identified and debated. The two bodies of literature reviewed, the evolution of overhead cost management and transaction cost theory, delivered the concepts and requirements needed for the subject matter; advantageous and disadvantageous features were identified. The interpretive summary that concludes the chapter portrays how the literature informed my understanding of the subject matter and how the material contributed to the subsequent development of the conceptual framework of the dissertation.

2.2 Classification of costs

Before exploring the two bodies of knowledge, the current status in literature of cost classification will be explored. It follows the principle that acquired assets and services are recorded at their actual costs (Horngren, Harrison, & Oliver, 2012). The comprehensive understanding of the concepts presented in this section provides the necessary foundation for the rest of the dissertation. An accounting information system consists of two major subsystems (Hansen & Mowen, 2006): (1) the financial accounting information system and (2) the cost management system. The first one is primarily concerned with producing outputs for external users (e.g. auditors, business partners, shareholders, tax authorities). The second one is primarily concerned with producing outputs for internal users utilizing it as inputs for the processes to reach management objectives. The dissertation used the first system for the income statement analyses, the second for qualitative interviews. It is worthwhile to mention that the two systems are not independent of each other. On the contrary, they utilize the same records from the databases and are integrated within the same ERP system. It depends solely on the purpose of the data: either external/official reporting or internal/tactical decision making.

Additionally, the strategic/tactical direction of the enterprise dictates the setup of the classification of costs (Heimerl & Tschandl, 2014). This direction shifts the focus to the elements that need proper monitoring in order to fulfill the enterprise's objectives. The cost management system helps to perform carefully crafted make-or-buy decisions, although with the pre-condition that the right granularity-level of cost elements is available. This means that if a product or a service is made by the enterprise, the needed structure for monitoring costs looks different compared to the scenario in which the product/service is bought from outside the enterprise. From an overhead costs point of view, the total cost classification is the proper

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starting point as it captures the entire costs. The classification helps to identify the cost items which are directly linked to the activity level; and it determines the cost items with no direct link to the activity level, referred to as indirect costs or overhead costs.

The classification of the used cost elements is depicted below:

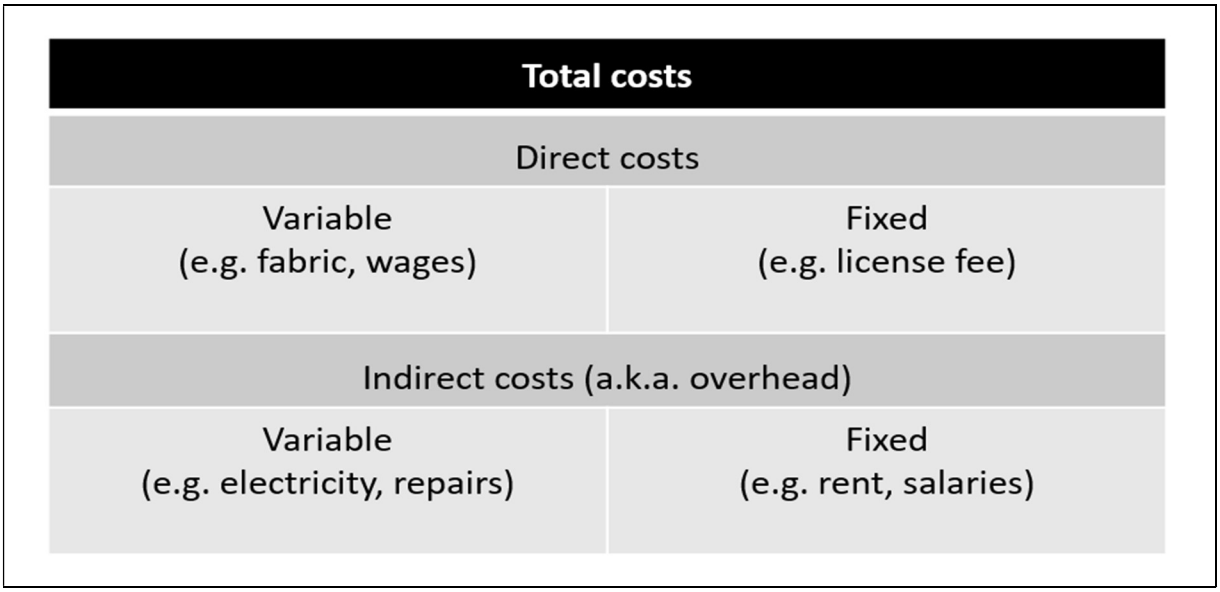

Figure 4: Classification of costs

Source: Own depiction

Figure 4 explains the structure of total costs, which consist of direct costs and indirect costs. Direct costs are inseparably linked with the cost object (i.e. products, customers, departments, projects, or activities). They comprise of variable and fixed costs. Direct variable costs fluctuate corresponding to the level of activity; the variability is proportional to production. Direct fixed costs remain constant irrespective of changes in the level of activity. Overhead lumps all costs other than direct material and direct labor into one category called indirect costs. Again, there is a differentiation between variable and fixed costs. Indirect variable costs rise and fall corresponding to the level of activity but are not directly linked to the cost object. Indirect fixed costs occur regardless of the activity level. The adjustment of overhead is a mid- to long-term effort, which means it takes more than one year to see noticeable change. (Hansen & Mowen, 2015; ICAI, 2012).

Overhead costs are indirect costs and are needed expenses for operating a business (i.e. costs not directly related to the sellable cost object – in a broader sense, the manufactured product or the delivered service and not variable during the period of one year) that range from

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rent to administrative costs to marketing costs. Overhead costs refer to all indirect non-labor expenses required to operate the business.

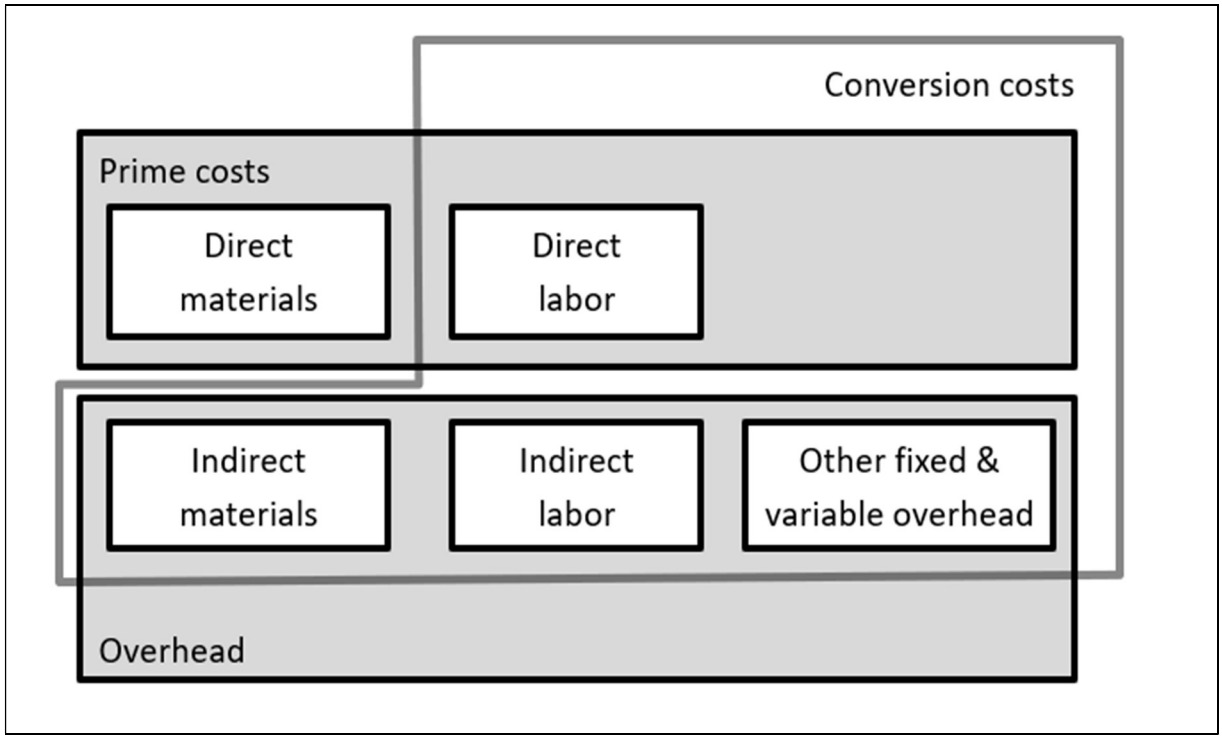

Figure 5: Concepts of prime costs and conversion costs

Source: Own depiction

Figure 5 groups elements of direct and indirect costs into prime costs, overhead, and conversion costs. Prime costs add up by direct material and direct labor. Both can immediately be assigned to the cost object being sold. Overhead consists of indirect materials, indirect labor and any other fixed & variable overhead; it requires driver-tracing or allocation to assign the overhead to the cost object. Conversion costs consist of direct labor and overhead costs; for a manufacturing firm, it can be interpreted as the cost of converting raw material into a final product (Hansen & Mowen, 2015; Horngren, Datar, & Rajan, 2015).

The product cost calculated in accordance with the Generally Accepted Accounting Principles (GAAP) are needed to evaluate the inventories of the different states of the products (i.e. raw, WIP, finish goods; MRO supplies) for the balance sheet; and to calculate the cost of goods sold on the income statement.

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Table 1: Summary of different types of costs

Cost types	Meaning/relevance for the dissertation	Source
Conversion costs	It is the sum of direct labor and overhead costs.	Cornerstones of Cost Management (Hansen & Mowen, 2015)
Opportunity costs	The profit missed by choosing one alternative instead of another; the net return that could be earned if a resource were brought to its best alternative usage.	Business Research (Günther, 2014)
Overhead	All costs other than direct materials and direct labor are lumped into one category called overhead.	Cost and Management Accounting (ICAI, 2012)
Prime costs	It is the sum of direct material costs and direct labor costs.	Cornerstones of Cost Management (Hansen & Mowen, 2015)
Relevant costs, also called differential costs or incremental costs	A differential cost for a particular decision that changes if an alternative decision is chosen.	Cost and Management Accounting (ICAI, 2012)
Sunk costs	Already incurred costs; sunk costs are irrelevant for all decisions, because they cannot be changed.	Effektives Gemein-kostenmanagement (Gleich & Marfleet, 2013)

Sources: see table, third column

Table 1 concludes the different types of costs in context to the dissertation. This insight influenced and inspired the elaborated design of the conceptual framework in Chapter 2.6. Overhead costs is an imprecise term with respect to meaning and clarity, which will become apparent during the analysis of the income statements of the involved companies in Chapter 4.7. In the next section, the evolution of overhead costs management is examined for the research topic.

2.3 Evolution of overhead costs management

The modern approach towards overhead costs management broke ground with Activity-based costing (ABC) in 1985 by the publication “The Hidden Factory – Cutting the explosive growth of overhead costs requires mastery of more than just what happens on the shop floor” (Miller & Vollmann, 1985) in the periodical *Harvard Business Review*. The authors laid out that the ongoing automation efforts had substantially increased the overhead costs of an industrial organization. Their long-term study demonstrated that the overhead as a percentage

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of value added had risen from around 50% in 1850 to almost 80% by the mid 1980s. Other sources state that the trigger for innovations in cost accounting was the rising Japanese competition observed by Western enterprises, particularly in the automotive and electronics industries. The initial assumption that unfair competition and low wages were the reasons for the success of the far-east enterprises turned into the discovery that outdated accounting systems drew the focus to the wrong, hence unsuccessful, products (Turney, 2010).

The German version of an advanced method of cost accounting of overheads became popular under Prof. Horváth – born in Sopron, Hungary, Professor in Stuttgart, Germany – who published with Prof. Mayer in 1989 new ways for more transparency of costs and, hence, more effective production strategies. The authors called their method Prozesskostenrechnung (germ.), which stands for a process-oriented assignment of activities to cost objects (Horvath & Mayer, 1989).

Time-driven activity-based costing (TD-ABC) is a further development of ABC, which primarily uses the factor of time for all assignments of costs to sellable cost objectives (Gosselin, 2006). The aim of TD-ABC is the response to the criticism directed towards the ABC method, mainly regarding the effort and the complexity of implementing and maintaining it. The purpose of TD-ABC is to monitor labor time in a highly repetitive work environment (Hoozée & Hansen, 2018; Siguenza-Guzman, Auquilla, Van den Abbeele, & Cattrysse, 2016).

Sticky costs describe the asymmetric behavior of an organization concerning how to accrue and remove costs (Banker & Byzalov, 2014). It is often associated with overhead costs, which are easy to obtain but hard to reduce. The dynamics of increasing and decreasing work along a hysteresis loop are explained in 2.3.4.

2.3.1 Activity-based costing

The central purpose of activity-based costing is to determine the actual costs of a value creation process. It uses average processing times (which is the major difference to the later described Time-driven ABC). ABC is often used in repetitive industries since it enhances the accuracy of cost data. It helps to produce nearly true costs and classifies the costs incurred by the company during its value creation process. ABC is a method of assigning overhead costs to sellable products and services.

The missing link within the situation in an Industry 4.0 environment (see Figure 9 on page 28) is the practical interpretation of the vast amount of data that is generated by the

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numerous activities. The average processing times, which are applied in ABC are just a shortcut in absence of the available computer/database integration in the 1990s. The question arises whether the method needs a re-work in order to reflect the capabilities of modern AI algorithms.

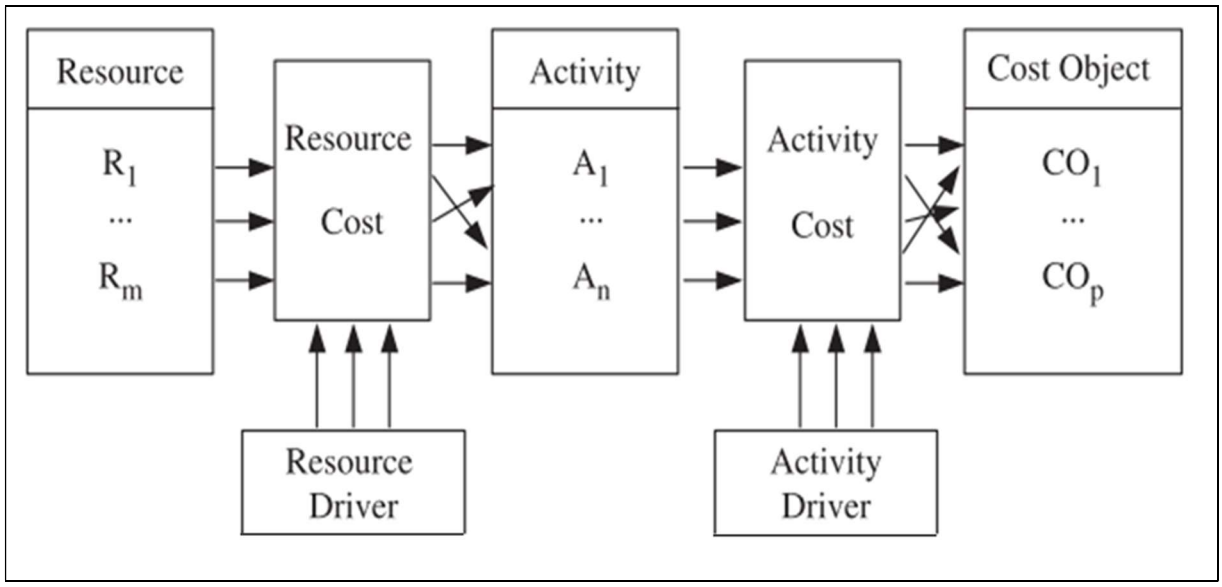

Figure 6: Generic model of Activity-based costing

Source: Own depiction

The ABC system (see Figure 6) assigns resources to cost objects by using resource, resource cost, resource driver, activity, activity cost, and activity driver. It is based on activities, which consider any event, unit of work, or task with a specific goal (e.g. performing purchase orders or machine setups). The cost driver rate is the total of the activity cost pool divided by the overall number of activities in a certain period; it is used to calculate the amount of overhead costs related to the activities of a business process for this cost pool. ABC helps to gain an overview of costs, allowing companies to determine a compelling pricing strategy (Barth, Livet, & Guio, 2008).

2.3.2 Prozesskostenrechnung

Prozesskostenrechnung is a sophisticated two-level model introducing main-processes and sub-processes (Horváth, 1998; Horváth & Mayer, 2011). Based on an analysis of activities, bottom-up sub-processes are then defined (e.g. placing a purchase order). These sub-processes are then aggregated at the next higher level to a main process (e.g. purchase-to-pay).

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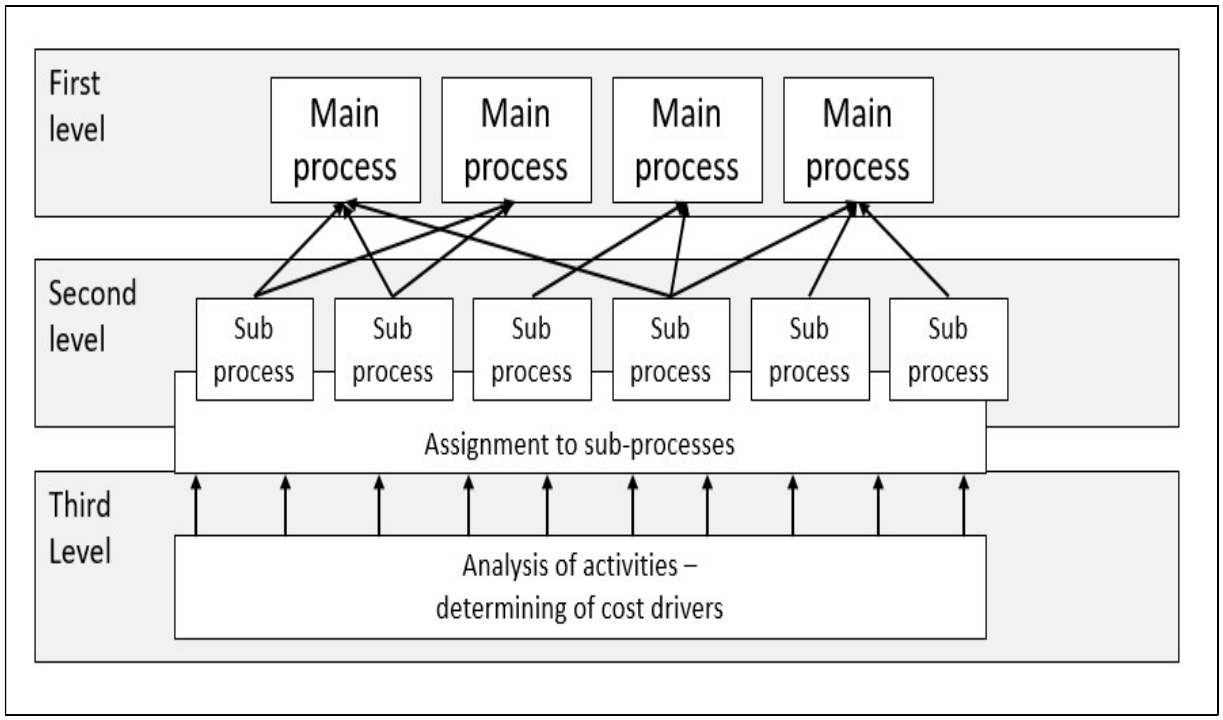

Figure 7: The three conceptual levels of Prozesskostenrechnung

Source: Horváth, 2011, p. 485; slightly modified

Figure 7 depicts the three different levels starting at the bottom with the analysis of activities. The subprocesses (often) take place in an organization entity, such as in a department. The main process occurs across several departments. Cost drivers indicate the consumption of resources, which quantifies the cost of the process. This approach is helpful if overhead costs need assignment to a value creation process. The application of Prozesskostenrechnung fits best for highly repetitive activities in indirect areas of an organization. It delivers focus on the essential activities for value creation within the organization.

2.3.3 Time-driven activity-based costing

TD-ABC uses time consumption functions, which allocates pre-set periods of times to subprocesses based on equitable time-consumption. For example, the time consumption function for order acceptance considers the different processing time for new customers or for existing customers (Hoozée & Hansen, 2018). For this purpose, the time consumption function reflects next to the base rate an additional processing time if a new customer is activated. Furthermore, customer-specific information can be incorporated into the time consumption functions (Siguenza-Guzman et al., 2016). Once the time-consuming function of the processes

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has been established, the costs of the respective processes can be determined by multiplying the processing time with the hourly rate for this process.

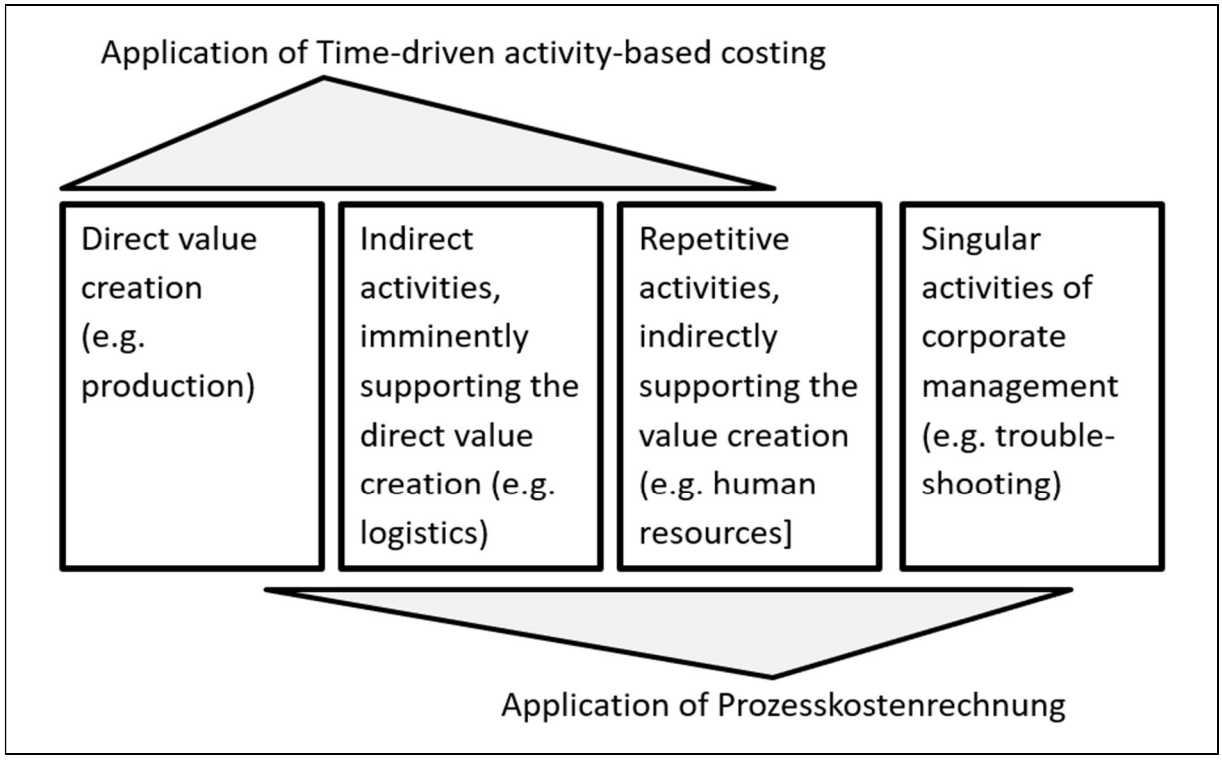

Figure 8: Application of time-driven activity-based costing

Source: Horváth, 2011, p. 484, slightly modified

Figure 8 depicts the different areas of applications of TD-ABC and PKR. The range for TD-ABC goes from direct value creation to repetitive activities (Monroy, Nasiri, & Peláez, 2014). Prozesskostenrechnung covers basically the same areas, however additionally offers an application for singular activities of corporate management.

2.3.4 Sticky costs

The term sticky costs describes the asymmetric cost behavior in industrial organizations. It is often, but not exclusively, associated with overhead costs. The accumulation of sticky costs happens easily as the level of activity increases (Ciftci & Salama, 2018). Yet, as the activity decreases, it is hard to reduce the costs by the same amount as the cost built-up occurred (yet, most certainly, by the same level of activity); therefore, they are disproportionate or 'stick' to the organization. Many, but not all, costs arise because decision-makers commit to resources. Some commitments to resources can be altered on short notice, however have costly ramifications (e.g. changing an already started production run, costs for installation/disposal of

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capital equipment, severance payments to laid-off employees, training costs for new employees). Therefore, in order to soften the consequences, some costs remain within the organization, even if the level of activity does not justify them anymore. They stick in the organization based on leadership behavior. Overhead costs are associated with sticky costs because of their long-term nature.

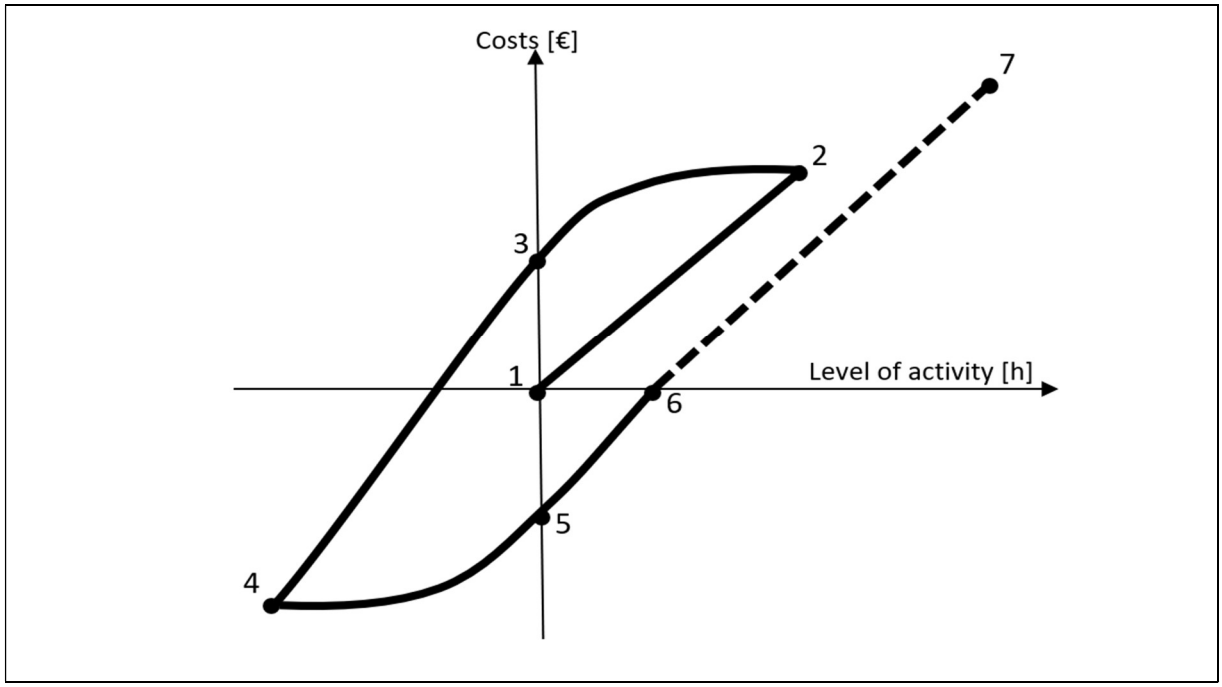

Figure 9: The dynamics of sticky costs

Source: Banker & Byzalov, 2014, p. 18, own interpretation

Figure 9 displays the dynamics of sticky costs, also known as asymmetric cost behavior (Banker & Byzalov, 2014). The starting point is at 1. As the level of activity increases, costs for resources are spent to reach point 2. Afterwards, as the level of activity decreases the installed costs (i.e. overhead) remains hesitantly within the organization, therefore sticky. Only a gradual reduction is accomplished down to point 3, which is from a level of activity point of view the original starting point, yet with higher costs. An aggressive cost cutting program may reduce the costs to point 4, which is proportional to the corresponding level of activity (i.e. few costs and also fewer employees). This cost level might be defended for some time even if the level of activity increases. At point 5, the increase in efficiency is visible, the same level of activity as at 1 is performed but at significantly lower costs. The same is true at 6, although now more activities are completed with the same costs as at point 1. Finally, point 7 is the starting point of a new hysteresis of sticky costs.

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2.3.5 Summary on overhead costs management

The contemporary evolution of overhead costs management starts with ABC followed by Prozesskostenrechnung. Both approaches (Miller/Vollmann and Horváth/Mayer) have the same intention. They aim to shed light on the steadily increasing costs of overhead. The American approach has a rather robust, operational approach, using primarily cost drivers on a full cost basis. The German method uses a comparatively sophisticated two-level model with main-processes and sub-processes. TD-ABC applies time consumption functions. Sticky costs address the behavioral dimension of cost management.

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Table 2: Summary of requirements on overhead costs management

Requirement	Context	Source
Clarity	Achieving clarity may prevent disputes regarding cost-reimbursement contracts, income tax payments, and labor council matters.	Cost Accounting - A Managerial Emphasis (Horngren et al., 2015)
Ease of use	With the use of overhead costs systems, the businesses expect an easy/mostly self-explanatory application. Only the needed functionality without time-extensive trainings are required.	Journal of Accounting & Organizational Change, (Byrne, 2011)
Expandability	It is expected that the overhead costs system works together with existing software solutions in the company. The compatibility of advanced planning applications in conjunction with available systems is a must, especially the mutual access to the same set of master data.	SSRN Electronic Journal (Somohano & Martinez Garcia, 2016)
Functionality	The businesses expect an easy and traceable allocation of the overhead costs to the cost object. Additionally, the simulation of different scenarios is desirable to use it for pricing strategies.	Journal of International Studies (Novák, Dvorský, Popesko, & Strouhal, 2017)
Optimization of processes	The proper maintenance of master data enables the organization to tweak the optimization of activities and processes. Reliable cost transparency is the major objective.	The Business Process Management Guidebook (Breyfogle, 2013)
Resource expenditure	Standard office packages are preferred. Advanced ERP solutions like SAP Hana are an option if needed; no additional /expensive hardware is mandatory.	Cost Management Accounting and Control (Hansen & Mowen, 2006)
Social aspects	With the use of overhead costs system, the businesses expect active involvement of the employees. Ideally, it acts as employee motivation to deliver extraordinary value for the general good. On the other side it is considered as undesirable that the employees feel observed, 'spied on' with such a system.	Journal of Cleaner Production (Sierra, Yepes, & Pellicer, 2018)
Time effort	For the daily operation, no more time than two hours per week are allotted to track and maintain the cost allocation. As a reference, 30-40 seconds serve as a benchmark for each transaction.	24th Annual Conference of the International Group for Lean Construction (Kim & Kim, 2016)
Velocity	Velocity is the number of units of output that can be produced in each period of time (units produced/time). With incentives to reduce product cost, organizations find ways to increase velocity.	Cost Management Accounting & Control (Hansen & Mowen, 2006)

Sources: see table, third column

Table 2 concludes the review on evolution of overhead costs management with essential requirements found in literature. Several requirements demand simultaneous consideration. This insight influenced and inspired the elaborated design of the conceptual framework in Chapter 2.6. In the next section, the impact of the transaction cost theory is examined for the dissertation.

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2.4 Transaction cost theory

Transaction costs are defined as a cost in making any economic trade when participating in a market in connection with the transaction of rights of disposal (e.g. purchase, sale, rent), or an in-house hierarchy (i.e. managerial transaction costs). Oliver E. Williamson developed the transaction cost theory (TCT) in the 1970s, which led to him being awarded the Nobel Memorial Prize in Economics in 2009. The transaction cost theory addresses the issue why some economic transactions should take place within firms and other transactions preferably occur between firms, that is, in the marketplace. The theory lays out when an organization should control the decisions, or when the market should have decision power (Williamson, 1981). Transaction costs stand for those costs arising from the use of the market (i.e. in connection with the transaction of rights of disposal), or an in-house hierarchy. (A discussion follows in the section 2.4.1.) For overhead-cost management, the transaction cost theory is relevant because it addresses the issue of cost types depending on the governance model. For example, it reflects the needed overhead to run a purchasing department, which participates in the marketplace. In terms of the previously covered classification of costs, these expenses of the purchasing department are indirect fixed costs. If an in-house hierarchy is used in terms of a production department, the costs of direct material and direct labor are prime costs and therefore direct costs. The governance model concerning how to run and control the business from an administration point of view inflicts transactions costs that depend on uncertainty.

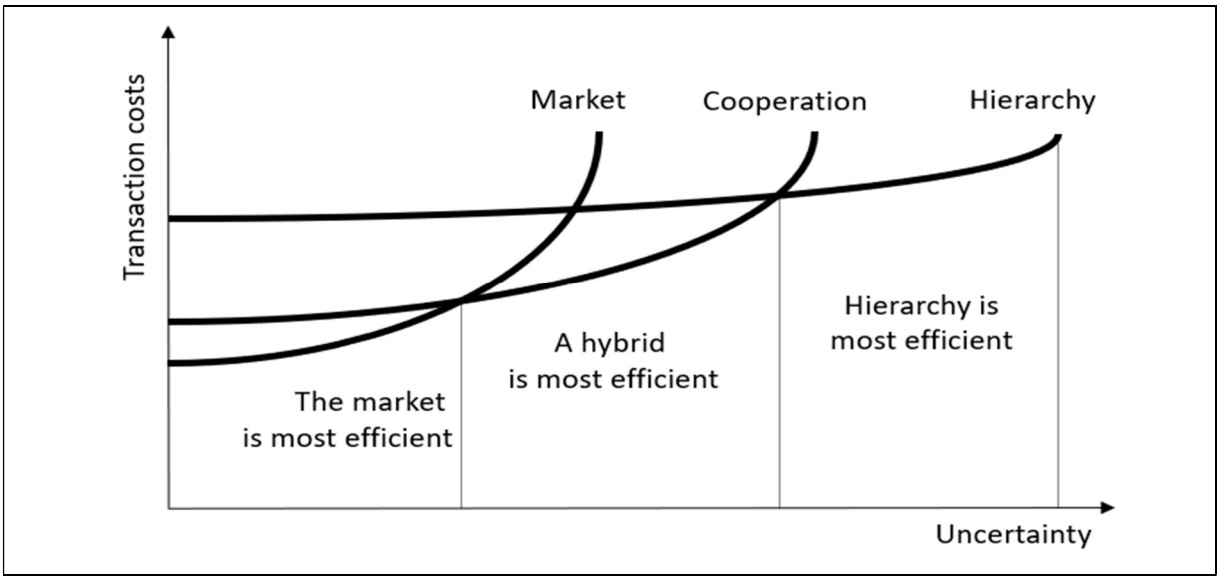

Figure 10: Transaction cost theory governance model

Source: Picot et al., 2002, p. 15; Williamson, 2007, p. 17, slightly modified

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Figure 10 explains three different scenarios – market, cooperation, or hierarchy – along the horizontal axis, which stands for uncertainty. The theory assumes that the transaction costs are the lowest in a market scenario if the uncertainty is low (e.g. commodities). On the other hand, when products and/or services have a high level of uncertainty (e.g. engineer-to-order product), the hierarchy scenario offers the lowest transaction costs.

2.4.1 Economic transaction

The Institute for Research on World-Systems at the University of California in Riverside explains economic transaction as the "transfer of goods, the rendering of services (including saving and risk taking), and transfers of money and other investments between residents" (IRWS, 2014). There are two categories: (1) transactions involving two-way transactions and (2) transactions involving one-way transactions. The first (two-way transactions) contains (a) sales of goods or the consumption of services against monetary payment, credit instruments, or titles to investment (i.e. capital items), (b) bartering, which is the trade by exchange of goods or services rather than by the use of money, and (c) the interchange of capital items (e.g. sales of one currency against another, sales of securities against money, or the disbursement of incurred commercial debt). The second (one-way transactions) stands for (d) gifts in kind, (i.e. goods and services), (e) gifts of money and other capital items.

Williamson defines economic transaction as "when a good or service is transferred across a technologically separable interface" (1985). The termination or closure of an activity means the beginning of another or the next one. The transaction cost materializes at the interface, comparable to the friction on surfaces of a mechanical machine.

Halin takes the transfer of property rights into account, in addition. A transaction is "the exchange of goods and services, including the property rights of the individual goods and services. Accordingly, a transaction is a process that consists of one or more activities to clarify, to plan, and to implement the exchange relationships with economic, legal, and social implications" (Halin, 1995). This definition has the broadest scope; and it is used for the thesis. In particular, the identification of the transaction as a process containing activities applies perfectly for overhead costs management, which is process oriented as well.

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2.4.2 Causes of transaction costs

The reasons for negotiation, fraud, communication, and contract stipulation is the fact that knowledge is incomplete and not always commonly available. The importance of information is undisputed, but the role of information might be misleading in the discussion of transaction costs. Information costs are mandatory for transaction costs; information costs are a necessary condition for the presence of transaction costs. However, information costs are not always transaction costs. Steven Cheung commented that transaction costs are costs that cannot not prevail without information (Allen, 1999; Cheung, 2018).

Yoram Barzel encouraged a strong distinction between information and transaction costs. Information costs stand for the value of the information. The transaction costs cover the costs necessary to formulate and to manage contracts (i.e. information). It is possible to have information issues resulting in speculation, ignorance and insensitivity, which may result in a reduction of social value of the information, however these reductions are impossible when transaction costs are zero. With zero transaction costs, contracting is the perfect vehicle for information because contracts can be made over all contingencies. Information costs are at the source of transaction costs because they induce measurement based on the value of the information. Once the differentiation between information costs and transaction costs is defined, these consequences follow: information without costs means total property rights; information with costs means transaction costs hold self-imposed constraints; personal honesty does not automatically exclude transaction costs; and total costs, not only information or transaction costs, need minimization. Goods and services are complex clusters of characteristics that are alterable by individuals and variable in nature. (Allen, 1999; Barzel, 1977, 1985, 2012)

2.4.3 Structure of governance

Markets provide stronger incentives to minimize production costs. In contrast, hierarchy or vertical integration, which is the ownership of stages along the value creation process across different industries, enables a cost-effective governance structure for the transactions. The central recommendation of TCT is that the governance structure for a TCT postulates that market governance of transactions may disrupt an efficient investment in transaction-specific assets. This is caused by the opportunistic behavior of the market participants. Nevertheless, contracts can protect transaction-specific investments to some

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extent, however there is limited capability to cover all possible contingencies. As contracts become more flexible, they concede higher risk for opportunism. Therefore, asset specificity, combined with the risk for opportunism and limited contractual capabilities, influences the efficient governance structure to vertical integration. Yet, the internal limited capability curtails the number of activities controlled within a single organization. Therefore, companies should incorporate only transactions that they govern more effectively than through contracts or markets. Consequently, organizations based entirely on markets or on vertical integration are vulnerable concerning limited own technical capability. Production costs tend to decrease as the business moves toward the market because the market incentivizes the minimization of costs by greater economies of scale by means of an external provider, who serves multiple customers. The business management literature indicates that external suppliers may provide additional benefits like improved performance because of specialization in their field of expertise. (Foss & Weber, 2016; Ketokivi & Mahoney, 2017; Teece, 2019; Um & Kim, 2018)

Transactions should be chosen to maximize the value by minimizing cost of production and transaction. Thus, for making decisions in favor of or against outsourcing, it is key to consider not only the internal or external costs of providing the goods or services but also the costs of managing the transaction internally or externally (Berenjforoush, 2014; Corley & Gioia, 2011).

2.4.4 Summary on transaction cost theory

The literature review of transaction cost theory provides the dissertation with a theoretical foundation. Overhead costs depend on the boundary condition where and when they occur. Hierarchy, or vertical integration, drives the creation of overhead costs. The market on the other side of the spectrum of TCT inflicts direct costs when purchasing goods or services.

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Table 3: Summary of relevant concepts derived from transaction cost theory

Concepts	Context	Source
Governance	Establishment of an appropriate governance is of great help in stabilizing a relationship and strengthening the performance of overhead.	International Journal of Production Economics (Um & Kim, 2018)
Market	Cost and value are interdependent terms; both must be understood when choosing customers and markets. This is particular true for overhead costs.	From Cost to Performance (Stenzel & Stenzel, 2003)
Social implications	Overhead structures in businesses are closely associated with the culture and attitudes of the organization. Well established routines have led to the current style of operation.	Managing indirect costs (Grant, 2010)
Uncertainty	Change, – internally and externally - that impacts an entire organization, generates more uncertainty than any other activity.	SIAM Journal on Control and Optimization (Hernández-Santibáñez & Mastrolia, 2019)
Vertical integration	With Industry 4.0, the companies, departments, functions, and capabilities become much more attached to each other; inter-company, global data-integration networks evolve and enable genuinely autonomous value chains. Consequently, it drives overhead upwards.	BCG-The Boston Consulting Group (Waldner, 2015)

Sources: see table, third column

Table 3 concludes the input from the transaction cost theory. Several concepts need simultaneous consideration, which is a complex and genuine effort. For the first time, the term Industry 4.0 has been utilized in connection with concepts.

Subsequently, I will lay out the structure of Industry 4.0. The question arises: where does I4.0 start and were does it end? It helps to apply a supply chain management perspective, which contains, on the one hand, suppliers and, on the other hand, customers. In between is the value creation process that needs to be seen within a global context. Smart logistics, smart materials, smart grids, smart factories, smart buildings, and smart products belong to the external view. Smart, in the context of Industry 4.0, means digitalized capabilities, a prerequisite for digitalized processes and services. The entire landscape along the horizontal integration additionally contains competitors and business partners, who are not necessarily suppliers or customers. From an internal view, the cyber physical production system (CPPS) is the core for enabling vertical integration. It starts with strategic planning, engineering/lifecycle

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management, production planning, and smart production. The following figure displays the various aspects of I4.0.

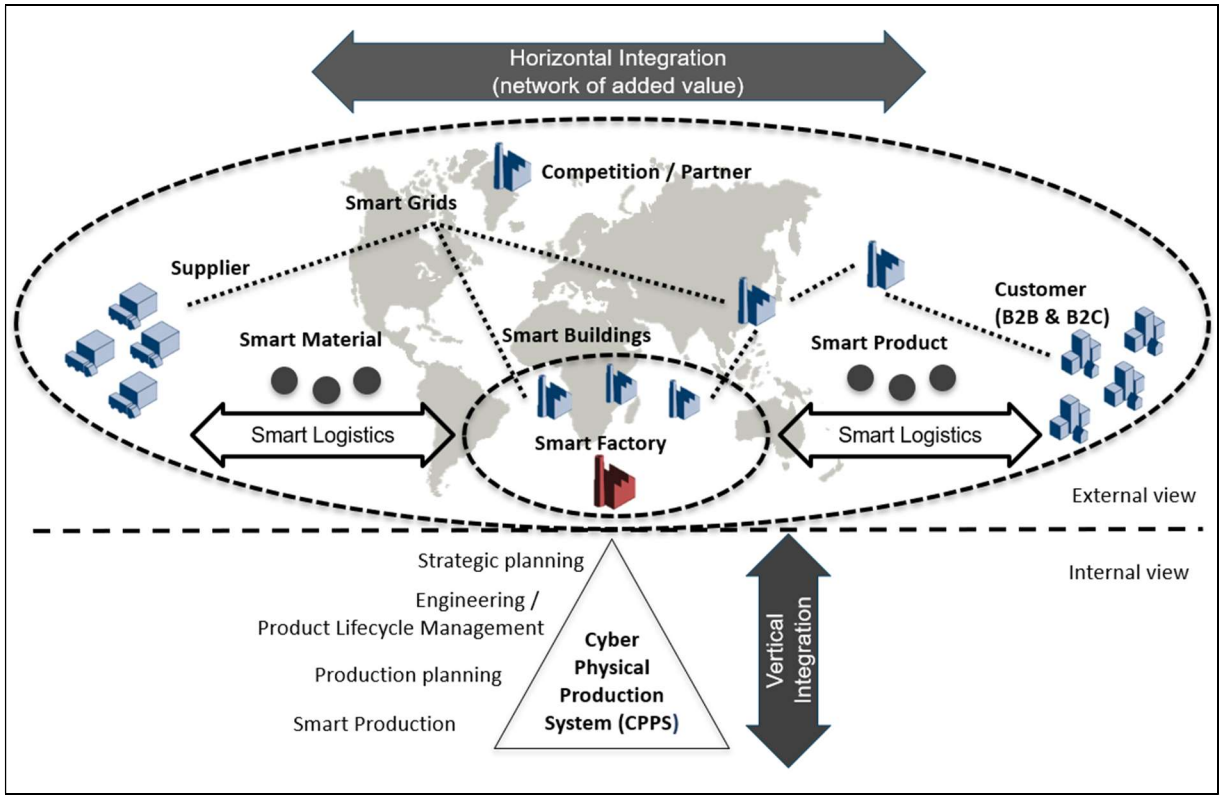

Figure 11: What is inside of Industry 4.0

Source: Waldner, 2015, p. 6, modified

Figure 11 demonstrates in context the terminology used in TCT. Above the horizontal line is the external view of I4.0; it shows the transaction between independent legal entities. Below the line is the internal view of I4.0; there, vertical integration links the different levels from strategic planning to smart production, using CPPS. The picture helps to establish the governance model as a reference point for the following research. All items in Figure 9 have in common that they are interlinked by digital means. Therefore, digitalization is a key attribute of Industry 4.0. This insight influenced the design of the conceptual framework in Chapter 2.6.

2.5 Summary of literature review

The literature review informed the dissertation in two fields: the status-quo of overhead costs management tools and transaction cost theory. The following table sums up advantageous and disadvantageous features and links the review items to the corresponding hypotheses.

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Table 4: Advantageous and disadvantageous features

Review item	Advantageous ++ Disadvantageous --	Underpinning which hypothesis? – Because?
ABC	++: hands-on, quick --: unprecise, creates more dust than clarity	H1: raises the question of innovation H2: associated with digitalization H3: examines the entities/requirements
PKR	++: sophisticated model, precise --: produces lots of data, easy to get lost in the amount of data	H1: raises the question of innovation H2: associated with digitalization H3: examines the entities/requirements
TD-ABC	++: clear focus concerning unit of measurement (time) --: limited use, only for repetitive industries	H1: raises the question of innovation H2: associated with digitalization H3: examines the entities/requirements
Sticky costs	++: compelling concept, links to management behavior --: abstract, needs data model	H1: raises the question of innovation H2: associated with digitalization H3: examines the entities/requirements
TCT	++: explains make-or-buy, determines governance model --: missing link to digitalization	H1: interacts to uncertainty H3: addresses the effect on overhead

Source: Own research

Table 4 points out for each review item the pros and cons by underpinning the hypotheses for further research. The research gap is identified as the following: (1) The methods of overhead costs accounting reach back several years; they reflect the current situation that overhead costs accounting is complex and deals with a large quantity of data. Nevertheless, the recent development of digitalization is missing. (2) Transaction cost theory addresses the issue of governance model that drives make-or-buy decisions. The literature discusses the vertical integration and the social implications but not the connection to Industry 4.0 from an overhead cost point of view.

2.6 Conceptual framework

The review and discussion of the literature, combined with my own insights and experience, have assisted to develop a conceptual framework for conducting the research and designing the dissertation. The conceptual framework developed for the dissertation helps to shape and sharpen the research process, to inform the design from a methodological perspective, and to determine the used instruments for data collection. Furthermore, the conceptual framework turns into the repository for the collected data, provides the foundation for the coding scheme and allows for various iterations of coding. Therefore, the conceptual framework accommodates an organizing structure for collecting the dissertation's findings, for the analysis, interpretation, and synthesis of the analytic categories. Further, the conceptual

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framework organizes the results of the dissertation, which allow the formulation of the conclusions, stated as theses in Chapter 6. From this perspective, the conceptual framework is the 'work horse' of this dissertation.

Table 5: Conceptual framework of the dissertation

Theme Research question Hypothesis Entities
Theme: Impact of digitalization on OH RQ1: How does the digitalization of processes impact the management of overhead costs? H1: Innovation (e.g. digitalization) drives the percentage of overhead costs continuously upwards. • Not at all • Somewhat • Heavily
Theme: Knowledge, skills, governance, attitudes RQ2: What are the limitations of the current approaches of the management of overhead costs in respect to methods and tools? If there are limitations, what can be done to overcome them? H2: The surge of digitalization has an impact on related methods and tools. • ABC • PKZ • TD-ABC • Sticky Costs • Satisfaction
Theme: Success factors RQ3: In general, what are the prerequisites for the successful management of overhead costs? H3: Digitalized services have a direct effect on overhead costs. • Speed • Transparency • Usability

Source: Own research

Each entity of the conceptual framework in Table 5 applies to the dissertation's research questions and the hypotheses as outlined in Chapter 1. The first research question seeks to find out how digitalization of processes impacts the management of overhead costs. Therefore, the theme to capture responses to this question is "Impact of digitalization on OH". The second research question seeks to identify what limitations of the current approaches of overhead costs management exists, with respect to methods and tools. The theme titled "Knowledge, skills, governance, attitudes" is all-encompassing and thus appropriate. The third research question is intended to uncover what the prerequisites for the successful management of overhead costs

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are. Hence, the theme is “Success factors”. The entities speed, transparency, and usability relate respectively (in the corresponding sequence) to the requirements velocity, clarity, and ease of use from the literature review in Table 2.

Further, to elaborate on each of the themes, I consulted the literature and challenged the pilot test data. The bulleted entities for each theme represent possible responses to the research questions. During the process of data collection, analysis and synthesis, some of the entities of each theme were added, others were deleted, and some were collapsed. Consequently, the conceptual framework perpetually evolved over time to fit the purpose. The completed conceptual framework is included as Appendix G.

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CHAPTER 3

RESEARCH METHODOLOGY

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3 Research methodology

The purpose of this dissertation is to explore with a sample of enterprises their perceptions of how the digitalization of processes impacts the management of overhead costs. Research methodology includes the identification of relevant concepts and theories, research methods and strategies that are well-tested in business studies, significant controversies, and potential research gaps (Bell, Bryman, & Harley, 2019). I postulate that a sophisticated understanding of the phenomenon in question would allow businesses (and others as well) to succeed from a more knowledgeable perspective in terms of ramifications and success factors of overhead costs transparency projects. In seeking to understand this phenomenon, the dissertation addressed three research questions. The research methodology uses qualitative and quantitative data and methods in order to answer the research questions. The following tables contains the different data sources, the reasons why they were used, the first occurrence, and the unit of analysis.

Table 6: Overview of used data sources

Data source	Used to…	Where, first used?	Unit of analysis
AlixPartners	set the context on a worldwide level	Service as a percentage of sales (Figure 32)	Global
Annual reports	validate findings from qualitative research	Overhead in percent (Figure 26)	Companies of the informants
BACH	triangulate the findings with a broader database	Panel of bank for the accounts of companies harmonized (Figure 13)	Austria, Slovakia
Statista, data volume	set the context on a worldwide level	Volume of data annually (Figure 28)	Global
Statista, R&D	set the context on a worldwide level	Percentage of R&D spending (Figure 30)	Global

Source: Own depiction

Table 6 contains five different data sources, which supported the dissertation with quantitative data. The sources for the qualitative data are provided in Table 9.

This chapter describes the dissertation's research methodology and includes discussions around the following areas: (a) rationale for the qualitative research design, (b) rationale for the quantitative research design, (c) rationale for the case study design, (d) explanation of the research sample, (e) information needed to conduct the study, (f) overview of the applied

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research design, (g) literature review, (h) income statement analysis from an overhead costs perspective, (i) data collection methods, (j) methods for data analysis and synthesis, (k) ethical considerations, (l) issues of trustworthiness, (m) coherent methodology, and (n) constraints of the dissertation. The chapter concludes with a summary which contains an overview for each research question and the applied research methods.

3.1 Rationale for qualitative research

A constructivist philosophical position is the foundation for qualitative research; it is concerned with how sociocultural complexities in the world are perceived, remembered, interpreted, and appreciated in a specific context at a certain point of time. Constructivism takes the ontological point of view that social phenomena are made real by social actors; their meaning is continually accomplished in a constant state of revision. The intent of qualitative research is to discover or unearth social ramifications; it enables the researcher to enter into the perceived world of others and aims to gain a holistic understanding. It contrasts with a reductionist understanding intended by quantitative research, see next section (Bell et al., 2019).

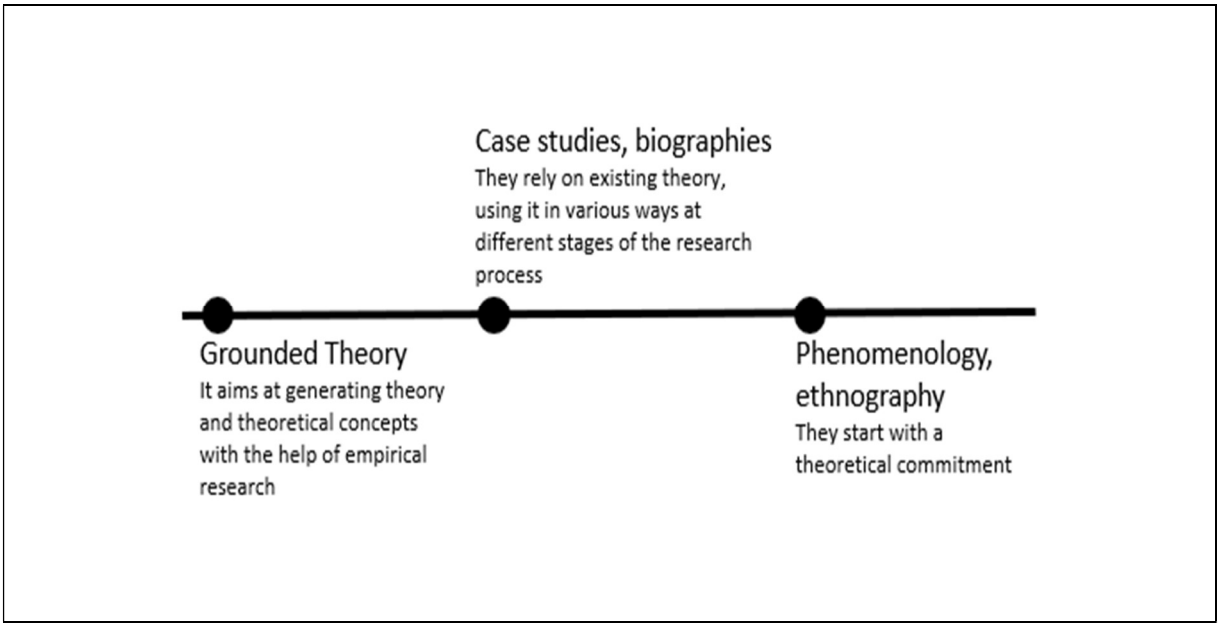

Figure 12: Continuum of the use of theory within different qualitative research approaches

Source: Chigbu, 2019; Creswell, 2014

Figure 12 shows where case studies, and likewise multi-case studies, are located in the continuum of qualitative research approaches. On the left, Grounded Theory dominates the field of inductive research by creating mid-level theories. On the right, phenomenology/ ethnography starts with a theoretical commitment that is then described based upon the

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practical findings. Case studies in the middle rely on existing theory (e.g. transaction cost theory), however produce a new understanding for a specific practical setting.

Qualitative research in business and management studies have become more and more popular since the late 1990s. Specialist journals like *Qualitative Research in Organization and Management*, and a number of text- and handbooks deliver plenty of evidence. It has proven suitable for citation analysis, data collection (e.g. interviewing, focus groups, diaries), qualitative content analysis, theory elaboration, and theory generation. Greater standardization, increased methodological and scientific rigor, and validity are associated with this trend (Bell et al., 2019; Cassell, Cunliffe, & Grandy, 2018).

I was concerned that purely quantitative methods would be unlikely to extract the rich data necessary to acknowledge the proposed research purpose. In my opinion, the research questions were well suited to the qualitative research design, with respect to the following features: (a) comprehending the research processes by what point in time specific events and activities need to take place, (b) developing a deep understanding of the context, (c) facilitating bilateral exchange between the interview partners and me, (d) endorsing an interpretive viewpoint, and (e) allowing for flexibility concerning the outcome.

3.2 Rationale for quantitative research

A quantitative research design applies sensitivity for the analysis of the data. Sensitivity analyses help to assess the robustness of the findings based on the data of the sample. The objective is primarily the testing of hypotheses in order to determine facts by designating and distinguishing relationships between variables. Descriptive statistics provides a quantitative range and puts the research findings into context with respect to their relevance. It describes the basic characteristics of the data in the dissertation by providing sample summaries and its measures. Simple graphics (e.g. boxplot diagram, funnel chart, time-series, tree map) form the basis of the quantitative analysis of data; they present quantitative descriptions, which are easily comprehensible. In the dissertation, there are various of measures used to capture relevant incidents. Descriptive statistics help to simplify the amount of data in a sensible way; it reduces a vast amount of data into a simpler, more easily readable summary.

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Table 7: Terms in descriptive statistics

Term	Explanation
Frequency	The number of times a certain value appears in a data set
Maximum	The highest or largest score in a data set
Mean	The average or the sum of the values divided by the number of values
Median	The middle score of data when set in numerical order. The middle position is found by ordering the scores, counting the number of scores, adding 1, and dividing by 2
Minimum	The lowest respectively smallest score in a data set
Mode	The most frequently occurring score in a data set
Range	The difference between the highest and the lowest score

Source: Regents of the University of Minnesota, 2020

Table 7 contains terms, which are used in the chapter on the presentation of findings. They form the quantitative foundation of the dissertation. The qualitative interpretation of the data uncovers the findings, which is constructed upon the quantitative foundation. The quantitative numbers could be used later for benchmark studies across industries and regions. For the sake of a solid triangulation of different methods, the dissertation applies a qualitative and quantitative approach, also known as a mixed methods approach.

3.3 Rationale for multi-case study methodology

The subject and purpose of the dissertation were deemed best for a multi-case study inside the framework of a qualitative research approach and a quantitative evaluation. From a research methodological point of view, a multi-case study is an intensive qualitative description, analysis, and syntheses of a phenomenon, social unit, or system confined by time or place (Creswell, 2014; Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Merriam & Tisdell, 2015; Miles, M. A., Huberman, 1994; Stake, 2013). As Merriam & Tisdell (2015) indicate, a qualitative case study is a fitting design for understanding and interpreting innovative business phenomena. As they describe it,

> *A case study design is employed to gain an in depth understanding of the situation and meaning for those involved. The interest is in process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation. Insights gleaned from case studies can directly influence policy, practice, and future research. (Merriam & Tisdell, 2015, p. 21)*

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The dissertation fits well with Merriam & Tisdell's criteria because it sought to better understand how businesses deal with the digitalization of processes with respect to overhead costs, the limitations of the current approaches and what can be done against them as well the prerequisites for the successful management of overhead costs.

3.4 The research samples

The dissertation's sample used a purposeful sampling procedure. Purposeful sampling applies the selection of participants from a pool of potential candidates; it is a typical method of case study methodology and yields the most information about the phenomenon encompassed within the study (Silverman, 2013; Welch & Patton, 1992). I sought to identify individuals from multiple industries. It led to a snowball sampling strategy, a.k.a. network or chain sampling (Miles, M. A., Huberman, 1994; Patton, 2015). When employed, individuals were asked to recommend other seasoned experts whom they assumed to be knowledgeable and interested in the evolution of overhead costs. The criteria for selection of participants were:

- All participants had to have at least 10 years of experience in the industry, and
- All participants had to have senior management responsibilities.

The discriminating time frame of 10 years was decided by me to ensure adequate experience in a business-professional environment. Purposeful sampling allowed for sampling across various locations and industries in Austria, Hungary and Slovakia. The research sample included 20 individuals from industries in seven branches, namely aviation, automotive (OEM), automotive (parts), beverage, chemicals, steel, and transportation/logistics. Additionally, variation across differentiating characteristics established the purposeful selection. All participants were of senior management capacity. Differentiating characteristics between them were along the following parameters: age, background, educational background, gender, and length of time spent in the current role.

3.5 Information needed to conduct the study

This research focused on 20 individuals from seven branches located in Austria, Hungary and Slovakia. In seeking to understand how these individuals have experienced the impact of digitalization on processes, three research questions were utilized to gather the information needed. The conceptual framework determined the needed information to answer

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the research questions; it fell into three themes: (a) the impact of digitalization on OH, (b) the knowledge, skills, governance, attitudes, and (c) the success factors. This information included:

- The impact of the digitalization of processes on the management of overhead costs, which includes the individuals' perceptions of what they needed to know.
- Limitations of the current approaches of the management of overhead costs in respect to methods and tools. And, if there are limitations, what can be done to overcome them.
- The prerequisites for the successful management of overhead costs with a perpetual consultation of the literature for the theoretical foundation of the dissertation.

These three themes serve as a repository for all found entities during the research, both qualitatively and quantitatively. They are the guideline for the results.

3.6 Overview of the applied research design

The following list compiles the seven steps used to perform the dissertation in chronical order. Consecutively in the next sections, there is a detailed discussion of each of these steps.

1. Prior to collecting actual data for the dissertation, a comprehensive review of literature in the fields of overhead costs management and transaction cost theory was performed to reflect the contributions of other scientific writers and scholars.
2. After the defense of the proposal, I received approval from the Joint Cross-border PhD Programme to move on with the dissertation. The approval confirmed the suggested steps of research containing the processes, procedures, methods, and tools to be compliant with current scientific standards for studies of socio-organizational subjects; it respects, in particular, the participants' confidentiality and their informed consent.
3. The potential participants were drawn from a pool of personal contacts and recommendations considered interested in and suitable for the subject matter. I reached out to them by telephone; those who accepted their nomination for participation received the survey by email. The survey collected demographic data, meta data of the businesses as well as perceptual data that supported addressing the three hypotheses, the development of findings, and answering the three research questions.

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4. Semi-structured, in-depth interviews were conducted with the first 20 participants, who turned in their survey. The interviews took place onsite or per phone with enterprises located across Austria, Hungary, and Slovakia in seven industries.
5. After each interview, the participants received critical incident instruments with the request to turn in further complimentary data at their own discretion. Of the 20 participants, nine responded.
6. Interview data responses were analyzed and coded within and between the interviews.
7. A focus group meeting was conducted with six professionals who were drawn from the pool of participants to cross-check and validate the data collected through the interviews.

Theses seven steps ensure a triangulation of participants and methods. Literature, income statement analysis, surveys, interviews, critical incidents, and a focus group (in this chronological order) are the cornerstones in accordance to the standards for the study of socio-organizational subjects.

3.7 Ramifications of the literature review

A continuous and selective review of literature accompanied the dissertation in order to illuminate relevant sources and knowledge bases. Two topics of literature were identified: overhead costs management and transaction cost theory. The constant review of needed literature was embedded as a parallel source of information for the dissertation. The focal point of the review was to build a better understanding of what inspired participants to further develop the complex of overhead costs management, the challenges, and the prerequisites inherent to field. It examined the effect on businesses and the methods accommodated to meet the challenges in dynamic economic environments under the influence of VUCA.

3.8 Income statement analysis

The income statement analysis was completed from a perspective of overhead costs impact. For the sectors of the sample enterprises, the income statement data of 2008, 2013, and 2017 were selected as provided by the BACH database system of the European Committee of Central Balance-Sheet Data Offices, short ECCBSO (www.eccbso.org).

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The BACH database system contains information from eleven countries of the European Union, namely Austria, Belgium, Croatia, Czech Republic, France, Germany, Italy, Poland, Portugal, Slovakia, and Spain. It holds general national data (e.g. GDP, income per capita), consolidated data of balance sheets, income statements, financial structure, financial and debt ratios, profitability, activity ratios, and capital ratios. The historical data reaches back to 2001. An interactive dashboard supports the efficient extraction of data. All data can be downloaded as PDFs, pictures, Excel spreadsheets or raw data. A print function is available as well.

Figure 13: Navigation panel of BACH, downloaded on Dec-28, 2019

Source: European Committee of Central Balance-Sheet Data Offices, 2020

Figure 13 shows the navigation panel of BACH, which stands for Bank for the Accounts of Companies Harmonized and contains harmonized annual accounting information from European non-financial corporations. The initial objective of ECCBSO was to foster the analysis of non-financial corporations' data by accomplishing tasks collectively, exchanging information mutually, and refining the processing techniques. The objectives were enlarged to

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cover the use of non-financial corporations' data to accomplish central banks' functions in such fields as economic and financial research, financial stability, statistics, supervision, and risk assessment. This database contributes to achieving the national statistical institutes' goals. Further, the objectives include the improvement of the analysis of non-financial corporations, the promotion of the effort carried out by the many national Central Balance-Sheet Data Offices belonging to the members of the European System of Central Banks (ESCB). It works together with the European Central Bank, Eurostat and the national statistical institutes to leverage synergies. They administer the information about the data entities (e.g. income statements) of non-financial enterprises as it is relevant for the functions of the ESCB and the Euro system. The European statistical system is supported as well. The chairman is elected every three years under the members of the institutions joining the committee. The secretary is safeguarded by the body whose representative has been elected as chairman; the mandate of the secretary serves as long as the chairman. The meetings of the ECCBSO take place at least once a year. In summary, the BACH database holds detailed income statement information.

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Revenue			**€100**
Less:	Direct costs (variable)		
	Cost of goods sold (COGS)		-35
	Gross margin		65
Less:	Indirect costs (fixed)		
	Operating expenses/SG&A		-25
	• Selling	15	
	• Distribution expense		
	• Selling expense		
	• Marketing expense		
	• General	5	
	• Rent, property taxes		
	• Utilities		
	• Postal charges		
	• Supplies		
	• Computer equipment		
	• Adminstration	5	
	• Salaries		
	• Benefits		
	• Wages		
	Operating income/EBIT		40
Less:	Other costs		-10
	Earnings before tax (EBT)		30
Less:	Taxes		-10
	Net profit/earnings after tax (EAT)		20

Figure 14: Reference income statement for the analysis

Source: BACH database system; slightly modified

Figure 14 shows the reference income statement, which is used in the findings and interpretation chapters to challenge the outcome of the qualitative survey as another database for data triangulation. The dynamics over time of the direct costs (i.e. COGS) played a pivotal role in understanding the development of overhead cost management. Further, income statements of selected enterprises of the participants were analyzed by line item and put into perspective.

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3.9 Data collection methods

The employment of multiple methods for the sake of triangulation is critical in gaining a solid understanding of the phenomenon under study. Moreover, it is mandatory for rigorously performed research, regardless if quantitative or qualitative. It sets the research effort on solid ground; similar to mechanical equilibrium that needs three contact points for steadiness. This grand design adds breadth, depth, and rigor to the dissertation and provides robust evidence of the collected data (Bell et al., 2019; Creswell, 2014; Denzin & Lincoln, 2011). Therefore, the dissertation used multiple and different data-collection methods; specifically, in the following chronological sequence: survey, interviews, critical incidents, and focus group.

3.9.1 Phase I: Survey

The potential participants were contacted by phone; all except for four agreed to contribute. I decided on an arbitrary limit of 20 participants in order to reach saturation of the research. As it turned out, 20 participants were sufficient. Practically the same results could have been explored with fewer participants, which became recognizable after the 14th interview. The 20 individuals received a questionnaire by email with the request to return the completed and scanned forms within four weeks. The questionnaire was designed to collect profile meta-data and it also asked participants about their perception of overhead costs. Along with the questionnaire, a contact letter including a recommendation from Professor Székely, and a research consent form was sent. These instruments of the survey appear as Appendix A, B, and C.

The distinct advantage of the survey methodology is the inconspicuous, modest, and relatively easily manageable process (Fink, 2013; Fowler, 2014; Willis & Boeije, 2013). Although, it must be emphasized that surveys are great for collecting meta-data (e.g. size of the enterprise, number of employees, percentages of key indicators), yet they have constraints in exploring complex social relationships. These constraints hold true for finding out the motivation for certain behaviors and/or complicated patterns of interaction. In order to enable a statistical description of the replies, the survey employed Likert-type scales. In order to stay consistent with the qualitative research tradition, the survey posed open-ended questions for each of the three themes. The intention was to seek and tap into personal experiences and shed light on participants' perceptions. The survey opened the data collection and has, therefore, a dedicated position within the dissertation's methodological design. It served as a useful

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introductory tool, as an essential puzzle-piece, along with other subsequent data-collection methods.

3.9.2 Phase II: Interviews

The primary method for data collection was the interview method within the dissertation. It was perceived that the direct interaction within the interviews had the most value for the dissertation because of its potentially colorful, rich, and thick responses as descriptions. Further, it gave me the opportunity to clarify answers in the survey, scrutinize statements, and find out more information (Creswell, 2014; Marshall & Rossman, 2016; Stake, 2013). Creswell (2014), Marshall and Rossman (2016), and Stake (2013) postulate that individual, in-depth interviews offer the advantage of capturing the interviewee's genuine perspective on the subject under study. The interview is a fundamental tool in qualitative research (Ginn & Munn, 2019; Seidman, 2013a). Ginn and Munn (2019) see the qualitative research interview as a means to dive into the world from the subject's point of view, to understand it and to unfold the meaning of the experiences of the interviewees. Similarly, Patton (1990) claims, "qualitative interviewing begins with the assumption that the perspective of others is meaningful, knowable, and able to be made explicit". My logic for using the interview method is that it offers an opportunity to satisfy my curiosity about the subject matter, to legitimately interact with people (i.e. to talk to and to listen to them), to generate desperately needed data for the dissertation, and to capture the authentic meaning of their experiences in their own voice.

Nevertheless, in addition to the undisputable strengths of interviews, there are constraints associated. Firstly, not everybody is equally articulate, cooperative, vocal and perceptive. Secondly, performing effective interviews is difficult and requires substantial training and preparation. Thirdly and lastly, interviews are not perfectly objective for data gathering. There is always, even when trying to mitigate it, a subjective touch to interviews as it results from the interaction between the interviewee and the interviewer and in the context it takes place (Fontana & Frey, 2005; Rubin & Rubin, 2012; Seidman, 2013a).

Interview Guideline of Questions and Pilot Interviews. With guidance from my supervisor, I used the dissertation's conceptual framework with the research questions and hypotheses to develop the interview guideline. I drew a matrix to illustrate the relationship between the dissertation's research themes and the interview questions. It was organized to include a low barrier opening question, essential aspects to be covered, and precise pre-

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determined questions for directly comparable responses. Three doctoral colleagues double-checked the guideline and provided feedback. Their comments were considered, and I resubmitted the schedule of questions to my supervisor. With the supervisor's approval, two pilot interviews were conducted; the themes circled around the impact of digitalization on OH, methods/tools, knowledge, skills, governance, attitudes, and success factors. As an outcome from the pilot interviews, the essential aspects were fine-tuned; they enabled the flexibility for new directions if they should emerge during the interview. The final interview guideline is included (Appendix D).

Interview Process. I sent personal emails to the selected participants, described again the purpose of the dissertation and followed up after the survey, invited them for the interview at a convenient date and time, either by telephone or by meeting. All 20 individuals confirmed their participation in an interview; the interviews took place between July and October 2019 – twelve onsite, eight per telephone. At the beginning of the interview, a reminder concerning the already signed research consent form was provided. All interviews were recorded electronically in their entirety with the app *Diktiergerät*. At the end of each interview, the interviewee was asked to complete and return by email a critical incident instrument (see Chapter 3.9.3) based upon personal experience and perceptions. On completion of the interview, the recorded interview was transcribed word-for-word and coded according to the coding scheme as shown in Appendix H.

3.9.3 Phase III: Critical incidents

I selected critical incidents as an additional instrument to supplement the survey and interview data. They serve the purpose of uncovering further data that unfolded after the interview. Flanagan (1954) formulated first critical incident as a data collection method. It is based on an inductive and descriptive approach for the collection of data, and emphasizes the process of understanding the meaning grounded in lived experience (Bogdan, Robet, Biklen, 2007). Of particular importance is that written critical incident reports probe assumptions by allowing time for reflection (Adams, 2001; Marshall & Rossman, 2016). There is support in the literature for the usage of critical incidents as an effective method for complementing the data collection; several authors indicate its advantages (Adams, 2001; Bogdan, Robet, Biklen, 2007; Flanagan, 1954). Nevertheless, I paid attention to Adams' repeated caution that critical incidents cannot be the solitary method for data collection. Critical incidents are singular

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recollections, and therefore too short for abundant descriptions. It is not an alternative to interviews and/or observations, but rather a useful supplement. Additionally, critical incidents might diminish the accuracy of the data because they rely only on the participant's recollection, which is by nature subjective. Further, it is possible to miss salient incremental data by not inquiring about the specific context, which may leave the information incomplete.

The applied critical incident instrument was developed by me with refinements by the already mentioned experienced co-workers; it was tested in the field in conjunction with the pilot interviews. The results of the field test demanded minor corrections which were reflected in a final critical incident instrument provided (Appendix E). The 20 participants received the critical incident instrument after the interview from me. The instrument asked respondents to think about an occasion when they felt frustrated regarding overhead cost management or were wondering about overhead cost management. Specifically, the participants were requested to describe the incident as detailed as possible, indicating why digitalization drives overhead, which capabilities they miss most in their OH system, and what makes a OH system successful. In order to make it convenient for the participants to respond, they received a prepaid, pre-addressed envelope to turn in the instrument. Alternatively, an electronic submission was welcome as well. All participants were asked to turn it in as soon as possible, while the memories were still stimulated by the interview. After a follow up two weeks later, I received nine critical incident forms. Unfortunately, none of them were fully completed. I had hoped for a greater rate of response, but when analyzed, the returned critical incidents served as a suitable validity check on aspects of the data uncovered in the survey and interviews.

3.9.4 Phase IV: Focus group

Liamputtong (2015) defines focus groups, or group interviews as individual interviews in a group setting plus the observation of the participants with their interaction; this serves as a distinctive research method. A focus group is a controlled group discussion focused on a particular topic (Rantala, Behm, & Rosén, 2019; Stewart, Shamdasani, & Rook, 2012). The goal is to establish an honest and interactive conversation, developing in depth the selected topic. Focus groups take place under the assumption that a convenient atmosphere fosters a broad range of opinions, therefore a fuller and more thorough understanding of the topic under study will be obtained. A focus group is a planned, well-structured but still flexible method (Liamputtong, 2015). Rantala, Behm and Rosén (2019) list various applications of focus groups

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in business research which fit well with the purpose of the dissertation, such as to: (a) extract a range of experiences, ideas, and opinions; (b) explain differences in perspectives; (c) expose insight into indicators that craft opinions; and (d) explore ideas that emerge from the discussion.

Whereas there are useful characteristics of focus groups, they do not come without disadvantages. Levings (2014) describes "groupthink" as a possible outcome and therefore a disadvantage; it refers to a streamlined opinion caused by a few dominating participants. Furthermore, a focus group requires strong facilitation skills because of the need to manage the conversation while soliciting purposeful data; potential logistical difficulties were addressed by an assistant and a second moderator supported the effort.

The focus group discussion was conducted with six already known participants who had already participated in the survey and individual interview; the discussion took a little bit longer than 1 ½ hours. The participants were carefully selected based on the already established criteria; the dual purpose of the focus group interview was the following: (a) to support and explain the information obtained so far, and (b) to dig for additional data to ensure credibility and trustworthiness. I asked the group in the open-ended format to explore three issues. First, do they feel comfortable to deal with overhead costs and how? Second, did they experience challenges with overhead costs management and, if so, how? Third, what makes overhead costs management successful?

The selection process proceeded in the following manner: I contacted all of the 20 study participants to encourage them to join in the focus group discussion. The participants were advised of the specific purpose of the method. They were informed that the discussion would take place in the conference room SR20 at the University of Applied Sciences in Kapfenberg, Austria. Twelve of the 20 participants responded that they were interested in joining the discussion, but because of time constraints and availability, in the end only six respondents could participate. I sent a thank-you email to all participants who had expressed their interest. Following that, I sent the group a memo laying out the logistical specifics of the discussion.

3.10 Methods for data analysis and synthesis

Overall, the challenge throughout data collection and analysis was to manage the vast amount of data. It was necessary to densify the information, to identify and recognize significant patterns, and finally to construct the conceptual framework. Merriam & Tisdell

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(2015) advise scholars to make data collection and analysis a simultaneous activity; it mitigates the risk of overwhelming, repetitious, and unfocused data.

The formal process of data analysis began by designating alphanumeric codes based on the entities of the dissertation's conceptual framework. I shared samples of coded interviews with two experienced co-workers; the discussion with them confirmed my designations. Then, I prepared large flip chart sheets. The color-coded sheets were hung on the walls. Each sheet held the theme with the entities of the conceptual framework. With the progress of the coding of the transcripts, new flip chart sheets were added to capture the new observations as they emerged. Each observation was written on an adhesive tag, marked with the origin (i.e. survey, interview, critical instrument, focus group) and the corresponding participant code. The coding schema with the legend is depicted in Appendix H.

After that, I wrote narratives about each of the sheets. These narratives turned out to be fruitful in cross-checking the data. Further, they served as a secondary analysis. As a next step, to check if there were any occurrences that would resolve for differences or similarities between participants, I tested the coded data on the sheets against frequency charts prepared for each theme. The frequency charts were later used for the tag clouds in Chapter 5. To facilitate the writing of the dissertation, the participant code was always captured. Further, this procedural step supported my cross-case analysis of the data, which is described in more detail in Chapter 3.13.

The coding process fragmented the data sources (i.e. survey, interview, critical instrument, focus group) into separate themes. It requires looking at each detail. The subsequently following synthesis required piecing together these fragments to reconstruct an integrated and holistic explanation. Overall, this approach yielded a number of clusters, patterns, and finally themes that were linked together; either divergently or similarly. Essentially, I applied a three-layered process in reflecting about the data. Firstly, I examined and compared traces and patterns within the themes. Secondly, I compared intervening traces and patterns across the themes. Thirdly, the dissertation was embedded in the scientific community with respect to former research work; therefore, it was repeatedly compared and contrasted with broader literature, income statements and BACH database. These three layers were inseparable, interlocked and iteratively applied throughout the process of synthesizing the fragments (cf. Bell et al., 2019).

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Based on the analyses and the emerging synthesis, I was capable to proceed and to reflect about the broader implications on the unit of analysis. In Chapter 6, I composed three theses and prepared various research-related and practical recommendations.

3.11 Ethical considerations

Ethical issues relating to privacy protection of the involved stakeholders (especially the participants) were of integral concern (Marshall & Rossman, 2016; Merriam, 2009; Merriam, 1998; Pring, 2004; Seidman, 2013b; Wankel & Stachowicz-Stanusch, 2011). In social science as well as in other fields, the researcher is responsible for protecting and informing the participants. The research process requires absolute voluntary cooperation. It is a fundamental prerequisite that the participants are informed about the purpose of the study. The central issue with respect to protecting the participants is the way how the information is handled. It was guaranteed by the research consent form (see Appendix B) that no serious ethical danger was posed to any of the participants and this holds true for their well-being as well.

The dissertation employed various safety measures in order to guarantee the rights and the protection of the participants: Firstly, informed consent prevailed as a priority throughout the entire dissertation. The written and signed consent to voluntarily engage with the dissertation was received from each participant. Secondly, the participants' interests and rights were placed first when decisions were needed with regards to reporting and dissemination of data. I was obligated to keep confidential the clear names and/or other significant identity characteristics of the participants. They approved the use the official income statements of the sample organizations. From a practical data handling point of view, precautionary measures were performed to secure the storage of research-related records and data; nobody (besides me) has had access to the material.

3.12 Issues of trustworthiness

Trustworthiness features are of essential importance in quantitative and qualitative research. As the primary research design of the dissertation is qualitative, I took considerable effort to address the trustworthiness features. It involves the rather traditional quantitative research issues of reliability (i.e. the degree to which its consistency is measured over time) and validity (i.e. the degree to which the measurement purports to be measured). For qualitative research, trustworthiness is established by using the terms confirmability, credibility,

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dependability, and transferability (Lincoln, Lynham, & Guba, 2011). Lincoln, Lynham, & Guba point out that trustworthiness in qualitative research should be evaluated differently from quantitative research because of the different nature of it (i.e. words versus numbers). Nevertheless, independent of the used terminology, qualitative research aims to work on the rebuttal of potential biases by mitigating them through conduct, design, analysis, and synthesis (Bell et al., 2019). This is exactly what I was striving for throughout the dissertation.

Confirmability as a concept in qualitative research parallels the notion of objectivity in quantitative research. It implies that the findings are the honest and traceable result of the research, and not the outflow of subjectivity, wishful thinking, nor biases of the researcher. To achieve this requirement, I identified and made transparent the decision trail for public judgment by disclosing the original quote from the interview and/or critical instrument, explaining the coding schema with a legend, and by clarifying my detailed steps. Although, I realized the futility of attempting to achieve independent objectivity, I nevertheless reflected on a regular basis and illustrated how the data traces back to its origins.

Credibility as a concept in qualitative research parallels the notion of internal validity in quantitative research. It demands that the findings are credible and accurate from the perspective of the researcher, the reader and those involved. The criterion is essential for any research (Creswell, 2014; Marshall & Rossman, 2016; Maxwell & Maxwell, 2013; Merriam, 2009; Saldana, 2009). Interpretive and methodological validity test the credibility of the reached conclusions. From a quantitative stance, it aims to seek a statistical verification through significance of the conclusions (Mason, 1996).

Dependability as a concept in qualitative research parallels the notion of reliability in quantitative research. Reliability in the traditional sense refers to the extent of how believable the research findings are and whether can they be replicated by other similar studies. The problem with qualitative research is that is does not offer identical subjects and experiences at a certain point in time to provide a reasonable degree of dependability. As laid out by Lincoln, Lynham and Guba (2011), the more important question arises as to whether the findings are dependable and consistent with the data collected. I understood it in this way: in qualitative research, the objective is not to eliminate potential inconsistencies but to ensure that I recognize them when they occur. Therefore, it became imperative for me to journal my procedures and to pay careful attention to the consistent use of the themes, categories, coding schemes, and entities.

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Transferability as a concept in qualitative research parallels the notion of external validity in quantitative research. It refers to external validity in the sense of whether the findings apply to another context as well. Yet, the intended goal of the dissertation is not to generalize. Nevertheless, it needs to be addressed that the reader detects if and to what extent the particular phenomenon in the certain context can transfer to another similar context (Lincoln et al., 2011). Patton (2015) promotes the thinking of "context-bound extrapolations", which is defined as "speculations on the likely applicability of findings to other situations under similar, but not identical, conditions". Concerning this issue, I tried to address transferability by detailed, rich description of the experienced situations with the participants in the specific context. It was done by my own interpretation, using original quotes from the interviews and/or critical instruments, and by referring in context to quantitative data from other studies. Thick, rich, in-depth descriptions provide the foundation for the claim that qualitative research can be relevant in broader, more general contexts (Moser & Korstjens, 2018).

3.13 Coherent methodology

The dissertation used several methods to portray the findings, the analyses, and the synthesis. All applied methods formed together a coherent methodology with the purpose of triangulation. The triangulation followed the different levels of investigation as laid out in Figure 2: Unit of analysis for the dissertation. The following table contains for the Chapters 4 and 5 the applied methods, the reasons why they were used, the first occurrence, and the unit of analysis.

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Table 8: Overview of applied methods for coherent methodology

Method	Applied to…	Where, first used?	Unit of analysis
Bar chart	present categorical data in a timeline	Overhead in different years (Figure 26)	Companies of the informants
Boxplot	depicting groups of numerical data through their quartiles	The meaning of overhead costs (Figure 23)	Companies of the informants
Correlation	show the inter-dependencies of two variables	Correlation number of employees versus revenue (Figure 19)	Companies of the informants
Funnel chart	represent stages of different levels	Size of enterprises (Figure 17)	Companies of the informants
Line chart	present data-series in an ascending timeline	Volume of data annually (Figure 28)	Global
Table	provide a compact summary of data	Demographic matrix of the participants (Table 10)	Individuals, informants
Tag cloud	express the frequency of items by font-size	Terms in analytic category (Figure 29)	Individuals, informants
Tree-map	display the structure of data	Educational background (Figure 15)	Individuals, informants

Source: Own depiction

Table 8 contains eight different methods that were used throughout the dissertation. Each method serves a special purpose that is explained later in context. Together they assemble a coherent methodology to provide a solid foundation of the dissertation.

3.14 Constraints of the dissertation

The dissertation contains constraints, some of which concern the general critiques of quantitative and qualitative research methodology and some are implicit in the dissertation's research design. I gave careful thought as to how to account for these constraints and how to minimize their impact. The unique characteristics of quantitative and qualitative research methodology hold potential constraints in their usage.

Because the analysis conclusively depends on the choices and thinking of the researcher, qualitative studies in general have constraints relating to the researcher's subjectivity. Quantitative studies are hampered by the improper representation of the target population, the inability to control the environment, and the difficulty in telling data analysis. A dominating concern is the bias of the researcher; it frames the assumptions, interests, needs and perceptions.

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The pivotal constraint of the dissertation at hand is the issue of my subjectivity and the potential bias due to my participation in conducting the research. My personal experience in the industry with the subject matter certainly contains a set of opinions which I needed to set strictly aside. Related to that may have been the difficulty of the interviewees to adjust to the researcher transforming into the role of the interviewer, a phenomenon referred to by Maxwell & Maxwell (2013) as participant reactivity. Because some of the participants knew me already, their responses may have been affected and influenced. They could have tried to fraternize with me by offering responses they perceived I was looking for or they thought I would perceive as helpful. In contrast, it would be possible that because of the personal acquaintance, these few participants could have held back and been less candid in the discussions; however this did not take place as proven by the very active discussions.

Recognizing these constraints, I took the following measures. First, I acknowledged my potentially biased agenda and stated my assumptions up front. Second, the coding schema with the legend was scrutinized by peer review; the same took place with the transcripts and coded interviews. Finally, to mitigate the constraints during data analysis and synthesis, I removed all participant names and used only the participant code.

3.15 Summary of research methodology

In summary, this chapter provided a detailed description of the dissertation's research methodology. Quantitative and qualitative case study methodology was employed to illustrate the phenomenon of how businesses deal with the digitalization of processes with respect to overhead costs, the limitations of the current approaches and what the success factors in managing overhead costs successfully are. The sample of participants consisted of 20 purposefully selected individuals. Four data collection methods were employed, namely surveys (quantitative and qualitative), individual interviews (qualitative), critical incidents (qualitative), and focus group (qualitative). The data were challenged with literature, other databases and the emerging findings. Credibility and dependability were addressed by carefully selected strategies, in particular triangulation of sources and methods.

Different qualitative and quantitative methods were used in the dissertation. Table 6 contains the data-sources for the quantitative research, Table 9 gives an overview of the qualitative methods.

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Table 9: Overview of qualitative methods for needed information

Research question	Information needed	Method
1. How does the digitalization of processes impact the management of overhead costs?	Participant's perceptions of the dynamics of digitalization affecting business processes and how it influences the overhead costs	Survey, interview, critical incidents, focus group
2. What are the limitations of the current approaches of the management of overhead costs in respect to methods and tools? If there are limitations, what can be done to overcome them?	Participant's perception concerning governance models that impact overhead costs; risk management with regards to uncertainty and severance of inaccuracy	Survey, interview, critical incidents, focus group
3. In general, what are the prerequisites for the successful management of overhead costs?	Participant's observations and future assumptions about the driver for transparency and fairness of cost allocation	Survey, interview, critical incidents, focus group

Sources: own research

Table 9 explains – beginning with the research question – what type of information is needed; followed by the chosen method to obtain it. The findings are presented in the next chapter. They are consistent with the above mentioned research methods. A review of the literature was conducted to craft the theoretical foundation for the design and analysis of the dissertation. The analysis enabled the development of the themes consistent with the research questions and the hypotheses. Through a comparison with the literature, interpretations of the findings, and drawing conclusions, the dissertation resulted in recommendations offered for academic institutions, businesses, and further research. The intent was that the dissertation contributes to the understanding for the academic and business community, both current and future, with regards to managing overhead costs. Additionally, it is hoped that the dissertation will be of value to those educators who are responsible for training prospective business leaders and scholars.

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CHAPTER 4

PRESENTATION OF FINDINGS

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4 Presentation of findings

The following section displays the metadata of the survey. It explains the demographic matrix of the participants, the structure of the enterprises concerning revenue, number of employees, R&D spending, and percentage of service. Later, in Chapter 5, these findings are put in context according to benchmarks outside this study. The numbers provided by self-disclosure were double-checked (and confirmed) by cross-referencing with public information.

Table 10: Demographic matrix of the participants

#	Participant Code	Pseudonym	Industry	Educational background	Topic-related experience (years)	Gender	Age
#1	OHM114C	Georg	automotive, OEM	PhD	13	M	39
#2	OHM289Z	William	aviation	PhD	17	M	42
#3	OHM878D	Isabella	automotive, parts	MSc	15	F	44
#4	OHM743V	Ute	beverage	MSc	9	F	33
#5	OHM650H	Brian	chemicals	Dipl.-Ing.	14	M	43
#6	OHM189M	David	transportation, logistics	PhD	16	M	48
#7	OHM544P	Diane	automotive, parts	MSc	22	F	54
#8	OHM901K	Serge	chemicals	Dipl.-Ing.	17	M	43
#9	OHM007U	Gerhard	automotive, parts	MSc	15	M	46
#10	OHM467Z	Lazlo	aviation	Technician	19	M	51
#11	OHM399R	Barbara	transportation, logistics	MSc	13	F	38
#12	OHM511V	Sabrina	steel	Ing.	16	F	41
#13	OHM946U	Joachim	automotive, parts	MSc	12	M	27
#14	OHM778Q	Miroslav	beverage	PhD	10	M	35
#15	OHM444Y	Csaba	automotive, parts	PhD	23	M	52
#16	OHM801X	Alexander	steel	MSc	18	M	50
#17	OHM754Z	Dimitar	automotive, OEM	Dipl.-Ing.	11	M	39
#18	OHM999R	Gertrude	automotive, OEM	Dipl.-Ing.	22	F	49
#19	OHM485A	Gerlinde	beverage	Ing.	21	F	46
#20	OHM302C	Herbert	transportation, logistics	MSc	17	M	42
	Total N = 20				mean: 16,0 median: 16 mode: 17 max: 23 min: 9 range: 14	M = 13 (65%) F = 7 (35%)	mean: 43,1 median: 43 mode: 39 max: 54 min: 27 range: 27

Source: Own research

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Table 10 shows 20 different participants from seven distinct industries. There are seven females (35% of the sample) and 13 male participants (65% of the sample) between the ages 27 to 54 years old. Joachim (pseudonym, participant code OHM946U) is with 27 years by far the youngest. Nevertheless, when participating in the research he had already 12 years of experience in the automotive parts industry (started as apprentice and worked his way up to cost engineering department manager, attending a master program at university as a part-time student). Another impressive track-record has the oldest participant: Diane (pseudonym, participant code OHM544P) is 54 years old and works in the automotive parts industry as well (skill area manager for the powertrain of battery electrical vehicles). Diane has the second most experience in the field with 22 years; Csaba (pseudonym, participant code OHM444Y) has the most experience with 23 years. One participant, Ute (participant code OHM743V), has only nine years of experience in her field, precisely 9.4 years at the time of the interview. It would apparently contradict the selection criteria of the research sample as defined in Chapter 3.4. Nevertheless, because of her background in chemical engineering in the beverage industry with assignments in the Netherlands, South Africa, and the United States of America she qualifies for the survey; it brings a useful inter-cultural perspective into the study. At the completion of the dissertation, she was still in her position and therefore had reached the once self-imposed criteria for the length of experience with 10 years. The set-up of the educational background is displayed in the following tree-map:

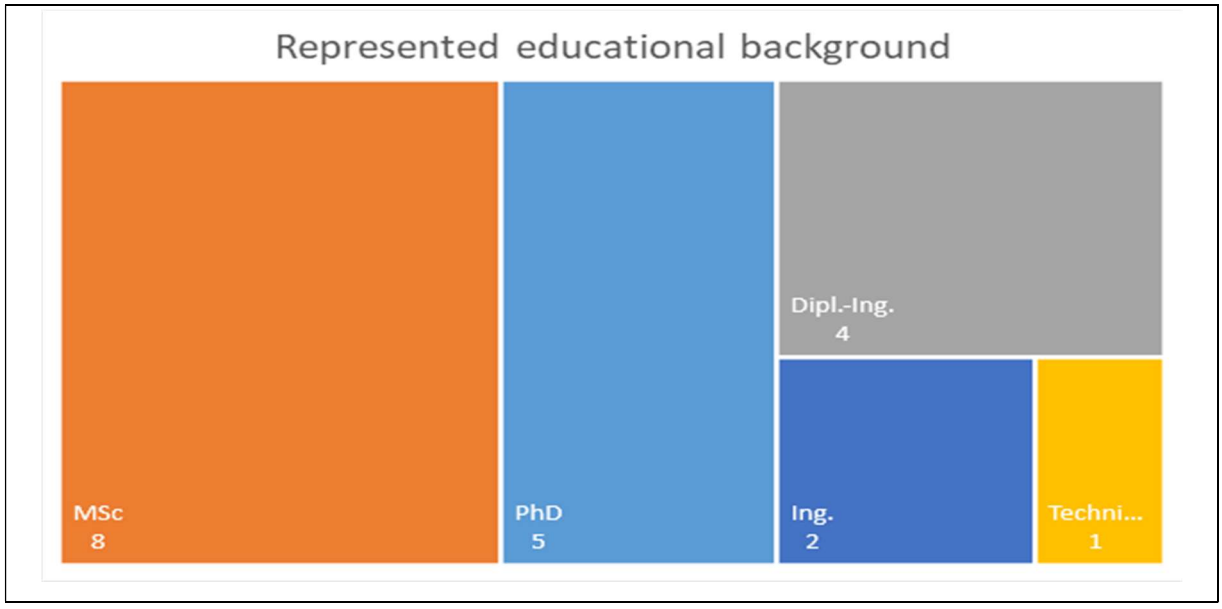

Figure 15: Educational background of the participants

Source: Own research

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Figure 15 shows in a tree-map the structure of the various educational backgrounds of the participants stating the highest obtained educational degree or industry training, respectively. Master of Science (with eight individuals) is held by the most participants. The Master's degrees were earned in the field of business administration, chemical engineering, electrical engineering, industrial engineering, and mechanical engineering. Five participants hold a PhD in various fields, which encompass agile factory layout management, logistics-controlling in supplier relationship management, strategic influencing factors on merger and acquisition transactions, thermal behavior of aeronautic parts in outer space, and total quality management in the service sector. Four Diplomingenieure (Dipl.-Ing.) are part of the panel as well, their background is electrical engineering, industrial engineering, and mechanical engineering. Two Engineers (Ing.) obtained their degree in the higher technical school system in Austria for mechanical engineering. One participant, a technician (OHM467Z) has no formal higher education yet brings in an extensive level of experience in cost management in the aviation industry. Eight of the participants give lectures at local universities; hence understand the academic demands for scientific work.

Applying another tree map, the set-up of the various industries in the study are demonstrated by the following figure. It displays a weakness of the dissertation as the number of different industries is limited.

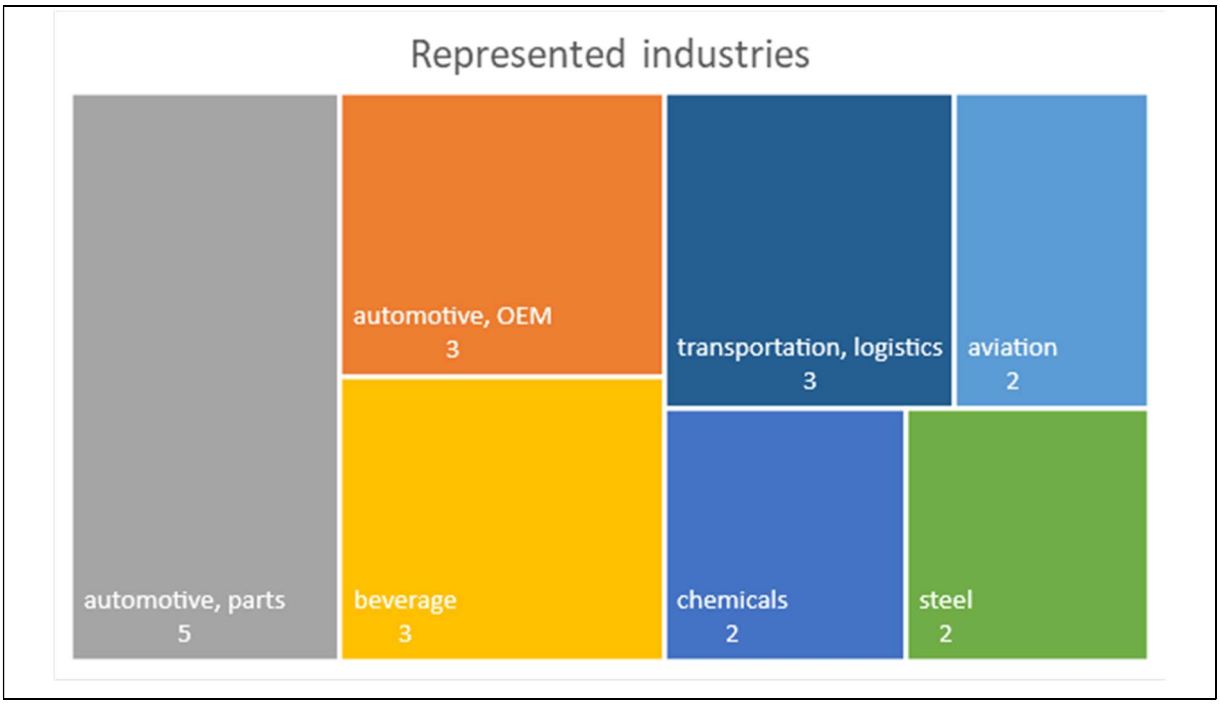

Figure 16: Represented industries in the dissertation

Source: Own research

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Figure 16 displays in a tree map of the representation of the seven various industries in the dissertation. Automotive (parts) has the highest number of participants with five, followed by automotive (OEM), beverage, and transportation, logistics with three participants each. Aviation, chemicals, and steel each have two representatives in the study. In total, they add up to the 20 different enterprises. The structure of the industries becomes important when the results of the multi-case study is compared to larger, multi-national databases.

4.1 Metadata of the study

The first metadata portrays the yearly revenue. It is for all economic valuations the main indicator for the size of an enterprise. The selection of the companies took place without taking revenue purposely into account, rather only with the previously explained criteria for the interview partners. Nevertheless, it is worthwhile to set the context of the involved companies by using revenue as a metric. The selected cluster of the revenue buckets is consistent with the recommendation of the European Union and the Wirtschaftskammer Österreich[1] (BACH, 2019; WKO, 2013). The subsequent figure unveils the following structure of the participating companies.

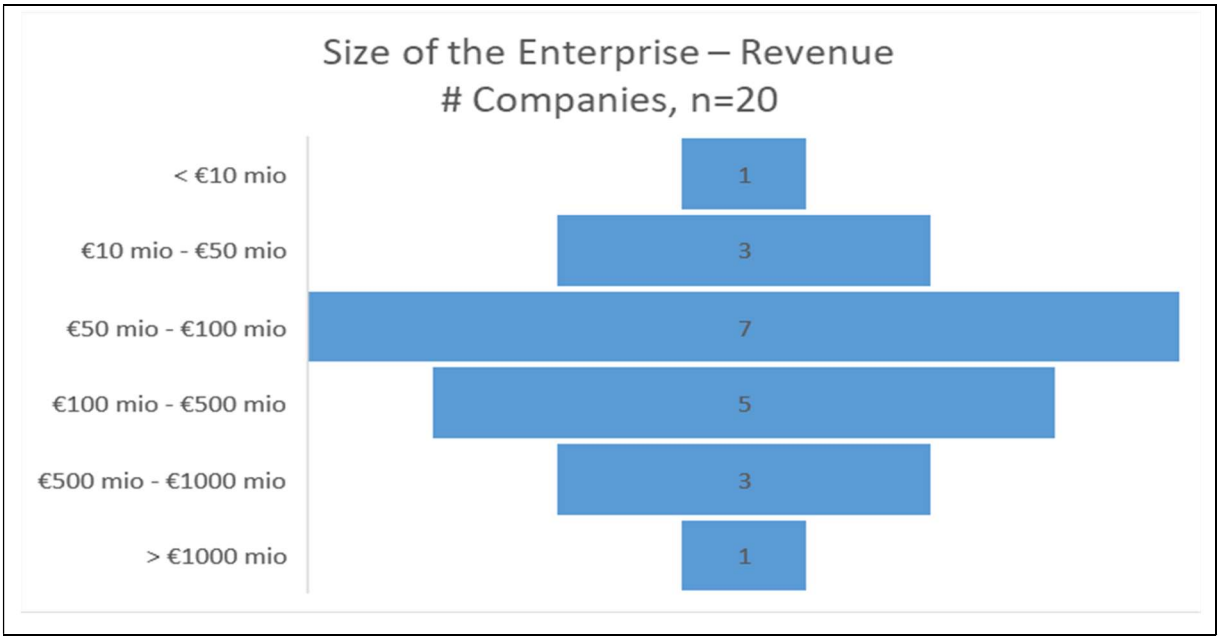

Figure 17: Size of the enterprises from a revenue point of view

Source: Own research

[1] The Austrian Chamber of Commerce

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Figure 17 includes within a funnel chart the structure of interviewed enterprises based upon revenue. The categories range from below €10 million in revenue (one entry) to more than €1 billion in revenue. Most entries were in the category of €50 to €100 million revenue. It is worthwhile to mention than an almost symmetric profile was represented. The next funnel chart addresses the number of employees.

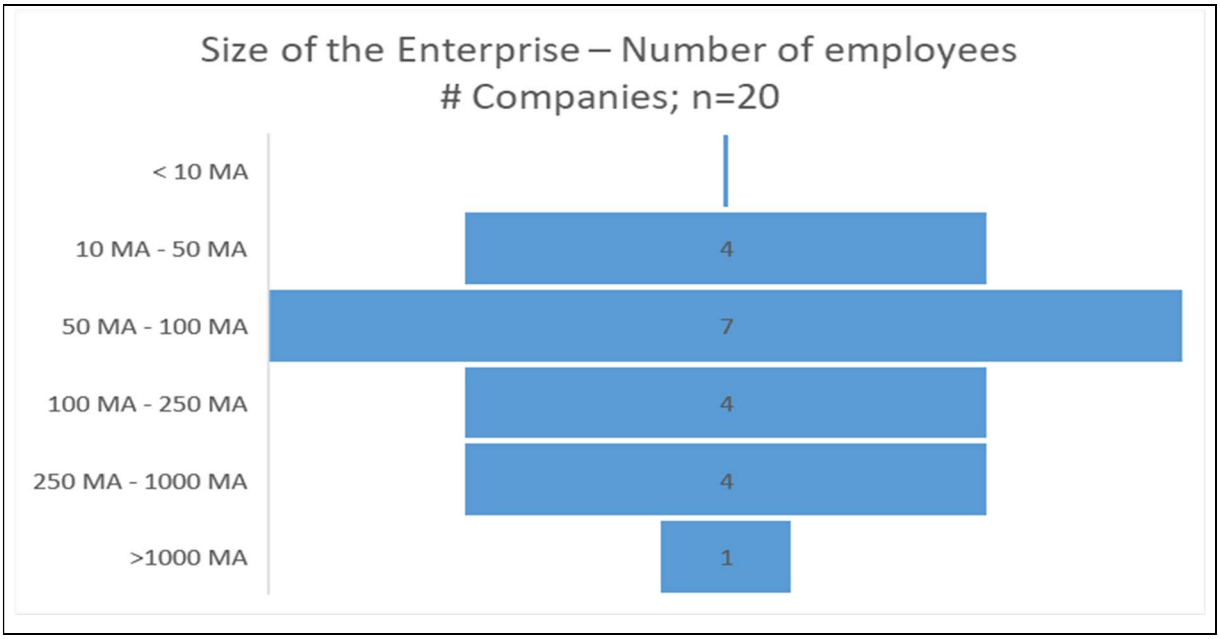

Figure 18: Size of the enterprises from the point of view of number of employees

Source: Own research

Figure 18 shows in the second funnel chart the structure of the interviewed enterprises based upon the number of employees (MA stands for Mitarbeiter, germ.). The categories range from less than 10 employees (no entry) to more than thousand employees (one entry). Most enterprises were in the category of 50 to 100 employees (seven entries). Small and mid-size enterprises (SME) are defined in the category of number of employees as below 250 full-time equivalents (WKO, 2013). Based on this definition there are 15 SMEs, or 75% of the participating 20 enterprises, represented in the study.

It is worthwhile to correlate the revenue with the number of employees. It is expected that there is a progressive relationship with employees on the abscissa. The graph is represented below:

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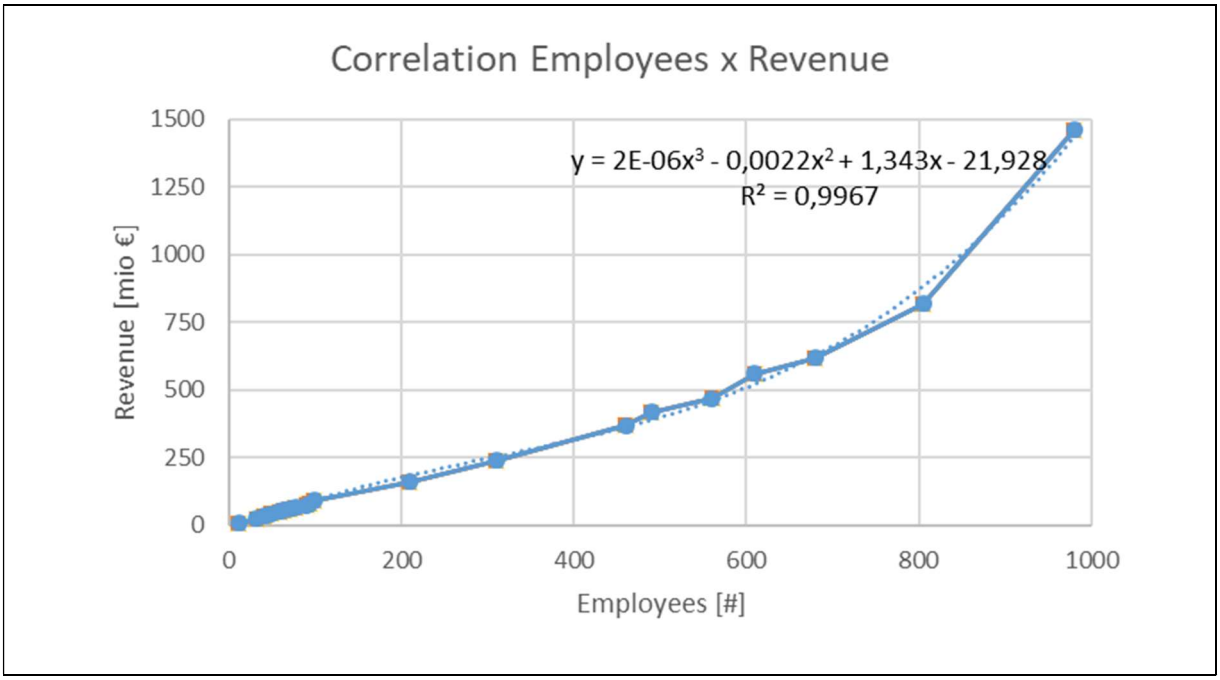

Figure 19: Correlation: number of employees and revenue

Source: Own research

It is interesting to see in Figure 19, that there is a compelling correlation between the number of employees and the amount of revenue. The third polynomial order of the trend line delivers a R-squared value of 0.9967. The expected progressive function was confirmed. Other sources confirm a similar curve shape (Gunkel, 2010; Hall & Rosenberg, 2010; Manyika, Sinclair, & Dobbs, 2012).

The third funnel chart addresses the aggregated data for spending on research and development as a percentage of revenue. This information will be later utilized to validate the profile of the sample with data of a broader database (see 5.3 Analytic category 2: Meaning of innovation).

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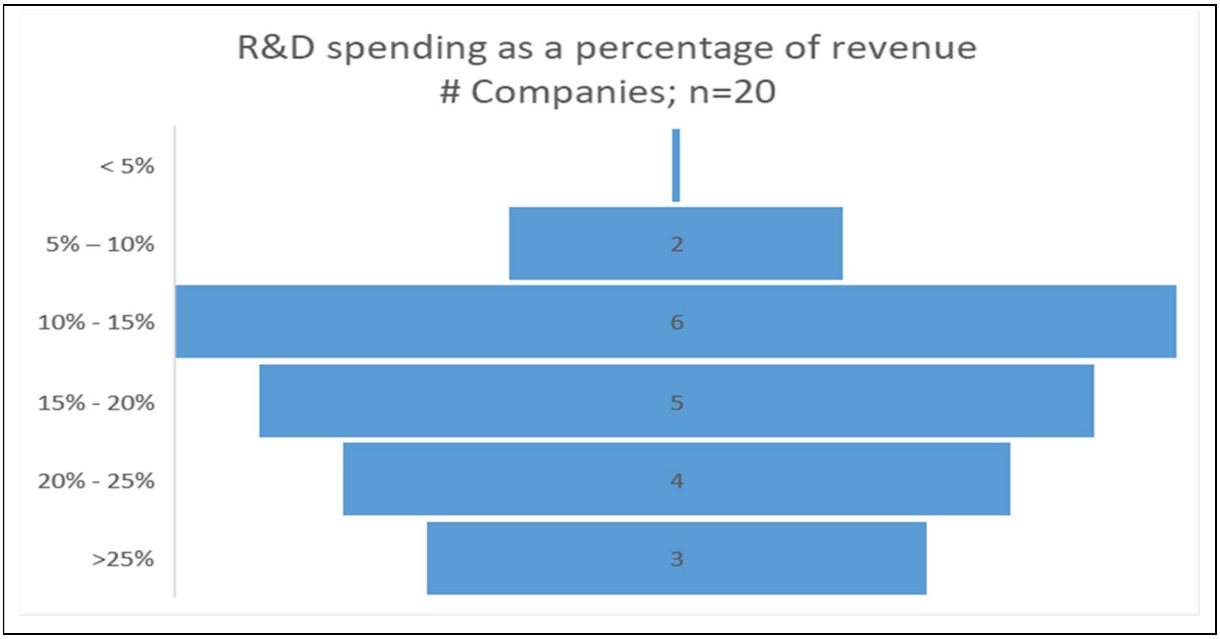

Figure 20: Research and development spending as a percentage of revenue

Source: Own research

Figure 20 shows the structure of interviewed enterprises based upon R&D spending as a percentage of revenue. The categories range from below 5% (no entry) to more than 25% (three entries). Most entries were in the category of 10 to 15% employees (six entries). It is worthwhile to mention that in the sample enterprises are overrepresented with a rather high (more than 10%) R&D spending percentage. As a comparison, the R&D spending in 2017 for Austria was 3.2% of GDP, in Hungary 1.4% and in Slovakia 0.9% (The UNESCO Institute for Statistics, 2017). Finally, the data of the survey allows to display the R&D spending as a percentage of revenue about the participating enterprises.

The next chart addresses the aggregated data for service as a percentage of revenue, whereas service is defined as non-production added value for customers. This information will be later utilized to validate the profile of the sample with data of a broader database (see 5.3 Analytic category 2: Meaning of innovation).

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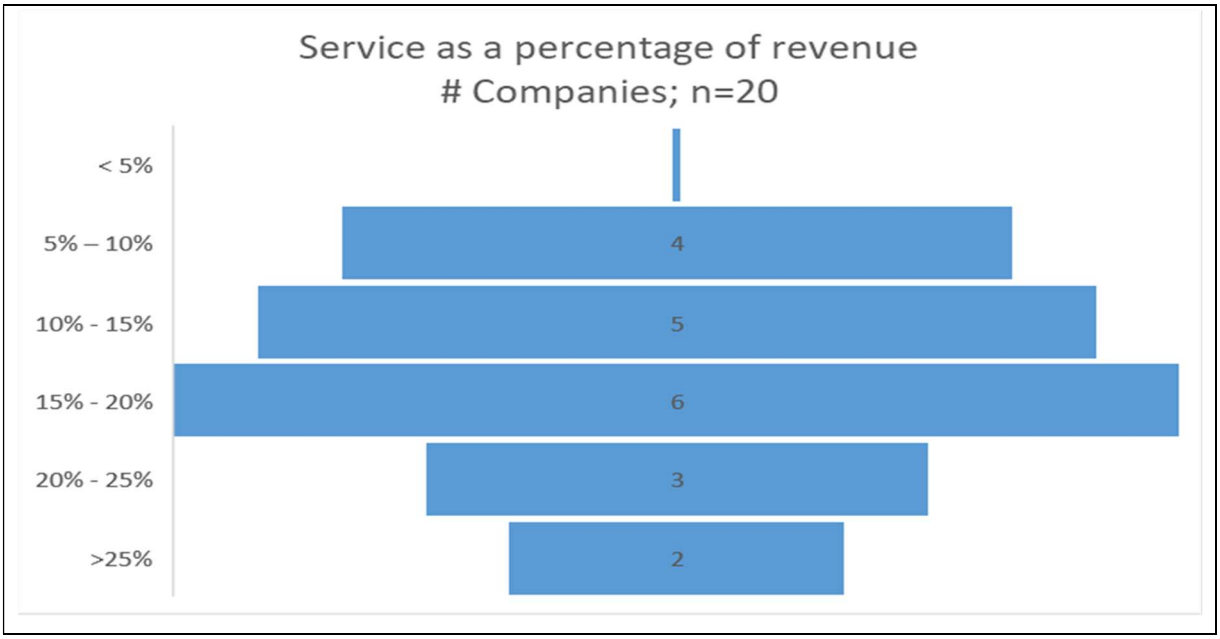

Figure 21: Service as a percentage of revenue

Source: Own research

Figure 21 depicts in the fourth funnel chart the structure of interviewed enterprises based upon the service as a percentage of revenue. The categories range from below 5% (no entry) to more than 25% (two entries). Most entries were in the category of 15 to 20% service as a percentage of revenue. It is worthwhile to mention that the profile points slightly to the first levels (seen from the bottom), which indicates that the selected enterprises have rather more than 15% of service as a percentage of revenue. A correlation between R&D and service proved to be meaningless, as it is specific for each individual industry.

The next section describes further the outcome in terms of deliverables from the survey, the interviews, the critical incidents, and the conducted focus group. Subsequently, the findings will be presented.

4.2 Connection of research questions to questionnaire

A survey using a questionnaire (see Appendix C) was applied to gather data from the informants (i.e. twenty senior experts representing twenty different companies). The questionnaire built on findings from the literature review and asked specifically for empirical confirmation in a pre-defined range, and also collected data if outside the expected range. This turned out to be a rich source of information for subsequently conducting the interviews and the focus group.

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Table 11: Research questions and corresponding interview questionnaire

Research question	Interview questionnaire
How does the digitalization of processes impact the management of overhead costs?	Please indicate in the Likert scale the following statement: • Overhead costs have increased steadily over the past 15 years. • Innovations (e.g. Industry 4.0, digitization) increase overhead costs. • Overhead costs will continue to rise in the future.
What are the limitations of the current approaches of the management of overhead costs in respect to methods and tools? If there are limitations, what can be done to overcome them?	Please indicate in the Likert scale the following statement: • The digitization of business processes influences the services of our company. • Digitization creates new services. • Digitization is a completely normal innovation that occurs again and again in industrial history. • We have the right methods / tools to measure the efficiency (in terms of impact and costs) of innovation. – If not, what is missing and why?
In general, what are the prerequisites for the successful management of overhead costs?	Please indicate in the Likert scale the following statement: • An increase in services increases overhead costs to the same extent. • Through digitization, services can be allocated to the cost unit based on the cause. • Speed, transparency and ease of use are the predominant factors for successful overhead cost management. • There will be an increase in services (digital and non-digital) in the future.

Sources: own research

Table 11 lays out the connection between research questions and questionnaire. The questionnaire collects data expressed in a Likert scale from the informants using their senior experience (see Appendix C). Additionally, they had room for comments if they wished to unveil essential qualitative information already in the questionnaire; some used it as a marker for the interviews to be followed. The results of the survey were collected, aggregated, and further analyzed. They form the quantitative foundation of the outcome which is described in the following section.

4.3 Outcome from the survey, interviews, critical incidents, and focus group

The survey delivered quantitative data to address the three hypotheses. The results are shown in the following finding sections by means of boxplot diagrams.

The interviews delivered qualitative data which was coded using the coding schema with a legend provided in appendix H. In addition to the entities from the conceptual framework,

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one more entity (SF4) was added as it turned out that it is helpful to capture miscellaneous responses concerning success factors as mentioned by the interviewees.

The critical incidents were dispersed after the interviews to capture any additional, applicable information the participant might recall later. Nine critical instruments were returned but not all of them were fully completed. The provided data was matched and used for the corresponding findings.

The focus group interview delivered in-depth, qualitative data. It required practical considerations upfront, during and after the focus group meeting. The selection and equipment of the room, the professional media usage for the recordings, an assistant, the declarations of consent for the use of audio, declarations to guarantee confidentiality, and the concern that the group can work in an undisturbed and focused manner were the essential items. The participants of the focus group meeting volunteered and were invited to Kapfenberg, Austria.

Table 12: List of participants at the focus group meeting

#	Participant Code	Pseudonym	Industry	Educational background	Topic-related experience (years)	Gender	Age
#1	OHM114C	Georg	automotive, OEM	PhD	13	M	39
#6	OHM189M	David	transportation, logistics	PhD	16	M	48
#10	OHM467Z	Lazlo	aviation	Technician	19	M	51
#12	OHM511V	Sabrina	steel	Ing.	16	F	41
#16	OHM801X	Alexander	steel	MSc	18	M	50
#18	OHM999R	Gertrude	automotive, OEM	Dipl.-Ing.	22	F	49

Sources: own research

Table 12 shows the demographic details of the participants. For conducting the meeting in an objective manner, a second moderator was assigned, who is an experienced lecturer with a background in the field of overhead costs management and Industry 4.0. She helped to direct the meeting, in addition to the author, who served as the lead moderator. The group of six experts and the team of two moderators met in the seminar room SR20 at the University of Applied Sciences in Kapfenberg, Austria. The focus group interview took place on October 11th 2019. A positive, supportive atmosphere was created in spacious, bright surroundings. The

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physical well-being was well taken care of and, among other things, drinks were provided. The room concept had 35 square meters of area available with a long window front.

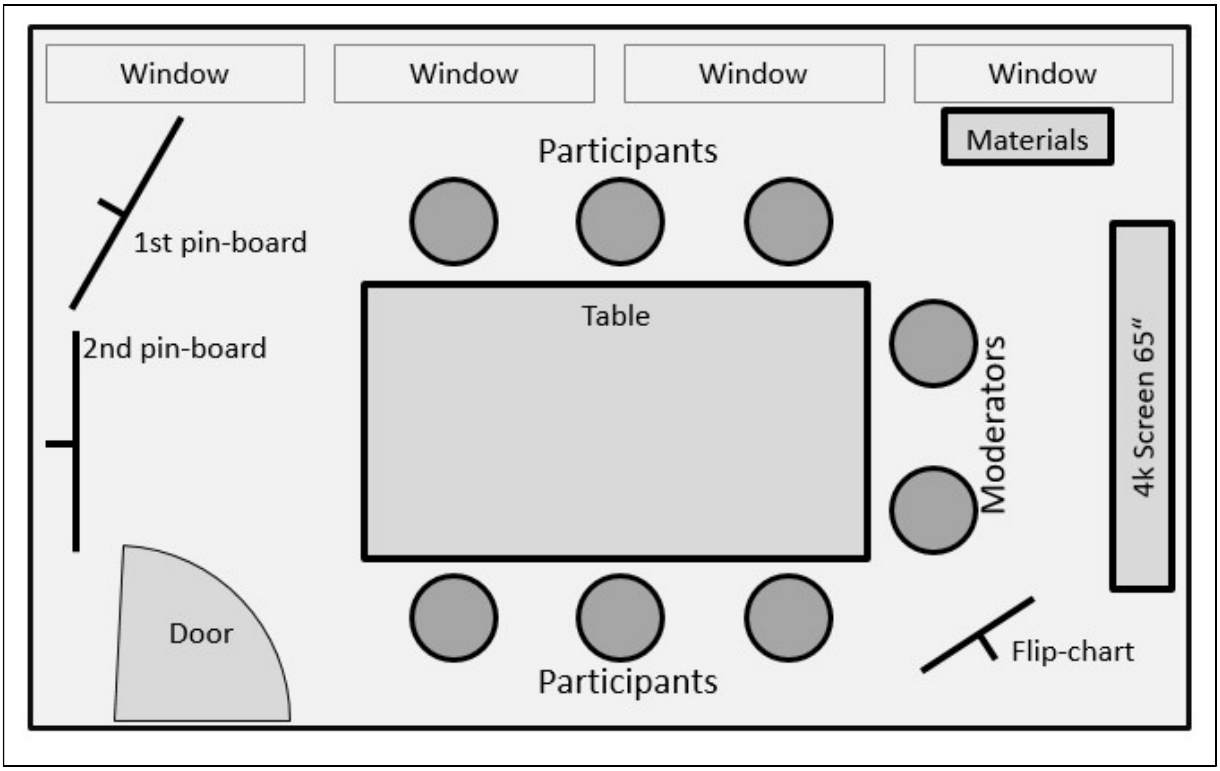

Figure 22: The setup of the room SR20

Source: Own depiction

As depicted in Figure 22 the following materials were available: two pin-boards, a flip -chart, plenty of paper, board markers, cards, glue dots, magnets, scissors, cohesive tape, pins, a large table, eight chairs, one small tables for materials, and a 4k screen 65”. The moderators sat at the head of the table. In this way, the participants followed the moderators and the presentation on the screen by one direct line-in-sight. An assistant looked occasionally after the group; he helped to set up the room, ensured a good indoor climate, brought drinks and snacks to the table during breaks, and was a permanent contact point for any necessities. The moderators recorded the audio with an app called *Diktiergerät*. For the workshop, the declarations of consent for the use of audio as well as to guarantee confidentiality were prepared. All participants, the moderators and the assistant received the documents at the beginning of the meeting. The team discussed the three themes of the dissertation by building on the survey, which all six participants had completed upfront individually and anonymously. The outcome is portrayed in the findings below.

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4.4 Finding 1: Heavy impact of digitalization

The survey in appendix C provided the raw data for the creation of the boxplot diagrams. The boxplot diagrams display the first, second (median) and third quartile of the data. Additionally, the mean shows the average of the data. The symbols in the survey present the categories strong consent, consent, ambivalent, refusal and strong refusal. In order to translate the categories into numbers an ordinal value was introduced next to the corresponding category; it is depicted in Table 9.

Table 13: Applied ordinal values for the categories of the questionnaire

Symbol	Category	Ordinal value
++	strong consent	10
+	consent	8
+ / -	ambivalent	6
-	refusal	4
--	strong refusal	2
n/a	not applicable	0

Sources: own research

The frequency of the ordinal values in Table 13 was used for the boxplot diagrams. The foremost advantage of values in an ordinal scale is the ease of comparison between the depicted categories. It is convenient to group the categories after ordering them. Therefore, it is effectively applied in questionnaires, polls, and surveys due to the straightforwardness of analysis and categorization. However, the disadvantage of the approach is the still subjective judgement of the respondent concerning the category. Therefore, it makes sense to follow up in a qualitative research design with an interview that allows to find out background information and motivation for the selected choices in the survey. I did exactly this during the interviews with the participants. None of the original selections changed, however richer description became apparent throughout the interview. For each of the three hypotheses, the numbers are grouped in separate figures; the first addresses hypothesis 1 with three supporting sub-hypotheses forming the meaning of overhead costs management, see Figure 23.

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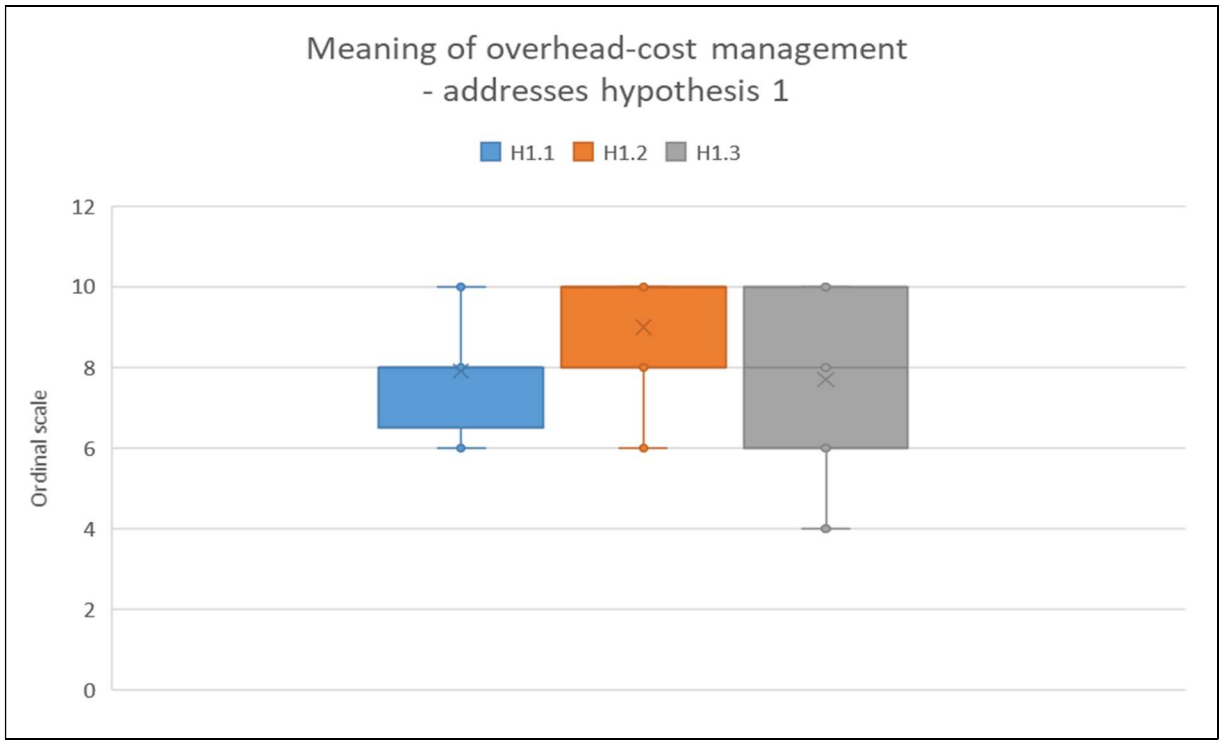

Figure 23: The meaning of overhead costs management, n=20

Source: Own research

In Figure 23 above, the selections of the 20 participants in the questionnaire are counted and analyzed. H1.1 stands for <The overhead costs have continuously increased over the last 15 years>. The results range from 6 to 10, respectively ambivalent to strong consent in the corresponding category. The first quantile is at 6.5, the third at 8. Therefore, the range of the interquartile is 1.5. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 6 for the lower whisker. The mean value is 7.9, the median is at 8. There are no outliers.

H1.2 stands for <Because of innovations (e.g. Industry 4.0, digitalization) the overhead costs increase>. The results range from 6 to 10, respectively ambivalent to strong consent in the corresponding category. The first quantile is at 8, the third at 10. Therefore, the range of the interquartile is 2. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 6 for the lower whisker. The mean value is 9, the median is at 10. There are no outliers.

H1.3 stands for <The overhead costs will continue to rise in the future>. The results range from 4 to 10, respectively refusal to strong consent in the corresponding category. The first quantile is at 6, the third at 10. Therefore, the range of the interquartile is 4. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 4 for the

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lower whisker. The mean value is 7.7, the median is at 8. There are no outliers. Overall, H1 with “Innovation (e.g. digitalization) drives the percentage of overhead costs continuously upwards” appears to be validated. But, because of the small sample size a further qualitative investigation is needed.

After using the survey and appraising the responses, the qualitative interviews were conducted. As baseline served the interview guideline in appendix D. Quotes in the interviews disclosed the following information:

> *OHM754Z: “I have seen a constant rise of overhead costs in the last 10 years. I recall from my predecessors that they said the same for the 10 years prior to that. This means we are talking about a time span of 20 years where we have seen a constant rise of overhead costs in the automotive OEM market.”*
>
> *OHM901K: “In the chemical industry, we have a continuous increase of overhead because of much tougher regulations. It is definitely an obviously unavoidable trend of the last decades. I believe it continues because there is value provided by the overhead. We just need to find smart ways of identifying and allocating it.”*

Additionally, the critical instruments delivered more information concerning finding 1, which is displayed here:

> *OHM114C (CI): “We have been struggling for years, at least the last 15 years, with a permanent increase of overhead costs. At the time of implementation, it made sense but over time the justification became difficult. We need to pay close attention to the stickiness of overhead.”*

It is interesting to recognize that OHM114C talks about the past 15 years, however has, according to the demographic matrix, just 13 years of experience. When addressing the issue in the focus group meeting, the following response was given:

> *OHM114C: ”Oh, I was not aware of that. [laughs] For me it feels like an eternity. It looks like I was not precise enough when I filled out the critical instrument. Even missing the two years to the mentioned 15 years, it is fair to say that the statement is true for the company I work for.”*

The discussion turned to VUCA and its ramification on overhead costs management. The following discourse took place:

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> *OHM467Z: "We see a diminishing effect on visibility. Our customers in the aviation industry give us much less time to develop, manufacture and deliver. This volatile, uncertain behavior makes it very hard and expensive [raises voice] for us to have the right resources in place when needed. Our response is variabilization of costs; it supports temporary, short-term activities, addresses uncertainty, and mitigates risk."*
>
> *OHM511V: "I'd like to second what Lazlo is saying. Although, in the steel industry we have a little bit more stability. You just build a steel plant every fifty years, at least. [laughs] Nevertheless, VUCA leads to reluctance as well. We wait to the very last moment – often it is too late, in my humble opinion – that we hire people. Investments as well are postponed to the very moment. On top of that come restrictive labor laws that make it not easier."*

There is consensus in the group, that the importance of overhead is going to increase because of the dynamics in the marketplace. It is fueled by the continuous growth of the digitalization of processes:

> *OHM801X: "I have a statement to make. Digitalization and services go hand in hand. Look how our children consume information nowadays. It is primarily all digital, unfortunately, as I admit. There is nothing better than a good old lexicon of paper containing metallurgical diagrams. [laughs] I am from the steel industry like Sabrina. We do steel plant layout optimization on tablets using augmented reality."*
>
> *OHM189M: "We have the same situation. In transport and logistics, the digitalization of processes has made our life much easier. On the one hand, if I think about route management. On the other hand, it has made it much faster, almost hectic. It needs good proper planning to handle the speed. Once the process is going it is going, there is no way back."*
>
> *OHM999R: "Well, we heard a lot about the inevitability of digitalization. But let's go back to Wolfram's original question. What has this to do with overhead management? Well, I think a lot. Because it needs overhead first, in terms of system experts and infrastructure, before we can talk about digitalization. Industry 4.0 is not really new; it's just another logical innovation."*

The entities of the first theme of the conceptual framework (see 2.6) were matched to the interviews, the critical instruments, and the focus group by applying the coding schema with legend provided in appendix H. The highly subject assessment requires attention with regards to the categories 'not at all', 'somewhat', and 'heavily':

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Table 14: Description of the categories of finding 1

Category	Description
not at all	it is not critical; nobody will miss it
somewhat	it is important, but there are workarounds possible
heavily	decisive for future success; if it is missing there is an indispensable gap

Source: Own research

Table 14 holds the definition of categories used for finding 1. As previously described, the qualitative assignment was double-checked by co-workers, who came up with a similar assessment. The results are summed up in the next table; if critical incident instruments were available, they are marked with '(CI)':

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Table 15: Finding 1 - data summary table

				Impact of digitalization on OH		
#	Participant Code	Pseudonym	Industry	Not at all	Somewhat	Heavily
#1	OHM114C	Georg	automotive, OEM			X (CI)
#2	OHM289Z	William	aviation			X
#3	OHM878D	Isabella	automotive, parts			X(CI)
#4	OHM743V	Ute	beverage			X
#5	OHM650H	Brian	chemicals		X	
#6	OHM189M	David	transportation, logistics			X
#7	OHM544P	Diane	automotive, parts			X
#8	OHM901K	Serge	chemicals			X(CI)
#9	OHM007U	Gerhard	automotive, parts			X(CI)
#10	OHM467Z	Lazlo	aviation			X
#11	OHM399R	Barbara	transportation, logistics			X(CI)
#12	OHM511V	Sabrina	steel			X
#13	OHM946U	Joachim	automotive, parts			X
#14	OHM778Q	Miroslav	beverage		X(CI)	
#15	OHM444Y	Csaba	automotive, parts			X
#16	OHM801X	Alexander	steel			X
#17	OHM754Z	Dimitar	automotive, OEM			X(CI)
#18	OHM999R	Gertrude	automotive, OEM		X	
#19	OHM485A	Gerlinde	beverage			X(CI)
#20	OHM302C	Herbert	transportation, logistics			X
	Total: N = 20			0 (0%)	3 (15%)	17 (75%)

Source: Own research

Finding 1 in Table 15 demonstrates a strong opinion about the impact of digitalization on overhead and the management of it. A clear majority (75%) state that there is a strong impact of digitalization on overhead costs management; 25% indicated a partial impact, none said "not at all". Let's recall that the interpretation of the three categories is fundamental for the further meaning of the impact of the digitalization on overhead costs management. 'Heavily' was only coded if the interviewee gave the impression during the interview, the focus group meeting, and/or with the returned critical incident that it is mission-critical for the future success of the enterprise. Another characteristic of the description 'heavily' was that it holds decisiveness for

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upcoming decisions; and if missed, there is apparent disparity compared to competition. Digitalization in the context of overhead costs management is definitely something they desire. They expect a benefit from it, that would not exist without it. Eight participants returned critical incident instruments corresponding to the theme <Impact of digitalization on OH>. Except for one, all mentioned in the critical instrument that the impact of digitalization is heavy on overhead. In summary, the first finding was detected by quantitative and qualitative means using survey, individual interviews, critical incidents, and focus group interview.

4.5 Finding 2: Dissatisfaction with methods and tools

The next figure addresses hypothesis 2 with four supporting sub-hypotheses forming the meaning of innovation for services, see Figure 22. It follows the same logic concerning ordinal values and frequency as in the previous boxplot diagram. The boxplot diagram was used to depict the range, the median, the mean, the first and the third quantile and the whiskers on both ends. The responses came from the survey (Appendix C) sent out to the participants. Each individual response was carefully analyzed, captured in a spreadsheet, and I applied the ordinal values from Table 9 to draw the diagram.

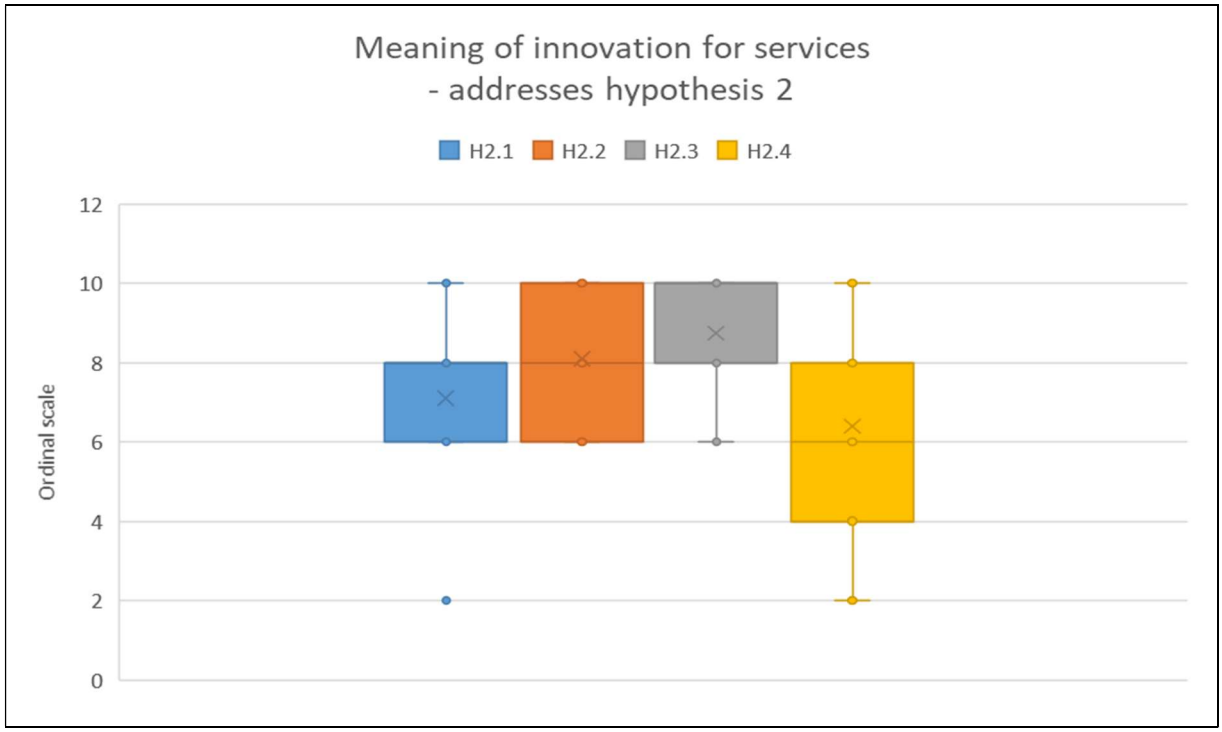

Figure 24: The meaning of innovation on services, n=20

Source: Own research

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In Figure 24 H2.1 stands for <The digitization of business processes influences the services of our company>. The results range from 2 to 10, respectively strong refusal to strong consent in the corresponding category. The first quantile is at 6, the third at 8. Therefore, the range of the interquartile is 2. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 6 for the lower whisker. The mean value is 7.1, the median is at 8. There are two outliers at 2.

H2.2 stands for <Digitalization creates new services>. The results range from 6 to 10, respectively ambivalent to strong consent in the corresponding category. The first quantile is at 6, the third at 10. Therefore, the range of the interquartile is 4. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 6 for the lower whisker. The mean value is 8.1, the median is at 8. There are no outliers.

H2.3 stands for <Digitization is a normal innovation, as it occurs again and again in industrial history>. The results range from 6 to 10, respectively ambivalent to strong consent in the corresponding category. The first quantile is at 8, the third at 10. Therefore, the range of the interquartile is 2. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 6 for the lower whisker. The mean value is 8.7, the median is at 10. There are no outliers.

H2.4 stands for <We have the right methods / tools to measure the efficiency (in terms of impact and cost) of innovation>. The results range from 2 to 10, respectively strong refusal to strong consent in the corresponding category. The first quantile is at 4, the third at 8. Therefore, the range of the interquartile is 4. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 2 for the lower whisker. The mean value is 6.4, the median is at 6. There are no outliers. Overall, H2 with “The surge of digitalization has an impact on related methods and tools” seemed to be validated. But, because of the small sample size a further qualitative investigation is needed to find out more about the contentment of overhead costs methods and tools.

After using the survey and appraising the responses, the qualitative interviews were conducted. As baseline served as the interview guideline (appendix D). The following quotes from the interviews support the findings:

> *OHM189M: ”It was impossible to apply PKR in its original, hence theoretical setup. The reason was that the technical description dominates and there is a lack in process thinking. The thinking in cost centers avoids the process view and therefore PKR. A change needs completely new booking and logistics*

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processes. The key to success is again the pull/lean process. It helps to optimize the processes."

Later in the interview OHM189M explained that the current tools are unsatisfactory so far, which was seconded by OHM485A in the subsequent statement. It is worthwhile to mention that both said similar quotes independently of each other with regards to completely different industries (i.e. transportation/logistics versus beverage) and without knowing each other:

OHM189M: "We had too much buffer of material. After we changed to pull we reduced WIP by 50% which stands for €200m. It was completed in two years work. But we came only close to real process costs. Because of Industry 4.0 so much transparency will be produced that PKR will become really possible, for the very first time. So far PKR had no real chance. Before that cost center accounting was to 99% dominant. PKR was a nice buzz word but not realistic."

OHM485A: "Time-driven activity-based costing had a very promising start a while ago. But there was never a follow-up; at least I have not seen it. The lack of knowledge in our organization - I guess it is fair to say in most organizations – is a major limitation. There is a need to capitalize on the capabilities and functions that we have now on our fingertips. AI will become a huge topic in the upcoming years."

Additionally, the critical instruments delivered more information about the methods, which is displayed here:

OHM189M (CI): "We need better tools. It starts already with the missing theoretical methods. ABC, time-driven ABC, and PKR were all promising beginnings. But they were ahead of their time. I miss the link of Industry 4.0 capabilities with the strategic foresight of Professor Horváth when introducing PKR."

It is interesting to recognize that OHM189M, a representative of the transportation and logistics industry who holds a PhD, mentions the strategic implication of methods and how hard it is to bring them to life in industrial practices. When addressing the issue in the focus group meeting, the following response was given:

OHM189M: "Yes, we see a gap between theory and practice. From my perspective, the theoretical framework setting is lagging behind. The real innovation in this field goes back to Horváth with the 'új folyamat gondolkodás' [hun., means new process thinking; comment by author]. I am wondering when we will see a similar giant step in the future."

A similar view concerning this issue was echoed by OHM801X, a representative of the steel industry in the focus group meeting:

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OHM801X: "I have a quite identical point of view. It seems we need a joint effort to address the issue. I understood from the meeting today that nobody is really happy with the tools and methods that at our disposal right now. In my opinion, the industry is in the driver's seat and needs to actively approach the academic community to move forward. I would even go so far that it is in the best interest of the EU to set up and do a founding of research projects concerning this topic. It would make all us much more competitive in the global market."

OHM511V: "I'd welcome it very much if universities, ideally applied universities, and selected – because interested – companies would work together. We should set up a European program to promote SME in overhead issues. Given the enormous tax burden and regulations we have in Europe, we are falling behind in a global perspective. We are way too inflexible; and this starts with the tools and methods. My perception is that far east and American companies by far don't have all these restrictions."

OHM999R: "Perfectly right. It becomes an issue of national interest on a European level to protect our industry. If we don't know precisely our cost structure in terms of how to allocate the huge amount of overhead to the cost object that we are going to sell, then we have a problem. I am very unhappy with the current situation. The methods and tools available to us are from the mid 1990s; everything takes too long and is therefore too late. Inflexibility is a big issue."

Then, the discussion turned back to methods and tools; Industry 4.0 was mentioned again. The interrelation of OH costs management and digitalization was brought to the table. Further, a wider perspective from a geographical perspective ("Portugal") was opened.

OHM114C: "The problem with the currently available methods and tools is the lack of usability. We produce tons of data every year but when I ask my guys what it means for calculating a sustainable price based on true costs, I receive a helpless shrugging of shoulders. Then it takes hours if not days for finding the information I need for the decision. It is mindboggling. On one side we are talking about Industry 4.0 that should enable everything instantaneously and on the other side we are lagging at least 20 years behind concerning tools."

OHM467Z: "I could not have said it better. There is a huge gap between expectations and capabilities. I would immediately contribute in joint forces to link overhead costs management and digitalization better together. We just represent four industries in this room but have obviously a lot in common concerning the subject matter. I am pretty sure others are struggling as well, outside our industries and outside our perimeter. What do SMEs in Portugal think about this matter? It would be an interesting question to answer."

The entities of the second theme of the conceptual framework (see 2.6) were matched to the interviews, the critical instruments and the focus group by applying the coding schema

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with legend provided in appendix H. The results are summed up in the following table; if critical incident instruments were available, they are marked with "(CI)":

Table 16: Finding 2 - data summary table

				Limitations of methods/tool				
#	Participant Code	Pseudonym	Industry	ABC	PKZ	TD-ABC	Sticky Costs	Satisfaction
#1	OHM114C	Georg	automotive, OEM	X				N(CI)
#2	OHM289Z	William	aviation		X			N(CI)
#3	OHM878D	Isabella	automotive, parts	X				N
#4	OHM743V	Ute	beverage	X				N
#5	OHM650H	Brian	chemicals	X			X	N
#6	OHM189M	David	transp., log.		X		X	N(CI)
#7	OHM544P	Diane	automotive, parts		X		X	N
#8	OHM901K	Serge	chemicals		X		X	N
#9	OHM007U	Gerhard	automotive, parts	X				N
#10	OHM467Z	Lazlo	aviation		X			N(CI)
#11	OHM399R	Barbara	transp., log.		X			N
#12	OHM511V	Sabrina	steel			X		N
#13	OHM946U	Joachim	automotive, parts	X				N(CI)
#14	OHM778Q	Miroslav	beverage			X		N(CI)
#15	OHM444Y	Csaba	automotive, parts		X			N
#16	OHM801X	Alexander	steel		X			N(CI)
#17	OHM754Z	Dimitar	automotive, OEM		X			N
#18	OHM999R	Gertrude	automotive, OEM			X	X	N(CI)
#19	OHM485A	Gerlinde	beverage			X	X	N
#20	OHM302C	Herbert	transp., log.		X			N(CI)
	Total: N = 20			6 (30%)	10 (50%)	4 (20%)	6 (30%)	No (100%) Yes (0%)

Source: Own research

Finding 2 in Table 16 shows 100% dissatisfaction with the currently used methods and tools. It is noteworthy because the survey first showed in the results for H2.4 that the enterprises were quite happy with the available methods/tools; the median had been at 6, the mean at 6.4, which both represent ambivalent in the category of the ordinal value. It turned out during the

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interviews that the question in the survey had often been misunderstood in terms of the definition of innovation. When specifically addressing innovation in terms of overhead costs management in the interviews, all participants said that they expect much more from the methods and tools. They wonder why academia and SAAS providers do not deliver more suitable innovations. A similar observation concerning knowledge transfer is reported in Szendi & Székely, (2015); there is an reluctance of SAAS providers to initiate with academia I4.0 programs to reflect the needs of businesses. Nine participants returned critical incident instruments corresponding to the theme <Knowledge, skills, governance, attitudes>. The responses from the interviews about what can be done to overcome the limitations were manifold: (1) a strong request to academia to invent new concepts, (2) further usage of Industry 4.0 capabilities to turn data quickly into information, (3) sticky costs are acknowledged however the concrete application with tools is lacking. The second finding was detected by survey, individual interviews, critical incidents, and focus group meeting.

4.6 Finding 3: Usability and speed are predominant factors

The next figure addresses hypotheses 3 with four supporting sub-hypotheses forming the meaning of services for overhead costs, see Figure 23. It follows the same logic concerning ordinal value and frequency as it was previously applied using boxplots.

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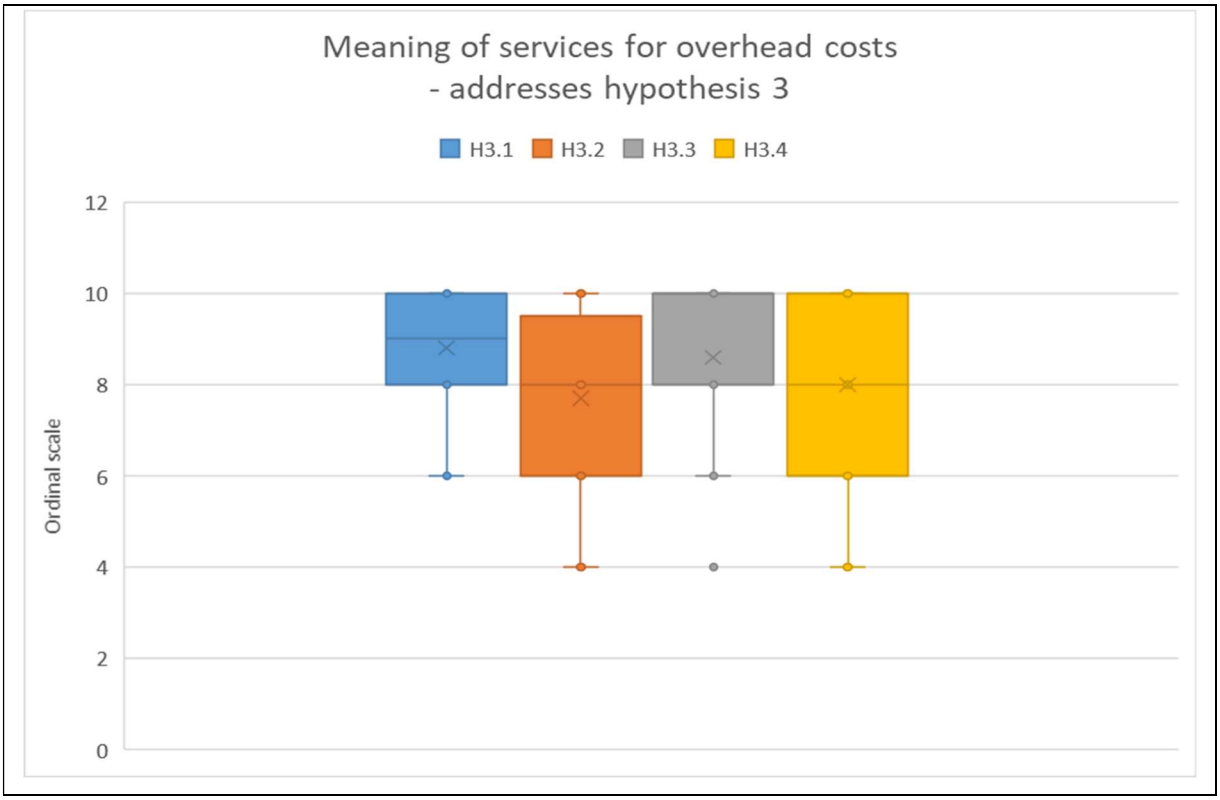

Figure 25: The meaning of services on overhead costs, n=20

Source: Own research

In Figure 25, H3.1 stands for <An increase in services will increase overheads to the same extent>. The results range from 6 to 10, respectively ambivalent to strong consent in the corresponding category. The first quantile is at 8, the third at 10. Therefore, the range of the interquartile is 2. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 6 for the lower whisker. The mean value is 8.8, the median is at 9. There are no outliers.

H3.2 stands for <Services can be assigned to the cost unit by digitization in accordance with the cause>. The results range from 4 to 10, corresponding respectively to refusal to strong consent in the corresponding category. The first quantile is at 6, the third at 9.5. Therefore, the range of the interquartile is 3.5. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 4 for the lower whisker. The mean value is 7.7, the median is at 8. There are no outliers.

H3.3 stands for <Speed, transparency, and usability are the predominant factors for the successful management of overhead costs >. The results range from 4 to 10, respectively refusal to strong consent in the corresponding category. The first quantile is at 8, the third at 10. Therefore, the range of the interquartile is 2. The whiskers using 1.5 times of the range of the

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interquartile leads to 10 for the upper whisker and 6 for the lower whisker. The mean value is 8.6, the median is at 10. There is one outlier at 4.

H3.4 stands for <There will be an increase in services (digital and non-digital) in the future>. The results range from 4 to 10, respectively refusal to strong consent in the corresponding category. The first quantile is at 6, the third at 10. Therefore, the range of the interquartile is 4. The whiskers using 1.5 times of the range of the interquartile leads to 10 for the upper whisker and 4 for the lower whisker. The mean value is 8, the median is at 10. There are no outliers. Overall, H3 with "Digitalized services have a direct effect on overhead costs" appears to be validated. But, because of the small sample size a further qualitative investigation is needed.

After using the survey and appraising the responses, the qualitative interviews were conducted. The interview guideline (appendix D) served as a baseline. The following information was disclosed:

> *OHM754Z: "Usability and speed are definitely the predominant factors. Additionally, I would like to mention consistency."*
>
> *OHM189M: "Speed and transparency are the most important ones, in this sequence. Additionally, I would like to mention easy access around the globe; it is essential in the logistics industry."*
>
> *OHM485A: "It is very hard to generalize, because each industry has its own demands. But the overall topic is VUCA, therefore speed and anticipation of results are key. It boils down at the very end to flexibility, not only in our business behavior but also how we will manage our overhead costs in the future. Our industry sees a shift to service capabilities, which demand overhead."*

Additionally, the critical instruments delivered more information, which is displayed here as an example:

> *OHM650H (CI): "The major prerequisites for successful overhead costs management remain caution about building up overhead in the first place., since they usually remain sticky. The chemical industry needs huge investments that are earned only in the long run. Nevertheless, it means to find smart ways to allocate the overhead to the cost object, which is in our case the product we sell to the customer. Of course, the more transparent it is, the better the decisions will be in finding priorities."*
>
> *OHM467Z (CI): "Truth of data and legal compliance are mission critical We have customer and suppliers around the globe. I need to trust the data. Unfortunately, too often the data is not reliable because of unclear definitions.*

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Ideally, I can use the data, e.g. PO information from suppliers directly in my cost management system."

It is interesting to recognize that OHM467Z, a representative of the aviation industry, who is in management capacity as an educated technician with 19 years of subject matter experience, mentions the inter-connectivity of the data with the business partners as a success factor. When addressing the issue in the focus group meeting, in order to find out what was meant by legal compliance in context with purchase order information, the following discussion arose:

OHM467Z: "With legal compliance I meant that we can use the transactional data submitted via EDI from our partners immediately. Hence, it does not need any sanitizing concerning regulations and tax laws, domestic and international. Let me give you an example: Customs and tariffs are a significant cost factor in our business for selecting the right supplier. So far, we have found no cost management tool that reflects that correctly. It needs still manual intervention, which is failure-prone and time consuming. Usability and speed are the essential success factors."

OHM189M: "We have a similar issue! The inconsistency of internal cost accounting and official/external financial reporting is often mind-boggling. Just think about the GAAP regulations. I'd expect from Industry 4.0 SAAS provider usability, this means client-friendly solutions. What we have so far is unsatisfactory. There is so much talk about artificial intelligence. I am not aware of any provider who offers packages that are doing the sanitation. This would definitely speed up the process."

OHM114C: "I would raise another issue. It is about acceptance of employees. What do I mean with that? At the end of the day, we depend on the participation of our employees. It they don't track properly and don't see a value in the advanced overhead costs management tools, we will not succeed. It's a thin red line. On one hand, we need their involvement, on the other hand, we need to protect their privacy. If tracking activities is seen as spying, we lose."

It brings in a new notion into the discussion; the human resource aspect of the subject matter. There has been consensus in the focus group that the acceptance of the tools is mandatory, following the general management principle: If performance in needed, a reason must be given.

OHM999R: "Perfectly right, communication and explaining the bigger picture because with VUCA, it is even more important. We need a compelling narrative why we are doing it, and how it helps to create the urgently needed cost transparency. The apps nowadays are great. We use them with tablets on the

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shop floor. Because of the speedy creating of demand profiles we can react very quickly to fulfill it. Of course, this works only in a consequent pull environment."

OHM511V: "I tend to agree with that. Although it might not be quite that fast in our industry. Nevertheless, speed matters. Although on top of it I would place usability. Because if the tools are user-friendly than we have the acceptance of our employees. Presumed that we have explained the cause. It is a give and take situation. The requested transparency for the decisions is not for free; it needs tons of communication and training. Then we will succeed."

OHM801X: "Someone said it already. It is all about how we deal with VUCA. The world is no longer in the mid 1990s. It became literally volatile, uncertain, complex and ambiguous. Digitalization fueled and still fuels this process. What was once thought that the internet brings us break-through advantages in terms of speed, fires back now that we experienced a huge complex uncertainty. It needs lean and flexible processes to deal with it."

The entities of the third theme of the conceptual framework (see 2.6) were matched to the interviews, the critical instruments and the focus group by applying the coding schema with legend provided in appendix H. The results are summed up in the following table; if critical incident instruments were available, they are marked with "(CI)":

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Table 17: Finding 3 - data summary table

				Prerequisites		
#	Participant Code	Pseudonym	Industry	Speed	Transparency	Usability
#1	OHM114C	Georg	automotive, OEM	X		X(CI)
#2	OHM289Z	William	aviation		X	X
#3	OHM878D	Isabella	automotive, parts	X	X	X
#4	OHM743V	Ute	beverage	X	X	X(CI)
#5	OHM650H	Brian	chemicals	X	X	X(CI)
#6	OHM189M	David	transportation, logistics			X
#7	OHM544P	Diane	automotive, parts	X	X	X
#8	OHM901K	Serge	chemicals	X	X	X
#9	OHM007U	Gerhard	automotive, parts		X	X
#10	OHM467Z	Lazlo	aviation	X		X(CI)
#11	OHM399R	Barbara	transportation, logistics	X		X
#12	OHM511V	Sabrina	steel	X		X
#13	OHM946U	Joachim	automotive, parts	X		X(CI)
#14	OHM778Q	Miroslav	beverage	X		X
#15	OHM444Y	Csaba	automotive, parts	X		X
#16	OHM801X	Alexander	steel	X	X(CI)	
#17	OHM754Z	Dimitar	automotive, OEM	X		X
#18	OHM999R	Gertrude	automotive, OEM	X	X	
#19	OHM485A	Gerlinde	beverage	X	X	X(CI)
#20	OHM302C	Herbert	transportation, logistics		X	X
	Total: N = 20			16 (80%)	11 (55%)	18 (90%)

Source: Own research

Finding 3 in Table 17 depicts that a majority of participants cite usability and speed as the predominant factors. More than half indicated that transparency of OH is instrumental. The survey asked about speed, transparency, and usability; the appraisal of the responses showed a strong vote in favor of these three factors. Nevertheless, in the interviews it turned out that usability and speed by far outweigh the remaining factor transparency, clearly positioning usability in first place and then speed. One interviewee (David) said that he sees

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completely different success factors, namely process robustness against error proneness and data storage safety as dominant factors, however only usability fits his perception. Seven participants returned critical incident instruments corresponding to the theme <Success factors>. After the interviews, critical incidents, and focus group discussion, the following twelve factors with the corresponding frequency were captured; multiple entries were allowed:

Table 18: Frequency of factors called in interviews.

Factor	Frequency (20 maximum)
Usability	18
Speed	16
Transparency	11
Consistency of data	9
Acceptance of the employees	8
Easy access around the globe	6
Truth of data	5
Legal compliance	4
Anticipation of results	4
Compatible with GAAP	2
Process robustness against error proneness	1
Data storage safety	1

Source: Own research

Concerning speed, there was a consensus (see Table 18) in the focus group that, on the one hand, speed is essential for seizing opportunities, however, on the other hand, speed 'kills' in terms of unfocused hyperactivity. Therefore, speed is seen as a delicate issue. It needs a smart interpretation of speed; maximum possible speed "speed of light by internet" (Laszlo) is not the perfect answer but an intelligent interpretation as to what makes sense at which point in time. The responses from the survey, interviews, critical incident instruments, and focus group meeting concerning what could be done to overcome the limitations were manifold: (1) strong request to academia to invent new concepts, (2) usage of Industry 4.0 capabilities to turn

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data quickly into information, (3) sticky costs were acknowledged but lack the concrete application in tools. The finding number three was detected by survey, individual interviews, critical incidents, and focus group interview.

4.7 Line-itemized income statement analysis to counteract findings

As preparation for the individual interviews and focus group interview, I performed a line-itemized income statement analysis based on the official numbers in annual reports. The perspective of the analyses was to identify overhead specific costs and corresponding notes with detailed explanations. Some income statements carry line-items with a name that includes overhead, such as manufacturing overhead. However, many other overhead items are not so explicitly named. The obvious conclusion from the analysis is that the distinction between overhead and non-overhead expenses is of subordinate importance for the structure of income statements. Nevertheless, it is important to know for the dissertation where to find overhead expenses on the income statement: Firstly, product production overhead expenses are reported above the gross margin line. Secondly, all other overhead expenses from the enterprise's core business appear below the gross margin line, under operating expenses. Thirdly, activities outside the core business incur as overhead expenses and the enterprises report this kind of overhead under significant headings below the operating income line (e.g. extraordinary items or financial expenses). The legally binding reporting standard IFRS request full absorption costing, which means that that all costs that occur during the value creating process are reported (Oyj & Koukkula, 2011).

The purpose of the line-itemized income statement analysis was to be prepared to challenge statements made during the interviews. The annual reports of the years 2008, 2013, and 2017 were used for the analysis. These selected years are consistent with available data from the BACH database system in order to draw conclusions from the comparison. I wished to be in a position with the line-itemized income statement analysis to double-check if the perception of the interviewees was consistent with the official numbers. This approach offered the opportunity to gain insight beyond the numbers with narratives from the interview partners within the context of digitalization, that the numbers alone would not tell. Eight enterprises (see Appendix N) were purposely selected, where (a) sufficient public data was available, and (b) the participants were willing to discuss it. I challenged the income statements against the employee and revenue data in the survey. The participants explained the discrepancy that they

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reported in the survey 'their' business unit and not the entire enterprise group. Four of the eight enterprises had representatives in the focus group: OHM114C, OHM999R, OHM511V, and OHM801X.

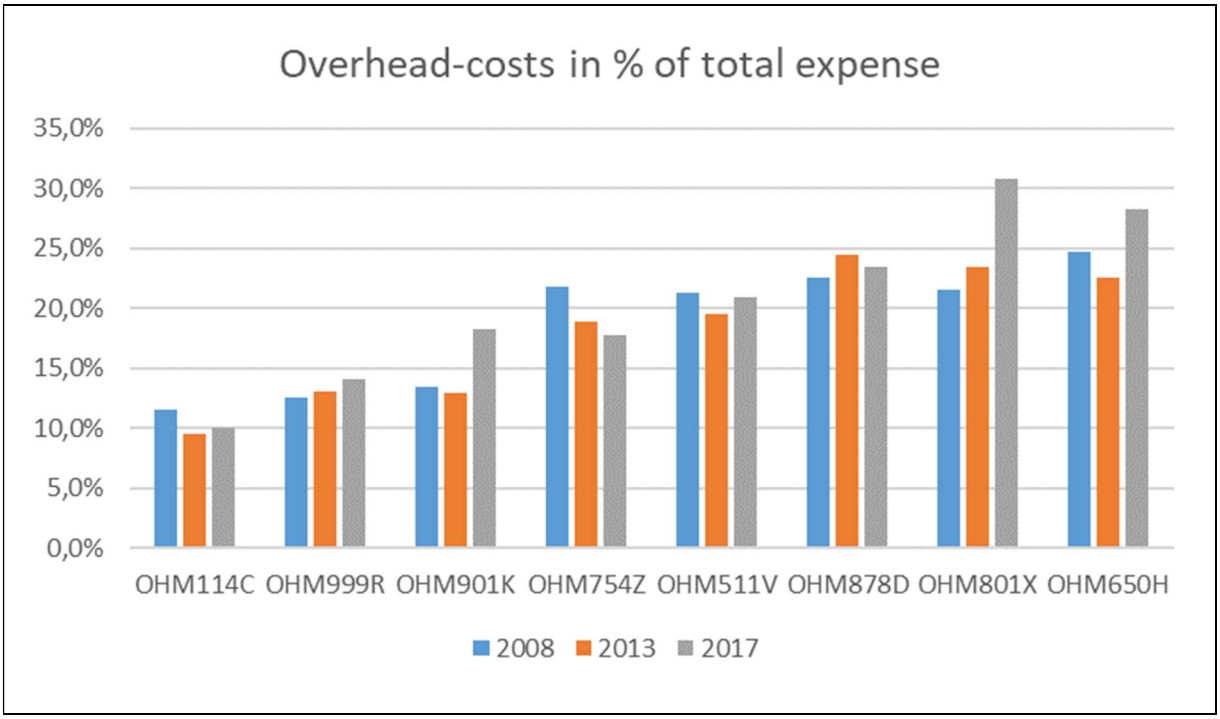

Figure 26: Overhead in percent of total expense

Source: Own depiction

Figure 26 shows for the selected enterprises the overhead costs for the years 2008, 2013, and 2017. It used the assumption that the expenses above the gross margin line were all direct costs without overhead called COGS or cost of sales, respectively. This was not precisely true as the analysis made apparent. Nevertheless, it gave a first insight into the operational strategy of the enterprise in terms of which expenses were reported as an isolated line-item. Further, and this is the core value of the analysis, it showed the dynamics over time for the specific enterprise over a 10-year period. The data was collected from their income statements of the official annual reports. The detailed data and the calculations are provided in Appendix M. The reported years were chosen intentionally in order to be consistent with the analysis based on the available data of the BACH database.

The clustered column chart above shows overhead in percent of the total expense; the lowest number is 9.6% (OHM114C) in the year 2013, the highest is 30.8% (OHM801X) in the year 2017. Each set of numbers tells a story worthy of further investigation by means of interviews. Above all, it is of interest to find out (1) what is the dynamic over time for the

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individual enterprise, and (2) are there any patterns in the corresponding industry or even across the investigated industry. The following itemized income statement analysis for each of the enterprises above looked for these traits.

OHM114C represents an automotive OEM. The income statement reported an aggregated line of COGS next to other lines of several expenses. In the notes of the annual report, COGS is split into material, direct labor, and manufacturing overhead. Manufacturing overhead is $6.2b and represented 16.7% of all expenses or 18.5% of the reported COGS in 2017. This means that this amount needs to be added to the other expenses of $37b for the true overhead costs. Explicitly the annual report stats the COGS increased because of overhead, precisely from $5.8b in 2016 to $6.2b in 2017, which is an increase of 5.6%. Concerning digitalization, the annual report states that the enterprise uses smart factory manufacturing processes to provide efficient and competitive product operations. This includes the use of digital communication among employees, machines and products (Enterprise OHM114C, 2017). During the interview the following was mentioned in this context:

> *OHM114C: "Overall we see a buildup of overhead. It's not only because of digitalization but of many other factors that makes running a sophisticated business in the automotive industry very complex. Other factors are still growing investments for automation and first of all to prepare for Industry 4.0 in general. At the end of the day, digitalization should help us to manage the complexity better. But it is a two-sided sword, on one side it helps to manage VUCA better, on the other side it adds to the complexity."*

OHM999R represents an automotive OEM. The income statement reported an aggregated line of cost of sales next to other lines of several expenses. The notes in the annual report explain that cost of sales included direct materials and direct production, wages, as well as a directly attributable portion of the necessary indirect materials and indirect labor costs, scheduled production-related depreciation, and expenses attributable to the products from the scheduled amortization of capitalized development costs. No further detailed lines of the composition of cost of sales were shown. Nevertheless, the notes revealed that cost of sales includes expenses of €277m in relation to the diesel issue in North America; taking out this amount from cost of sales and adding it to overhead would hardly decrease cost of sales, which reports €50.5b or 86% of all expenses in 2017. Concerning digitalization, the annual report states that the megatrends of digitalization, sustainability, and urbanization are transforming the automotive industry; the enterprise consistently digitalizes their business processes for

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creating the leading ecosystem for premium mobility and digital services. This transformation to a new age of mobility is flanked by an extensive program of measures through streamlining costs, reducing complexity and unlocking new income potential and, in the process, cementing its profitability expectations for future mobility. Digitalization enables materializing substantial efficiency potential along their entire value chain and allows for continuation of financing investments in future topics (Enterprise OHM999R, 2017). During the interview, the following was mentioned:

> *OHM999R: "Officially, we keep detailed overhead costs private and report only what is requested by law, particularly IFRS rules. It is proprietary information. Nevertheless, I can say that comprehensive digitalization of the sales processes has the potential to cut distribution costs by 1 percentage point. This is a lot, approximately €53m per year."*

OHM901K represents an enterprise in the chemicals industry. The income statement reported an aggregated line of COGS next to other lines of several expenses. The notes explain line-items of €300k for depreciation, amortization and impairment in COGS, further costs of defined benefit plans and other long-term employee benefits are recognized with €18,1m in COGS in the year 2017. Of the commodity cash flow hedges, gains amounting to €14,4m (losses amounting to €579m) were removed from hedging reserve during 2017 and were reclassified to the income statement and included into COGS. There was no partial operative ineffectiveness of the commodity cash flow hedges, therefore no losses were recognized in COGS at year end 2017. With the higher feedstock price environment, COGS increased in 2017 compared to 2016, despite overall lower sales volumes. Taking these items from the notes into consideration and deducting them as indirect costs from the reported COGS, then overhead costs increase slightly to €1284m or 18.3% of all expenses. Concerning digitalization, the enterprise focuses on developing a learning organization, supporting the needs of a growing company and leveraging the benefits and opportunities of digitalization. No further statements about digitalization were found in the annual reports (Enterprise OHM901K, 2017). During the interview the following was mentioned in this context:

> *OHM901K: "In the chemical industry, we have huge overhead hidden in production costs that is not made visible in the public income statement. We can draw some conclusions regarding the other expenses which are clearly overhead. Another characteristic of our industry – I believe – is the dependency*

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> *on raw material prices. It is the major portion in our COGS without going into too many details."*

OHM754Z represents an automotive OEM. The income statement reported an aggregated line of cost of sales next to other lines of several expenses. The notes explain itemized items of depreciation of equipment on operating leases with €8b, refinancing costs with €2.2b, impairment losses on receivables from financial services with €0.5b, and other cost of sales with €5.3b. These items deducted from cost-of-sales (€130b) lead to expense of goods sold at €114b. Further, amortization of capitalized development costs is an element of manufacturing costs and is allocated to those vehicles and components by which they were generated and is included in the cost of sales when the inventory (vehicles) is sold; it is represented in the amount of €1.3b in expense of goods sold. Adding these items to the other overhead expenses the overall overhead increases to €28.02b or 18% of all expenses. Concerning digitalization, the supervisory board dealt with initiatives relating to the recruitment of digital talent, employees' digital qualification and the digitization of HR tools. Connected vehicles and digital services are sales clinchers. The digital anticipation service supports customers from the time they buy a car until their new vehicle is delivered. The sustainability strategy 2030 concentrates on four focal topics in the following sequence: vehicles, digitalization, mobility services, and responsible conduct (Enterprise OHM754Z, 2017). During the interview the following was mentioned:

> *OHM754Z: "We see a transformation in the automotive industry with a strong focus on general enablement of customized mobility. We see this movement regardless which type of engineered mobility and/or powertrain technology. It is an open playing field and we do whatever makes sense to our customers. Based on the officially reported numbers, you see a decrease of overhead. But, this is diluted as we do not show details of expense of goods sold. With respect to the statements about digitalization, you can draw the conclusion that there is substantial effort to enable the organization for Industry 4.0."*

OHM511V represents an enterprise in the steel industry. The consolidated income statement was prepared using the cost of sales method. The functional areas of cost of sales, administrative expenses, distribution costs, and other operating expenses may include amortization of intangible assets. No further line-item details for cost of sales were reported. Further, the annual report stated that the reconciliation of depreciation, amortization and

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impairment of property, plant and equipment and intangible assets were presented by functional area. Therefore, cost of sales as were considered as the best feasible data for non-overhead. Concerning overhead, ongoing activities focused on the systematic continuation of cost-cutting and optimization programs as well as new initiatives, especially in the area of digitalization, without detailing any numbers. They refer to the strategic focus on the increasing influence of digitalization. Their leadership in innovation, the comprehensive digitalization of processes as well as the resulting qualitative optimization of products for aerospace, automotive, and energy industries had created the prerequisites for the continued expansion of their dominant position worldwide in specialty steels. The 'digital learning factory' project had been introduced to train apprentices for the digitalization of the work environment. The rapidly advancing digitalization contributed increasingly to the enhancement of process efficiency and quality. Research & development are a key component of digitalization and vice versa. The 'Digitalization Day', a two-day top-class symposium featured lectures by international experts, presented new information and expanded views of what is currently seen as the number one topic in the industry. A fully digitalized 550,000-ton wire rod mill went into regular operations, which is conform to the highest technological standard currently achievable in terms of purity, strength, and ductility (Enterprise OHM511V, 2017). During the interview the following was mentioned:

> *OHM511V: "We invest a lot in digitalization. It starts already on entry-level with the apprentices. Management accounting and financial accounting are two separate, but of course, interrelated system. We compete in a tough environment. Our competition has clearly a cost advantage. Therefore, we focus on specialty steels. Nevertheless, we need to defend our technological advantage. We do not allow detailed insight into our calculation."*

OHM878D represents an enterprise in the automotive parts industry. The income statement reported an aggregated line of cost of sales next to other lines of several expenses. The notes detail for cost of sales the following itemized items: €68m for material and expenses for procured services, €57m for personal, €11 for depreciation, and €14m for other operational expenses. Further, the notes in the annual report unveil that personal expenses for cost of sales and administration contains €40m for wages. I applied the assumption that the wages belong to direct costs; this is based on the definitions in Chapter 2.2 due to the imprecise handling of wages in the annual report. By taking these items into account, the true overhead costs increase to €88k or 45% of all expenses for the year 2017. The annual reports do not refer to any

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statements with regards to digitalization (Enterprise OHM878D, 2017). During the interview the following was mentioned in this context:

> *OHM878D: "As stated in the critical incidents, we see a heavy impact of digitalization on overhead. Honestly, I am surprised that we do not report it in the annual reports. Your calculation of true overhead costs makes sense. It shows that overhead is actually significantly higher than assumed. The major cost-driver concerning digitalization is the installation of our cloud-based ERP system. The advantages are impressive, but the costs, actually overhead, are quite high."*

OHM801X represents an enterprise in the steel industry. The income statement reported an aggregated line of COGS next to several other lines of expenses. The notes detail line-items for expenses with €116m for cost of material, €98m for personnel expenses, €35m for depreciation of property, plant and equipment including impairments, and €14m for amortization of other intangible assets including impairments. Except for cost of material, no hints are given about the portion of direct costs. This would have been especially helpful for personnel expenses. No further refinement of COGS takes place in order to make a more precise statement about overhead. Concerning digitalization, quality management, product and process control benefit from it by using modern software solutions to automate processes that require detailed planning and are prone to errors. It allows for saving time, reducing costs and delivering considerable efficiency increases also in terms of personnel resources. No further statements are made about digitalization in the annual report (Enterprise OHM801X, 2017). During the interview the following was mentioned in this context:

> *OHM801X: "Actually, our reported numbers show a sharp increase of overhead costs over the last ten years. The industry went and is still going through a massive change. High-costs countries, such as Austria, can only compete in a global market if we are faster, more precise than others. We need digitalized processes for that, which deliver information for decision making with 'speed-of-light'. Cost-cutting of direct labor and partial replacement of automation is definitely a fact."*

OHM650H represents an enterprise in the chemical industry. The income statement reported an aggregated line of cost of sales next to other lines of several expenses. The notes detail line-items for cost of sales for inventories recognized as an expense amounting to €30b in 2017; no further deductible line-items were reported. Depending on the type of intangible

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asset, amortization is reported under cost of sales, selling expenses, research and development expenses or other operating expenses. Depreciation of successful exploratory drilling is reported under cost of sales, however not detailed. Cost of sales includes all production and purchase costs of the company's own products as well as merchandise which has been sold in the period, particularly plant, energy and personnel costs. Concerning digitalization, they strengthen their capacity for innovation by utilizing the opportunities offered through digital technologies across the value chains. It helps to design the processes more effectively and efficiently. At their sites around the globe, they combine data with modern analytics. For example, they use predictive maintenance techniques at the steam cracker, the heart of their production. Several thousand sensors record process data, such as temperature and pressure, around the clock. This makes it easier to optimally operate and monitor the plants. The growing use of digital technologies secures their leading position in chemistry-based innovation. Additionally, digitalization is also changing vocational training. Course content is adapted to include Industry 4.0 topics such as modules on data management or automation, and modern communication technologies make new learning methods possible. Young people train for their future profession in modern workshops and laboratories, where they use digital technologies from the start (Enterprise OHM650H, 2017). During the interview the following was mentioned:

> *OHM650H: "Digitalization is huge. It has dominated the agenda already for years. And there is no end in sight. It is really a revolution from an innovation point of view. Digitalization is mostly overhead. I do not recall a single use-case where we can assign costs of digital services directly to the cost objects. It needs the assignment of cost drivers. It is an immense task and we are still learning. The tools so far are not sufficient, both from a theoretical as well from a practical point of view. Of course, our activity-based costing tools are highly proprietary; it is a key asset. We keep them strictly confidential and they are not disclosed."*

The three representatives of the automotive OEM industry showed the method cost of sales in their income statements. They all had in common that they were reluctant to disclose too detailed information, which would allow for drawing conclusions about the product cost calculation. They all mentioned that the industry is in a digital transformation. Each one of them portrayed their strategy of how to tackle the challenge. The installation of the digital

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infrastructure (e.g. cloud computing) is a major cost driver. OHM511V, as a representative of the automotive parts industry, confirmed this observation.

The two representatives of the steel industry demonstrated a similar reporting behavior. One reported cost of sales, the other COGS. Both did not enlighten the outside stakeholder with detailed line-item information for a thorough identification of overhead costs. With regards to digitalization, there was the common understanding that it is critical for automatizing the processes and for prevailing with quality products in a competitive business environment.

The two representatives of the chemical industry showed a more ambiguous picture. One company reported COGS, the other cost of sales. The notes in the income statements shed some light on how their expenses are designed. Concerning digitalization, there was a range from a rather shallow involvement on the one hand, and on the other hand there was an active push to apply all features of Industry 4.0 in their daily routine.

Overall, it can be said that there was an increase of the expenses above the gross margin line over the timeframe from 2008 to 2017. Each enterprise had an individual narrative, however there was without a doubt an impact of digitalization on overhead in the income statement for all. None of the investigated companies contradicted this.

4.8 Summary of presentation of findings

The results of the survey, the interviews, the critical incident instrument, and the focus group revealed three key findings. Concerning the number of participants, drawn from a pool of potential candidates, it emerged that after the 14 interviews no further themes/topics/items were thrown into the research arena. This was interpreted as having reached saturation of meaning for the qualitative research. Nevertheless, all twenty interviews were performed with the same rigor. The final interviews were used to confirm the previously stated issues. The above mentioned three findings are summed up in the following table, enriched with interpretations and conclusions:

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Table 19: Findings, interpretations, and conclusions

Findings	Interpretations	Conclusions
Finding 1: A majority of participants indicated that digitalization impacts heavily the OH.	• Overhead costs management are a 'hot' topic • There is a long-term trend from the past that seems to continue into the future • There are unrealistic expectations • Individual idiosyncrasies are part of the subject matter	Professionals who deal with overhead should not expect that there is a magical equation that solves all problems. Overhead costs management has always been difficult; digitalization does not make it easier. The primary purpose of overhead costs management is to assign indirect costs to cost objects. The bigger the OH, the more precision is requested.
Finding 2: All participants expressed their dissatisfaction with the currently used tools. The limitations are mainly inflexibility and lack of knowledge.	• Tools are used because of historical reasons • There was no effort to re-evaluate the situations • There are unrealistic expectations • A lack of understanding inflates the problem	Digitalization is another parameter that makes the equation even more complex. Being grounded in practice alone is insufficient. Enterprises need theoretical know-how, and they should acquire this through more formal education. In the absence of formal preparation, enterprises need to be open to new ways of learning.
Finding 3: The majority of participants cited that usability and speed are the predominant factors. More than half indicated that transparency of OH is instrumental.	• Twelve different factors were called, but there are three favorites • The dynamics of markets (VUCA) essentially dictate the factors • There is an eager interest to find better solutions • The requirements are clearly stated and understood	Dialogue with enterprises in the demonstrated setting can provide a source of information and support. It offers room for reflection and aligned action. Collaboration offers opportunities for development of new understanding and new learning. Progress also is largely a function of personal conduct as well as motivation and drive. The experience calls for collaboration.

Source: Own research

Based on the findings, interpretations, and conclusions as summarized in Table 19, an analysis, further in-depth interpretation and finally a synthesis is needed. This will be shown in the next chapter (Chapter five). The findings above stand for the items I have uncovered through the various research methods, namely quantitative survey, qualitative interviews, critical incident instruments, and the focus group. The interpretations are my thoughts about what the findings mean in context of the available body of knowledge. The conclusions are the logical consequence from the interpretations. The line-itemized analysis of the income

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statements delivered a diverse picture about the ramification of digitalization; overall, traits were identified in the income statements for the brisance of overhead and digitalization. The next two chapters holds the following: Chapter 5 explains analysis, interpretation, synthesis of the findings; Chapter 6 concludes with three theses and multiple recommendations as the result of the PhD thesis.

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CHAPTER 5

ANALYSIS, INTERPRETATION, AND SYNTHESIS OF FINDINGS

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5 Analysis, interpretation, and synthesis of findings

The purpose of this dissertation was to explore with a sample of businesses their perceptions of how the digitalization of processes impacts the management of overhead costs. The anticipation was a better understanding of the perceptions of the enterprises struggling at various stages of the journey of digitalization; it would provide insight how to encourage and support other and future businesses to successfully conduct their endeavors in mastering overhead costs.

The dissertation used naturalistic inquiry to collect quantitative data through a survey. Furthermore, in-depth interviews, associated critical incidents, and a recorded focus group discussion gathered qualitative data. The participants in the dissertation included 20 experienced business managers in seven different industries. Five of them have a PhD in business management, eight give lectures at local universities. Hence, there is impressive, academically trained knowledge represented within the group. The data were coded, analyzed, organized firstly by theme, research question and hypothesis; then secondly by detailed entities guided by the conceptual framework (see Chapter 2.6). The dissertation was established on the following three research questions:

1. How does the digitalization of processes impact the management of overhead costs?
2. What are the limitations of the current approaches in respect to methods and tools? If there are limitations, what can be done to overcome them?
3. In general, what are the prerequisites for the successful management of overhead costs?

Analytic categories are directly connected with each theme, research question and hypothesis. The purpose of an analytic category is to group the findings and the corresponding consequences together. It will lead then to the recommendations ergo results in terms of answered research questions and validated respectively falsified hypotheses. These same analytic categories contain the coded data with the findings displayed in Chapter 4. In the analysis, I sought mainly to connect patterns within the analytic categories, but also across the three themes of the dissertation which are (1) the impact of digitalization on OH, (2) knowledge, skills, governance, attitudes, and (3) success factors. As a secondary analytical level, the relevant theory is linked, as the themes are compared and contrasted to issues in academic literature.

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Chapter 4 produced the findings of the dissertation by organizing the data from various sources into themes to issue a readable narrative. Additionally, the sources delivered data which were portrayed with descriptive statistical methods. The purpose of that chapter was to create interpretative insights into the findings. Whereas Chapter 4 split apart and divided pieces of data to tell the story, this chapter compiles a holistic understanding in order to express an integrated picture.

After the analytic category development, three analytic categories are introduced. They are linked to the three hypotheses stated in Chapter 1. Information from the literature is woven into the categories. The chapter concludes with the revisiting of the hypotheses in Chapter 1 in order to validate or falsify them, respectively. The result is challenged against the BACH database of the European committee of central balance-sheet data offices, which holds detailed income statement information for different sectors. A summary, that charters a note concerning the effect of my possible bias in interpreting the findings, concludes this chapter.

5.1 Analytic categories development

To illustrate the process of developing the analytic categories, it is necessary to revisit the findings from Chapter 4. Upon careful analysis of the responses from and across the findings in the data summary tables, the connected patterns emerged, which leads to the analytic categories.

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Table 20: Analytic category development

Research Question	Finding statement	Outcome/consequence	Analytic category
1. How does the digitalization of processes impact the management of overhead costs?	Finding 1: The majority of participants indicated that digitalization impacts heavily the management of OH.	Enterprises need to deal with the fact that OH continues to rise because of market dynamics (VUCA).	Category 1: Meaning of overhead costs management
2. What are the limitations of the current approaches in respect to methods and tools? If there are limitations, what can be done to overcome them?	Finding 2: All participants expressed their dissatisfaction with the currently used tools. The limitations are mainly inflexibility and lack of knowledge.	Academia together with enterprises need to come up with new approaches that better utilize Industry 4.0 capabilities.	Category 2: Meaning of innovation
3. In general, what are the prerequisites for the successful management of overhead costs?	Finding 3: The majority of participants cited that usability and speed are the predominant factors. More than half indicated that transparency of OH is instrumental.	The methods/tool-gap could be closed by re-evaluating the success factors for digitalized services.	Category 3: Meaning of success

Source: Own research

Table 20 contains the logic to develop inductively the analytic categories. Each research question demands an answer, which is found in the findings. The findings statement imposes an outcome or consequence; it states the source of the research problem. The analytic category formulates a general category validated by data outside and inside the research sample and theoretical knowledge. Analytic category 1 is called “Meaning of overhead costs management”, analytic category 2 is called “Meaning of innovation for services”, and analytic category 3 is called “Meaning of services for overhead costs”. There are links and a pattern between the findings and the analytical categories, which is explained by the subsequent figure.

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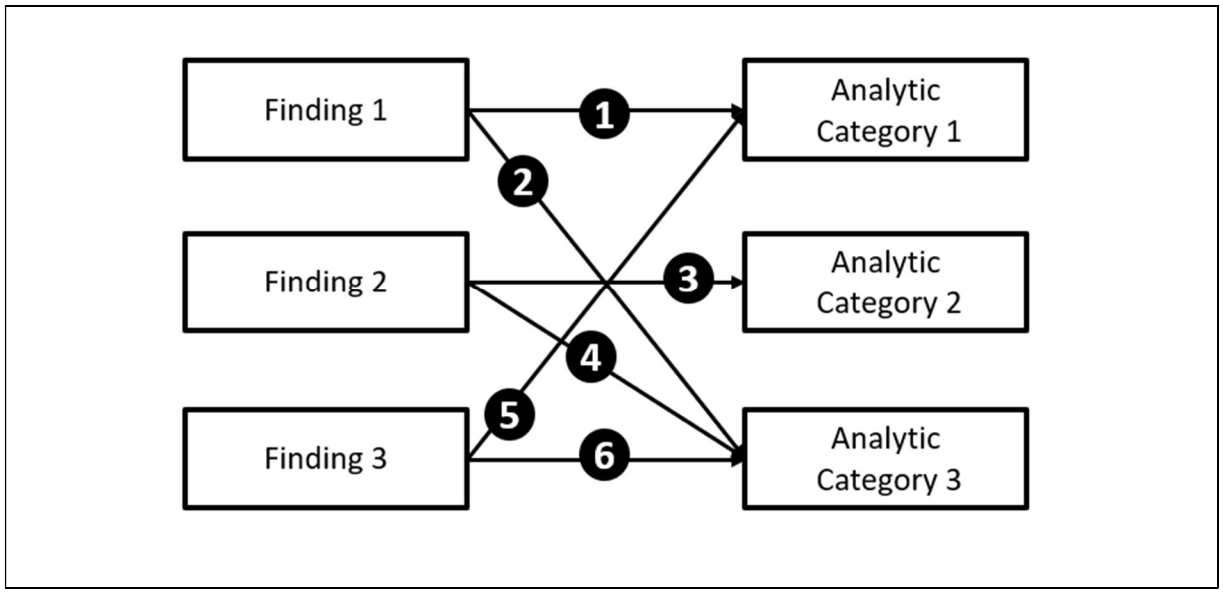

Figure 27: Assembly of the findings into analytic categories

Source: Own research

The six connectors in Figure 27 have the following justification: Connector ❶ links F1 with AC1 by the multiple statements that there is a heavy impact on overhead costs management because of digitalization. Therefore, the meaning of OH-costs management serves as a general analytic category. ❷ connects F1 with AC3 by the success factors usability, speed, and transparency. Hence, the meaning of success with regards to overhead costs is determined by numerous factors which depend on the business setting. ❸ combines F2 with AC2 by the dissatisfaction about the current tools/methods and the desperately needed innovation to close the gap for the digitalized processes. Consequently, the meaning of innovation depends on solving the identified challenges. ❹ couples F2 with AC3 by the dissatisfaction with the current tools/methods and the prerequisites of successful OH management. Ergo, the meaning of services depends on solving the identified challenges. ❺ relates F3 with AC1 by the success factors and the significance of proper OH-costs management for the sustainable achievement of an enterprise. Thus, the meaning of OH-costs management depends on solving the identified challenges. ❻ associates F3 with AC3 by the success factors and the impact of OH-costs. Thus, the meaning of success relies on re-evaluating the processes as well as the corresponding technological strategies. If seen from the receiving part, then AC1 echoes F1 and F3; AC2 speaks to F2; and AC3 echoes F1, F2, and F3.

The overriding findings of the dissertation revealed that enterprises perceive that overhead costs management deserve more attention. The perceived neglect of overhead costs management led enterprises to try out their own interpretations without academic guidance.

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The perceived disconnect between innovation for new methods and overhead costs management entitled enterprises to utilize Industry 4.0 technologies. For the synthesis, the following symbols are used:

Table 21: Synthesis of the analytical categories

Analytic category	Symbol
AC1: Meaning of overhead costs management	■
AC2: Meaning of innovation	◆
AC3: Meaning of success	★
Synthesis:	■ + ◆ + ★ = ●

Source: Own research

The symbols in the right-hand column in Table 21 are applied in the following analytic categories. The vast amount of explored qualitative data was used to explain and justify each analytic category.

5.2 Analytic category 1: Meaning of overhead costs management

The substance of overhead costs management is proven since the publication of the hidden factory (Miller & Vollmann, 1985). Finding 1 of the dissertation confirmed the importance of it, then and now, almost 35 years later. Miller & Vollmann stated that the increase of generated data drives the phenomenon of raising overhead cost. In order to validate the foundation of the statement recent numbers of the volume of generated data were researched. Statistics over the last 15 years with an outlook to the next five years provided a long-term dimension of annually generated data worldwide, as depicted in the next figure.

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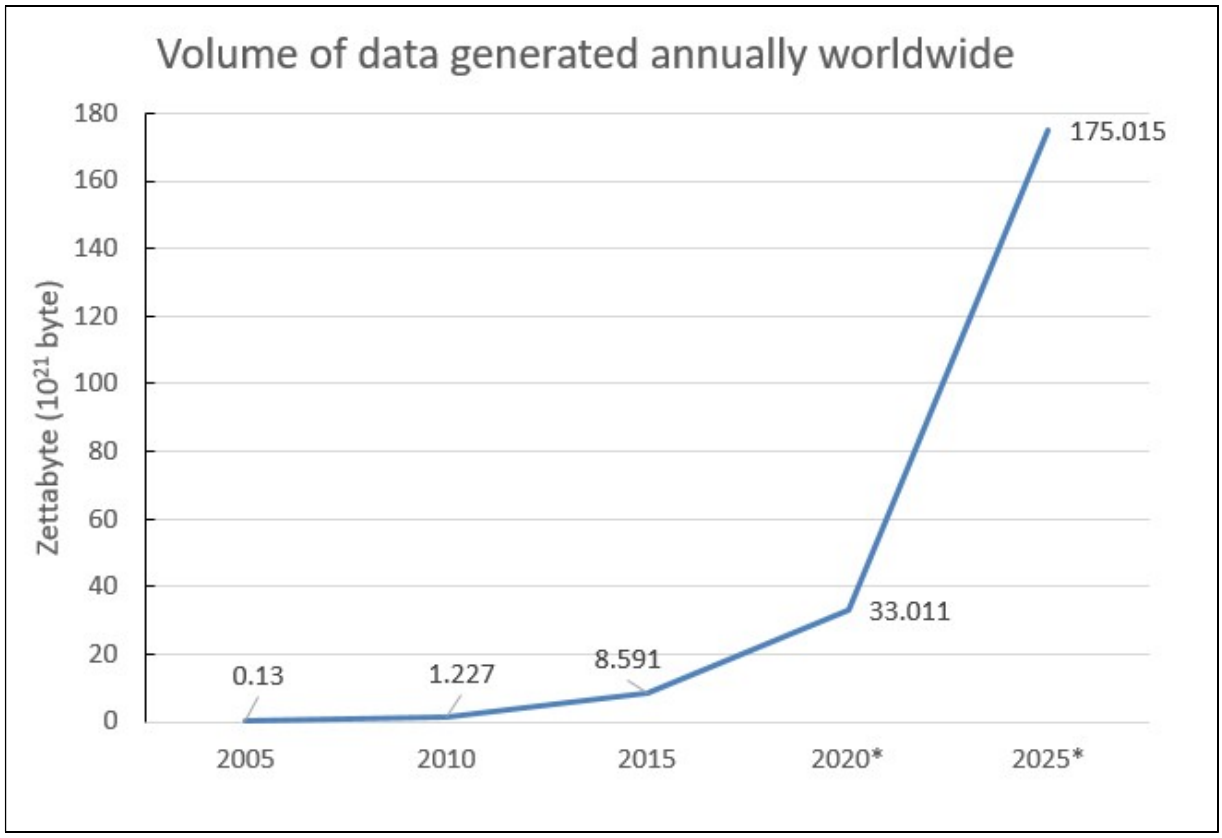

Figure 28: Volume of data generated annually worldwide

Source: Statista, 2019

Figure 28 shows in a line-chart an increase over the course of the last 15 years from 0.13 to 33.0 Zbyte of annually generated worldwide data; it became 250 times higher. Based on the outlook of Statista, the volume of the generated data will further more than quintuple in the upcoming five years to 175.0 Zbyte in 2025. It means that the management of data, and in a narrow sense overhead, will indeed result in a proliferate issue. The consequence of the issue might be new roles and responsibilities that did not exist before (e.g. the function Chief Information Officer, which is the highest ranking position in a company with regards to data, has become popular recently, yet hardly existed 10 years ago).

From a qualitative point of view, the interviews and the focus group delivered from finding 1 and finding 3 these most-used terms: usability, speed, transparency, prevail, increase, pinnacle. Indeed, many additional related words and synonyms were provided. This is an indication that the terminology in the field is changing by adapting to pressing needs. A tag cloud, which serves the purpose of expressing the frequency of utilized terms with the size of fonts, is applied as visualization method (Trattner, Helic, & Strohmaier, 2018). The top 100 most used terms for AC1 are depicted in following tag cloud:

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Figure 29: Tag cloud for analytic category 1

Source: Own research

Figure 29 depicts the most used terms in the interviews and the focus group meeting. The dissertation delivers inductively the first analytic category, called meaning of overhead-cost management.

5.3 Analytic category 2: Meaning of innovation

Figure 18 in the presentation of findings section contains the results of the survey concerning R&D spending based on revenue in a funnel chart. The bandwidth goes from 2 companies in the range of 5-10% to 3 companies of more than 25%. Let's compare this range to overall figures per industry in the following figure using another data source.

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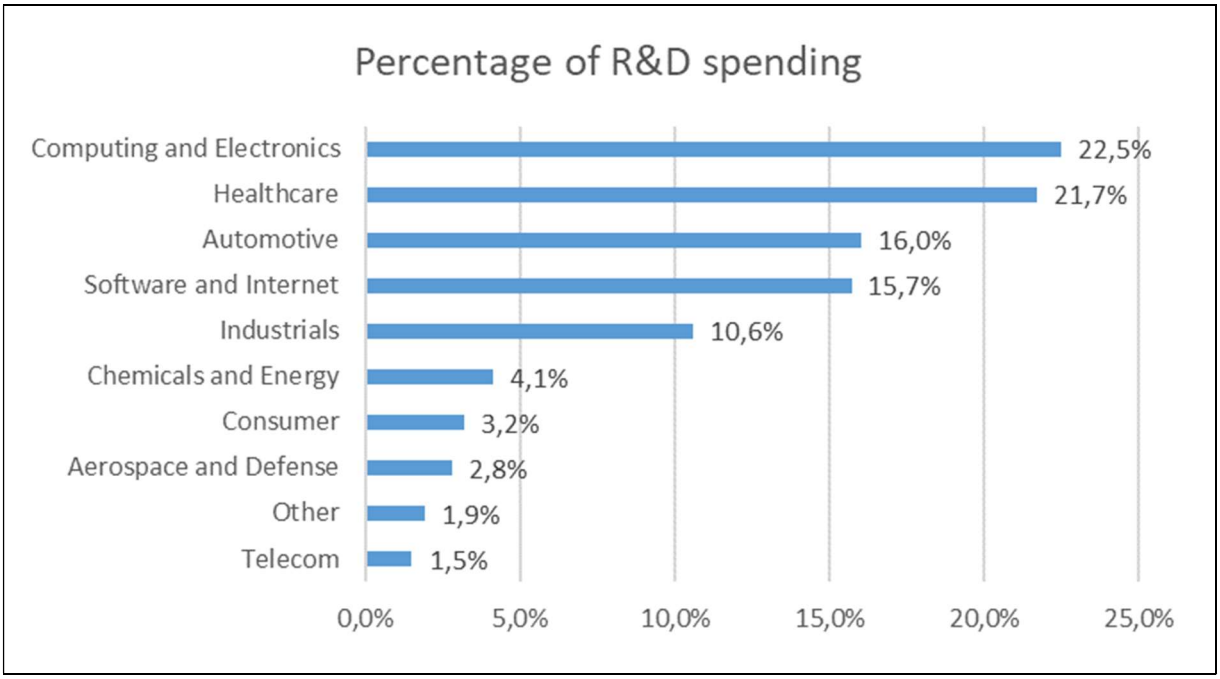

Figure 30: Percentage of R&D spending in different industries

Source: Statista 2019; n=1000

Figure 30 reflects industries in Europe with R&D spending from 1.5% to 22.5%. The numbers are in a similar range to those from the survey. The data from Statista (2019) serve as a benchmark. The industries in the survey are automotive, industrials, chemicals and energy, aerospace and defense. The figure above offers the same industries as reference. The range of R&D in the survey goes from 5% to 25% and more; Statista (2019) reports numbers for the identical industries in a similar range. Therefore, it validates the findings concerning R&D in the dissertation. The conclusion is that the amount of R&D – in a broader sense innovation – is a driving force for all industries. However, the amount of it depends heavily on the industry. Telecom, once a driver of innovation, accounts for only 1.5%, whereas Computing and Electronics record 22.5%.

From a qualitative point of view, the interviews and the focus group delivered from finding 2 these most used terms: dissatisfaction, inflexibility, lack of knowledge, innovation, increase, academic. Overall, the top 100 most used terms in the context of AC2 are the following and depicted in the next tag cloud:

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Figure 31: Tag cloud for analytic category 2

Source: Own research

Figure 31 depicts the most used terms in the interviews and focus group meeting. The findings in Chapter 4 echo this perception. The dissertation delivers inductively the second analytic category, called meaning of innovation.

5.4 Analytic category 3: Meaning of success

Figure 19 in the presentation of findings section contains the results of the survey concerning service based on revenue in a funnel chart. The bandwidth goes from 4 companies in the range of 5-10% to 2 companies of more than 25%. Let's compare and discuss the range to overall figures per industry in the following figure.

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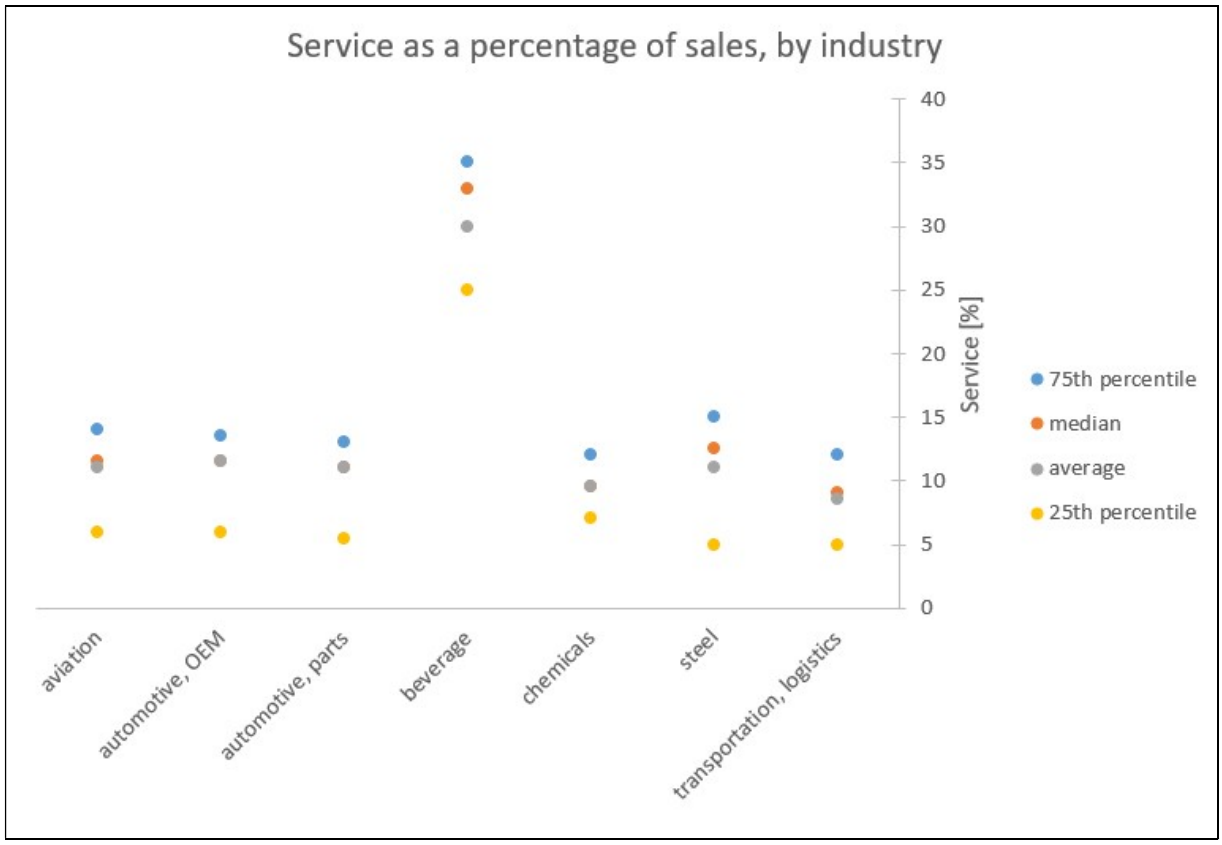

Figure 32: Service as a percentage of sales, by industry

Source: AlixPartners, 2018; n=50.000

Figure 32 depicts data on a global level from AlixPartners in 2018 for the same industries as used in the survey of the dissertation. The lowest 25th percentile in the figure above is 5%, the highest 75th percentile is at 35%. The survey of the dissertation delivers values in the range from 5% to more than 25%; hence the data is in a similar range to the much larger study of AlixPartners.

As reference, the Table 17 contains the detailed data:

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Table 22: Service as a percentage of sales, by industry

Industries	75th percentile	median	average	25th percentile
aviation	14	11.5	11	6
automotive, OEM	13.5	11.5	11.5	6
automotive, parts	13	11	11	5.5
beverage	35	33	30	25
chemicals	12	9.5	9.5	7
steel	15	12.5	11	5
transportation, logistics	12	9	8.5	5

Source: AlixPartners, 2018; n=50.000 global companies

Table 22 shows data the 75th percentile, the median, the average, and the 25th percentile for the same seven industries as used in the survey. The data source contains 50.000 global companies. Compared with the meta-data of the survey, in Figure 19 the data is consistent. The 20 interviews deliver the following corresponding qualitative data:

> *OHM467Z: "We introduced activity-based costing with brute force. We had to crush undisputed but well-established routines in the organization. The resistance at the beginning was enormous, but the capability to make better decisions convinced everybody in the end. At the end of the day, it's all about services. They are the tricky part; you need the resources for them ahead of time. It is excessive. You only find out if it was worthwhile when customers return for more business."*

It turned out that for services, in this particular case in a procurement department of a multi-national company, the precise tracking of activities is even more important. The following statement demonstrates this:

> *OHM544P: "The worker appreciated the fact that her workload [to follow-up POs] became transparent to management. There was doubt about when the follow-up really took place. The tracking capabilities of the ERP system enabled the generation of a precise workload-profile that convinced management to re-organize. The costs for the resources first look exorbitant, but then we realized that these are – finally – true costs which need overhead costs allocation. The workload-profile enables us to do precisely that."*

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It is fair to say that services contribute significantly to overhead costs. The participating companies mentioned in the interviews a range from 60 to 90%. This means that in the case of the lower limit, 60 percent the overhead-cost are caused by services; 40 percent are other indirect costs. In case of the higher limit (90%), almost all overhead costs are services. Yet, this is questionable, because it concludes that this enterprise has hardly any costs for infrastructure. All in all, overhead costs occur and need to be paid even if there is no service revenue. Therefore, the cost driver for services are important for understanding overhead costs.

From a qualitative point of view, the interviews and the focus group delivered from finding 1, finding 2 and finding 3 these most used terms: usability, speed, transparency, consistency of data, acceptance of the employees. The top 100 most used terms for AC3 are depicted in following tag cloud:

Figure 33: Tag cloud for analytic category 3

Source: Own research

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Figure 31 depicts the most commonly used terms from the interviews and focus group meeting concerning F1, F2, and F3. The findings in Chapter 4 echo this perception. The dissertation delivers inductively the third analytic category, called meaning of success.

5.5 Revisiting the hypotheses with synthesis

It is appropriate at this point to revisit the three hypotheses underlying the dissertation, as stated in Chapter 1. These hypotheses were presented at the inception of the dissertation and were based on my background, professional experiences, and the research problem. The three hypotheses identified at the outset are discussed next in respect to the analysis and synthesis of the dissertation's findings.

First hypothesis: Innovation (e.g. digitalization) drives the percentage of overhead costs continuously upwards.

Second hypothesis: The surge of digitalization has an impact on related methods and tools.

Third hypothesis: Digitalized services have a direct effect on overhead costs.

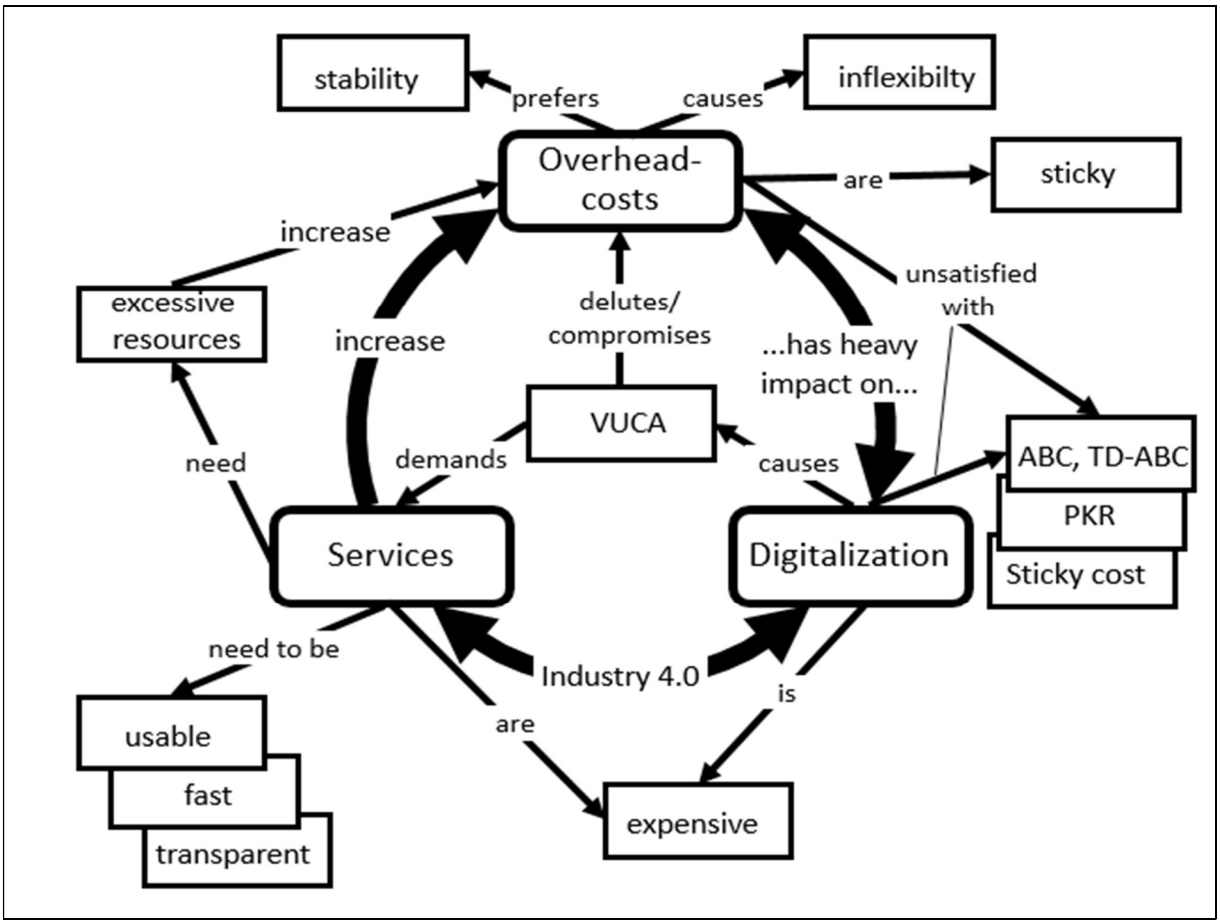

Figure 34: Synthesis of hypotheses, findings, and entities

Source: Own research

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Figure 34 depicts the synthesis of the research work; based on Figure 3 in Chapter 1. The entities of the conceptual framework and the findings belonging to the analytic categories are incorporated in the figure above.

The first hypothesis underlying the research was that innovation (e.g. digitalization) drives the percentage of overhead continuously upwards. This hypothesis held true according to the first finding. The sample of enterprises in this dissertation expressly stated that the digitalization increases the percentage of overhead.

The second hypothesis was that the surge of digitalization has an impact on related methods and tools. This hypothesis turned out to be true. Initially, enterprises appeared to be dependent on Industry 4.0 technologies. Although, contrary to the original belief, the businesses first need a compelling use case in order to advance with related services. In addition, the application of the right methods and tools is needed in order to track and control the overhead. This notion was illustrated in the second finding of the dissertation.

The third hypothesis was that digitalized services have a direct effect on overhead costs. This hypothesis held true as well. The reason is that it needs a bypass through (often expensive) resources in order to perform the services. These resources are indirect costs and therefore overhead costs. The characteristics of suitable processes dealing with digitalization are usability, speed, and transparency. They are dictated by VUCA business environments.

Volatile situations, lack of certainty about future revenue streams, complex highly inter-dependent processes, and ambiguous interpretations are not necessarily a stringent predictor of increasing overhead costs per se. It is true that the entire cost of the service can be directly associated to the sellable product, then it becomes direct cost. Nevertheless, it is only theoretically possible in very rare cases (e.g. a dedicated salesperson that serves only one customer), in the multi-case study at hand it was not mentioned a single time. In fact, when asked about dedicated resources for easy cost assignment, it was denied. The requirements are user-friendly, fast, and transparent services, which are delivered multi-dimensionally with great flexibility over a broad customer basis. It had been the quintessence illustrated in the third finding.

All tags were summarized in order to merge and synthesize the discovered terms. From a qualitative point of view, the interviews and the focus group delivered for the syntheses these most used terms: usability, innovation, future, dissatisfaction, flexibility. The top 100 most used terms are depicted in following tag cloud:

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Figure 35: Tag cloud of the synthesis

Source: Own research

Figure 35 shows the combined tag clouds of the three analytic categories. The source of the data is from the interviews and the focus group meeting. The dissertation delivers inductively the synthesis of the analytic categories.

5.6 Challenge of the results by BACH

The findings so far require a challenge against a broader database over a longer period of time. The BACH database systems of ECCBSO (www.eccbso.org) contains historical income statement data that goes back to 2001. To satisfy the research purpose, I selected the

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data of the years 2008, 2013, and 2017, which were the latest available. BACH provides the expenses of the income statement by disclosing the details listed in the following table.

Table 23: Legend of the definitions in BACH

Expenses	Contents
I5 - Cost of goods sold, materials and consumables	Includes cost of materials and consumables used and the cost of goods sold in the period.
I6 - External supplies and services	Includes expenses with external supplies and services in the period.
I7 - Staff costs	Includes expenses with the staff recognized in the period.
I8 - Other expenses	Includes other expenses not identified in previous items (I5, I6 and I7).
I81 - Of which: Operating taxes and other operating charges	Details of other expenses relating to operating taxes and other operating charges.
I82 - Of which: Provisions (net of reversals)	Details of other expenses relating to Provisions (net of reversals)
I83 - Of which: Financial expenses other than interests on financial debt	Details of other expenses relating to financial expenses, except interests on financial debts (included in I10)
I84 - Of which: Extraordinary expenses and impairments (net of reversals), except on inventories and receivables	Details of other expenses relating to extraordinary expenses and reduction/increase in fair value and impairment charges (net of reversals), except impairments (net of reversals) included in I85
I85 - Of which: Impairments (net of reversals) on inventories and receivables	Details of other expenses relating to impairment charges (net of reversals) on inventories and receivables
I9 - Depreciation and amortization of intangible and tangible fixed assets	Includes depreciation and amortization of assets included in the items A11 and A12 recognized in the period.
I10 - Interests on financial debts	Includes financing costs recognized in the period.
I11 - Tax on profit	Includes income taxes recognized in the period.

Source: BACH (2019)

Table 23 depicts the expense with the code and the name of the expense as well as the contents of the definition that is used in the following figures. COGS represent, according to the definition, direct costs. Non-COGS are indirect costs and per definitionem above. Yet, the definition for COGS is questionable as there is a portion of production overhead necessary to run the operation. Nevertheless, compared to the much higher number of non-COGS on the expense side of the income statement, it is a somewhat acceptable approximation. We will return to this in Chapter 6 when dealing with recommendations for future research. The following twelve figures are for the sector manufacturing in Austria and Slovakia and for the sector transportation/storage in Austria, both for the years 2008, 2013, and 2017. They are used

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to investigate similarities or discrepancies to AC1, AC2, and AC3 based on a much larger database, the number of reported firms is always mentioned in the description of the figure.

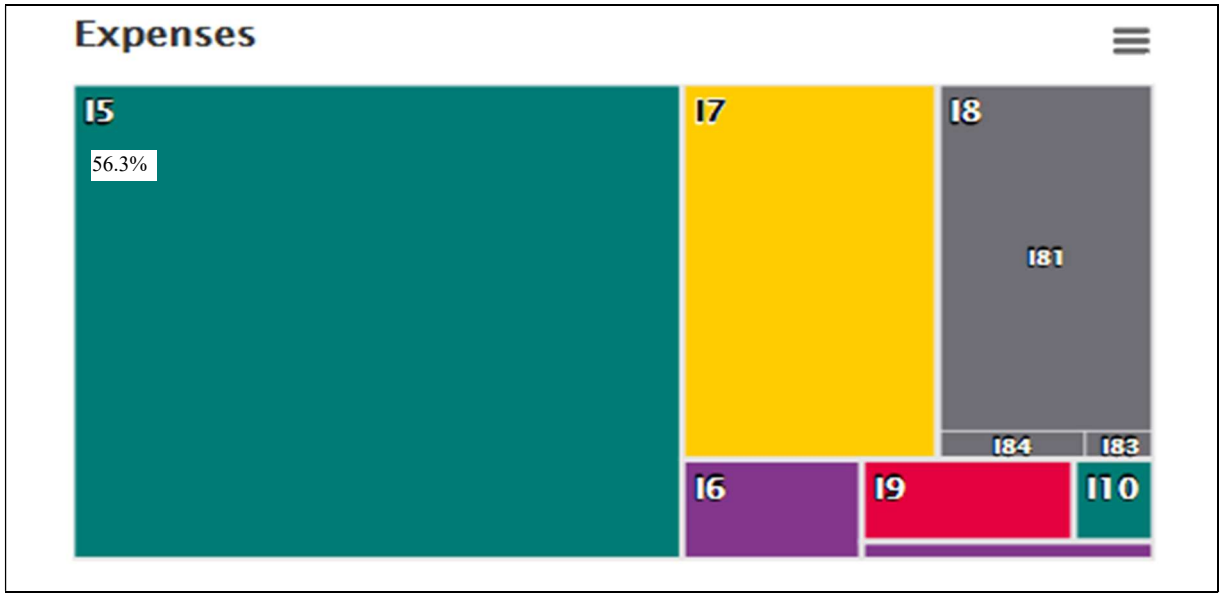

Figure 36: Manufacturing AUT in 2008; number of firms: 10.441

Source: BACH (2019)

Figure 36 displays the structure of the expenses in the sector manufacturing in Austria in the year 2008. COGS (I5) represent 56.3% of the total expenses, all others – referred to as overhead – account for 43.7%.

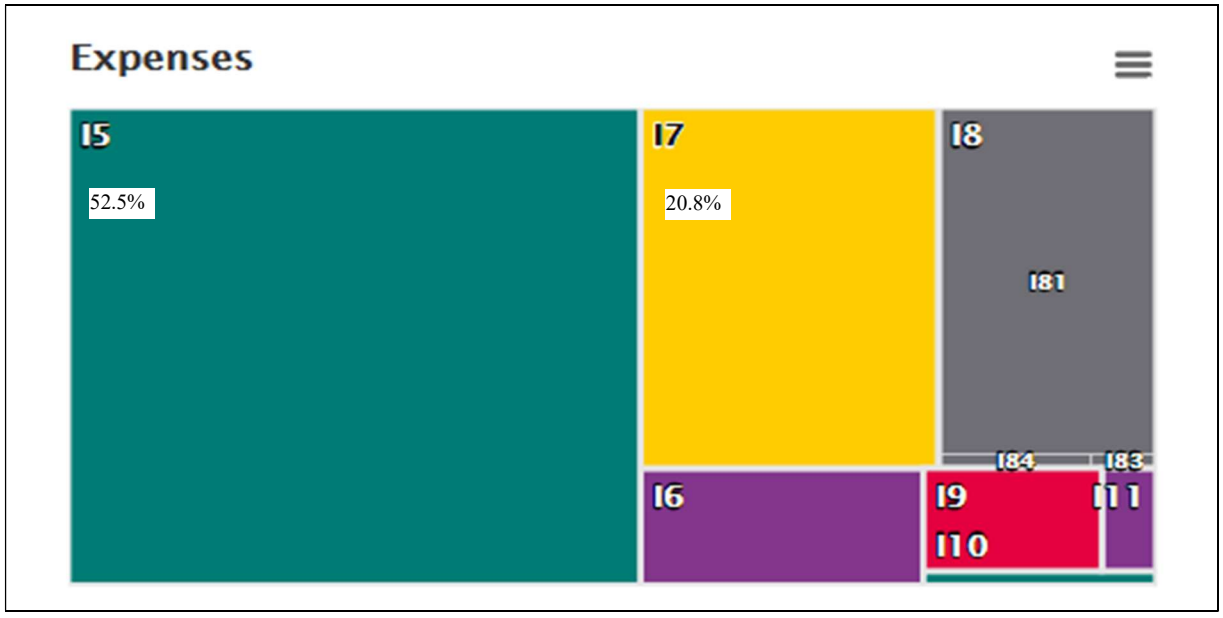

Figure 37: Manufacturing AUT in 2013; number of firms: 10.520

Source: BACH (2019)

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Figure 37 displays the structure of the expenses in the sector manufacturing in Austria in the year 2013. COGS (I5) are represented with 52.5% of the total expenses, all other expenses – referred to as overhead – account for 47.5%. Staff costs (I7) are with 20.8% the next biggest block of expenses.

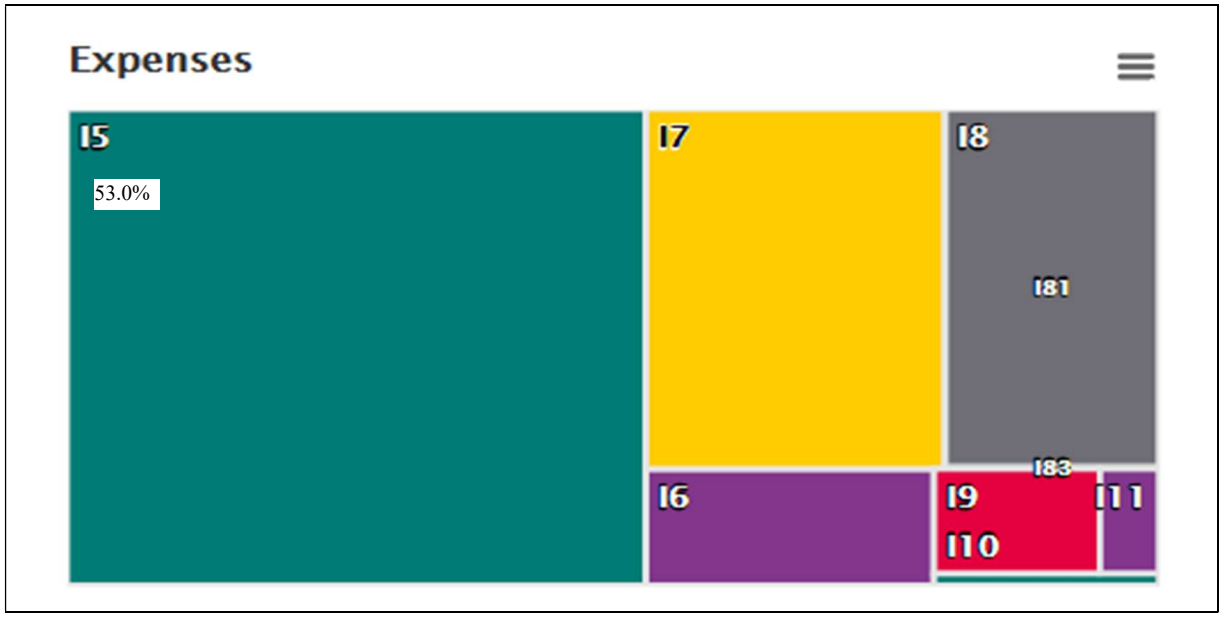

Figure 38: Manufacturing AUT in 2017; number of firms: 9.009

Source: BACH (2019)

Figure 38 displays the structure of the expenses in the sector manufacturing in Austria in the year 2017. COGS (I5) represent 53% of the total expenses, all others – referred to as overhead – account for 47%.

In total numbers, for the sector manufacturing in Austria the following timeline appears. The data is recorded for the years 2008, 2013, and 2017 (the latest available):

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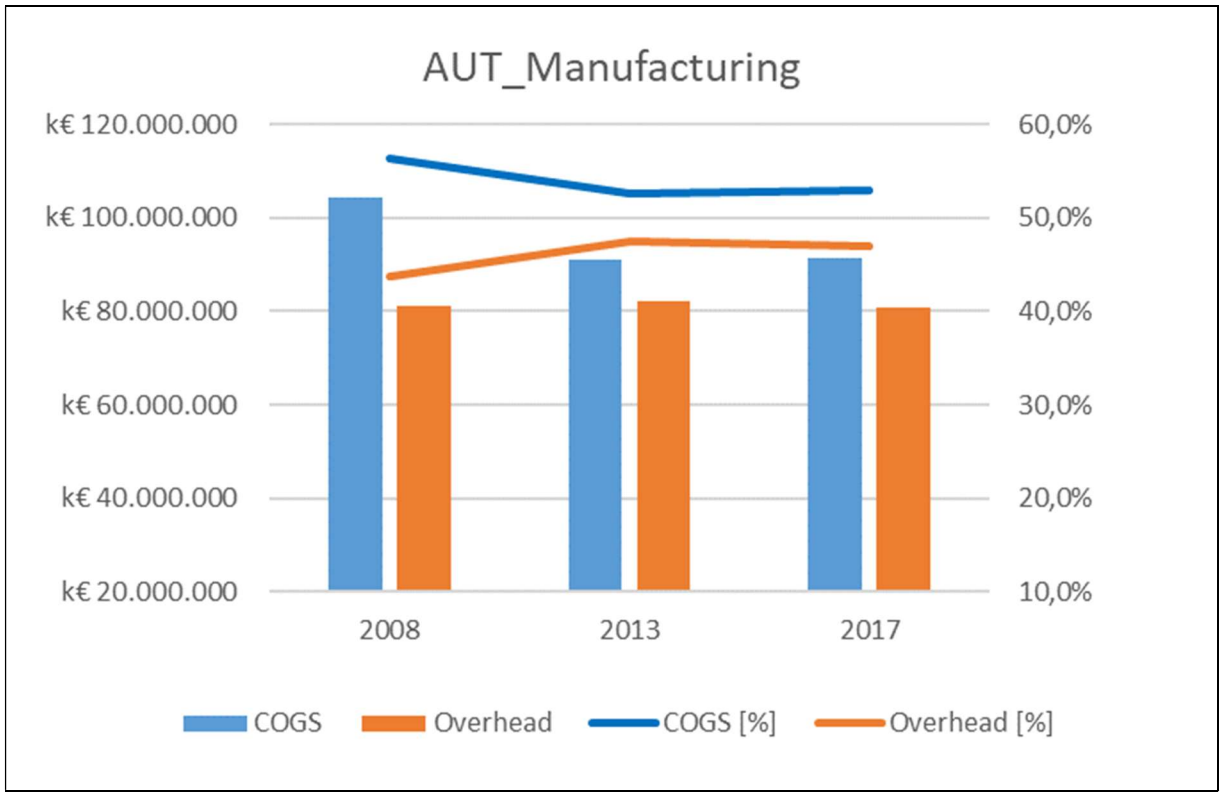

Figure 39: Manufacturing AUT: COGS and overhead for 2008, 2013, and 2017

Source: BACH (2019)

Figure 39 shows the dynamics of overhead over time. In 2008, overhead of €81b was reported, representing 43.7% of the total expenses. The percentage increases to 47.5% for 2013 and remains at 47% for 2017. There is an increasing trend for the sector manufacturing. If we relate these data with the survey and statements of the interview participants, which are (see Table 7 for reference) OHM114C, OHM289Z, OHM878D, OHM650H, OHM189M, OHM544P, OHM901K, OHM007U, OHM467Z, OHM399R, OHM511V, OHM946U, OHM801X, OHM999R, and OHM302C, we can summarize the following:

1. Yes, it is true. There is a steady increase of overhead based upon percentage over the period of years from 2008 to 2017. However, in total numbers, the overhead remained almost flat. The increase is bound to the fact that COGS decreased in the reported period.
2. No, there is no significant increase of COGS. COGS even decreased from €104b in 2008 to €91b in 2013 and remained at €91b in 2017. This means that the sector had fewer direct costs over the reported time span whereas the overhead stayed constant based on the total amount, which indicates 'sticky' circumstances concerning overhead.

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If we do the same exercise for the sector transportation and storage for Austria during the years 2008, 2013, and 2017, the following data is available. Again, all data come from BACH.

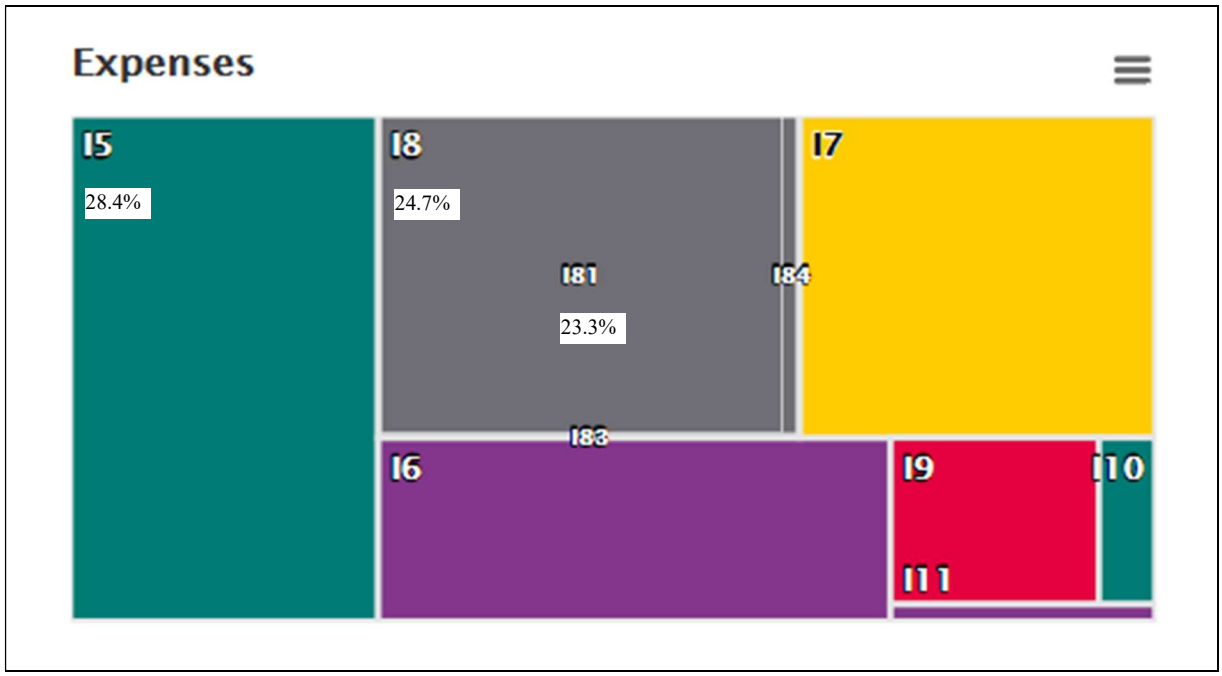

Figure 40: Transportation and storage AUT in 2008; number of firms: 4.082

Source: BACH (2019)

Figure 40 displays the structure of the expenses in the sector transportation and storage in Austria in the year 2008. COGS (I5) represent 28.4% of the total expenses, all others – referred to as overhead – account for 71.6%. It is worthwhile to mention that COGS are much smaller in this sector than in the previous one. COGS is just by a small margin on first position, Other expenses (I8) and operating taxes and other operating charges (I81) account for 24.7%, and 23.3%, respectively. We use this observation later when discussing the timeline over the 10 year timespan.

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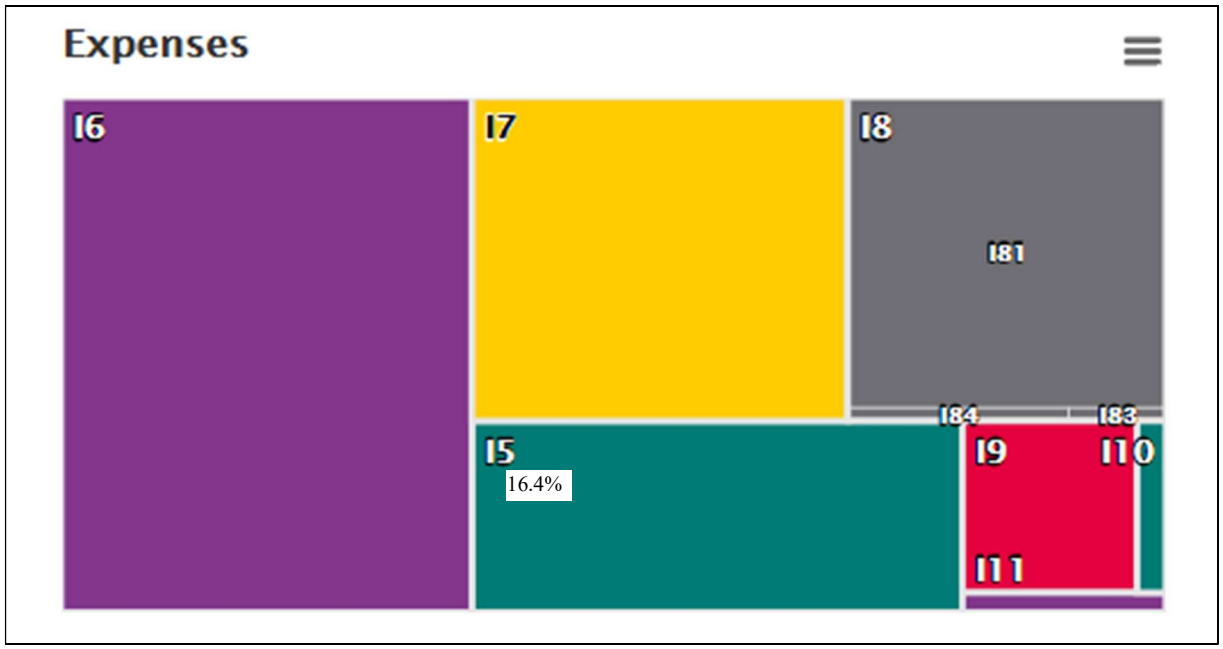

Figure 41: Transportation and storage AUT in 2013; number of firms: 4.228

Source: BACH (2019)

Figure 41 displays the structure of the expenses in the sector transportation and storage in Austria in the year 2013. COGS (I5) represent 16.4% of the total expenses, all others – referred to as overhead – account for 83.6%.

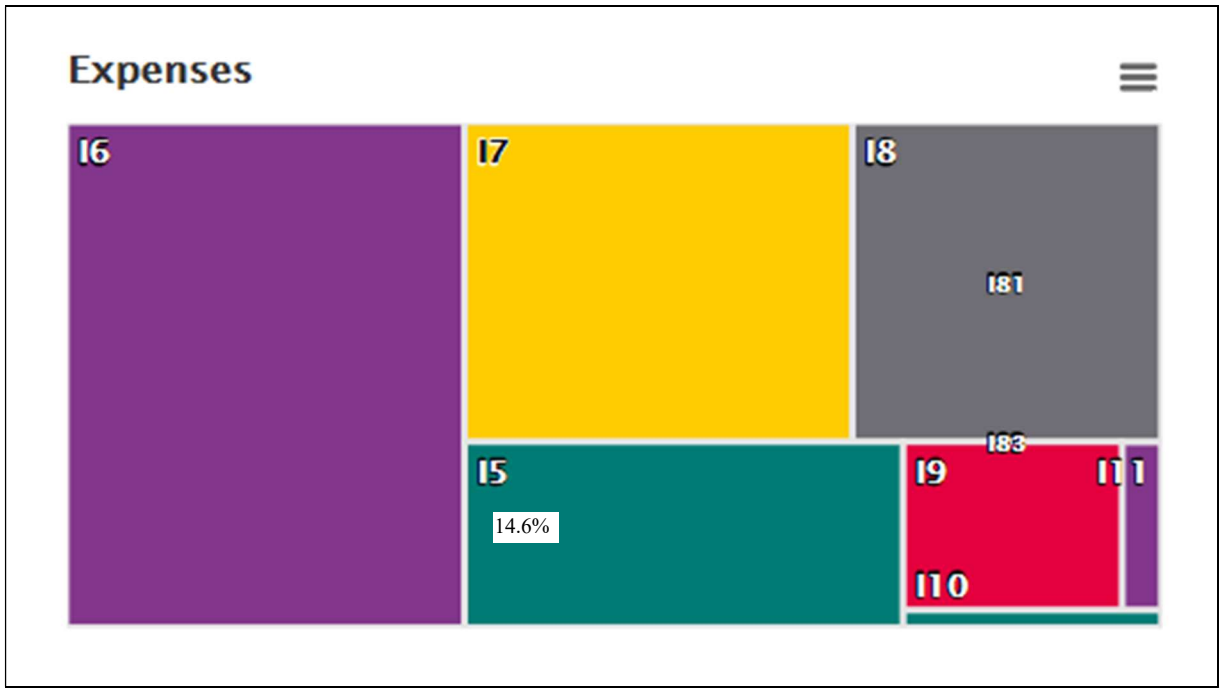

Figure 42: Transportation and storage AUT in 2017; number of firms: 3.664

Source: BACH (2019)

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Figure 42 displays the structure of the expenses in the sector transportation and storage in Austria in the year 2017. COGS (I5) represent 14.6% of the total expenses, all others – referred to as overhead – account for 85.4%.

In total numbers, for the sector transportation and storage in Austria, the following timeline appears. The data is recorded for the years 2008, 2013, and 2017 (latest available):

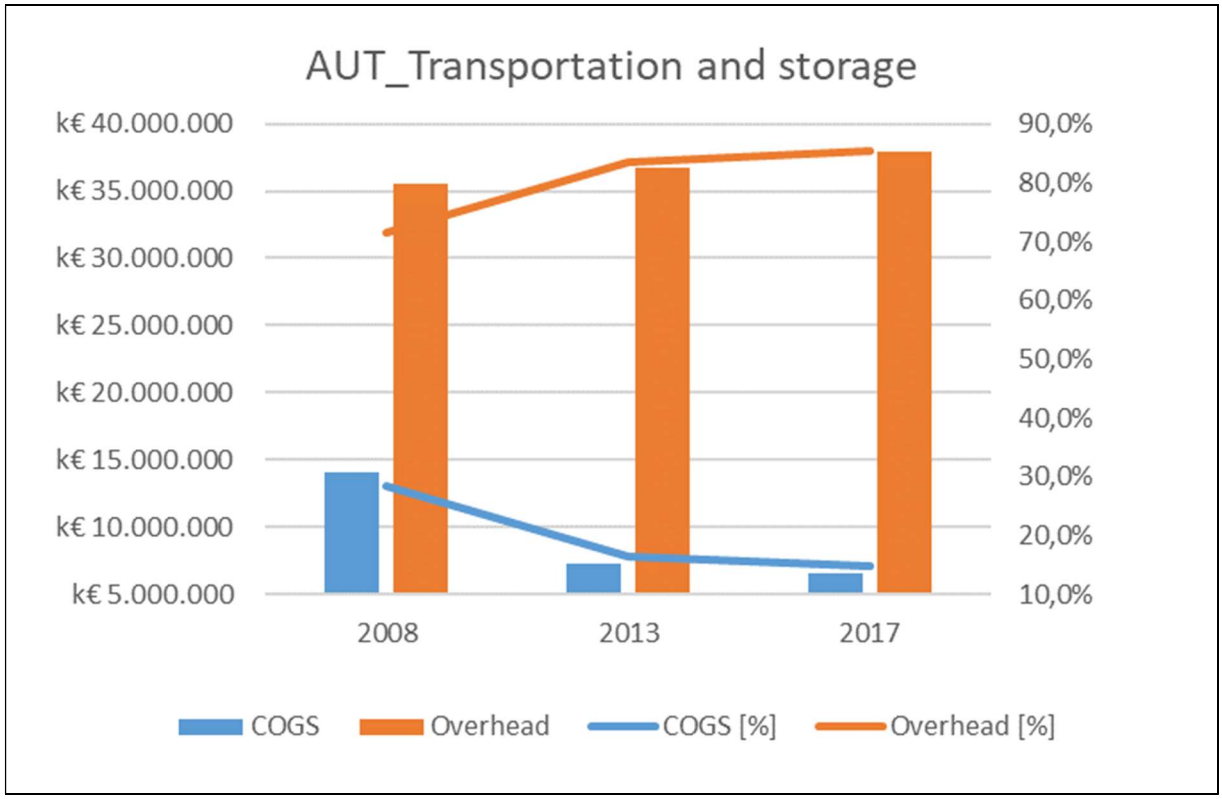

Figure 43: Transportation/storage AUT: COGS and overhead for 2008, 2013, and 2017

Source: BACH (2019)

Figure 43 shows the dynamics of overhead over time. In 2008, overhead of €35.6b were reported, representing 71.6% of the total expenses. The percentage rises to 83.6% for 2013 and further to 85.4% for 2017. There is an increasing trend for the sector transportation and storage that flattens over the remaining four years. If we relate these data with the survey and statements of the interview participants, which are (see Table 7) OHM743V, OHM778Q, and OHM485A, we can say the following:

1. Yes, it is true. There is a steady increase in overhead based on percentage over the last 10 year period. Total numbers of the overhead increased as well; they were €35.6b in 2008, €36.8b in 2013, and €37.9b in 2017.
2. Yes, COGS decreased from €14.1b in 2008 to €7.2b in 2013 and €6.5b in 2017. This means that the sector had fewer direct costs over the reported timespan. It is a

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significant difference compared to the previously discussed sector; it supports AC2 that the amount of R&D depends heavily on the industry. Further, it is consistent with the statement from OHM485A, that the sector faces a noticeable shift to services performed by overhead.

The same approach is applied to display the data of Slovakia for the sector manufacturing for the years 2008, 2013, and 2017. All data come from BACH. Suitable quotes from the interviews are weaved throughout. A timeline for the three selected years shows the change over time.

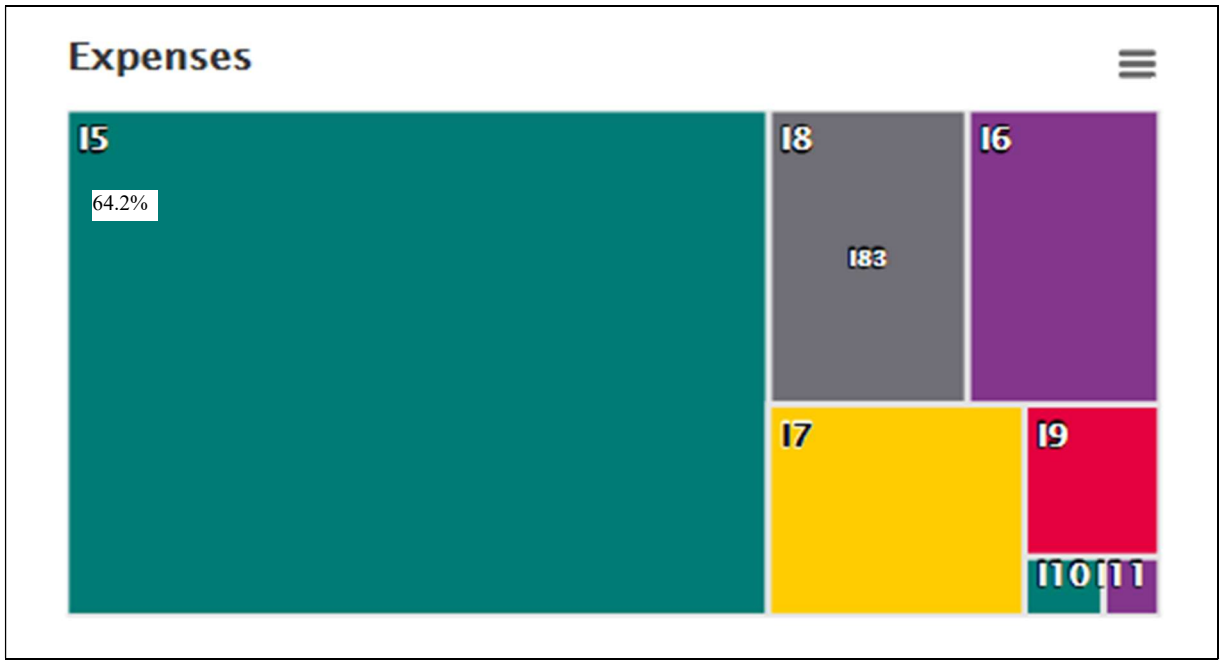

Figure 44: Manufacturing SK in 2008; number of firms: 8.431

Source: BACH (2019)

Figure 44 displays the structure of the expenses in the sector manufacturing in Slovakia in the year 2008. COGS (I5) represent 64.2% of the total expenses, all others – referred to as overhead – account for 35.8%. It is noticeable, that COGS in Slovakia is considerably higher than in Austria with 56.3% in 2008. This indicates that the manufacturing in Slovakia still executes higher transparency concerning direct costs. It is supported by the statement from OHM444Y during the interview:

> *OHM444Y: "We experienced a change over the last ten years. I remember we once had a rather simple and effective calculation model for our products. There was plenty of direct labor and direct material. We could assign them straight to the cost object we sold to the customer. Unfortunately, we lack this level of*

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transparency nowadays. Doing business became much more complex and ambiguous because of the digitalized processes.“

Figure 45: Manufacturing SK in 2013; number of firms: 11.653

Source: BACH (2019)

Figure 45 displays the structure of the expenses in the sector manufacturing in Slovakia in the year 2013. COGS (I5) represent 65.8% of the total expenses, this is about 10% higher than in Austria during the same year. All other expenses – referred to as overhead – account for 34.2% in Slovakia.

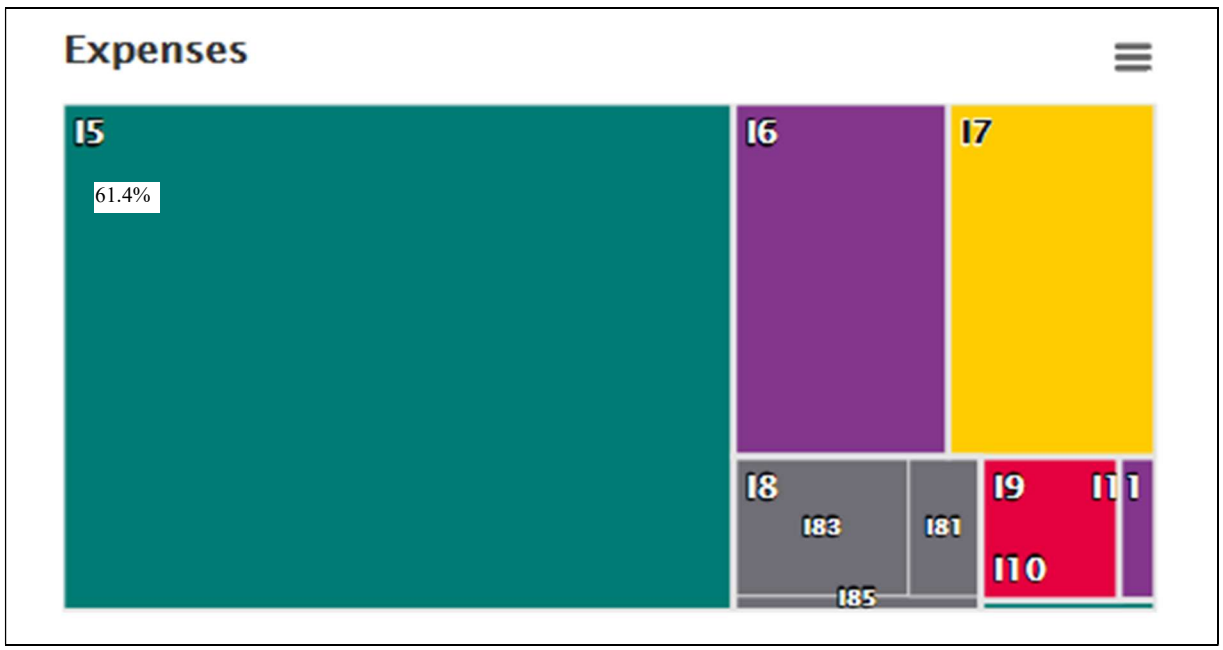

Figure 46: Manufacturing SK in 2017; number of firms: 2.620

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Source: BACH (2019)

Figure 46 displays the structure of the expenses in the sector manufacturing in Slovakia in the year 2017. COGS (I5) represent 61.4% of the total expenses, all others – referred to as overhead – account for 38.6%.

In total numbers, for the sector manufacturing in Slovakia, the following timeline develops. The data is recorded for the years 2008, 2013, and 2017 (latest available):

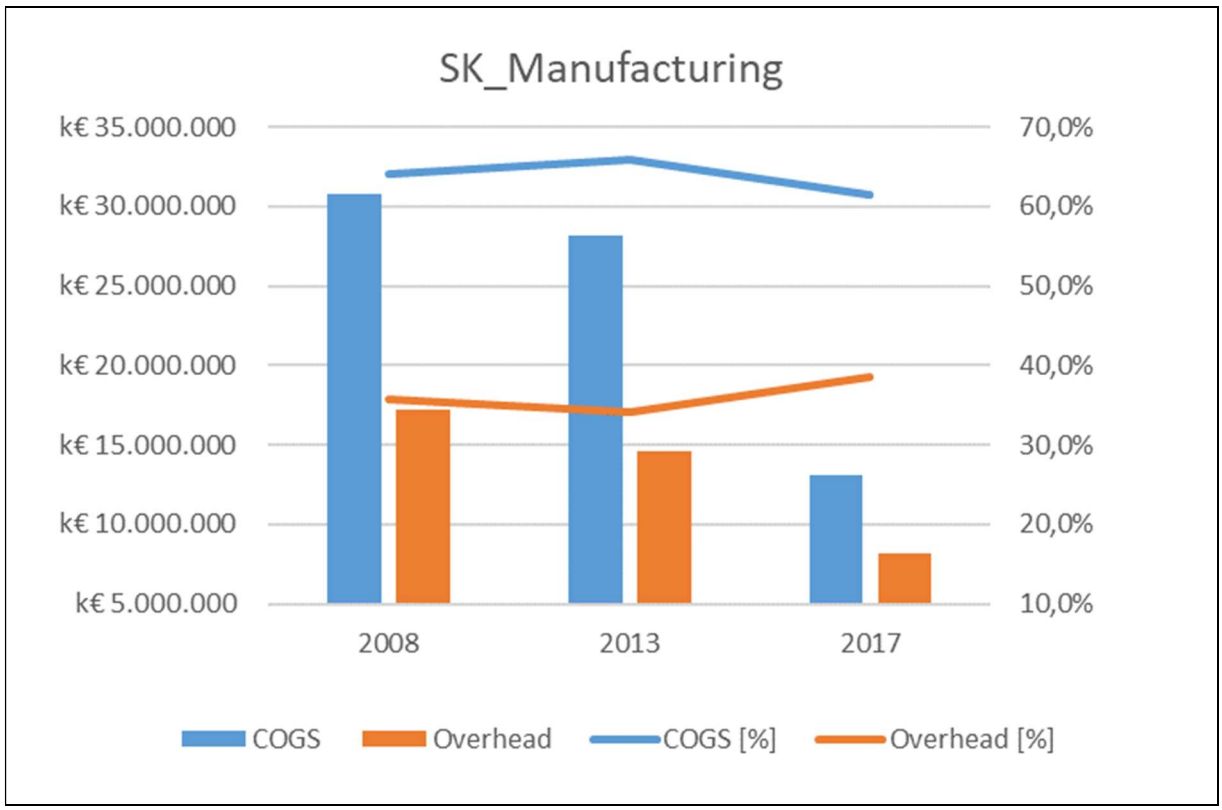

Figure 47: Manufacturing SK: COGS and overhead for 2008, 2013, and 2017

Source: BACH (2019)

Figure 47 shows the dynamics of overhead over time. In 2008, overhead of €17.2b was reported, representing 35.8% of the total expenses. The percentage decreases slightly to 34.2% for 2013 and rises to 38.6% for 2017. The total numbers for 2017 are diluted as the Slovakian Ministry of Finance reported data of 2.620 firms in 2017 compared to 11.652 firms in 2013. Nevertheless, based on percentage, there is an increasing trend for the sector manufacturing. If we relate these data with the survey and statements from the interview participant, (see Table 7) OHM444Y, we can deduct the following:

1. Yes, it is true. There is an increase of overhead based on over the last 10 year period. The total numbers of overhead decreased based on a different counting method.

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2. OHM444Y stated that digitalization has had a heavy impact on overhead. Unfortunately, no critical instruments were provided by OHM444Y to confirm this.

If we look over the BACH data of the three sectors in two different countries, the following can be summarized:

1. It is fair to say that the manufacturing sectors in Austria and Slovakia demonstrate a similar behavior concerning overhead, yet with the important addition that in Slovakia the increase of overhead is even more eminent than in Austria.
2. There is a steady increase of overhead based on percentage over the last 10 year period. There is no indication that this trends stops.
3. COGS diminish over time. It is indicated that the direct costs assigned to the cost object hold a lower percentage. Therefore, advanced overhead costs tools are needed to handle the increasing porting of indirect costs.

The triangulation of different databases was used to strengthen the outcome of the dissertation. The comparison of the results from the BACH data analysis with the challenge of the line-itemized income statement analysis in 4.6 shows the following:

- The industry sectors manufacturing in Austria and Slovakia show an increase of the expenses above the gross margin line, as do the enterprises of OHM114C, OHM999R, OHM901K, OHM754Z, OHM511V, OHM878D, OHM801X, and OHM650H.
- Both analyses foster hypothesis H1, that innovation (e.g. digitalization) drives the percentage of overhead costs continuously upwards. This is supported by statements from experts in the specific industries.
- Both analyses foster hypothesis H2, that the surge of digitalization has an impact on related methods and tools. This is supported by statements from experts in the specific industries.
- Both analyses foster hypothesis H3, that digitalized services have a direct effect on overhead costs. This is supported by statements from experts in the specific industries.

This analysis flows in the next section into the summary of interpretations of findings. Later it will be used in the final chapter of the thesis to formulate theses, to highlight the scientific innovation, and to offer recommendations.

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5.7 Summary of interpretation of findings

This chapter illustrated the overhead situation from a sample of enterprises. In summary, the discussion portrays the nuanced and complex nature of the overhead situation. It discloses various reasons that enterprises might feel insecure in dealing with overhead costs management. It offers an explanation why businesses struggle in the efforts to make best use of the accessible tools and methods. Furthermore, it unveils the success factors in a constant search for prerequisites to master overhead costs management.

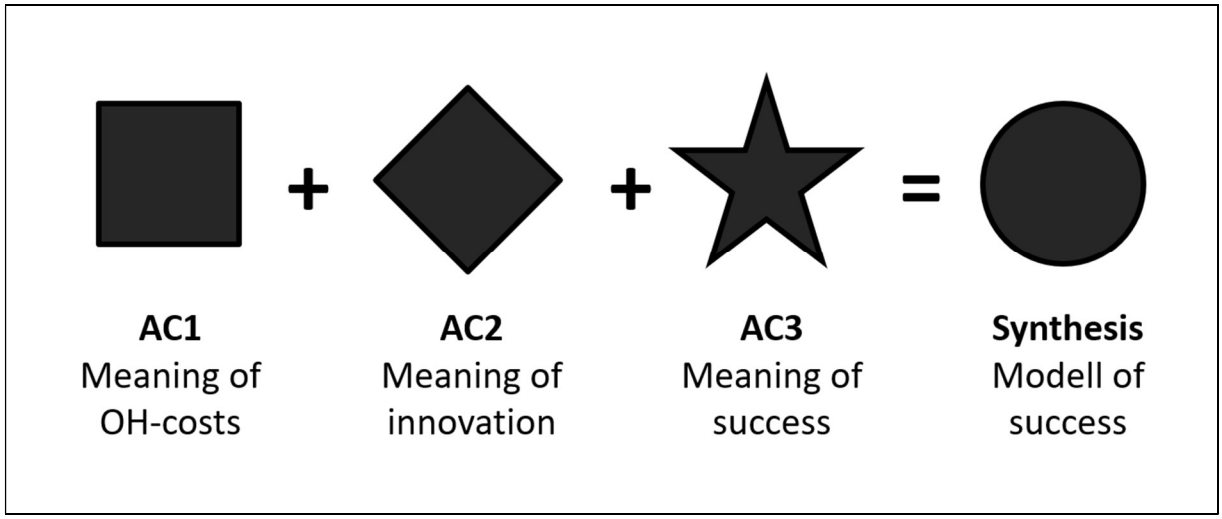

Figure 48: Syntheses of the analytic categories

Source: Own depiction

The effort of analyzing the findings was to create a facetted and multi-layered, as well as holistic and consolidated synthesis, as depicted in Figure 48. The challenge throughout the data collection and data analysis, which were not isolated periods of the dissertation but rather a constant struggle to find best answers, was to make sense of large amount of unstructured data, condense the volume of information, recognize significant patterns, and build a framework for communicating the spirit of what the data disclosed, given the research purpose. Moreover, I performed pervasive analyses within the multi-case study and across external data and did not discover any compelling ties between any of the demographic attributes (age, gender, educational background, discipline) when interpreting the findings.

Presenting an analysis of the findings uncovered in the dissertation at hand necessitates a degree of caution. First, the research sample was a mid-size survey with data from interviews from only participants involved with overhead costs management. Second, the focus of the dissertation was in the perimeter of around 200 km of Kapfenberg; it included businesses in Austria, Hungary, and Slovakia. Thus, the perceptions of experts in overhead costs

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management outside this perimeter were not represented. Additionally, the dissertation interacted with business in seven different industries; others were not represented. For this reason, it must be emphasized that the following conclusions are specific to the lived experiences of the sample group under examination ergo unit of analysis.

In addition to the potential biases commonly inherent in qualitative research with researcher-as-instrument, I acknowledge a possible bias in analyzing the findings because there are several participants I have been acquainted with for a long period of time. To this end, and to keep circumspection, throughout the process of data collection and analysis, I engaged in continuous critical reflection through journaling and dialogue with experienced and demanding co-workers. Nevertheless, there is the possibility that other researchers might have told a different narrative, this chapter is substantially, and conclusively a presentation of how I understood and made meaning of the material and the connections.

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CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

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6 Conclusions, scientific innovation, and recommendations

The purpose of the multi-case study in the dissertation was to explore, by means of a sample of businesses, the perceptions of how the digitalization of processes impacts the management of overhead costs. The conclusions from the dissertation follow the research questions, the findings, the analytic categories, the validation/falsification of the hypotheses, and finally postulate three theses: (1) the perception that digitalization capacitates overhead costs management; (2) the persuasion that competencies are insufficient; and (3) the prerequisites that overhead costs management succeeds. It answers the research questions, points out the new scientific contribution and concludes with recommendations and a summary of the dissertation.

Table 24: Concluding summary of research questions and hypotheses

Research question, hypotheses	Results:
RQ1: How does the digitalization of processes impact the management of overhead costs?	✓ - answered
RQ2: What are the limitations of the current approaches of the management of overhead costs in respect to methods and tools? If there are limitations, what can be done to overcome them?	✓ - answered
RQ3: In general, what are the prerequisites for the successful management of overhead costs?	✓ - answered
H1: Innovation (e.g. digitalization) drives the percentage of overhead costs continuously upwards.	✓ - validated
H2: The surge of digitalization has an impact on related methods and tools.	✓ - validated
H3: Digitalized services have a direct effect on overhead costs.	✓ - validated

Source: Own depiction

Table 24 contains the results of the three research questions and the three hypotheses. From a qualitative standpoint, saturation was reached; quantitatively, a triangulation with data of the sample and external sources was performed. The three research questions have been answered; the hypotheses were validated. The following theses are concurrent with the corresponding analytic categories.

6.1 Perception: Digitalization capacitates overhead costs management

The first research question was: How does the digitalization of processes impact the management of overhead costs? The dissertation delivered the following answer: The

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digitalization of processes impacts the management of overhead costs by making it even more complicated than it already had been before. The surge of data that additionally requires the transformation to information challenge the capabilities of the organizations. The amount of data quadrupled in the last five years and is anticipated to quintuple in the next five. The installation and maintenance of databases has become a delicate and expensive act. Cloud computing helps to mitigate the physical burden. Furthermore, risk management deserves much more awareness. Finally, compliance with how to deal with the data plays a pivotal role; the amount of data is excessive. Excelling in overhead costs management in the digital era becomes the masterpiece of digital competence. Digitalization empowers the enterprises to understand their overhead costs better with the boundary conditions mentioned in Chapter 4.6. For the first time in industrial history, enterprises with Industry 4.0 now have the effective tools at hand, which enable them to effectively perform overhead costs management, however with the prerequisite that the proper level of knowledge is achieved.

Hypothesis 1 – Innovation (e.g. digitalization) drives the percentage of overhead costs continuously upwards – was validated by qualitative means with full satisfaction. All participants confirmed the hypothesis. The benefit of the increase lies in the digital empowerment to understand better overhead costs. The answer to the first research question is embedded in the statement that digitalization has a heavy impact on overhead costs. It is supported by primary and secondary quantitative data and concludes with the postulation of the first thesis:

> The digitalization of business processes enables the management of overhead costs.

6.2 Persuasion: Competencies are insufficient

The second research question was: What are the limitations of the current approaches of the management of overhead costs with respect to methods and tools? If there are limitations, what can be done to overcome them? The dissertation delivered the following answer: The current approaches provide a solid backbone that is stringently linked to academic concepts. The last 15 years have brought forward new ways of better understanding overhead costs. ABC, PKR, TD-ABC, and sticky cost behavior helped to gain a better understanding, in terms of actively influencing overhead costs within the cost structure of an organization. Nevertheless,

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there are still obstacles to overcome. The three strongest or most unfavorable limitations are: First, there is again the enormous complexity that is created by the vast amount of data. Secondly, all methods and tools are too slow for real-time decisions. Thirdly, the level of education of employees concerning the awareness of the criticality of overhead costs is an obstacle.

The limitations could be tackled in the following way: (1) understand, use, and invest in capabilities of artificial intelligence, (2) keep costs variable as long as possible and therefore directly assignable to sellable cost objects, and (3) invest heavily in awareness-training within the employee base with regards to the impact on and influence of overhead costs management. Consequently, lean processes would focus primarily on value creation, avoid waste, and therefore draw attention to direct assignable costs as the desired outcome.

Hypothesis 2 – The surge of digitalization has an impact on related methods and tools – was validated by qualitative means with full satisfaction. All participants confirmed the hypothesis. It is supported by primary and secondary quantitative data. It endorses the answer of the second research question with the statement that the several cited limitations are a critical bottleneck for the expanding the digitalization of services. It concludes with the postulation of the second thesis:

The competencies in digital overhead costs management are insufficient.

6.3 Prerequisites: Overhead costs management success

The third research question was: In general, what are the prerequisites for the successful management of overhead costs? The dissertation delivered the following answer: It is paramount to stay informed about accounting innovations. Necessity is truly the mother of invention. This is particularly true as industries are on the brink of the fourth industrial revolution. Firstly, the answer demands a close link between academia and business. The businesses need the theoretical framework that connect all ideas from practical work about overhead cost management to existing theories and concepts. Secondly, new ways enabled by Industry 4.0 technologies (e.g. apps, augmented reality, autonomous systems, cloud computing) uncover as the major success factors the two terms usability and speed. Nevertheless, it is not sufficient to only own them, but rather an enterprise needs to perform

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and master them. Costs for training programs, the installation of knowledge managers, allotted time for employee training, available cutting-edge technology – all of which are ideally ahead of the competition – are the desired ingredients. Thirdly, cost consciousness across all levels in the organization opens the door for continuous improvement. All, especially the so-called 'small' changes, point in the right direction of making a difference, as they cumulate finally in impressive momentum.

Hypothesis 3 - Digitalized services have a direct effect on overhead costs – is validated by qualitative means with full satisfaction. All participants confirmed the hypothesis. It is supported by primary and secondary quantitative data. The connecting piece is the design of digitalized services that empower the organization to quickly understand the purpose of the overhead costs, which is consistent with the answer to the third research question. It concludes with the postulation of the third thesis:

Overhead costs management succeeds with usability and speed.

6.4 New scientific contribution

The innovative value of this dissertation lies in the first qualitative research of the overhead costs situation in the sectors manufacturing and transportation/storage with companies in Austria, Hungary, and Slovakia. The dissertation is supported by quantitative methods and provides a long-term perspective from 2008 to 2013 to 2017. It demonstrates the suitability of qualitative research for problems in business, management, and markets; reaching saturation concerning the collected data from the manifold sources has explicitly been considered. It fosters the qualitative turn in management research as described by Goulding (2002), who initiated this tradition.

The following theses are postulated:

1. The digitalization of business processes enables the management of overhead costs.
2. The competencies in digital overhead costs management are insufficient.
3. Overhead costs management succeeds with usability and speed.

Another novelty presents the link to ECCBSO. It turned out that the BACH database system provides suitable information and offers value for scientific research in overhead costs

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management. It confirmed the statement from Vollmann (1985) that emerging countries have a steeper increase in overhead as they catch up to industrialized countries.

The scientific contribution of the dissertation consists of disclosing the principle of transaction costs for the practical application to overhead costs in the context of innovation. The impact of the decision for making or buying goods and services should be immediately simulated with overhead costs tools to evaluate the ramifications to the real world, which is a necessity before any investment takes place. The trend of increasing overhead costs was revealed in the work, the directions of priority in the industrial sectors became apparent, and the principles and mechanism for managing overhead costs in an organization were presented. The model with the synthesis of entities, findings, and hypotheses (Figure 32) portrays the new scientific contribution. The model links overhead costs, digitalization, and services together with three findings and several entities. It serves as a concept of overhead-cautious cost management and introduces a set of measures aimed at transparency, velocity, and usability. VUCA stands centrally in accordance with market realities. The theoretical generalizations provided in the dissertation can be used as material for discussion in academic communities. In addition, they may be of interest to educational, managerial, and scientific activities.

Nevertheless, as a drawback, the dissertation disclosed with the income statement analyses that the term overhead costs requires careful interpretation; it is hardly useable from a scientific point of view as it is imprecisely applied as a category term by itself. It seems suitable to work with the clearly distinguishable terms direct/indirect or variable/fixed costs as a category in management accounting. Nevertheless, overhead is a widely used, however imprecise term and plays an insignificant role in public released income statements.

The following recommendations are for (a) academic institutions, (b) businesses, and (c) future research. The thesis finishes with a summary reflecting on the journey.

6.5 Recommendations for academic institutions

For academic institutions in the fields of business management and information technology, the topic of overhead cost management in conjunction with digitalization will remain relevant for the upcoming years. Industry 4.0 technologies deliver plenty of empirical data, both qualitative and quantitative. Nevertheless, there are indications that new theories might be needed to explain the current observations. Qualitative research approaches will help to inductively build new mid-level theories. Furthermore, quantitative research might

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deductively confirm generally accepted grand theories using the advantage of Big Data with artificial intelligence. Therefore, the following should be considered in a workshop when doing research:

1. Narrate the present-day situation. Outline in a program/workshop the current situation of cost structure and cost reporting concerning overhead costs; state the objectives.
2. Brainstorm and create a list of values. What matters? What are your industry/enterprise/individual values that relate to sustainable overhead costs management? How will society be impacted by them?
3. Brainstorm and create a list of alternatives. How might these values play out in practice or in daily operations? What is necessary that (1) usability, (2) speed, and (3) transparency are reflected properly? What are potential future practices in overhead costs management (i.e. procedures you are dreaming of performing, capabilities you have heard of from others)?
4. Brainstorm and create a path of continuum on which to anchor alternatives. What are the characteristics among these practices? Which prerequisites are necessary for practical implementation and long-term impact? Participants decide on the two most appealing alternatives on the continuum. Draw diagrams to represent two alternatives and four quadrants, each applying to SWOT.
5. Brainstorm and create future scenarios of overhead costs management. Discuss the scenarios and make them fit into the quadrants of the diagram. Ask challenging questions. Where do the scenarios fit on the continuum?
6. Determine next steps and a new narrative. Participants describe in detail the processes of future scenarios using specific examples from the list of values and alternatives. The outcome serves as the backbone for future academic curriculums.

I recommend especially paying attention to the following conclusions of the dissertation from an academic point of view: First, invest in research for new methods that support usability, speed, and transparency; these entities were the most mentioned throughout the interviews; all efforts pivot around them. Second, develop an interactive education system which supports the subject matter of overhead costs management in action-oriented trainings of Industry 4.0 processes; this includes the competency driven dimensions subject-matter, methods, social, and personal competence. Third, request funds from the industry, which is desperately interested in

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the topic; the visualization of use-cases helps the sponsors to open the door for sufficient monetary support.

6.6 Recommendations for businesses

For businesses, the topic of overhead cost management will remain important for the upcoming years. It is particularly true in highly competitive markets. There are indications that the visibility of costs becomes a lifesaver in the age of digitalization. The reasons for this statement are threefold: (1) VUCA continues to dominate the business arena, (2) agile business reactions enable the materialization of short-term opportunities, and (3) the setup of overhead cost management is a strategic task.

Benchmarks provide the comparability needed to quickly identify potential efficiency (i.e. doing it right) opportunities. Although, identifying opportunities does not necessarily mean knowing they are effective (i.e. doing the right thing). The subsequent five-step recommendation can initiate a workable project plan for ongoing overhead cost management improvements:

1. External functional benchmarking. As already mentioned, benchmarking may open insights into specific functions (e.g. engineering, human resources, SCM) and even sub-functions (e.g. shipping). It allows for focused adjustments that can be made to cost structures and business processes, rather than general, across-the-board cost alignments for all departments and functions. The process is transparent and fact-driven. Therefore, benchmarked data is useful in persuading functional managers to do targeted adjustments.
2. Quantitative assessment of value drivers. Acquiring a solid understanding of the internal costs of the various processes empowers management to decide how specific functions can become more effective (e.g. through avoiding waste by applying lean principles). Hence, it provides value beyond pure efficiency (i.e. doing it right) by deciding to do the right thing ergo being effective.
3. Assessment of target operational improvement levels. Once potential improvements have been identified, managers should swiftly assess which improvement levels are realistic, what does it take by when, and what are stretch goals serving as lighthouses for orientation. A list of priorities, ranked by impact, helps to focus on

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first things first. It might even impact the overall design and structure of the organization, which makes it a strategic task.

4. Qualitative stakeholder interviews. Discussions with the organization's stakeholders result in an understanding of any unknown organizational complexities and provide additional insight into potential management buy-in/implementation challenges within the organization. Such insights often go beyond the known facts and figures and disclose unknown specifics that need smart consideration to avoid potential roadblocks.
5. Greenfield process design. At the end, based on the performed analyses and interviews, management proposes purposeful process targets. These serve as a detailed and analytical basis for comparison with the existing processes or organization. A plan for action, implementation, and control is then developed to monitor the deltas between targets and existing processes.

The five-step recommendation is a hands-on approach for businesses. It contains shortcuts in terms of scientific rigor. Nevertheless, this approach developed and carried out by the author has proven success in more than fifteen overhead cost improvement projects.

6.7 Recommendations for future research

I recommend for further research to be conducted in order to develop a larger database of information. This would provide a more comprehensive understanding beyond the set-up of this dissertation. It should further develop a platform as to why some enterprises succeed in managing overhead costs and how they are doing it. The BACH database system of ECCBSO offers plenty of data, currently containing detailed information from eleven countries in the European Union. Therefore, the following should be considered:

1. Based on the constraints of the dissertation and to correct my bias, a survey of a larger sample should be conducted. It should contain enterprises from all regions in Europe and, if possible, even worldwide; more industries need to be added. It would allow for discovering the extent to which the same or similar findings exist.
2. A further similar study using the same criteria should be undertaken among enterprises which completely ignore the impact of digitalization by focusing only on overhead costs management. This approach would allow for drawing conclusions as to whether digitalization is really a game changer.

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3. A comparison and analysis should be undertaken to access the recent experiences of only academic fellows in the field of overhead costs management and digitalization. This research should be undertaken to find out similarities and/or differences in perspectives compared with the twenty business leaders in the dissertation at hand.

These considerations conclude the recommendations section. It addressed issues for academic institutions, businesses and for future research. The bottom line is that there is still plenty of work to do in the subject of overhead costs management in conjunction with digitalization.

6.8 Summary

As the dissertation comes to the close, I want to pause for a moment and reflect on the journey. It has been a tremendous experience. It brought me to new spheres, where I had never been before. The interaction with the professors, the co-workers, and the many participants from multiple industries in different countries was a fascinating enterprise in itself. It pushed me to the edge in order to capitalize on my organizational capabilities. I learned a lot, not only from a subject matter perspective, but also from an organizational and cultural perspective. All conferences I could attend throughout the PhD program opened new points of views, new challenges, and new locations. Furthermore, I met friends for life. I had the privilege of publishing several articles during the PhD program, which gave me ample opportunity to develop and to fine-tune my writing capabilities. The excellent guidance of the Doctoral School, my supervisor Prof. Em. Dr. Székely Csaba, DSc, the reviews of my publications by my co-workers, and the two anonymous reviewers helped tremendously to carve out my original meaning consistent with academic standards. Summarizing the dissertation, the following is delivered per chapter:

Chapter 1 introduced to the topic, explained the research problem, contained the research questions, formulated the research approach, stated the hypotheses, referred to the values, and related to the rationale and significance of the subject matter. The structure of the dissertation was explained.

Chapter 2 reviewed the needed literature. It laid out the evolution of concepts and tools of overhead costs management, provided the theoretical foundation with the transaction cost

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theory, and referred to the concept of Industry 4.0. It held a summary of the literature review and described the conceptual framework.

Chapter 3 described the research methodology. It set the context of qualitative and quantitative research as well of multi-case study methodology. The research sample, the needed information, and the income statement analysis were defined. Subsequently, the data collection methods, the methods for analysis and synthesis, issues of trustworthiness, and the constraints of the dissertation were laid out. It finished with a chapter summary.

Chapter 4 presented the findings of the dissertation. It contained the metadata of the study, the outcome of the different research instruments, the three clustered findings, and a line-itemized income statement analysis. It formed the substrate for all subsequently following results and concluded with a chapter summary.

Chapter 5 dealt with the analysis, interpretations, and synthesis of the findings. It created three analytic categories with the corresponding interpretation, revisited the hypotheses, built the synthesis, challenged the results against the BACH database and closed with a chapter summary.

Chapter 6 contained the conclusions and the recommendations of the dissertation. It answered explicitly the research questions and postulated three theses as the major result of the thesis. It pointed out the new scientific contribution. Recommendations for academia, businesses, and future research with a summary finished out the dissertation.

My fondest hope is that this dissertation shed some light on the complex topic of overhead costs management in the context of Industry 4.0 from a qualitative and quantitative perspective. It may help to demystify the topic of succeeding in the digital era. At the same time, by providing input for the academic learning system, I am grateful to contribute as a fellow researcher.

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APPENDICES

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Appendices

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APPENDIX A: First contact letter to participation companies

Please support the PhD thesis of Wolfram Irsa

Dear Ladies and Gentlemen!
At the University of Applied Sciences Burgenland, as part of the PhD program "Program in International Economic Relations and Management", a PhD thesis takes place on the subject of innovation in overhead cost management by Dipl.-Ing. Wolfram Irsa, CIRM CFPIM. I kindly ask you to support the PhD student.
Sincerely yours,
Prof. Em. Dr. Székely Csaba, PhD
University of Sopron
Faculty of Economics

Please support the PhD thesis on the topic Innovation in overhead cost management

Dear Ladies and Gentlemen!
As part of my PhD, I am conducting a survey on innovation in overhead cost management.
I would like to ask you to take part in my survey. Your participation is very important to me and supports me in preparing my PhD thesis.
The survey takes about 30 minutes, your answers are stored in a personal non-assignable manner and are evaluated anonymously.
If you wish, you can send your email address in a separate message to wolfram.irsa@gmail.com, you will receive the results of the survey by email in spring 2020.
Thank you very much in advance for your participation.
Sincerely yours,
Dipl.-Ing. Wolfram Irsa, CIRM CFPIM
PhD student in the PhD program in International Economic Relations and Management

Appendix A: First contact letter to participants with letter of recommendation

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APPENDIX B: Research consent form

FH Burgenland - PhD Program „Programme in International Economic Relations and Management“
Principal Researcher: Dipl.-Ing. Wolfram Irsa, CIRM CFPIM
Research Title: Innovations in Overhead Cost Management
You are invited to participate in a research study that explores the innovations in overhead cost management. Your participation in this study requires an interview during which you will be asked questions about your opinions and attitudes relative to your experience in overhead cost management. The duration of the interview will be approximately 30 minutes. With your permission, the interview will be audiotaped and transcribed, the purpose thereof being to capture and maintain an accurate record of the discussion. Your name will not be used at all. On all transcripts and data collected you will be referred to only by way of a pseudonym.
This study will be conducted by the researcher Wolfram Irsa, a doctoral candidate at University of West Hungary. The interview will be undertaken at a time and location that is mutually suitable.
Risks and Benefits
This research will hopefully contribute to understanding the innovations in overhead cost management, and so the potential benefit of this study is improvement of robustness of European companies. Participation in this study carries the same amount of risk that individuals will encounter during a usual conference activity. There is no financial remuneration for your participation in this study.
Data Storage to Protect Confidentiality
Under no circumstances whatsoever will you be identified by name in the course of this research study or in any publication thereof. Every effort will be made that all information provided by you will be treated as strictly confidential. All data will be coded and securely stored and will be used for professional purposes only.
How the Results Will Be Used
This research study is to be submitted in partial fulfillment of requirements for the degree of PhD at University of West Hungary in Sopron, Hungary. The results of this study will be published as a dissertation. In addition, information may be used for educational purposes in professional presentation(s) and/or educational publication(s).
Participant's Rights

- I have read and discussed the research description with the researcher. I have had the opportunity to ask questions about the purposes and procedures regarding this study.
- My participation in this research is voluntary. I may refuse to participate or withdraw from participation at any time without jeopardy to any consequences.
- The researcher may withdraw me from the research at his professional discretion.
- If, during the course of the study, significant new information that has been developed becomes available that may relate to my willingness to continue to participate, the investigator will provide this information to me.
- Any information derived from the research that personally identifies me will not be voluntarily released or disclosed without my separate consent.
- If at any time I have any questions regarding the research or my participation, I can contact the researcher, Wolfram Irsa, who will answer my questions. The researcher's phone number is +43 680 1120261.
- If at any time I have comments or concerns regarding the conduct of the research, or questions about my rights as a research subject, I should contact the PhD Program's Review Board. The phone number is +43 5 7705-4510. Alternatively, I can write to the Review Board at Campus 1, A-7000 Eisenstadt.
- I should receive a copy of the Research Description and this Participant's Rights document.
- Audiotaping is part of this research. Only the principal researcher will have access to written and taped materials. Please check one:

(. . . .) I consent to being audiotaped.
(. . . .) I do NOT consent to being audiotaped.

My signature means that I agree to participate in this study.
Name (Please print):

_____
Participant's signature:

_____
Date: ____/____/_____

Investigator's Verification of Explanation
I, Wolfram Irsa, certify that I have carefully explained the purpose and nature of this research to _____ (participant's name). He/she has had the opportunity to discuss it with me in detail. I have answered all his/her questions and he/she provided the affirmative agreement (i.e., assent) to participate in this research.
Investigator's signature:

_____
Date: / /

Appendix B: Research consent form

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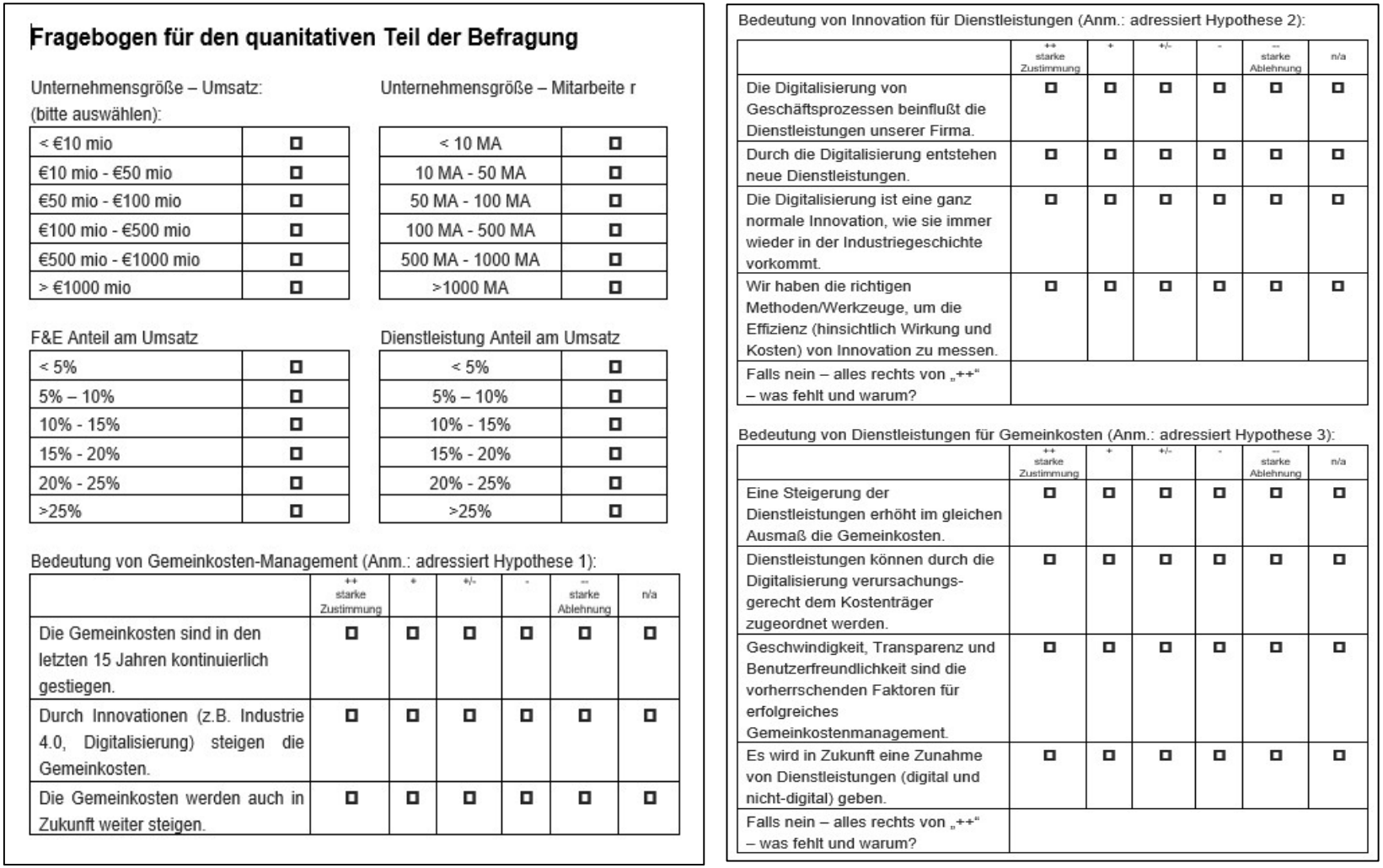
APPENDIX C: Survey



Fragebogen für den quanitativen Teil der Befragung

Unternehmensgröße – Umsatz: (bitte auswählen):

< €10 mio	☐
€10 mio - €50 mio	☐
€50 mio - €100 mio	☐
€100 mio - €500 mio	☐
€500 mio - €1000 mio	☐
> €1000 mio	☐

Unternehmensgröße – Mitarbeite r

< 10 MA	☐
10 MA - 50 MA	☐
50 MA - 100 MA	☐
100 MA - 500 MA	☐
500 MA - 1000 MA	☐
>1000 MA	☐

F&E Anteil am Umsatz

< 5%	☐
5% – 10%	☐
10% - 15%	☐
15% - 20%	☐
20% - 25%	☐
>25%	☐

Dienstleistung Anteil am Umsatz

< 5%	☐
5% – 10%	☐
10% - 15%	☐
15% - 20%	☐
20% - 25%	☐
>25%	☐

Bedeutung von Gemeinkosten-Management (Anm.: adressiert Hypothese 1):

	++ starke Zustimmung	+	+/-	-	-- starke Ablehnung	n/a
Die Gemeinkosten sind in den letzten 15 Jahren kontinuierlich gestiegen.	☐	☐	☐	☐	☐	☐
Durch Innovationen (z.B. Industrie 4.0, Digitalisierung) steigen die Gemeinkosten.	☐	☐	☐	☐	☐	☐
Die Gemeinkosten werden auch in Zukunft weiter steigen.	☐	☐	☐	☐	☐	☐

Bedeutung von Innovation für Dienstleistungen (Anm.: adressiert Hypothese 2):

	++ starke Zustimmung	+	+/-	-	-- starke Ablehnung	n/a
Die Digitalisierung von Geschäftsprozessen beinflußt die Dienstleistungen unserer Firma.	☐	☐	☐	☐	☐	☐
Durch die Digitalisierung entstehen neue Dienstleistungen.	☐	☐	☐	☐	☐	☐
Die Digitalisierung ist eine ganz normale Innovation, wie sie immer wieder in der Industriegeschichte vorkommt.	☐	☐	☐	☐	☐	☐
Wir haben die richtigen Methoden/Werkzeuge, um die Effizienz (hinsichtlich Wirkung und Kosten) von Innovation zu messen.	☐	☐	☐	☐	☐	☐
Falls nein – alles rechts von „++" – was fehlt und warum?						

Bedeutung von Dienstleistungen für Gemeinkosten (Anm.: adressiert Hypothese 3):

	++ starke Zustimmung	+	+/-	-	-- starke Ablehnung	n/a
Eine Steigerung der Dienstleistungen erhöht im gleichen Ausmaß die Gemeinkosten.	☐	☐	☐	☐	☐	☐
Dienstleistungen können durch die Digitalisierung verursachungs-gerecht dem Kostenträger zugeordnet werden.	☐	☐	☐	☐	☐	☐
Geschwindigkeit, Transparenz und Benutzerfreundlichkeit sind die vorherrschenden Faktoren für erfolgreiches Gemeinkostenmanagement.	☐	☐	☐	☐	☐	☐
Es wird in Zukunft eine Zunahme von Dienstleistungen (digital und nicht-digital) geben.	☐	☐	☐	☐	☐	☐
Falls nein – alles rechts von „++" – was fehlt und warum?						

Appendix C: Survey

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APPENDIX D: Interview guideline

Guidelines for the qualitative part of the survey

With regard to the interview on the subject of overhead cost management, senior management opinion is recorded. The interview lasts 20 to 25 minutes on the following research questions:

1. How does the digitalization of processes impact the management of overhead-costs?
2. What are the limitations of the current approaches of the management of overhead-costs in respect to methods and tools? - If there are limitations, what can be done to overcome them?
3. In general, what are the prerequisites for the successful management of overhead-costs?

• The interview is semi-structured with a few pre-determined key questions.

• The interviewee conducts the conversation with his or her answers.

• The interview aims to uncover facts but is not interested in their statistical validity.

• It is more about understanding what exactly is important for the interviewee and how her/his knowledge is to be viewed and assessed in the context of the topic.

• The interview is based on the active listening method. In doing so, the interviewer encourages the informant to report his/her experiences, understanding, etc.

• The questions are answered / discussed generically. This means that no company-specific information is required. Our aim is to understand the opinion of experienced experts from practice. The exact process emerges in the conversation.

• Questions of remembrance must not be mixed up with questions to be reflected upon or assessed from today.

• Collecting - checking - sorting – subsuming.

• 1-5 sets of questions.

• Attitude and evaluation questions are asked in a separate block if necessary.

• Questions that are open but do not stimulate a longer statement are asked at the end.

Leitfragen organisiert in Fragenbündel A-E

[1] möglichst einfache **Erzählaufforderung**	[2] wichtige, unbedingt zu behandelnden **Aspekten**	[3] konkrete **vorformulierte Frage**
A		Wie definieren Sie Overhead-Kosten?
B Wie haben Sie das Overhead-Kostenmanagement in den letzten 10 Jahren erlebt?	• Herausforderungen/Was wäre notwendig? • Limitationen/Was fehlt? • Methoden • Werkzeuge • Transparenz • Kultur, Betriebssoziologie • Analyse/Verstehen der Ursache • Warum hat es sich verändert? • Ist es besser geworden, gleichgeblieben, schlechter geworden? • Von wem sind die Änderungen ausgegangen?	
C Was sind die Einschränkungen der derzeit eingesetzten Methoden und Werkzeuge?	• Was funktioniert gut? – Warum? • Was funktioniert nicht? – Warum? welche Kriterien sind wichtig? • Was müsste gemacht werden? • Ausbildungsniveau?	
D Was braucht es für erfolgreiches Overhead-Kostenmanagement?	• Welche Kriterien sind wichtig? • Wie zufrieden sind Sie mit der Erfüllung der Kriterien? • Welche Vereinbarungen verwenden Sie für interne Prozesse? • Gibt es ein Service Level Agreement? • Wie ist das Management der Overheadkosten organisiert? Zentral? Dezentral? • Wie werden Mitarbeiter ins Gemeinkostenmanagement eingebunden? • Wie werden freigewordene Ressourcen bei erfolgreicher Senkung der Gemeinkosten verwendet? • Wann ist der richtige Zeitpunkt für aktives Overhead-Kostenmanagement?	Wie definieren Sie Erfolg bezüglich Overhead-Kostenmanagement?
E Zusammenfassung		Gibt es zu Overhead-Kosten Management noch etwas, das Sie erwähnen möchten?

Definition Overhead: fixe Gemeinkosten des Gesamtunternehmens
Gemeinkosten: werden den Kostenträgern nicht direkt zugeordnet werden, weil kein unmittelbarer Leistungszusammenhang oder aus Gründen der Wirtschaftlichkeit kostenstellenweise erfasst. (z.B. beschäftigungsunabhängige Energiekosten, Schmiermittelverbrauch, Hilfslöhne, Hilfsmaterial; Gehälter der Unternehmensleitung, Feuerversicherungsprämien, Treibstoffkosten, Fuhrpark, Kurierdienste, Verpackung, Entsorgung, Marketing, Reisekosten, Telekommunikation)
Fixe Kosten: fallen unabhängig von der Ausbringungsmenge an; ergeben sich aus der Bereitstellung einer Kapazität, daher auch Bereitschaftskosten genannt. Beispiele: kalk. Miete und Pacht, kalk. Zinsen, Abschreibung auf das Anlagevermögen, Kosten für Beratung, Versicherung, Beleuchtung, Bewachung.

Appendix D: Interview guideline

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APPENDIX E: Critical incident instrument

Critical Incident

In reflecting on the time that you have been involved in overhead-cost management, please recall one particular occasion while making decision/reflections that you felt frustrated or were wondering:

In 1–2 short paragraphs, please describe that experience:

- Theme - Impact of digitalization on OH: Why is it that digitalization drives overhead?

- Theme - Knowledge, skills, governance, attitudes: What capabilities do you miss most in your OH system?

- Theme - Success factors: What makes a OH system successful in terms of speed, transparency, usability? Are there any others?

Thank you very much! Your perceptions are very helpful to us in trying to understand the "overhead cost experience."

Appendix E: Critical incident instrument

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APPENDIX F: Participants demographics matrix

#	Participant Code	Pseudonym	Topic-related experience (years)	Gender	Age
#1	OHM114C	Georg	13	M	39
#2	OHM289Z	William	17	M	42
#3	OHM878D	Isabella	15	F	44
#4	OHM743V	Ute	9	F	33
#5	OHM650H	Brian	14	M	43
#6	OHM189M	David	16	M	48
#7	OHM544P	Diane	22	F	54
#8	OHM901K	Serge	17	M	43
#9	OHM007U	Gerhard	15	M	46
#10	OHM467Z	Lazlo	19	M	51
#11	OHM399R	Barbara	13	F	38
#12	OHM511V	Sabrina	16	F	41
#13	OHM946U	Joachim	12	M	27
#14	OHM778Q	Miroslav	10	M	35
#15	OHM444Y	Csaba	23	M	52
#16	OHM801X	Alexander	18	M	50
#17	OHM754Z	Dimitar	11	M	39
#18	OHM999R	Gertrude	22	F	49
#19	OHM485A	Gerlinde	21	F	46
#20	OHM302C	Herbert	17	M	42
	Total N = 20		mean: 16,0 median: 16 mode: 17 max: 23 min: 9 range: 14	M = 13 (65%) F = 7 (35%)	mean: 43,1 median: 43 mode: 39 max: 54 min: 27 range: 27

Appendix F: Participants demographics matrix

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APPENDIX G: Conceptual framework

Theme Research question Hypothesis Entities
Theme: Impact of digitalization on OH RQ1: How does the digitalization of service processes impact the management of overhead cost? H1: Innovation (e.g. digitalization) drives the percentage of overhead-costs continuously upward. • Not at all • Somewhat • Heavily
Theme: Knowledge, skills, governance, attitudes RQ2: What are the limitations of the current approaches of the management of overhead costs in respect to methods and tools? - If there are limitations, what can be done to overcome them? H2: The surge of digitalization has an impact on related methods and tools. • ABC • PKZ • TD-ABC • Sticky Costs • Satisfaction
Theme: Success factors RQ3: In general, what are the prerequisites for the successful management of overhead costs? H3: Digitalized services have a direct effect on overhead-costs. • Speed • Transparency • Usability

Appendix G: Conceptual framework

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APPENDIX H: Coding schema with legend

1. Impact of digitalization on overhead

ID1 Not at all

ID2 Somewhat

ID3 Heavily

2. Knowledge, skills, governance, attitudes/KSGA

KSGA1 Activity-based costing

KSGA2 Prozesskostenrechnung

KSGA3 Time-driven Activity-based costing

KSGA4 Sticky Costs

KSGA5 Satisfaction

3. Success factors/SF

SF1 Speed

SF2 Transparency

SF3 Usability

SF4 Miscellaneous

Appendix H: Coding schema with legend

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APPENDIX I: Coded interview transcript 1

Participant: OHM754Z

Date: July 12, 2019

INTERVIEWER: What is your opinion about overhead and digitalization? How do you see this subject as an industrial engineer and automotive manager?

OHM754Z: I am more than eleven years in this field. Currently I am in charge for the largest ICE [internal combustion engine] factory in the world. I know the topic very well. [I have seen a constant rise of overhead costs in the last 10 years.] **ID3** I recall from my predecessors that they said the same for the 10 years prior to that. This means we are talking about a time span of 20 years where we see a constant rise of overhead costs in the automotive OEM market. [Digitalization helps to increase transparency about the cost, but it has a price tag.] **ID3/SF3** The price is primarily driven the enormous amount of data that is created. The data is no information yet. It is even far away from a model.

INTERVIEWER: Thank you for the insight. But what does this mean for tools that are at your disposal? Isn't there a massive change going on?

OHM754Z: Yes, and no. Customizing is enabled through digitalization. Therefore, Industry 4.0 is desirable. Although it is essential to decide carefully where to have the transparency. There is the risk to drown in the flood of data. [There was already in the 1990ies an effort to digitalize manufacturing processes and apply ABC.] **KSGA1** It was called CAM. The CNC machine could not yet talk to each other. In the 1990ies, industry was often manual, almost everything analog. Then happened the transformation of processes from analog to digital – in a quite primitive way. [This took place in front of the background to create flexibility.] **SF1** The main topic was to reduce the non-productive time off the total time. [The non-productive time was primarily set-up time; we tried to get a handle on it with CAM.] **KSGA5**

Today there is a network of production equipment on a completely different level. We started already to think about Industry 4.0 in 2012. [It is a total interlinking of all processes, which becomes very expensive once you decide to have it.] **KSGA4** A real interlinking means, not just to write data into a storage and then there they are. It is a total interlinking. For me this focus will bring enormous advantage for pull processes. This is a radical change of thinking from push to pull. If this is done consequently it represents fifty percent of Industry 4.0, at least.

INTERVIEWER: Thank you for that. Finally, what are in your opinion the prime success factors for a successful overhead-costs management in the future?

OHM754Z: [Usability and speed are the predominant factors.] **SF3/SF1** [Additionally, I would like to mention consistency.] **SF4**

Appendix I: Coded interview transcript 1

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APPENDIX J: Coded interview transcript 2

Participant: OHM189M

Date: September 2, 2019

INTERVIEWER: What is your opinion about overhead and digitalization? How do you see this subject as an industrial engineer and director in the transportation and logistics industry?

OHM189M: The real advantage of digitalization lies in the interlinking of process steps – buzz word IoT – for a transparent management system in terms of controlling the processes. [Although, first comes the pull principle, digitalization helps then. It's not the other way around. Pull processes support the same advantages for creating transparency in overhead-costs. This is huge.] **ID3** The pull process works only if there are interlinked processes.

INTERVIEWER: What are the biggest challenges concerning overhead-costs management?

OHM189M: The data management is very expensive; I mean really (raises voice) very expensive. The transition to central storage in a cloud costs sky-high. It is so expensive that even a global player needs to think about how to organize it from a money point of view. A huge multi-national can do some parts by themselves, small companies need to outsource. Data storage is not a bargain. [And once you have it there is no way back (laughs).] **KSGA4**

INTERVIEWER: What about PKR?

OHM189M: [It was impossible to apply PKR in its original, hence theoretical setup.] **KSGA2** The reason had been that the technical description dominates and there is a lack in process thinking. [The thinking in cost centers avoids the process view and therefore PKR.] **KSGA2** A change needs completely new booking and logistics processes. The key to success is again the pull/lean process. It helps to optimize the processes. We had too much buffer of material. After we changed to pull, we reduced WIP by 50% which stands for €200m. This has been completed in two year's work. But we came only close to real process costs. [Because of Industry 4.0 so much transparency will be produced that PKR becomes really possible, for the very first time.] **KSGA2** So far PKR had no real chance. Before that cost center accounting was to 99% dominant. PKR was a nice buzz word but not realistic.

INTERVIEWER: Thank you very much for the insight. Finally, what are in your opinion the prime success factors for a successful overhead-costs management in the future?

OHM189M: [Speed and transparency are the most important ones, in this sequence.] **SF1/SF2** [Additionally, I would like to mention easy access around the globe; this is essential in the logistics industry.] **SF4**

Appendix J: Coded interview transcript 2

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APPENDIX K: Coded interview transcript 3

Participant: OHM485A

Date: August 26, 2019

INTERVIEWER: What is your opinion about overhead and digitalization? How do you see this subject as an industrial engineer and manager in the beverage industry?

OHM485A: [The management of overhead-costs and digitalization as we see it to materialize under Industry 4.0 are a perfect couple. I love the capabilities we are getting in our hands.] **ID3**

INTERVIEWER: Is it fair to say that the digitalization of overhead creates so much transparency that it is worthwhile because it increases efficiency?

OHM485A: It really depends. I believe in a well-organized organization it is difficult to constitute the advantage because of the cost of the digitalization is very high. But it is possible (laughs).

INTERVIEWER: Are you satisfied with the currently available tools and methods?

OHM485A: [Definitely no! There are still ways to go.] **KSGA5** [Time-driven activity-based costing had a very promising start a while ago.] **KSGA3** But there was never a follow-up; at least I have not seen it. There is a need to capitalize on the capabilities and functions that we have now on our fingertips. AI will become a huge topic in the upcoming years. I am wondering what the academic world is waiting for. It looks like that the industry needs to lead the way (laughs).

INTERVIEWER: Thank you. Finally, what are in your opinion the prime success factors for a successful overhead-costs management in the future?

OHM485A: This is very hard to generalize, because each industry has its own demands. [But the overall topic is VUCA, therefore speed and anticipation of results are key.] **SF1/SF4** It boils down at the very end to flexibility, not only in our business behavior but also how we manage our overhead-costs in the future.

Appendix K: Coded interview transcript 3

10.13147/SOE.2021.006

APPENDIX L: Original data from the BACH database - ECCBSO

Source: (www.eccbso.org)

Date of data extraction: January-15, 2019

Austria, sector manufacturing, all companies

Expenses					
Category	**2008**	**Category**	**2013**	**Category**	**2017**
I5	104461504	**I5**	90915915	**I5**	91247888
I6	6550391	**I6**	10954134	**I6**	11143055
I7	34475744	**I7**	35958137	**I7**	35463077
I8	29304382	**I8**	26211679	**I8**	25589043
I81	27108821	**I81**	25089050	**I81**	25276134
I82	0	**I82**	0	**I82**	0
I83	689514	**I83**	340190	**I83**	330293
I84	1506045	**I84**	782438	**I84**	0
I85	0	**I85**	0	**I85**	0
I9	6332649	**I9**	6021372	**I9**	5788825
I10	2358866	**I10**	1173657	**I10**	851809
I11	1995964	**I11**	1837028	**I11**	2051295

Austria, sector transportation and storage, all companies

Expenses					
Category	**2008**	**Category**	**2013**	**Category**	**2017**
I5	14105708	**I5**	7235093	**I5**	6503444
I6	8489764	**I6**	16417115	**I6**	16167608
I7	10427594	**I7**	9360561	**I7**	9952712
I8	12285465	**I8**	7987509	**I8**	7968384
I81	11589351	**I81**	7694194	**I81**	7937310
I82	0	**I82**	0	**I82**	0
I83	211656	**I83**	89269	**I83**	31074
I84	484457	**I84**	204044	**I84**	0
I85	0	**I85**	0	**I85**	0
I9	3108994	**I9**	2329513	**I9**	2952075
I10	846624	**I10**	382584	**I10**	368454
I11	428015	**I11**	306067	**I11**	514948

Slovakia, sector manufacturing, all companies

Expenses					
Category	**2008**	**Category**	**2013**	**Category**	**2017**
I5	30769448	**I5**	28147707	**I5**	13064633
I6	4882564	**I6**	4905277	**I6**	2896958
I7	4688275	**I7**	4539568	**I7**	2803899
I8	5114866	**I8**	2639468	**I8**	1464663
I81	0	**I81**	0	**I81**	34391
I82	0	**I82**	0	**I82**	0
I83	1588100	**I83**	214655	**I83**	82943
I84	0	**I84**	0	**I84**	0
I85	0	**I85**	51676	**I85**	12138
I9	1803507	**I9**	1681468	**I9**	760653
I10	401248	**I10**	250431	**I10**	78897
I11	295657	**I11**	596265	**I11**	204324

Appendix L: Original data from the BACH database – ECCBSO

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APPENDIX M: Expenses for the itemized income statement analyses

OHM650H	EUR million	2008		2013		2017	
Sales		62304		73973		64475	
Cost of sales	(a)	46455	75%	55483	78%	43929	72%
Selling expenses	(b)	5777	9%	7423	10%	8262	13%
General and adminstrative e	(c)	1058	2%	1366	2%	1412	2%
Research and adminstrative	(d)	1355		1835		1888	
Other operating expenses	(e)	2500	4%	2570	4%	2949	5%
Other expenses from partici	(f)	82	0%	70	0%	60	0%
Interest expenses	(g)	601	1%	688	1%	560	1%
Other financial expenses	(h)	758	1%	274	0%	429	1%
Income taxes	(i)	2671	4%	1540	2%	1448	2%
Minority interests	(j)	393	1%	331	0%	274	0%
			0%		0%		0%
			0%		0%		0%
Overhead	(b)+(c)+(d)+(e)+(f)+(g)+(f)	15195	25%	16097	22%	17282	28%
Expenses	(a)+(b)+(c)+(d)+(e)+(f)+(g)+	61650	100%	71580	100%	61211	100%
source: www.basf.com							

OHM114C	USD million	2008		2013		2017	
Sales		23704		34835		38946	
Cost of goods sold	(a)	20982	88%	30287	90%	33258	90%
Material				22293		24349	
Direct labor				2272		2743	
Overhead				5722		6166	16.7%
Depreciation and amortizati	(b)	873		1063		1173	
Selling, general and administ	(c)	1319	6%	1616	5%	1668	5%
Impairment charges	(d)	283	1%		0%		0%
Interest expense	(f)			16	0%	70	0%
Other expense	(g)			144	0%	39	0%
Income taxes	(e)	257		360	1%	744	2%
Overhead	(b)+(c)+(d)+(e)+(f)+(g)	2732	12%	3199	10%	3694	10%
Expenses	(a)+(b)+(c)+(d)+(e)+(f)+(g)	23714	100%	33486	100%	36952	100%
source: www.magna.com							

OHM754Z	EUR million	2008		2013		2017	
Revenue		95873		117982		164330	
Cost of sales	(a)	74314	78%	92457	81%	129999	82%
Selling expenses	(b)	9204	10%	10455	9%	12965	8%
General adminstrative exper	(c)	4124	4%	3965	3%	3809	2%
Research and non-capitalize	(d)	3055	3%	4101	4%	5938	4%
Other operating expenses	(i)			399	0%	1042	1%
Share of loss from companie	(e)	998	1%		0%		0%
Other financial expense	(f)	2228	2%	349	0%	230	0%
Interest expense	(j)			884	1%	582	0%
Income tax expense	(g)	1091	1%	1419	1%	3437	2%
Minority interest	(h)	66	0%		0%		0%
Overhead	(b)+(c)+(d)+(e)+(f)+(g)+(f)	20766	22%	21572	19%	28003	18%
Expenses	(a)+(b)+(c)+(d)+(e)+(f)+(g)+	95080	100%	114029	100%	158002	100%
source: www.mercedes-benz.com							

OHM511V	EUR million	2008		2013		2017	
Revenue		10481204		11524401		12897800	
Cost of sales	(a)	7977871	79%	9221018	81%	9923300	79%
Distribution costs	(b)	866099	9%	964606	8%	1149600	9%
Administratice expenses	(c)	468224	5%	570623	5%	662200	5%
Other operative expenses	(d)	324749	3%	296725	3%	413600	3%
Finance costs	(e)	262908	3%	267083	2%	174900	1%
Income tax expense	(f)	202485	2%	132731	1%	224600	2%
Discontinued operations	(g)	25155	0%		0%		0%
	(h)				0%		0%
	(i)		0%		0%		0%
	(j)		0%		0%		0%
Overhead	(b)+(c)+(d)+(e)+(f)+(g)+(f)	2149620	21%	2231768	19%	2624900	21%
Expenses	(a)+(b)+(c)+(d)+(e)+(f)+(g)+	10127491	100%	11452786	100%	12548200	100%
source: www.voestalpine.com							

OHM878D	EUR million	2008		2013		2017	
Revenue		105.9		139.8		195.4	
Cost of sales	(a)	80.3	78%	105.7	76%	148.8	77%
Distribution c	(b)	6.3	6%	9.5	7%	12.4	6%
Administratic	(c)	13.7	13%	20.8	15%	26.5	14%
Other operati	(d)	0.5	0%	0.2	0%	0.3	0%
Finance costs	(e)	2.3	2%	3.4	2%	3	2%
Income tax ex	(f)	0.5	0%	0.4	0%	3.3	2%
	(g)		0%		0%		0%
	(h)				0%		0%
	(i)		0%		0%		0%
	(j)		0%		0%		0%
Overhead	(b)+(c)+(d)+(e)+(f)+(g)+(f	23.3	22%	34.3	25%	45.5	23%
Expenses	(a)+(b)+(c)+(d)+(e)+(f)+(g	103.6	100%	140	100%	194.3	100%
source: www.pankl.com							

OHM901K	EUR million	2008		2013		2017	
Net sales		6697		8144		7564	
Production co	(a)	5716	87%	7035	87%	5751	82%
Sales and dist	(b)	539	8%	597	7%	673	10%
Administratio	(c)	279	4%	207	3%	220	3%
R&D costs	(f)			109		138	
Financial expe	(d)	46	1%	83	1%	75	1%
Taxes	(e)	24	0%	54	1%	173	2%
			0%		0%		0%
	(g)		0%		0%		0%
	(h)				0%		0%
	(i)		0%		0%		0%
	(j)		0%		0%		0%
Overhead	(b)+(c)+(d)+(e)+(f)+(g)+(f	888	13%	1050	13%	1279	18.2%
Expenses	(a)+(b)+(c)+(d)+(e)+(f)+(g	6604	100%	8085	100%	7030	100%
source: www.borealisgroup.com							

OHM801X	EUR million	2008		2013		2017	
Sales		389		459		324	
Cost of goods	(a)	270	78%	313	77%	229	69%
Selling expens	(b)	12	3%	19	5%	22	7%
General and a	(c)	17	5%	24	6%	38	11%
Other operati	(d)	17		14		18	
Interest expe	(e)	5	1%	15	4%	8	2%
Other financia	(f)			1	0%	1	0%
Income taxes	(g)	23	7%	23	6%	15	5%
	(h)		0%		0%		0%
	(i)		0%		0%		0%
	(j)				0%		0%
			0%		0%		0%
			0%		0%		0%
Overhead	(b)+(c)+(d)+(e)+(f)+(g)+(f	74	22%	96	23%	102	31%
Expenses	(a)+(b)+(c)+(d)+(e)+(f)+(g	344	100%	409	100%	331	100%
source: www.sbo.at							

OHM999R	EUR million	2008		2013		2017	
Revenue		34196		49880		60128	
Cost of sales	(a)	28848	87%	40691	87%	50545	86%
Gross profit		5348		9189		9583	
Distribution c	(b)	3240	10%	4641	10%	5297	9%
Adminstrative	(c)	302	1%	566	1%	685	1%
Other operating income		1588		1952		3326	
Other operati	(d)	622	2%	903	2%	2257	4%
Operating profit		2772		5031		4670	
Overhead	(b)+(c)+(d)	4164	13%	6110	13%	8239	14%
Expenses	(a)+(b)+(c)+(d)	33012	100%	46801	100%	58784	100%
source: www.audi.com							

Appendix M: Annual reports for the itemized income statement analyses

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APPENDIX N: Income statements from annual reports

in TEUR	Note	2017
Sales	23	**324,221**
Cost of goods sold	24	-229,327
Gross profit		**94,894**
Selling expenses	24	-21,713
General and administrative expenses	24	-37,902
Other operating expenses	25	-17,603
Other operating income	25	5,945
Profit from operations before impairments and restructuring measures		**23,621**
Restructuring gains	26	1,938
Restructuring losses	26	0
Impairment on property, plant & equipment	12	0
Impairment on goodwill	9	0
Profit from operations after impairments and restructuring measures		**25,559**
Interest income	27	1,798
Interest expenses	27	-8,096
Other financial income		0
Other financial expenses	28	-1,408
Gains / losses from remeasurement of option liabilities	29	-87,648
Financial result		**-95,354**
Profit / loss before tax		**-69,795**
Income taxes	30	15,435
Profit / loss after tax		**-54,360**
Average number of shares outstanding		15,951,940
EARNINGS PER SHARE IN EUR (BASIC = DILUTED)		**-3.41**

in CHF million	Note	2017
Revenue	4	**10 179**
Cost of materials		**2 935**
Personnel expenses	5	**3 765**
Other operating expenses	6	**2 144**
Depreciation, amortization, and impairment	16, 17	**153**
Change in provisions		**-5**
Total operating expenses		**8 992**
Other income	7	**-**
Operating profit		**1 187**
Financial income	8	**44**
Financial expenses	8	**59**
Result from associates	9	**-6**
Profit before taxes		**1 166**
Income taxes	10	**282**
Net profit		**884**
Net profit attributable to		
Shareholders of Schindler Holding Ltd.		**824**
Non-controlling interests		**60**
Earnings per share and participation certificate in CHF		
Basic	11	**7.70**
Diluted	11	**7.67**

OHM801X	EUR million	2008	2013	2017
		389	459	324

	Anhangsangabe	01.01.2017–31.12.2017 in €	in %
UMSATZERLÖSE		195.388	100,0
Umsatzkosten	(01)	–148.772	–76,1
Bruttoergebnis vom Umsatz		46.616	23,9
Vertriebskosten	(01)	–12.373	–6,3
Verwaltungsaufwendungen	(01)	–26.474	–13,5
Sonstige (betriebliche) Erträge	(03)	4.363	2,2
Sonstige (betriebliche) Aufwendungen	(03)	–342	–0,2
Betriebsergebnis (EBIT)		11.790	6,0
Finanzerträge		219	0,1
Finanzaufwendungen		–3.019	–1,5
Finanzergebnis	(04)	–2.800	–1,4
Ergebnis vor Ertragsteuern (EBT)		8.990	4,6
Ertragsteuern	(05)	–3.259	–1,7
ERGEBNIS NACH STEUERN		5.731	2,9
Zurechenbar zu Anteilseignern des Mutterunternehmens		*6.067*	*3,1*
Zurechenbar zu nicht beherrschenden Gesellschaftern		*–336*	*–0,2*

in millions of euros	Note	2017
Revenue	4	164,330
Cost of sales	5	-129,999
Gross profit		34,331
Selling expenses	5	-12,965
General administrative expenses	5	-3,809
Research and non-capitalized development costs	5	-5,938
Other operating income	6	2,824
Other operating expense	6	-1,042
Profit/loss on equity-method investments, net	13	1,498
Other financial income/expense, net	7	-230
Interest income	8	214
Interest expense	8	-682
Profit before income taxes[1]		14,301
Income taxes	9	-3,437
Net profit		10,864
thereof profit attributable to non-controlling interests		339
thereof profit attributable to shareholders of Daimler AG		10,525

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CONSOLIDATED INCOME STATEMENT

	Notes	2016/17	2017/18
Revenue	1,2	11,294.5	12,897.8
Cost of sales		-8,777.1	-9,923.3
Gross profit		2,517.4	2,974.5
Other operating income	3	348.8	415.7
Distribution costs		-1,079.2	-1,149.6
Administrative expenses		-622.3	-662.2
Other operating expenses	4	-356.0	-413.6
Share of profit of entities consolidated according to the equity method	5	14.6	15.2
EBIT		823.3	1,180.0
Finance income	6	51.5	44.5
Finance costs	7	-174.9	-182.0
Profit before tax		699.9	1,042.5
Tax expense	8	-172.9	-224.6
Profit after tax		527.0	817.9
Attributable to:			
Equity holders of the parent		496.8	775.2
Non-controlling interests		7.7	20.2
Share planned for hybrid capital owners		22.5	22.5
Basic and diluted earnings per share (euros)	30	2.84	4.40

CONSOLIDATED OTHER COMPREHENSIVE INCOME

	2016/17	2017/18
Profit after tax	527.0	817.9
Items of other comprehensive income that will be reclassified subsequently to profit or loss		
Cash flow hedges	7.0	7.1
Currency translation	62.2	-123.0
Share of result of entities consolidated according to the equity method	0.2	-1.2
Subtotal of items of other comprehensive income that will be reclassified subsequently to profit or loss	69.4	-117.5
Items of other comprehensive income that will not be reclassified subsequently to profit or loss		
Actuarial gains/losses	-13.7	22.9
Subtotal of items of other comprehensive income that will not be reclassified subsequently to profit or loss	-13.7	22.9
Other comprehensive income for the period, net of income tax	55.7	-94.6
Total comprehensive income for the period	582.7	723.3
Attributable to:		
Equity holders of the parent	551.3	684.8
Non-controlling interests	8.9	16.0
Share planned for hybrid capital owners	22.5	22.5
Total comprehensive income for the period	582.7	723.3

In millions of euros

[U.S. dollars in millions, except per share figures]

Years ended December 31,	Note	2017
Sales		$ 38,946
Costs and expenses		
Cost of goods sold		33,258
Depreciation and amortization		1,173
Selling, general and administrative		1,668
Interest expense, net	16	70
Equity income		(261)
Other expense, net	3	39
Income from operations before income taxes		2,999
Income taxes	11	744
Net income		2,255
Income attributable to non-controlling interests		(49)
Net income attributable to Magna International Inc.		$ 2,206

EUR thousand	2017
Net sales	7,564,335
Production costs	-5,750,863
Gross profit	1,813,472
Sales and distribution costs	-672,969
Administration costs	-219,609
R&D costs	-138,360
Other income	8,147
Operating profit	790,681
Net results in associated companies and joint ventures after tax	542,985
Financial income	8,972
Financial expenses	-74,720
Profit before taxation	1,267,918
Taxes on income	-172,823
Net profit for the year	1,095,095

	Explanations in Note	2017
Sales revenue	[4]	64,475
Cost of sales	[6]	(43,929)
Gross profit on sales		20,546
Selling expenses	[6]	(8,262)
General administrative expenses	[6]	(1,412)
Research and development expenses	[6]	(1,888)
Other operating income	[7]	1,916
Other operating expenses	[8]	(2,949)
Income from companies accounted for using the equity method	[9]	571
Income from operations	[4]	8,522
Income from other shareholdings		31
Expenses from other shareholdings		(60)
Net income from shareholdings		(29)
Interest income		226
Interest expenses		(560)
Interest result		(334)
Other financial income		70
Other financial expenses		(429)
Other financial result		(359)
Financial result	[10]	(722)
Income before taxes and minority interests		7,800
Income taxes	[11]	(1,448)
Income before minority interests		6,352
Minority interests	[12]	(274)
Net income		6,078

Appendix N: Income statements from annual reports

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APPENDIX O: List of publications

#	Title	Type
#001	Strategische Qualitätsmanagement in: HEIMERL, Peter/TSCHANDL, Martin: Controlling, Finanzierung, Produktion, Marketing, Wien 2015, ISBN 978-3-8252-4323-4.	Part of Monography
#002	Overhead Cost Management at ATLAS.ti User Conference: Qualitative Data Analysis and Beyond, Berlin 2015.	Presentation of the plenary lecture at international scientific conference
#003	Engineering Education - Status Quo In Austria In Comparison with The Academic Field of Business Education in: ISMAN, AYTEKIN: Turkish Online Journal of Educational Technology, Sakarya 2016, ISBN 2146-7242.	Scientific article, published in journal
#004	Engineering Education - Status Quo In Austria In Comparison with The Academic Field of Business Education in: INTE-International Conference on New Horizons in Education, Wien 2016, ISBN 2146-7358.	Conference proceedings
#005	The Impact of Online Community Marketplaces in a High-profile HORECA Area in: THI-Tourism & Hospitality Industry, Opatija 2018, ISBN 2623-7407.	Conference proceedings
#006	The Impact of Digitalization on Managing Overhead Costs in: Demographic Changes, Changing Economic Challenges - International Scientific Conference, Sopron 2018, ISBN 978-963-334-313-5.	Conference proceedings

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#	Title	Type
#007	Innovations for Managing Overhead Costs in: 4th International Scientific Conference for Doctoral students and Young Researchers, Eisenstadt 2018, ISBN 978-3-9519937-0-6.	Conference proceedings
#008	Contemporary Cost-managerial Solutions of the Industry 4.0 Era by the Example of the Maritime Freight Shipping Industry in: EUROWEEK - Business Digitalization - International Scientific Conference, Kapfenberg 2018, ISBN pending.	Conference proceedings
#009	Interaktive Lehre des Ingenieursstudiums -Technische Inhalte handlungsorientiert unterrichten, Springer Vieweg Verlag, Berlin 2019, ISBN 978-3-662-56223-9.	Monography
#010	A Qualitative Approach to Determine the Impact of Sticky Costs in the Manufacturing Industry in: Proceedings of FEB Zagreb 10th International Odyssey Conference on Economics and Business, Opatija 2019, ISSN 2671-132X.	Conference proceedings
#011	The Silent Diffusion of Sticky Costs in the HoReCa Industry in: Abstracts of ENTerprise REsearch InNOVAtion Conference, Rovinj 2019, ISSN 1849-7969.	Book of abstracts
#012	The Silent Diffusion of Sticky Costs in the HoReCa Industry in: Proceedings of ENTerprise REsearch InNOVAtion Conference, Rovinj 2019, ISSN 1849-7950.	Conference proceedings
#013	Contemporary Cost-managerial Solutions of the Industry 4.0 Era by the example of the Maritime Freight Shipping Industry in: TSCHANDL, Martin/SORKO, Sabrina: Business Digitalization - New Business Models, Smart Production and the Human side of Digitalization, Graz 2019, ISBN 978-3-7011-0441-3.	Part of Monography

Appendix O: List of publications by Wolfram Irsa

10.13147/SOE.2021.006

Declaration of academic honesty

I hereby declare on my word of honor, that I created the thesis at hand independently, that I did not use any material other than the citied resources and that I marked all results created by somebody else, be they overtaken into my thesis word for word or by a matter of meaning, accordingly.

I further declare that the thesis at hand was not submitted to any other institution (university, university of applied sciences, university of education or other comparable institution) to obtain an academic degree.

Sopron, December 2020

Signature