Business process management using artificial intelligence – An important requirement, success factor and business need for industry 5.0

A Thesis Submitted for Obtaining
the Scientific Title of PhD in Engineering
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in the Field of Engineering and Management
by

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FOREWORD

"I'm more interested in the future than in the past,
because the future is where I intend to live."
Albert Einstein

This doctoral study has been performed at the Politehnica University Timisoara, Romania, which has provided me with the educational and organizational framework to successfully research, execute, implement, and publish my research activities.

First, I would like to thank Prof. Anca DRAGHICI (the supervisor of the doctoral research and programme), who has supported me with great commitment during my research time and who has constantly provided new food for thought and ideas for the optimisation of scientific work. I wish her and the entire faculty continued success in research and teaching. In addition, I would like to express my sincere thanks to the lecturer and supporter PhD. Caius LUMINOSU. He has always accompanied me during my research work and has given me many important hints and suggestions over the years to be able to conduct research at a high scientific level.

Furthermore, I would like to thank to entire *Politehnica University of Timisoara, especially the staff of the Faculty of Management in Production and Transport* for the possibility and infrastructural support in carrying out the research. Through countless conversations with my guiding professors and research assistants of the university, I was able to expand my scientific knowledge extensively and to question other viewpoints for my work and research. It was a great and pleasant experience, not only from an academic point of view, but also from an intercultural perspective, which enriched my personality to a great extent.

Finally, I would like to thank the most important people in my life who supported me in this "learning adventure" - my family. Particularly, I would like to highlight my wife, who has brought up our children in a great way and has managed to put up with the exhausting schedule I have had over the past years, giving me the space and time necessary to work on this PhD and see it to its completion. I would also like to thank my two children for always driving me forward with their wonderful laughter and daily experiences. Finally, I also want to thank my mother and father for always believing in me and supporting me. I would not have made it this far without their constant support, encouragement, and kindness.

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Business process management using artificial intelligence – An important requirement, success factor and business need for industry 5.0

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Keywords: managementul proceselor de afaceri (BPM), inteligenta artificială (AI), Industry 5.0, modelul AI-BPM

Abstract: Scopul cercetării a fost acela de a concepe și executa o abordare sistematică a utilizării tehnologiei AI pentru BPM în vederea sprijinirii automatizării cu succes a proceselor de afaceri, în contextul Revoluției Industriale 5.0. Abordările BPM deja existente în vederea automatizării proceselor din Industria 4.0 au fost analizate și s-a concluzionat că ele oferă baza pentru înțelegerea dinamicii soluțiilor inginerești și manageriale, precum și a tendințelor pentru Industria 5.0. În plus, au fost examinate procesele decizionale și sistemul organizațional care să permită definirea unui inventar al avantajelor, punctelor tari în BPM și a fost analizat modul în care tehnologia AI poate fi utilizată în domeniul BPM. În final, evaluarea și analiza direcțiilor de cercetare relevante în domeniul managementului afacerilor, în vederea utilizării și implementării tehnologiei AI pentru optimizarea proceselor de afaceri a condus la dezvoltarea unei abordări de implementare AI-BPM pentru organizații (care operează în diferite ramuri ale economiei) în contextul Revoluției Industriale 5.0. Astfel, a fost dezvoltată o abordare metodologică, procedurală și tehnologică aplicabilă la nivel organizațional pentru fundamentarea teoretică și de execuție practică a demersului propus. Modelul dezvoltat a fost validat prin aplicarea sa într-un caz extins de utilizare, de mare complexitate dintr-o organizație orientate spre proces, având cu un volum mare de procese de afaceri.

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NOTATIONS, ABBREVIATIONS, ACRONYMS

AI	Artificial Intelligence
AI-BPM	Artificial Intelligent - Business Process Management
API	Application programming interface
AR	Augmented reality
BPaaS	Business Process Management as a Service
BPM	Business Process Management
BPMM	Business Process Management Maturity
BPMN	Business Process Modelling Notation
BPQM	Business Process Quality Management
CC	Cloud Computing
CDO	Chief Digital Officer
CEO	Chief Executive Officer
CIP Process	Continual Improvement Process /Kaizen
CMMI	Capability Maturity Model Integration
COM SSP	Core system for customer and order management
CPA	Cognitive process automation
CPS	Cyber-physical system
CRM	Customer Relationship Management
CRO	Chief Robotics Officer
CVP	Corporate Vice President
CX	Customer experience
DMP	Decision-Making Process
DL	Deep Learning
DTEI	Digital Transformation Enablers' Index
DTII	Digital Technology Integration Index
DTM	Digital Transformation Monitor (DTM)
DX	Digital Transformation
EFQM	European Foundation for Quality Management
HAVA	Human-Assisted Virtual Assistant
IA	Intelligent Automation
iBPM	Intelligent Business Process Management
IDSS	Intelligent Decision Support System
IoT	Internet of Things
IT	Information Technology
ITIL	IT Infrastructure Library

KM	Knowledge Management
KPI	Key Performance Indicator
MBAs	Management by Algorithm
ML	Machine Learning
MVP	Minimal viable product
NBA	Nachbearbeitungsaufträge / post-processing orders
OT	Operational technology
PDCA	Plan-Do-Check-Act
PPA	Process Performance Analysis
RACI	Responsibility assignment matrix
REST	Representational State Transfer
RPA	Robotic Process Automation
RTLS	Real-time locating systems
SAFe	Scaled agile framework
S-BPM	Subject-oriented Business Process Management
SCM	Supply Chain Management
SCRUM	Agile process framework for managing complex knowledge work
SMAC	Social, Mobile, Analytics, Cloud
SMART	Specific, Measurable, Achievable, Realistic, Timely
SME	Small and Medium Enterprises
SoI	System of Intelligence
SPICE	Software Process Improvement and Capability Determination
SW	Software
TOGAF	The Open Group Architecture Framework
TQM	Total Quality Management
UML	Unified Modelling Language
VR	Virtual Reality
4IR	Fourth Industrial Revolution

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1. THE RESEARCH CONTEXT AND APPROACH

"The future is happening NOW and we need to rise to the challenges if we are to thrive in the next Revolution."
Stuart Scanlon

In the "rapidly and continuously changing economy, organizations around the globe are still hard working on the transformation and digitalization of their business to achieve competitive advantages" (Finlay, 2017). To accomplish this, the companies must have the ability to identify trends and recognize changing customer requirements, to innovate and create new services and solutions for client satisfaction, "to handle the rising amount of data and derive strategic and effective decisions for the future business" (Thanh Dat, 2017). From the practical perspective, there is a strong need to handle the rising business challenges and complexity by faster changing market conditions. New technologies like Artificial Intelligence (AI) with big impacts on several business processes and changing customer requirements are the centre of the new Industrial Revolution. Existing theoretical frameworks guide the transformation only for the respective field of action but not in relation to each other. Therefore, the theoretical need exists to analyse present dependencies and relations to obtain an implementation approach.

1.1. Introduction - The research motivation and importance. Definition of the research niche

"Any intelligent fool can make things bigger and more complex…
It takes a touch of genius – and a lot of courage
to move in the opposite direction."
Albert EINSTEIN

In the digitalization time of the late Industry 4.0 Revolution, the speed to solve critical challenges, the optimization of business as well as management processes and application of modern technological solutions into business play a determinant role for the development and survival of an organization (Thanh Dat, 2017). Faster changing circumstances in different areas lead to faster, more frequent, and higher uncertainties in business decisions. The technology developments and changes have been experiencing a rapid, massive, and sometimes even devastating evolution over the last couple of years (Matarelli, 2018). These enormous developments with an impact on business can be underlined by having a look at some central platforms and services and the amount of generated data (Marr, 2018a):

- "Since 2016, 90% of the existing data in the world was generated;
- 2.5 quintillion bytes of data created each day at the current pace;
- 456,000 tweets are sent on Twitter every minute;
- 1.5 billion people are active on Facebook daily with every minute there are 510,000 comments posted and 293,000 statuses updated;
- 156 million emails are sent every minute worldwide and it is expected that there will be 9 billion email users by 2019;

- Growth of connected devices, from 2 billion in 2006 to a projected 200 billion by 2020 is one of the primary drivers for our data vaults to explode as well".

The way of managing this mass data and uncertainty will distinguish the prosperous and unsuccessful organizations in times of industrial revolution and digitalization. Further on, these enormous amounts of generated data and content in different forms have a huge impact on the Decision-Making Process (DMP) enterprises. Managers of today and tomorrow must make decisions regarding their business faster, more frequently and by confronting themselves with high uncertainties. Therefore, effectiveness of the DMP is an important aspect of using the efficiency and success of managers (as decision factors) within the business processes.

McBride (2018), Executive Vice President of Technology Transformation at Genesis, underlines this with the following words: "*The pace of technological and digital advance was rated as the top threat facing global business leaders, surpassing the current churn of economic, political, and environmental changes. The businesses we serve are already pressured by quarter-to-quarter profitability challenges, and the pace of technology change – which was perceived as a global challenge – adds fuel to the fire"*. This pressure in business can be felt by the search and implementation of new business strategies, more dynamic product-lifecycles, a new wave of customer centricity as well as the search of skilled people all over the world who are experienced and have courage to face the challenge of change, development and accelerating of organizations and businesses.

Scientists, visionaries, and unconventional thinkers have invented and developed innovative technologies like AI, Blockchain Technology, or the Internet of Things (IoT) which are gaining ground faster and faster. One of the reasons why this affects current events and processes within the business environment is the lack of experts. Only in Germany, more than 124.000 IT Experts are missing to design the digital transformation based on studies in 2019 (Kerkmann, 2019). This means four of five organizations cannot find suitable, qualified personnel in this area (Knitterscheidt, 2019). Therefore, the change will be much harder for companies dealing with these threats.

Many studies have dealt with the topic of analysing and assessing the main transformation problems companies are facing. For most organizations, two issues are at the centre of attention (Beste, 2018):

1. The introduction of new structures and processes and
2. The mastery of the greater complexity associated with the introduction of Industry 4.0.

"There is great deal of complexity in the process landscape of companies with the big challenge to optimize these processes in times of digitalization in an agile and flexible way" (Fahr, 2016). Historically evolved processes were optimized according to the known statement "*never change a running system*" to avoid process lags and issues within the supply chain. However, this has proven wrong. "Today's expectations of customers are far-ranging from fast accessibility via a variety of media, short processing times, high transparency, flexibility and a plus of convenience with high quality and a low price" (KPMG, 2017). To enable and provide the "requested customer output, an organization must use appropriate processes" (Beims, 2014).

The motivation for the present thesis is related to the approach of how to find the best way to handle (manage) those changes, to make sure the companies can master every challenge that comes into their way (most company leaders have already recognized that this change must happen rapidly to remain competitive, retain

customers and attract new business). Thus, Business Process Management (BPM) has become the method of choice as one of the most effective tools to execute Digital Business Transformation (Bpmonline, 2018). Bearing[1], a consultancy company, describes BPM as one of the keys on the way to digitalization and helpful with the permanent changes' companies must face (Höhne, 2015):

- BPM will gain in importance across industries and is increasingly perceived as a strategic topic;
- The focus of BPM is not only the reduction of process costs, but also the orientation of processes towards customers;
- There is a backlog demand for process measurement and process management;
- Top management support is "the most important success factor for the systematic implementation of process management".

Through the digitalization of the automation solutions, opportunities to generate new value of the classic management paradigm of people, process, and technology will be created. Especially AI holds significant power to improve business processes as well as enhance forecasting and decision-making capabilities within the next three years (IBM, 2018). Elżbieta Bieńkowska, European Commissioner for Industry, underlines this with her statement for the Digital Transformation Scorebook 2018: "*The future of industry is digital. Progress in technologies such as Big Data, AI and robotics, the Internet of Things and high-performance computing is already transforming the very nature of work and society.… AI is opening massive business opportunities and transforming value chains. It is therefore at the core of the renewed EU Industrial Policy, our work on SMEs, and the Digital Singe Market strategy"* (Probst et al., 2018). This declaration supports the importance of AI as well as digitalization for the business and the effects on the society. Entrepreneurs and business leaders are using AI for process modelling. The optimization will lead to seamless business processes and efficient and personalized process flows to achieve more customer satisfaction e.g., by next best offer or next best action activities (Bpmonline, 2018).

"*We are on the cusp of the Fourth Industrial Revolution, or Industry 4.0*" (Marr, 2018b). Despite the ongoing transformation process by digitalization, "there are some entrepreneurs who are looking into the future. They do not see the business processes and the organizations in status but as they could be within the nearest future of Industry 5.0 Revolution that has already becoming part of the business landscape" (Atwell, 2017; Paschek et al., 2019a).

Therefore, the scope of the PhD research is to design and execute a systematic approach of using AI for BPM to support successful business process automation in the context of Industry 5.0 Revolution.

Currently existing BPM approaches for process automation in Industry 4.0 have been analysed and provide the basis of understanding the dynamics of engineering and managerial solutions and tendencies for Industry 5.0. Furthermore, DMP and the organizational business system will be examined that will allow defining an inventory of positive characteristics. In addition, AI and how to drive this technology in the field of BPM will be investigated by considering both scientific and business perspectives. Finally, the proposed approach of using AI for BPM to support successful business process automation will consist of recommendations for action and analysed preconditions for its implementation and execution in a business environment.

[1] Retrieved from https://www.bearingpoint.com/en/

The general objective of the PhD programme is to evaluate and characterize the relevant business research directions of using and executing AI for business process optimization and develop an AI-BPM implementation approach for organizations (operating in different industries) in the context of Industry 5.0 Revolution. For this, a methodological, procedural, organizational, and technological approach for the theoretical and executional part will be developed to fulfil existing research gaps. The developed model is applied in a complex and extensive use case of a process-oriented organization with high process volume.

The **main operational objectives** pursued within the PhD programme to carry out the research described in the thesis are:

Objective 1:

a) Research and synthesis for building a bibliographic overview on AI for the DMP with business and social relations (to provide the scientific basis for the present research but also a potential source of study for future research and approaches in this area)
b) Research and assessment of relevant aspects of intelligent Business Process Management (iBPM) and/or Artificial Intelligent - Business Process Management (AI-BPM) (foundation for the present research approach)

Objective 2: Creating an AI-BPM approach (the AI-BPM Diamond Model including a methodology, methods and tools) for the implementation in different organizations (as a necessary precondition and framework parameter in small- and large-scale business environments, in order to create an understanding by the organizational management and offer the possibility of strategic orientation to generate business value)

Objective 3: Implementation and Execution of the AI-BPM Diamond Model in a large-scale business environment

Objective 4: Performing an analysis and assessment of the Use Cases outcomes (strategic and operational) to balance economic and social responsibility, visualization of the obtained results, and formulation of recommendations for improvement.

The **main theses** accompanying the research approach (define and applied during the doctoral programme) are:

Thesis 1: Industry and Society are constantly changing by technological developments with a huge impact on business and organizations. Therefore, the next industrial revolution will take place in the future.

Thesis 2: AI is the core transformative technology by which we are rethinking and optimizing human decision-making and Business Process Management.

Thesis 3: AI will enable humans to focus on missions of their role that add the most value.

Thesis 4: Business Process Management has become the method of choice as one of the most effective tools to execute business transformation into the next industrial revolution step and simplify complex process structures.

Thesis 5: The developed AI-BPM Diamond will successfully guide the transformation of organizations to generate high business value and optimize existing process structures into Industry 5.0.

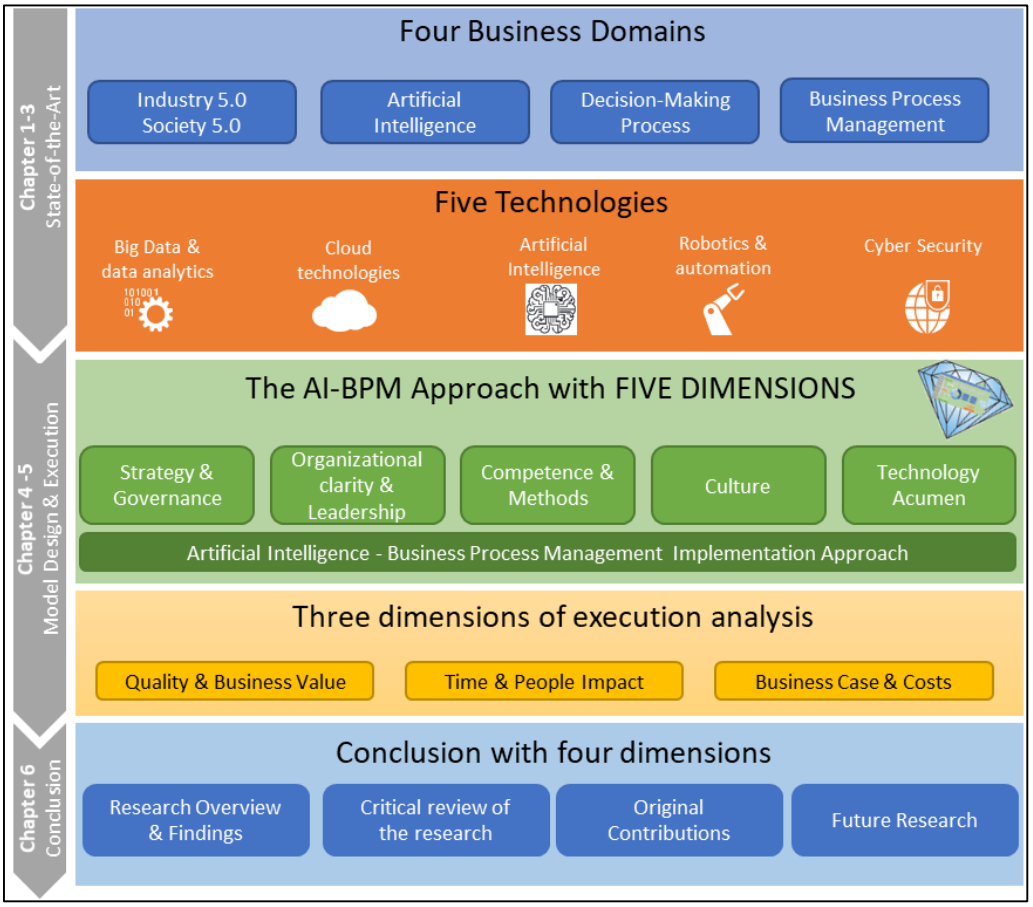


Figure 1.1 Overview of the research approach (the PhD thesis structure)

To achieve the operational objectives and prove the theses, I have valorised and developed several knowledge categories: my theoretical and practical knowledge acquired from: the first Economic Sciences programme at the Cooperative State University Eisenach, Germany, and the second programme of Master of Arts – in General Management at Steinbeis-University Berlin (School of International Business and Entrepreneurship), Germany, as well as the practical knowledge achieved from more than 10 years of experience with project and management responsibilities in large-volume outsourcing, cloud, process optimization and strategy projects (in different companies from the German economy). The implemented systematic approach has been conducted to solve the research theme associated with the

doctoral programme (that was developed between 2016 and 2020), as presented in Figure 1.1.

The PhD thesis consists of six chapters with a total length of 180 pages (including the references list). In addition, 10 Annexes were defined to support the debates and explanations with supplementary details. In total, the PhD thesis consists of 13 Tables and 64 Figures. The way each operational objective has been targeted is proven by the content of each chapter that describes the developed research activities and the results achieved together with relevant conclusions.

Chapter one to three deal with the scientific and practical state-of the-art analysis of the core indicators and technologies defined. Within chapter four, the AI-BPM Approach is defined. The execution of the AI-BPM approach takes place in chapter five considering the five dimensions. Further on, the detailed execution analysis and assessment are carried out related to three important impact dimensions. Chapter six summarizes the scientific work by recommendations for society and business and providing a critical review of the research and a short outlook, as can be seen in the following Figure 1.1. The detailed chapter contents are described in the following too.

Chapter 1, the "RESEARCH CONTEXT AND APPROACH", describes the problem of the research topic, the motivation, and the scientific and practical importance. Using selected examples from the literature, the challenge and the current state of research are underlined. Furthermore, the objectives and thesis of the PhD approach are briefly outlined. In addition, the chapter ventures a look into the future and describes the fifth Industrial Revolution. The term Industry 5.0 is described in more detail and the added value for companies and society is examined in detail. Since this revolution will be technology-driven, the chapter also focuses on the possible technological innovations and applications. In addition to the technological dimension, Industry 5.0 is strongly influenced by society. For this reason, it is described in more detail, considering the existing experience from Japan. The chapter also addresses the topic of leadership, which is a special focus in the context of Industry 5.0 in companies.

Chapter 2, the "BIBLIOGRAPHICAL RESEARCH ON ARTIFICIAL INTELLIGENCE FOR THE DECISION-MAKING PROCESS" deals with AI as a core technology of digitalization and industrial revolution. As a basis, the different forms of AI and the basic concepts are discussed. The learning types and the learning process help to understand how AI works. To get an insight into the application levels, the AI maturity model is presented in more detail. It shows how AI changes the business in a sustainable way and which consequences this can have. AI cannot function without data, so the formulation of the data strategy and the path to a data-driven enterprise are described in more detail. Finally, reference is made to the ethics in dealing with AI, and a country comparison of AI deployment in Europe is carried out, which reveals several gaps. Furthermore, core elements of decision-making as a central part of daily business are described. In addition to the basics and terminology, common approaches as well as the DMP with the important framework characteristics are described in more detail and the reference for integrating technology is established. Specifically, the use of AI to make decisions. The advantages and disadvantages are revealed and evaluated, and the benefits and risks are presented to generate a holistic view for business and social parts.

Chapter 3 is called "AN INVENTORY OF ACTUAL BUSINESS PROCESS MANAGEMENT ASPECTS (FOUNDATION OF THEORETICAL RESEARCH)". Based on the

detailed definition of the terms and the extensive discussion of the basics, the enablers and principles of BPM are also discussed. Since process management uses many different management techniques, the most important ones such as TQM, change management, knowledge management, kaizen or Six Sigma are outlined and connected. The evaluation methods and approaches of BPM serve as orientation and support for the practical part of the AI-BPM model. New technologies and trends ensure that BPM is constantly developing and the first links with AI have already been described in science. These were analysed and evaluated in this chapter to derive a How-to AI-BPM and the level of automations.

Chapter 4 summarizes the preliminary research and scientific comments and based on theoretical developments derived "A PROPOSED MODEL OF USING ARTIFICIAL INTELLIGENCE FOR BUSINESS PROCESS MANAGEMENT". As a result, the AI-BPM Diamond is designed and developed, which provides the framework for the implementation with five essential dimensions. Furthermore, an AI-BPM implementation model is created, which already represents the essential components of the AI-BPM design. In combination with the derived four phase process models, the fourth chapter is rounded off creating a sound theoretical basis for the implementation of an AI-BPM approach in practice.

Chapter 5 describes the "EXPERIMENTAL RESEARCH ON THE ANALYSIS AND EVALUATION OF THE AI-BPM DIMOND MODEL" and the application of the proposed AI-BPM Approach for the complex NBA use case. For this purpose, the process model is used as a checklist and the corresponding activities are carried out and described within the scope of the respective phase and the description of the company and the use case. The focus is on creating the transformation towards AI-BPM and process optimization by applying the AI-BPM Dimond Model. The concrete description of the transformation ends with the production of the AI-BPM model for the NBAs. This is followed by an analysis and evaluation of the achieved results and set targets. The chapter is rounded off by a detailed Lessons Learned, which summarizes a wide range of findings. In addition, ethics were also included in the analysis and the technological components were presented in relation to Industry 5.0 with AI-BPM.

Chapter 6, "CONCLUSION, CONTRIBUTION AND RECOMMENDATIONS" complements the work by providing a comprehensive summary of the most important findings by a research overview and research findings. It provides an overview of the complete work, highlights the core aspects as well as performs a critical review of the work. In addition, original contributions are presented.

Finally, the thesis ends with a REFERENCES list which contains 288 cite titles (articles, books and web pages) and a list of 10 ANNEXES with supporting documents and the details of the research approach, but also a CV of the author together with the list of publications. The research results were disseminated through 17 articles out of which 8 are indexing in the ISI Thomson/Clarivate Analytics database (2 of them being published in ISI Journals). All the publications were presented and published during the PhD programme (2016 – 2020) (Annex 10).

1.2. Delimitations of the research context

This sub-chapter reflects the state-of-the-art research approach and outlook to Industry 5.0 and Society 5.0, starting with a literature review on practical use cases and experiences. The transition from Industry 4.0 to Industry 5.0 is described by a practical point of view. Furthermore, a detailed characterization is carried out to identify the differences and similarities from Industry 4.0, Industry 5.0 and Society

5.0 by gaining advantages and disadvantages as well as the expected business value, as depicted in the following Figure 1.2.

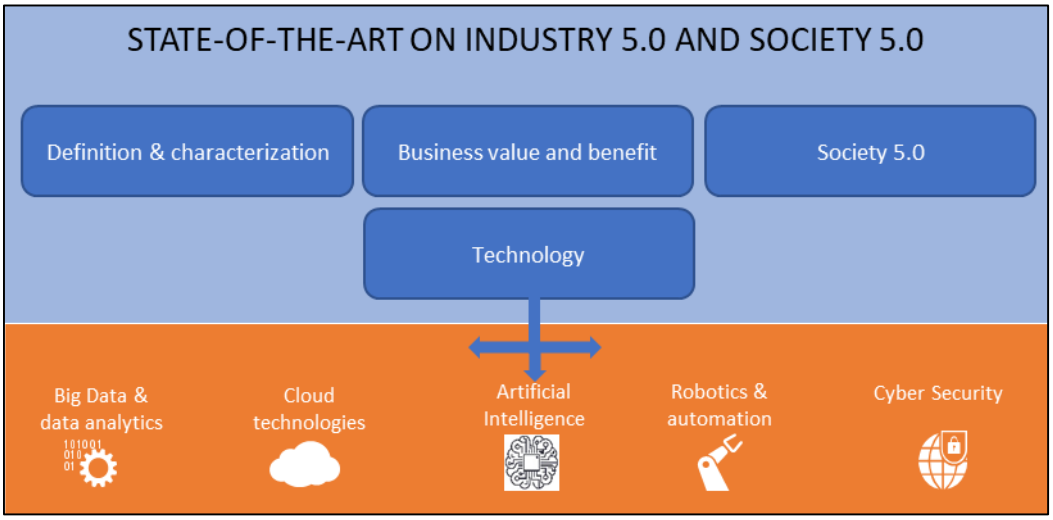


Figure 1.2 Topics addressed to define the research context

In addition, the essential business impact is assessed by the fundamental research, and recommendations about the Leadership and Management approach are given too regarding the combination and collaboration of humans and the Cyber-physical system (CPS).

Starting from Industry 4.0, "advances in robotics, AI and machine learning are launching in a new age of automation, as machines match or outperform human performance in a range of work activities, including ones requiring cognitive capabilities" (McKinsey and Company, 2017). Therefore, it is not new that production conditions and economic framework conditions change over time. Schumpeter, an Austrian political economist, and professor at Harvard University, described and established this phenomenon as *creative destruction*, or sometimes also known as *Schumpeter's gale*, about 100 years ago. In a nutshell, creative destructions describe the industrial change that constantly revolutionizes the existing economic structure by destroying the old one and creating a new one. Thereby, the creative destruction is triggered by innovation (Katte, 2020).

Regarding the duration of the individual industrial phases, the creative destruction by technological innovations is progressing faster and faster: "while the first three industrial revolutions took decades, today's revolutions only last until industrial implementation is complete", as shown in Figure 1.3 (Zambon et al., 2019). "Less than eight years has passed the literature started talking about Industry 4.0, which is already moving towards the next revolution: Industry 5.0" (Salgues, 2018; Özdemir and Hekim, 2018; Rossi, 2018).

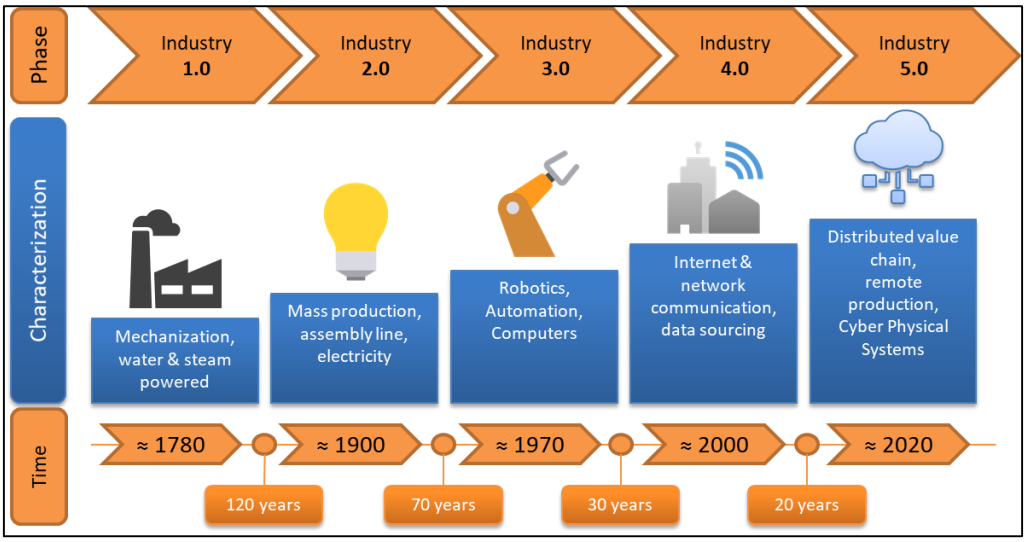


Figure 1.3 Phases and duration of industrialization (own presentation)

The "*term Industry 5.0 has been introduced to the research areas which are considered as next industrial revolution with impact on industry and economy, civil society, governance and structures as well as human identity*" (Vaidya et al., 2018). Consumers' high demand of customized products (individualization!) will be one mandatory reason for the next step of Industrial Revolution (Østergaard, 2018). Further on, "*products with a distinctive mark of human care and craftsmanship are those customers will pay most for like designer items of every kind, fine watches, craft beers or black hand dyed salt from Iceland with local coal. This demand of human touch will be rising in the future much more because consumers seek to express their individuality through the products they buy, which outlines a new kind of personalization, feeling of luxury society where the business have to deal with*" (Østergaard, 2018).

In the examination of the term Industry 5.0, it became clear that it has already been announced from 2016 by managers and researchers, as mentioned before. Within the last years, the term Industry 5.0 has become more and more common which can be seen in the growing number of research as well as search frequency analyses which count an increase by more than 75% in contrast to the past year by analysing google trends, as depicted in Figure 1.4 (status 15.08.2019). Thereby, most search requests are from Japan, Indonesia, India, and Turkey, as shown in the following Figure 1.4, too. It can be assumed that Japan generates the highest search requests due to the announcement of the term Society 5.0, by Japan's business federation Keidanren already in 2016 regarding the linkage between Industry 5.0 and Society 5.0 (Nirmala, 2016). The rising amount of search requests as well as publications show the growing demand of understanding, characterization, and exposure with Industry 5.0. Therefore, its crucial to define and analyse the term Industry 5.0 and its underlying characteristics.

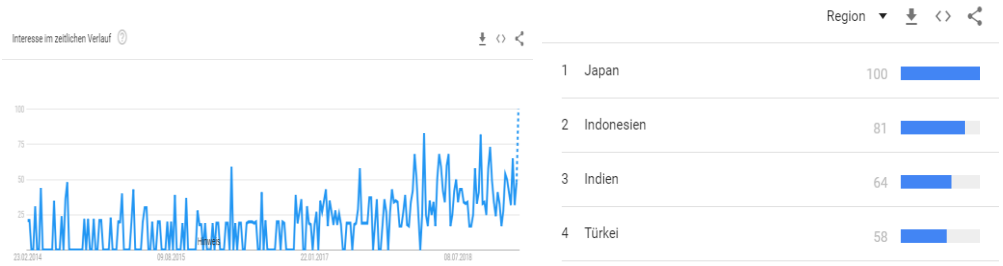


Figure 1.4 Industry 5.0 search requests on Google Trends

Industry 5.0 will affect how organizations operate, and pioneers will act sooner to prepare for tomorrow by fresh ideas, new thinking, and unfamiliar technology in an agile, flexible, and lean behaviour (Kospanos, 2017; Scanlon, 2018). Therefore, it is important to understand the definition and characteristics of Industry 5.0 as well as the differences in comparison with Industry 4.0. These core topics are executed within the following three sub-chapters.

1.2.1 Definition and characterization of Industry 5.0

The transformation of business into a smart chain will undoubtedly determine the world of production and is "the keystone of the industry of the new millennium. The research of the concept Industry 5.0 shows a lot of uncertainty about what it will bring and how it will disrupt business in detail, but it is going to break down barriers between the real world and the virtual one by new technologies which will be faster, more scalable and adopted globally" (Scanlon, 2018).

"Therefore, Industry 5.0 will increase the collaboration between humans, who take the creative side to take on more responsibility and increased supervision of systems to elevate the quality of production across the board", while smart systems like robots are working on monotonous, repetitive tasks. This outlook can be underlined by a survey with 512 manufacturing executives worldwide from Accenture's. They figured out that "85% of the participants foresee a collaborative production line between humans and robots in their plants by 2020" (Accenture, 2016).

To be more concrete, the "European Economic and Social Committee (EESC, 2018a) describes Industry 5.0 as … *focused on combining human beings' creativity and craftsmanship with the speed, productivity and consistency of robots*".

Other definitions focused on the implementation of AI as a core element to enhance the common human life, their collaboration aiming at enhancing human capacity and returning the human at the "Centre of the Universe" by naming "Society 5.0" a more exact term instead of Industry 5.0 (Skobelev and Borovik, 2017).

One more perspective of Industry 5.0 describes it as "faster, more scalable and more people concerned than the previous ones through the kind of technology at their disposal" (Rundle, 2017). "This will happen by the drive toward more advanced human-machine interfaces by enhanced integration, improved automation of robots paired with the power and creativity of human brains, which will lead to improved productivity" (Shelzer, 2017). "The mentioned collaboration between humans and technology will affect the economy, ecology, and the social world (Shelzer, 2017). Furthermore, these influences are accompanied by a waste prevention perspective applied in industrial upcycling" (Rada, 2018):

- "*Process waste* – overproduction, empty trucks on the roads, overstock.

- *Social waste* - People willing to work but having no opportunity and people who are not willing.
- *Physical waste* - general trash and trash of production lines and logistics.
- *Urban waste* - not necessarily needed Greenfields, empty spaces, inadequate infrastructure".

Another vision describes "factory workers and robots may end up working together on the design and sharing of workload across a variety of manufacturing processes. While robots are excellent for producing standard products in standardized processes in a high volume of production, customizing each individual product can be a challenge where robots need to be guided by humans within production processes" (Demir and Cicibas, 2017). To exploit automation "to its full potential, there is a need of human creativity that influences the processes in collaboration of collaborative robots or 'cobots' working with humans" (Ozkeser, 2018)

Phill Cartwright, from the Centre for Modelling and Simulation, underpinned the previous definitions by focusing on manufacturing. He characterizes the fifth industrial revolution by the important cooperation of human intelligent workers in harmony with cognitive computing, so the cooperation of humans and machines and added "*Industry 5.0 starts when you begin to allow customers to customize what they want*" (Rossi, 2018). Workforces will be upskilled to provide value-added tasks in production by putting humans back into industrial production with collaborative robotos (cobots). So, Industry 5.0 takes that concept of personalization and customization to the next level (Rossi, 2018).

In addition, "artificial gene synthesis (artificial DNA or DNA printing from synthetic biology field), new raw materials or sustainable uses of resources are further aspects of Industry 5.0 characterization with potential impacts on business. These fields put the human factor to the centre, in relationship with nature and physical integrity, too" (Sachsenmeier, 2016).

According to SAP, we are already talking of Industry 5.0, which shifts the focus to the customer as a key player and "user contributor" in the process and product value chain by new technologies. More in detail, "customers (both B2B and B2C) purchase and use intelligent, connected, and self-aware products capable of sharing information and data about their health, location, wear and tear, usage level, type, and timing, storage conditions and so on to the company which will be able to process these data and gain a big advantage by putting themselves in their customers' shoes to understand the behaviour, demands and so on. Thereby, the customer's intimacy increases with maturity, and each customer becomes a vital contributor of continuous insights". Looking ahead, SAP expects "Industry 5.0 will create new and more agile offerings centred around customers' demands, likes, needs, and preferences" (Guttman et al., 2017).

In summary, the following definition of the term Industry 5.0, which applies to this work, can be derived from the previous scientific studies: Industry 5.0 focuses on the return of humans to the industrial production chain and environment, working together and be supported by AI and further innovative technologies to enhance existing working procedures and processes by executing tasks by an increasing level of speed and accuracy with sustainable uses of resources (Salgues, 2018; Özdemir and Hekim, 2018; Skobelev and Borovik, 2017; Ozkeser, 2018; Rossi, 2018; Vollmer, 2018; Sachsenmeier, 2016). Next to the return of humans into the production chain, customers will be an essential part of the product value chain by their needs, demands and service expectations (Guttman et al., 2017). The improving interaction among computers, robots, and workers supported by AI "will become more significant than

any other technologies to take that concept of personalization to the next level and satisfy customer needs best" (Demir and Cicibas, 2017; Rossi, 2018).

1.2.2 Business value and benefits of Industry 5.0

"Looking ahead to Industry 5.0, SAP anticipate the further restructuring of product development and production in ways that will redefine not only processes but also what a product is and the value it provides to customers"[2]. Connected, interactive products help companies to gather data and information of "how customers use products day to day, which is different from traditional product usage and customer satisfaction data". These usage data by a stronger involvement of the customer "create for decision makers a unique window of opportunity into the customer experience to generate a clearer path to become a market leader and even innovator" (Guttman et al., 2017). As part of the product value chain by sharing their data, customers are offered highly customised "products and value-added, data-based services that meet their specific requirements". The "new market leaders will 'listen' continuously to their customers through streaming product usage data and respond swiftly with customer-driven products" (Guttman et al., 2017). This so-called co-innovation with customers as part of the end-to-end value chain can be defined as the highest level of customer-value-driven business models, as shown in Figure 1.5.

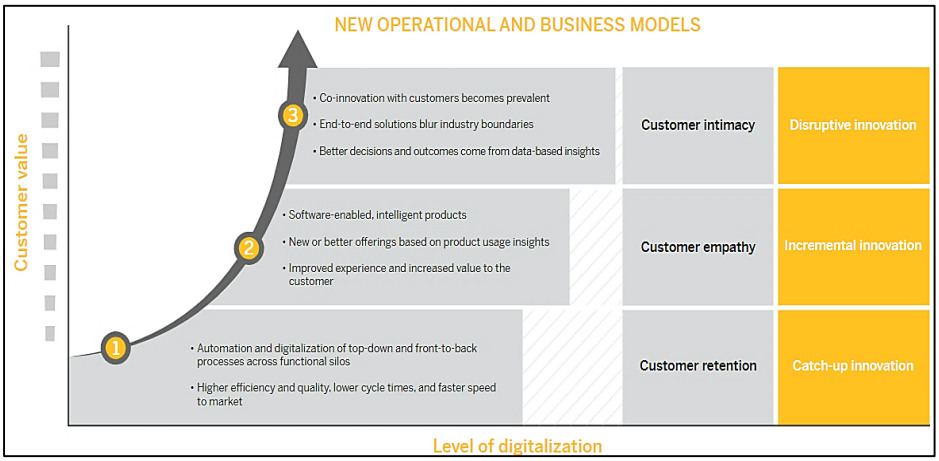


Figure 1.5 A model for going beyond Industry 4.0 (SAP, 2017)

Level 1 is defined by the inter-connectedness of machines, processes, and people by automating, integrating and "digitalizing top-down and front-to-back processes across functional silos to improve product quality, efficiency, and speed to market" by digitalizing horizontally and vertically (Guttman et al., 2017).

The second level is distinguished by "software-enabled, intelligent products that help the customer become an active contributor to the value chain by providing data about how much the products are used, rates of wear and tear, when products need to be re-paired or replaced, and so on". Based on these insights on product usage, "companies can develop investments with confidence in features and

[2] Available on: https://assets.cdn.sap.com/sapcom/docs/2017/05/bae613d3-b97c-0010-82c7-eda71af511fa.pdf

capabilities that customers really want, and truly differentiate themselves from competitors to deliver meaningful value" (Guttman et al., 2017; Rossi, 2018). For instance, the "Rolls-Royce's business model in the last ten years has flipped from selling engines to now having 50% of its revenue from providing services to the engine because they understand the design of failure of that engine and know what the quality process is of that engine and how they want that engine to perform"[3] (Rossi, 2018).

On level 3, the level with the highest customer value and level of digitalization, companies use customer usage data to "co-innovate with them and even build digital, value-added services around physical products. These end-to-end services can extend and redefine product value for entire markets, empowering companies to differentiate even the most commoditized products in new ways" by providing recommendations, improve operations, reduce costs, "share best practices with the customer on the optimal use of the product, given the design parameters; advise on how to achieve better outcomes and maximize return on investment; or implement predictive maintenance to maximize longevity and minimize downtime". These cases exemplify that manufacturers can support customers to make better data-driven decisions to improve their business (Guttman et al., 2017).

The collaboration between advanced technologies and humans as well co-innovation between manufacturer and customer, for instance, can lead to robots completing the automated manufacturing of goods, IoT and smart devices submit important production and usage data, while "BPM software will monitor the data. If an error occurs, a process is automatically triggered alerting the employee to act and decide what to do within the process chain"[4]. Therefore, Industry 5.0 promises companies "improved adaptability, change-readiness and a responsive working environment by digitalizing and automating their critical business processes while keeping humans at the centre of decision-making". Throughout this collaboration, companies can realize digital transformation and attain greater productivity, agility, and profitability by integration of customers into the value chain (Kospanos, 2017; Rossi, 2018).

A further benefit will be the fact that "machines do not replace human workers and create job losses to improve productivity" (Rendall, 2017, Østergaard, 2018). Østergaard (2018) underlined this by his experience at Universal Robots, where they have analysed that companies who deploy cobots end up employing more people. In addition, Mitsuru Kawai, Executive Vice President of Toyota, says: "*Robots do not improve processes. Only humans can improve processes. That is why they should always be the focus of attention*" (cite by (Bork, 2019)). Equally, Tesla boss Elon Musk said that he had progressed too fast in terms of automation. "*People are underestimated*", he wrote in a tweet sold in April after his company received a bad press due to manufacturing defects (Bork, 2019).

1.2.3 Technology of Industry 5.0

"*The key driver of digitalization are digital technologies*" (Urbach ,2018). Therefore, Big Data, Cloud technology, Internet of things and AI are the top supply chain drivers (Markoff and Seifert, 2018; Gartner, 2017b).

When discussing digitalization and digital transformation, some technical terms must be defined to avoid misunderstandings and incorrect interpretations. One

[3] Available at: https://www.raconteur.net/technology/industry-40-2018/manufacturing-gets-personal-industry-5-0

[4] Available at: http://www.pnmsoft.com/industry-5-0-man-meets-machine/

important term is the cyber-physical system (CPS) which refers to "networks of interacting elements, including sensors, machine tools, assembly systems, and parts, all connected through digital communications networks[5]" which are controlled or monitored by computer-based algorithms (Rasche, 2014). The main characteristics of a CPS are "decentralization and autonomous behaviour of the production process as well as continuous interchanging of data by linking cyber physical systems intelligently with the help of cloud systems in real time" (Vaidya et al., 2018). "CPS are working as a system by definition and form a part of the IoT" (Rasche, 2014).

In addition, organizations must consider that technology implementation alone is not enough, like Monty Hamilton, partner in PwC's Digital Services business and leader of the digital Operations within Telstra Digital, says: "*You can invest millions of dollars in technology, but if you don't have a culture that enables you to collaborate across the organization, nothing will change*."

The IoT is an emerging technology and describes billions of physical devices that are connected to the internet, collecting, and sharing data (Ranger, 2018).

Next to the named technologies, SMAC "Social Mobile Analytics Cloud" is a foundation "for an ecosystem that enables a business to transition from e-business to digital business" as well as driving business innovations (Debashis, 2016). SMAC arises due to the exponential growth "of structured and unstructured data created by mobile devices, wearable technology, connected devices, sensors and social media", generating new business models built on customer-generated data. The integration of social, mobile, analytics and cloud together create a competitive advantage and new business opportunities. The technologies behind SMAC are as follows (Rouse, 2017):

- "Social media platforms such as Facebook, Twitter or Instagram which provided businesses with new ways to reach, interact with, target and acquire customers";
- Mobile technologies and "devices allow to work and communicate anywhere and anytime if you have connection";
- "Analytics provide organizations' results of Big Data to understand and optimize work and predict future customer demands";
- "Cloud Computing provides a new way of accessing technology and the data a business needs to quickly respond to changing markets and solve business problems".

It may be noted that the marriage of data and technology is radically changing the "personal world and making it smarter while business must become smarter, too" (Marr, 2015).

Moreover, one core technology that will drive Industry 5.0 is Robotic Process Automation (RPA) which robotic software companies can use to capture and interpret the user interface and actions of other applications used in various business processes. In general, Robot dexterity will rise by teaching themselves to handle the physical world (Knight, 2019). RPA software in combination with AI will allow to understand specific processes and then automatically process transactions, input, and analyse data and communicate with other existing systems. It will mirror the way humans work with applications but faster and better. If something goes wrong in one of the RPA's automated processes or an important change needs to be made in a process, BPM software will kickstart a workflow that notifies an employee to look at the issue and provide all gathered information needed to make an educated decision that will produce the best business outcomes (Kospanos, 2017).

[5] Available at: http://www.pnmsoft.com/industry-5-0-man-meets-machine/

AI, Robotics, RPA, and BPM are setting the stage for Industry 5.0 (Kospanos, 2017). In addition, cyber security and cyber defenders are more important than before to "proactively hunt over companies' anonymized security data for the most important threats, such as human adversary intrusions, hands-on-keyboard attacks and advanced attacks like cyberespionage", mentioned Ann Johnson, Microsoft CVP Cybersecurity Solutions Group" (Johnson, 2019). By horizontal and vertical integration as well as adding mobile objects and IoT devices of customers or manufacturer to the value chain to gain information you will never know if there is a security issue and how big it will be. To cover this uncertainty, companies should use cyber security defenders to protect their business and data.

1.2.4 Industry 5.0 depends on Society 5.0

Humanity "is now in a new era in which innovation driven by enabling technologies is bringing significant changes to the economy and society" (Harayama, 2017). Further, Japan raised the core concept of Society 5 by the 5th Science and Technology Basic Plan (Salgues, 2018). Thus, the concept is considered a strategic part of the "*Basic Policy on Economic and Fiscal Management and Reform 2016*" and one of the growth strategies for the "*Council on Investments for the Future*", to enhance Japan's growth potential (Harayama, 2017).

The Japanese government considers that "Society 5.0 represents the 5th form of society in human history"[6]. Some characteristics are presented in the following:

- It is the future super-smart society built upon Society 4.0, which aims at the creation of "a society where people can resolve various social challenges by combining innovations such as AI, robots and big data into society" (Salgues, 2018; Ferreira and Serpa, 2018);
- It can be described as "a *social state where material and information are highly integrated enabling society to provide certain goods and services to people who need them at an appointed time, and free people from inconveniences caused by age, gender, region and language differences*." (Hong'e, 2019);
- Japan's Prime Minister Shinzo Abe said at the International Conference of the Future of Asia in 2017: "*The essence of Society 5.0 is that it will become possible to elicit quickly the most suitable solution that meets the needs of each individual. We will become able to solve challenges that have defied resolution until now*" (Jao, 2017).
- In combination with the statements of Østergaard (2018) regarding Industry 5.0 "*people will pay a premium if they believe a product will help them meet their deeper, more personal goals*". Thus, a direct linkage between Society 5.0 and Industry 5.0 can be determined in the field of fulfilling individual needs and personal goals.

In addition, "Society 5.0 predicts a sustainable, inclusive socio-economic system, powered by digital technologies and a cyber-physical system, in which cyberspace and the physical space are tightly integrated to become a universal technological mode supporting Society 5.0" (UNESCO, 2019). At this point, the connection to Industry 5.0 can also be drawn based on the closer linkage of

[6] Available at: http://www.ecns.cn/news/society/2019-06-29/detail-ifzkrnzp2015002.shtml

the cyber-physical system and people. These insights are mentioned by Hong'e, (2019) and Serpa (2018) when defining three major characteristics of Society 5.0[7]:

- Society 5.0 is "emphasizing on how to "*optimize the man-hour responsibility to get the job done*";
- Society 5.0 "focuses on the effectiveness of optimizing knowledge workers assisted by intelligent machines";
- Society 5.0 is "*meant for the harmonization of work with the help of intelligent machines for the benefit of the workers to put humans at the centre of innovation*".

People's life in a society 5.0 is characterized by a higher level of convenience and sustainability as before through optimally delivered products or services tailored to their individual needs as well as the "help to overcome chronic social challenges such as an ageing population, social polarization, depopulation and constraints related to energy and the environment"[8].

In summary, it can conclude that Society 5.0 is about digitalization and advanced IT technologies across all levels of the society to address key problems and resolve social issues like labour shortage or aging workforce rather than making simple productivity improvements (Skobelev and Borovik, 2017; Basu, 2018). The close interlocking with the properties of Industry 5.0 shows that the two evolutions (Industry 5.0 and Society 5.0) have adapted over time and have nearly similar objectives. Therefore, Industry 5.0 and Society 5.0 are used as synonyms in the present research.

1.3. Preliminary conclusion and facts

To summarize the different findings regarding Industry 5.0, this sub-chapter breaks down the four key things to be considered about Industry 5.0:

1. Industry 5.0 puts humans in the centre, uses Robots to support them and make the lives of humans better and easier;
2. Consumers will increasingly demand craftsmanship, personalized products and services, something special and unique. This will be created by humans through automation and cobots and a streamlined manufacturing process;
3. "Industry 5.0 is meant to optimize human efficiency and productivity through meeting the manufacturing complexity of the future in dealing with increasing customization through an optimized robotized manufacturing process[9]" (Fazzi, 2018);
4. Industry 5.0 is *"the proliferation of robotic automation"* which is inevitable (EESC, 2018 b).

The executed research and synthesis for building a bibliographic and practical state-of-the-art overview on Industry 5.0 (5th Industrial Revolution) has offered several insights into the future where the people are in the focus by collaboration supported by machines and AI within different fields of action. By putting people "back at the centre of production, Industry 5.0 will provide consumers the products they want today giving workers jobs that are more meaningful than factory jobs have been in well over a century" (Østergaard, 2018).

[7] As mention in: http://www.ecns.cn/news/society/2019-06-29/detail-ifzkrnzp2015002.shtml

[8] Available at: https://en.unesco.org/news/japan-pushing-ahead-society-50-overcome-chronic-social-challenges

[9] Mention a: https://www.mastercontrol.com/gxp-lifeline/3-things-you-need-to-know-about-industry-5.0/

Like Industry 4.0 (the 4th Industrial Revolution), this progress is driven by technological developments as well as the demands of human beings to solve existing society problems. Therefore, the development of Society 5.0 is evident; the new society places people in the foreground and meets the needs of everyone through targeted services and product solutions. The degree of satisfaction and comfort that can be achieved is also based on technological development and the use of AI.

In conclusions, futurists estimate that the main ambition of Industry 5.0 is to achieve the best human-machine collaboration. Thus, "Industry 5.0 will lead to the evolution of a global society (Pearce, 2017) and waste reduction and prevention activities, and thus a better use of scarce resources (Shelzer, 2017; Rada, 2018)".

It is impossible to ignore the existence and evolution into Industry 5.0, (Fazzi, 2018) as well as Society 5.0. When dealing with this topic, there are important questions that the business, leaders, and policymakers need to address soon to be competitive on a global market. Therefore, it can only be recommended to deal with these issues at an early stage in order not to miss the next steps of the Industrial Revolution as well as the changes in society.

Based on these findings, it can be confirmed that industry and society are constantly changing by technological developments with a huge impact on business and organizations, as already analysed. Furthermore, the path to the next Industrial Revolution which will start soon, has already been set.

2. BIBLIOGRAPHICAL RESEARCH ON ARTIFICIAL INTELLIGENCE FOR THE DECISION-MAKING PROCESS

"With AI, we're rethinking how we're doing everything!"
Sundar Pichai, CEO Google

Objective 1a: Research and synthesis for building a bibliographic overview on AI for the DMP with business and social relations (to provide the scientific basis for the present research, but also a potential source of study for future research and approaches in this area)

This chapter reflects the state-of-the-art research approach on AI in combination with the DMP, starting with a literature review for a clear and valid definition of AI for this research, continuing with the evolution of AI as well as the important framework conditions and technical aspects to implement and execute AI. Furthermore, the AI maturity model is explained in detail regarding the evaluation of AI within a concrete business. The explained dimension within the model is important for the business transformation by AI and the needed AI strategy. Therefore, an approach for developing the strategy will be elucidated. To correctly assess the status of the development in the companies, the external perception and thus also the benchmark with other companies and countries are important. Therefore, this chapter also deals with the AI gap in Europe and explains how it can be reduced and what consequences it has for companies.

Furthermore, the decision-making-process is characterized and linked to different application models. The challenges and development of the decision-making process provide a basis for the connection with AI. The resulting challenges and benefits are described, and future business decisions are considered in the context of the decision-making process.

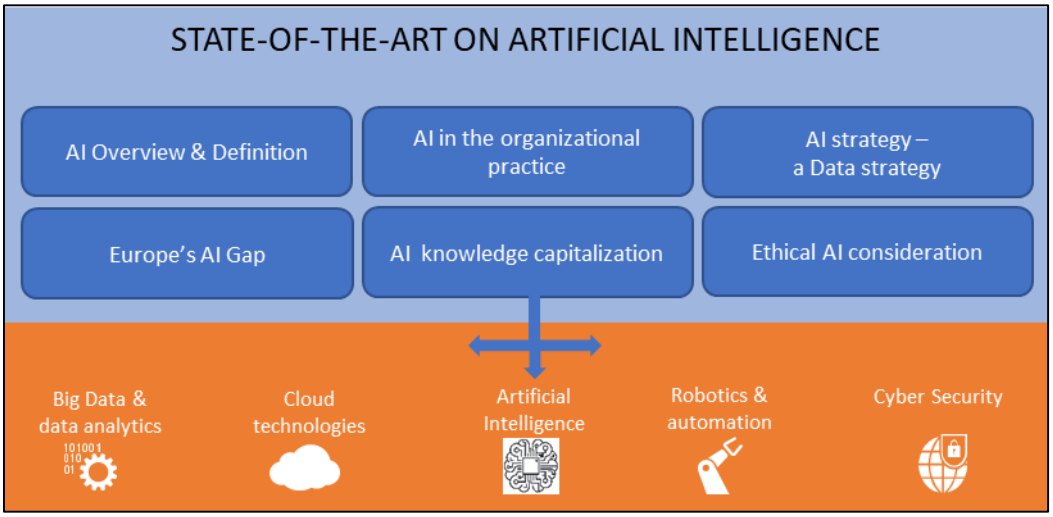


Figure 2.1 Topics addressed by the AI state-of-the-art

2.1. An overview of the Artificial Intelligence concept

Gartner identifies the AI-Driven Development as a core strategic technology trend in 2019 which will lead to a new level of flexibility and a swarm of collaborative intelligent things working together (Garfinkel, 2018). From the perspective of the present research, AI will be understood as stated by the following definition[10]: "***AI can be defined as a section of informatics and applied computer science to pattern human proceedings including learning, problem solving, drawing conclusions, decision-making and the ability for self-correction by learning from experience through interacting with other cyber physical systems in order to support, optimize or invent efficient and new solutions as well as new courses of actions. Therefore, AI is a computer programme running on any possible device or data canter with the skill to interact with its environment with the capability to imitate intelligent human behaviour"*** (Paschek et al., 2017b).

Based on this definition, five core capabilities/components of an AI application can be derived (Finlay, 2017; Breckheimer, 2017):

1. *Perception / Data input* – getting inputs via sensors, cameras, or other resources from the outside world;
2. *Data processing* - processing of the raw data and utilization of these to draw logical conclusions;
3. *Learning / prediction* – using past experiences and historical data to better analyse and predict new conclusions and specific cases;
4. *Derive instruction/Decision rules* - incoming information must be sorted according to importance based on experience and then executed. The rules for the processing can be automatically derived by the algorithms or defined in advance by business experts;
5. *Response / Data output* – executing of the learned action like writing, mailing, speaking, or doing something else.

One of the most common speculation is that AI will take over human jobs and end humanity at least (Echanique, 2018; Reilly, 2019). This myth is one of the most accepted ones, as out of convenience it is not understood what AI is and what is behind it. But AI and ML will help us to understand who we really are. At this point, the connection to Industry 5.0 and Society 5.0 is clearly visible, as shown in chapter 2 of this PhD. This underlines the opportunity of AI to make humanity more human than before (Echanique, 2018). This can be underlined by Christian Reilly, Chief technology Officer by Citrix, who stated that history shows that new technological innovations have led to economic growth and thus to an increased standard of living for the population if we, as a society, are responsible and consider the people with the new technology (Reilly, 2019). In addition, the World Economic Forum announced that AI will have "the power to substantially change society in the next 100 years" (Word Economic Forum, 2017; Ilg, 2018).

The Forbes Technology Council expects the use of AI to bring immense changes in 13 industries of Cybersecurity, DevOps and Cloud Hosting, Manufacturing, Healthcare, Construction, Senior Care, Retail, Business Intelligence, and Supply Chain

[10] The definition has been formulated during the PhD. research and I have operated in the framework of this definition since 2017.

Management, to name only the most important ones (Forbes Technology Council, 2019).

These changes will be made by innovations, where AI still has an important role to play by finding optimizations for existing practices. Through AI, a variety of business processes can be automated, decisions can be made using massive data sets, and the future can be predicted to force the revolution (Paquette, 2018).

Distinctive Forms of AI

In the literature, mainly two types of AI are distinguished because of the application areas (Urwin, 2016). The features and detailed capabilities are shown in Figure 2.2.

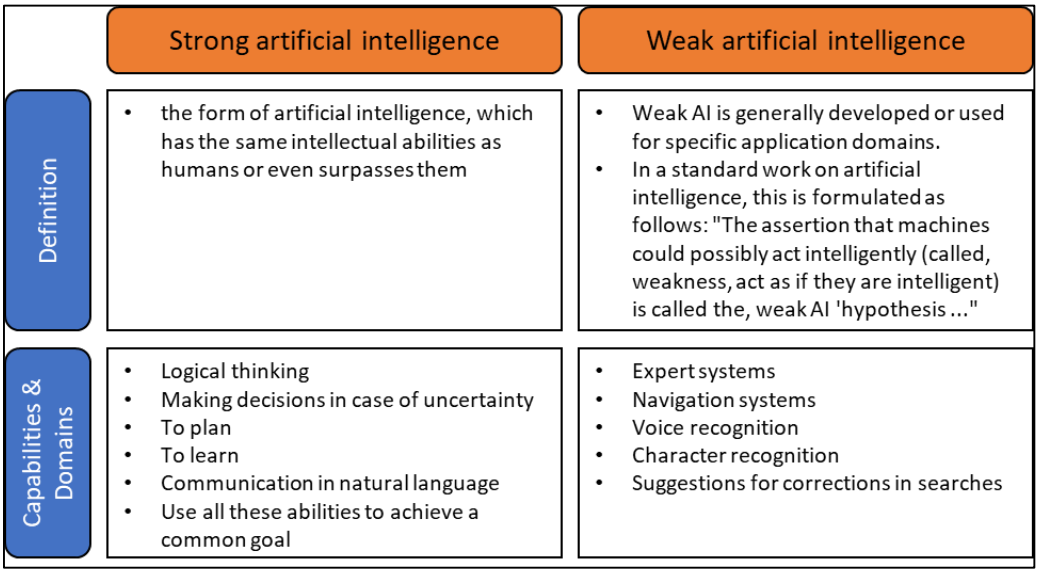


Figure 2.2 Strong vs. weak AI (Paschek et al, 2017b)

More in detail, *Weak AI* "is usually used by specific application problems in which no logical thinking, decision-making or even consciousness are required. Weak AI supports mainly as a provider of information on which humans' decisions are based. This includes, for example, navigation systems, voice recognition, correction suggestions when searching" (Paschek et al., 2017b).

Strong AI "is used in the literature when a machine has the same intellectual abilities or even outperforms a human being". Capabilities of strong AI are considered logical thinking, making decisions in case of uncertainty, planning something, learning something and the communication in a natural language (Paschek et al., 2017b). This is important to understand regarding the use case description in the following. In addition, researchers differentiate AI in three distinct forms, as described in Table 2.1.

Table 2.1 Forms of AI by MIT and Price Waterhouse Coopers
(MIT Technology Review Insights, 2016; Sincavage, 2017)

Assisted intelligence	Augmented intelligence	Autonomous intelligence
▪ Lowest level of AI ▪ for the automation of basic tasks to speed up and save money	▪ Middle level of AI ▪ Helps people to make more effective decisions ▪ The system will learn from a person's in-puts ▪ A person's decision will become more precise based on the system	▪ Most advanced level of AI ▪ Full automation AI ▪ Human not necessary within the loop and hands over control to the machine ▪ Human can intervene, e.g., driverless cars

As seen in Table 2.1, PwC and MIT choose a wider form of the AI designation and distinguish between assisted-, augmented- and autonomous intelligence. This must also be considered about automated decision-making and helps to better understand the respective assignment of the forms.

Differentiation of major terms in AI

One of the easiest ways to explain the relationship and dependency of AI, Machine Learning and Deep Learning - words that are very strongly mixed in everyday language use - is to visualize them as concentric circle, as depicted in the following Figure 2.3. Mainly, AI and machine learning are often used interchangeably, especially in the realm of big data (Dubey, 2018; Rouse, 2018a). Thereby, AI is the largest circle in this group and the idea that came first about the enablement of computers to mimic human behaviour and replicate human decision-making capabilities (Copeland, 2016; Finlay, 2017).

A subdomain of AI is Machine Learning (ML), which uses mathematical procedures to analyse data with the aim of discovering relationships and correlations as a learning system (Copeland, 2016; Finlay, 2017; Dubey, 2018). Thereby, ML is a science that involves the development of self-learning algorithms with the goal of increasing the speed (Dubey, 2018).

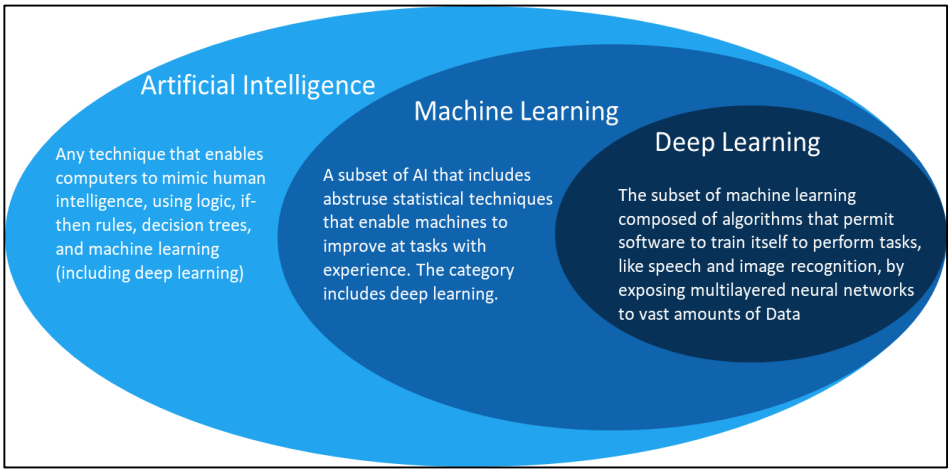


Figure 2.3 Differentiation of AI-ML-DL (own presentation)

The third circle is deep learning which is driving today's AI explosion and is characterized by emulating the learning approach of humans to gain certain types of knowledge (Rouse, 2018b; Hao, 2019). Deep Learning fits inside both circles because it represents a subset of both (Copeland, 2016). Comparing traditional machine learning algorithms with deep learning algorithms shows a hierarchy of increasing complexity and abstraction by Deep Learning, while machine learning algorithms are more linear (Rouse, 2018b).

Fields of AI

The use and characteristics of AI are manifold, as the different explanations have already shown. The following Figure 2.4 gives an overview of the fields of action and application areas, which are explained in more detail below.

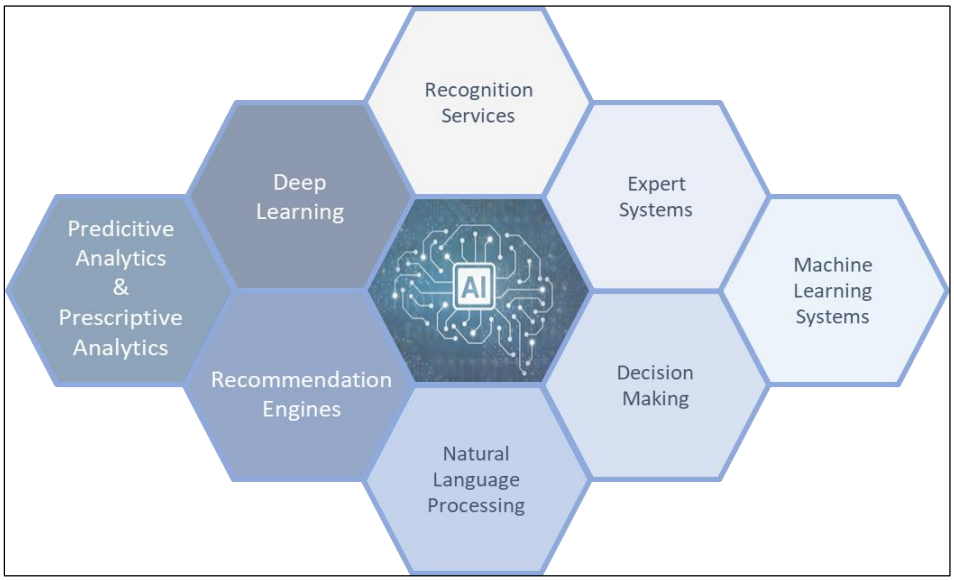


Figure 2.4 Fields of AI

As seen in Figure 2.4 different parts/domains are defining AI:

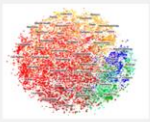
- ML can be described as *pattern recognition* and the automation of algorithms to enable computer systems to learn from huge amounts of data. Deep Learning is a special form of machine learning which can learn itself and independently create new model levels, but it is important to pick the right algorithm and the right data for the job at hand (Jou, 2018).
- Expert Systems are designed to support specific tasks (in areas for monotonous and rule-based tasks) by following complex algorithms. Recognition services identify images, objects, people, and anything else by focusing on the recognition of patterns and regularities in data sets. Natural Language Processing constructs an output of what has been said/written from a given input and formulates it in human language.
- A recommendation engine captures the past behaviour of a user and based on that, recommends products which might be alike. Predictive Analytics supports understanding the future.

- Prescriptive Analytics attempt "to quantify the effect of future decisions to advise on possible outcomes before the decisions are made".
- Decision Making is about data analyzation, evaluation of data and judgement of data by considering business details to execute a business decision in the end fully automated by a CPS. More details about the DMP can be found in subchapter 2.7.

Types of learning

Based on the kind of data available and the research focus, a scientist will choose to train an algorithm using a specific learning model (Salin, 2018). Therefore, a short explanation about the existing three main types of learning can be found in the following Table 2.2.

Table 2.2 Learning Typology

Supervised learning	Unsupervised learning	Reinforcement learning
Supervised learning is where you have input variables (x) and an output variable (Y) and you use an algorithm to learn the mapping function from the input to the output (Y = f(X)). The goal is to approximate the mapping function so well that when you have new input data (x), you can predict the output variables (Y) for that data. 	Unsupervised learning is where you only have input data (X) and no corresponding output variables. The goal for unsupervised learning is to model the underlying structure or distribution in the data in order to learn more about the data. 	... studies the problems and techniques that try to retro-feed its model in order to improve. It needs to be able to "sense" signals, automatically decide on an action, and then compare the outcome with a "reward" definition. It tries to figure out WHAT to do to maximize these rewards, but it does this by itself. 

Most machine learning algorithms used today in practice belong to the class of supervised learning. In supervised learning, an already known target variable y is presented ex post to the machine learning model, which is to be predicted as accurately as possible using a function f based on various influencing factors X in the data. The function *f* abstractly represents the respective machine learning model, which provides a mapping between the inputs and outputs of the model (Heinz, 2018).

$$y = f(x) \tag{2.1}$$

The learned target values of simple ML models are therefore usually static and change only in the historical course of time, which is already known ex post. In the course of time, new data points can be collected, which then flow into the learned mapping f between X and Y in the form of a *retraining*. Based on the forecasts of a model, further, usually still humanly controlled actions are then triggered. These often represent the actual decisions that have business-relevant effects or implications. The actual business decisions, which are made based on ML models, are therefore in many places not yet or only partially machine-controlled (Heinz, 2018).

According to the MIT Technology Review, supervised learning is the most frequently used and has the most practical applications so far. Since the rise of deep learning analysis reveals, "in the last few years, reinforcement learning, which mimics the process of training animals through punishments and rewards, has seen a rapid uptick of mentions in paper abstracts within the research and business" (Hao, 2019).

Next to the rise of Deep Learning "in October 2015, DeepMind's AlphaGo, trained with reinforcement learning, defeated the world champion in the ancient game of Go with an immediate effect on the research community"[11]. These described developments are shown in Figure 2.5. The outlook to the 2020s should be no different regarding the era of deep learning (Hao, 2019).

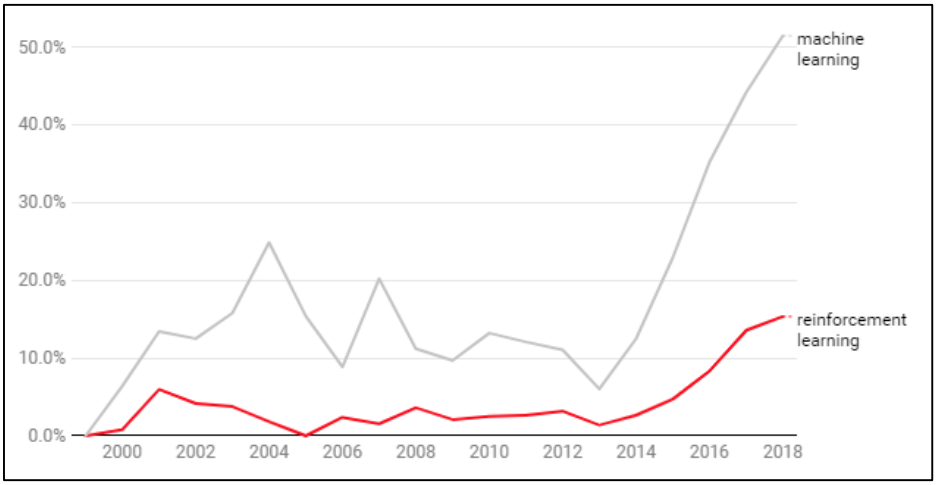


Figure 2.5 Machine learning vs. reinforcement learning (Hao, 2019)

In formal terms, ***reinforcement learning*** consists of five important components, namely (1) the agent, (2) the environment, (3) the status (state), (4) the action, and (5) the reward (Hao, 2019). Basically, the process can be described as follows: In an environment with a certain status (s_t), the agent performs an action (a_t) from the available action space A, which leads to a reaction of the environment in the form of rewards (r_{t}) (Hao, 2019). The abstraction can be seen in Figure 2.6.

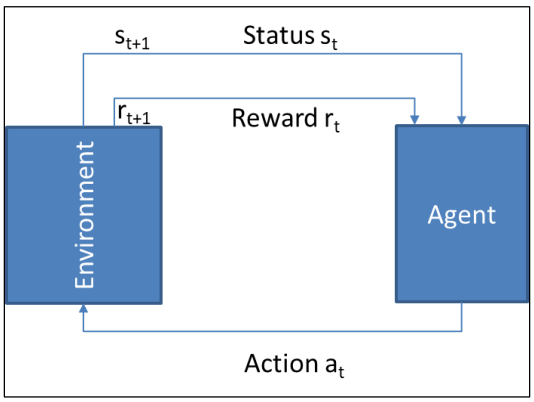


Figure 2.6 Reinforcement Learning abstraction

[11] As mentioned on: https://aiecommerce.com/2019/01/25/we-analyzed-16625-papers-to-figure-out-where-ai-is-headed-next/?msg=fail&shared=email

The environment's reaction to the agent's action now affects the agent's next state action choice (s_{t+1}) (Heinz, 2018).

Over thousand, hundred thousand or even millions of iterations, the agent can approximate a connection between his actions and the future expected benefit in each state and thus behave accordingly optimal (Heinz, 2018). Thereby, the agent is always in a dilemma between the use of the so far acquired experience on the one hand, and the exploration of new strategies to increase the reward on the other hand. This is called the *Exploration-Exploitation Dilemma*.

The learning process

To execute a deep learning, machine learning or any other AI application, the business should perform the following important and fundamental steps to become data driven and generate business value by using AI (Finlay, 2017; Turner, 2018; Rouse, 2018c; Sharma, 2018).

1. Identify, quantify, and understand the problem / Use Case;
2. Identify relevant data sets and preparation for the analysis;
3. Identify and choose the best AI method (ML, DL, …);
4. Pre-processing and variable selection;
5. Choose the algorithm to use and build an analytical model;
6. Train the model by a large amount of labelled data;
7. Run, assess, and validate the model and test performance against unlabelled data / human;
8. Visualize results and determine decision rules.

These eight steps are derived from different learning process step approaches by several researchers. The theory differentiates between numerous approaches; therefore, this derivation is made based on experiences from the author.

The benefits of AI

AI is already used to solve important problems humanity could not solve alone like improving the quality of diagnoses and treatment in healthcare (Whittlestone, 2019). Talking about AI often leads to the known benefits of automation and the associated disadvantages and risks posed by AI on humanity like AI taking control of lives to the extent that it proves to be detrimental to humanity, or unforeseen consequences can occur such as killer robots (Vyas, 2018). But next to this, AI will provide a huge number of benefits to business and society (Nagar, 2018; Henke et al., 2018; Howard, 2016; Accenture, 2018):

- Automation of Customer Interactions and faster response times via mail, calls, chats, purchase advices and many more through CPS up to 81%;
- Improved customer acquisition by better offering bundles and services up to 81%;
- Real-Time Assistance for critical actions with a high amount of data and dependencies;
- Data Mining Capabilities to discover relevant information after the processing of big data to provide better insights to improve business up to 79%;
- Improved decision-making across business processes within an end-to-end supply chain or risk management up to 85%;
- Enhanced Predictions based on a data analysis of the past and dynamic information to optimize the business and gain advantages;
- Increase of innovation to identify new business models up to 78%;

- Increase of organizational productivity and operational automation and efficiency through by cross-functional intelligence and collaboration with other technologies and CPS up to 78%;
- Increase of learning potential and individual security and decrease of loneliness.

Furthermore, AI systems consistently outperform human experts by 20-30% in the field of prediction with fewer errors or better case identification. Beyond, AI systems are unbiased because of the decision and prediction based on statistical evidence and faster than humans to analyse datasets with a million entries to take a decision afterwards. In addition, these systems mainly have only one-time costs for the development. Therefore, these are often cheaper than human counterparts (Finlay, 2017). All these benefits show a part of the number of advantages for dealing with AI. Therefore, the approach should be to think positively and achieve the benefits and not to analyse the disadvantages in the slightest and pay off on them.

2.2. AI approach in the organizational practice

2.2.1 AI Maturity Model

To successfully develop and execute an AI vision and strategy for a business, AI maturity will be highly relevant (Castrounis, 2019) to benchmark across the industry, identify and score your company's strengths and weaknesses, structure companies' AI strategy, goals, and investments and to accelerate the transition to AI (Youngerwood and Morrisey, 2018). Because "AI represents one of the biggest value opportunities in recent times, businesses should seize this opportunity and aim to be in the best possible position to capitalize on all the benefits that AI can bring"[12] (Pringle and Zoller, 2018). To be able to assess the existing business position, the AI maturity model will support.

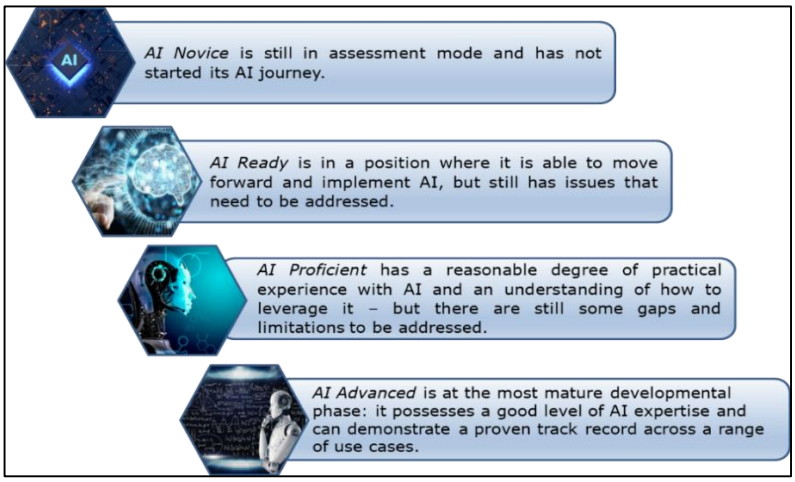


Figure 2.7 The fourth stages of AI competency according to the AI Maturity Model (synthesis from (Pringle and Zoller, 2018))

[12] As mentioned on: https://www.amdocs.com/sites/default/files/filefield_paths/ai-maturity-model-whitepaper.pdf

The challenge for leverage AI in organization could be manage through the AI Maturity Model. A good approach on implementing the AI Maturity Model is offered by Pringle and Zoller (2018) consisting of four core developmental phases of AI competency, as shown in Figure 2.7.

In addition to the phases, there are five assessment pillars, as shown in Figure 2.8, that allowed the evaluation of the organization's position during the AI journey (as depicted in Figure 2.9). "Each pillar contains a detailed set of criteria and associated questions to assess a company's level of AI maturity, as depicted in Annex 1. For a general pillar understanding, a short introduction for each pillar is given in the following: (Pringle and Zoller, 2018; Youngerwood and Morrisey, 2018).

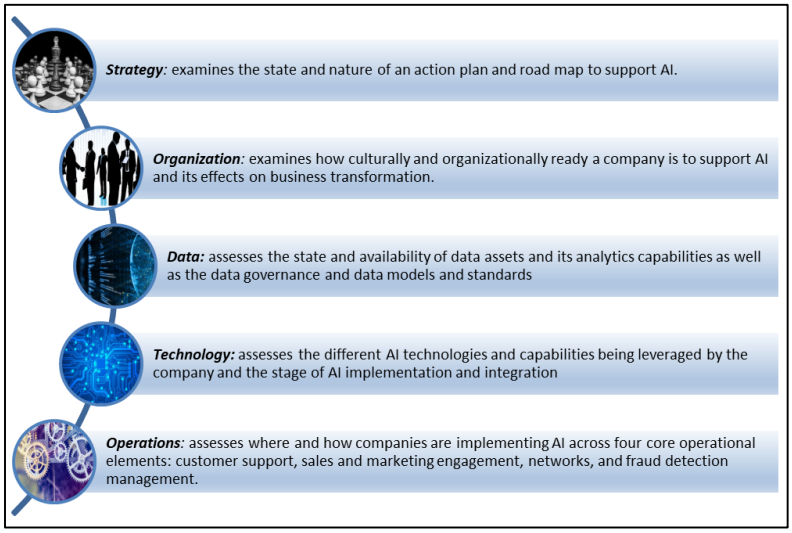


Figure 2.7 The five assessment pillars in the AI Maturity Model (synthesis from (Pringle and Zoller, 2018))

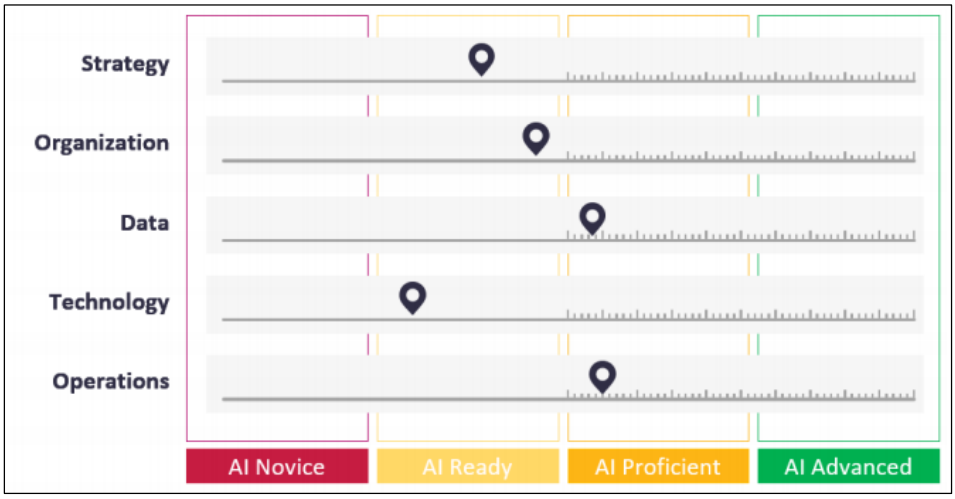


Figure 2.8 Illustrative scoring across the pillars (Pringle and Zoller, 2018)

With the help of the AI maturity assessment, it is possible for a company to compare itself with external companies, to measure itself and to document its own development. Thus, it is possible to analyse at which corner points of the AI implementation weak points still exist, to carry out appropriate optimizations and thereby become more successful.

2.2.2 AI transforming business

The access to information and technology is universal, but each organization uses them in different ways, purposes, and goals (Pandya, 2019). The technological development and changing political parameters that businesses have experienced over the last few decades have not been without issues (Piraino, 2018).

The ongoing digitization focuses on leading innovation, automation and AI implementation make people and processes more efficient (Uzialko, 2019; McCorry, 2019). With the opportunity of AI Systems to take decisions on their own by a fundamental set on data and external information and the ability to learn from taken decision, such systems will transform the business considerably (Uzialko, 2019).

In addition, Basu (2018), director at Cognizant, said: "*With improved maturity of IOT platforms, we are quickly achieving the goal of building 'Connected' Enterprises. Big data maturity is also significant at this point but most of the analysts and market data still points that we still lack the AI-maturity - we are building 'Connected enterprises' fast, but we have just started unleashing the power of AI to get the most from the collected data*". These quote underlines the big opportunity of AI in the business field (Pandya, 2019).

2.3. AI strategy – a data strategy

Businesses are expected to face extraordinary challenges and changes in the coming years, only automation-driven growth will be the constant in those changes (Pandya, 2019). So, consequently, there will be "more intelligence from data, from connected devices, social media, and industry" (Marr, 2017; Pandya, 2019). Furthermore, Data is the foundational asset for AI and companies, but also the most underutilized and critical asset of companies (Marr, 2017; Sundblad, 2018; Kumar, 2018). This foundational element really matters for three core areas: (Marr, 2017; Bull, et al., 2017).

- *Decision-making* – by gaining much better insights based on the amount of data to make better decisions across all areas of the business;
- *Improving operations* – for almost every type of business by tracking different parameters to improve processes and employee satisfaction;
- *Monetization of data* – by gathering and selling them as a service and new product offering.

To better understand the need of a data strategy, it is important to consider Maslow's Hierarchy of Needs "with the most basic, most important needs at the bottom of a pyramid and the most complex needs at the top" (Sundblad, 2018[13]). A similar structure is also used in the Data Science Hierarchy of Needs pyramid by Rogati (2017), as depicted in Figure 2.10.

[13] Available on: https://www.forbes.com/sites/willemsundbladeurope/2018/10/18/data-is-the-oundation-for-artificial-intelligence-and-machine-learning/#e69c1a851b49

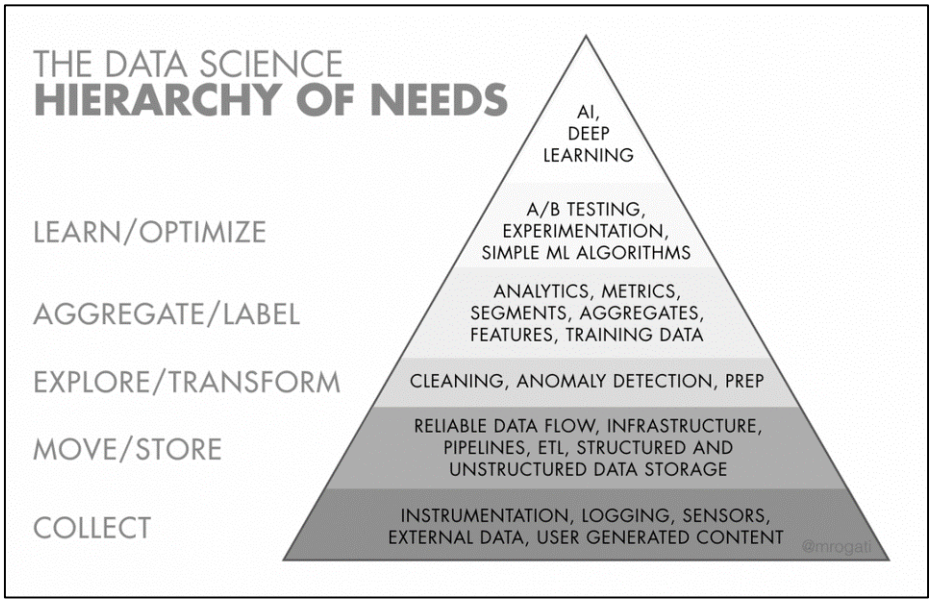


Figure 2.9 AI Hierarchy of Needs (Rogati, 2017)

"At the bottom is the need to gather the right data, in the right formats and systems, the right quantity because any application of AI will only be as good as the quality of data collected". The next layer is about how to store the data and how to convert the variance of data into a common format and common system to process these further (Rogati, 2017; Sundblad, 2018).

It is important to recognize that not all data has the potential to provide business value (Marr, 2017; Galimberti, 2017). Discovery is the key process to help find, cleanse and curate data before processing them (Rogati, 2017; Galimberti, 2017). The explore and transform layer is characterized by the data availability (Rogati, 2017; Sundblad, 2018). This includes the infamous 'data cleaning' to discover missing data and any anomaly to make sure capturing all data variables that are impacting the data strategy and AI use cases (Rogati, 2017; Sundblad, 2018).

At the aggregate level, the BI or analytics capabilities and system are used to detect if anything jumps out of the normal distribution. In addition, at this stage, training data are prepared by generating labels, either automatically or with humans in the loop (Rogati, 2017; Sundblad, 2018). With these training data, engineers are building models and algorithms to deploy an amazingly simple ML algorithm (Rogati, 2017).

Finally, the AI approach based on data allows the understanding and control processes by improving types of analytics with more AI and deep learning applications (Sundblad, 2018). The explained "Hierarchy of needs" can be seen as a procedure model to successfully develop AI applications and execute Big Data and Data analytics as a fundamental approach as described by Bernhard Marr in his book: "Data Strategy – How to profit from a world of Big Data, Analytics, and the Internet of Things".

Furthermore, business leaders must expand their thinking and begin questioning everything, starting with their strategy and everything based on data

(Marr, 2017). Thus, organizations need an overarching data strategy (Marr, 2017; Fleckenstein and Fellows, 2018).

The data strategy should support the AI strategy, while the AI strategy should support the business development in the context of different constrains as: profit maximisation, cost minimization, and risk manage. Fleckenstein and Fellows (2018) introduce the role of the Chief Data Officer (CDO) with the responsibility for enterprise-wide governance and the exploitation of information/data assets of the organization. Furthermore, Gartner predicts that "by 2019, 66% of large organizations will have a CDO, but only 20% will be successful because of the support of the CIO which will lead to more success"[14]. The data strategy approach for a given company should be based on three factors related to the answers of the following questions (Fleckenstein and Fellows, 2018):

1. "What are the organization's most pressing business problems?
2. What is the organization's current data management environment, and what pain points is the organization experiencing in this infrastructure?
3. What is the scope of the data strategy an organization wants to tackle?"

Companies should invest in their data analysing capabilities, become smart and belong to networks or connected organizations. One important capability is the digital data infrastructure (Marr, 2017; Pandya, 2019). For example, Japan has defined an AI technology strategy as a core aspect of Society 5.0 (UNESCO, 2019). Therefore, the "three phases for AI development and use" (UNESCO, 2019) are as follows:

1. "Expanding use of data-driven AI in each service domain;
2. General use of AI and data across services;
3. The formation of ecosystems through a complex merger of these services".

Throughout the world, only Canada and Japan have a national AI strategy, which underlines the important factor of business representatives and specialists like IT departments and researches to formulate a sustainable strategy (UNESCO, 2019).

2.3.1. 8 steps for becoming a Data-Driven Business

A study from McKinsey Global Institute indicates that data-driven companies make better decisions[15]. To become data-driven, it is important to develop a solid strategy for data quality, governance, access as well as having the right leadership to create a culture that places data at the heart of the organization (Kudikala, 2018). Furthermore, Marr (2019a) mentioned eight vital steps to becoming a data-driven business, as depicted in Figure 2.11.

[14] Available on: https://link.springer.com/book/10.1007%2F978-3-319-68993-7

[15] Supported also by: https://www.talend.com/blog/2016/09/13/eight-steps-to-becoming-a-data-driven-organization/

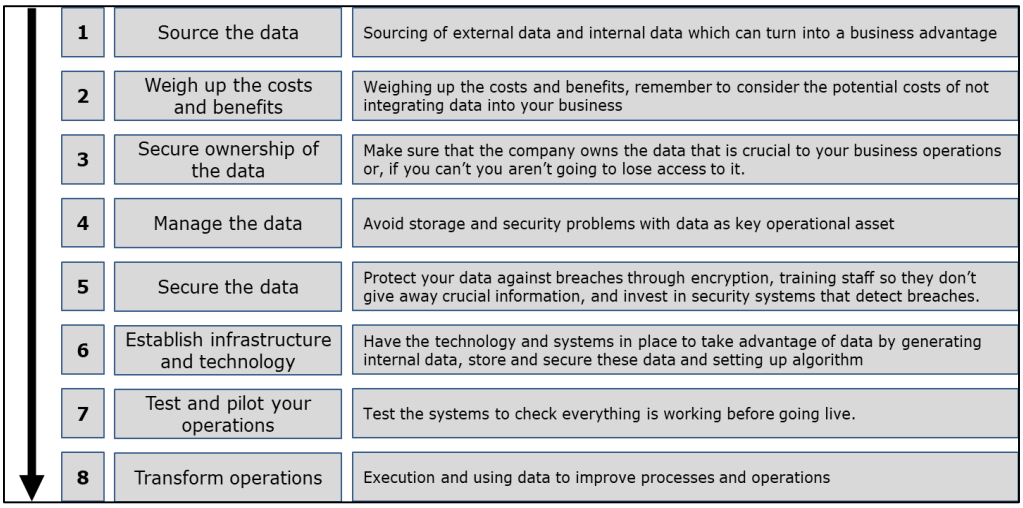


Figure 2.10 Eight steps for becoming data driven (Marr, 2019a)

Furthermore, the organization must empower employees to apply data and analytics to solve business problems and develop a data-driven mindset. Therefore, a data-driven culture must be established with an open communication approach about success and lessons learned. In addition, governance rules and policies must describe the sensitive data handling (Halper and Stodder, 2017).

Moreover, Marr (2017) mentioned four key business areas to identify objectives and key business questions to get the most out of the data by becoming data-driven:

1. Customers, markets, and competition;
2. Finance;
3. Internal operations;
4. People.

It is important to focus on the right business questions at the key business areas because only data that will help to identify the biggest concerns of the company matters (Marr, 2017). An excerpt of the questions can be seen in Annex 2.

2.3.2 Seven data management domains to consider

If a company has a business strategy and clear goals, there should be "an idea of major pain points and their priority to the business", too; data management is a major filed to address them. To focus on theses pain points, Fleckstein and Fellows (2018) provide some data management domain-specific questions that can be used, and which could positively impact the business (Figure 2.12).

The references analysed and the practical observations have demonstrated that data management domains are especially important when an effective data strategy must be established. Therefore, this is a preliminary condition to turn the data into business value for a successful business approach (Marr, 2017; Fleckenstein and Fellows, 2018).

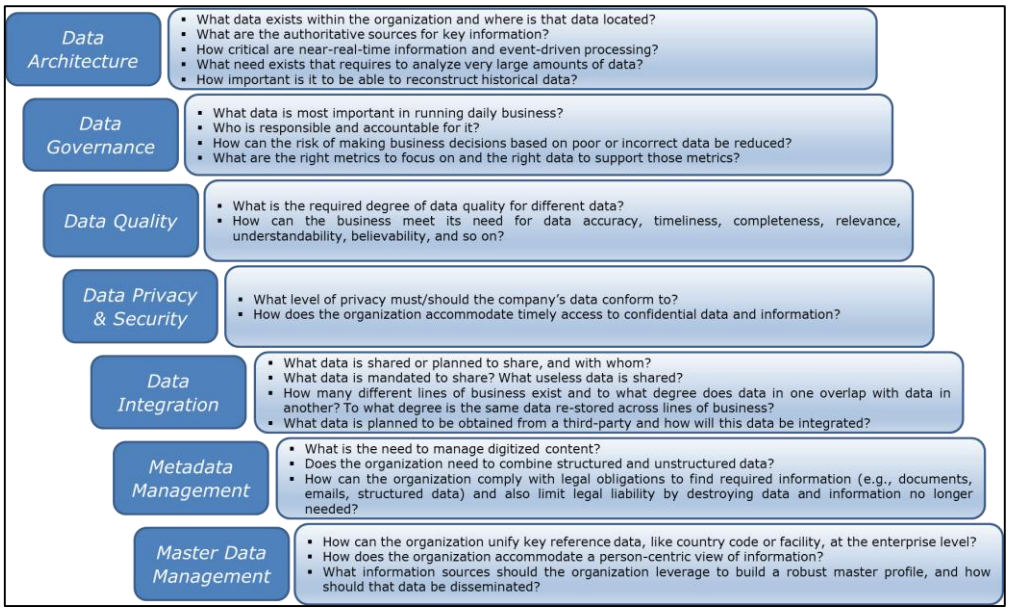


Figure 2.11 Data management domain-specific

2.4. Ethical dimension talking about AI

Talking and researching about AI inevitably leads to the question of bias and ethical principles. The previous chapter outlined the question of how to handle the displacement of people in the business process through greater automation and the use of AI as well as the fear of employees to lose their job. So why is it so important to talk about the ethical aspect of AI?

Therefore, large organizations like Google, Facebook or Amazon have already established partnerships in the field of AI from 2016 and they support research on different ethical aspects in AI, including issues of bias (Marr, 2019b).

Based on a research of Accenture, Intel, Forbes and SAS, *"AI adopters indicated relatively strong ethical processes in place today, with 63% affirming that they "have an ethics committee that reviews the use of AI," and 70% indicating they "conduct ethics training for their technologists[16]"* (Accenture, 2018).

Three specific steps have been listed that can be taken to minimize the risk of spreading societal biases[17] (Marr, 2019b):

1. "Validate the algorithms themselves and ensure that nothing about the way they are coded perpetuates bias";
2. "Consider ways in which AI itself can help to mitigate against the risk of biased data";

[16] Available from: https://www.sas.com/content/dam/SAS/documents/marketing-whitepapers-ebooks/third-party-whitepapers/en/ai-momentum-maturity-success-models-109926.pdf

[17] As mentioned in the article: https://www.forbes.com/sites/bernardmarr/2019/01/29/3-steps-to-tackle-the-problem-of-bias-in-artificial-intelligence/#a3f36547a128

3. "An AI algorithm that has been trained on data provided by society cannot be better than the society, unless it has been designed to be"[18].

Furthermore, the challenge is that ethical considerations are often problem or domain specificity, which means the decision whether something is OK or not depends on the situation. Concrete in the field of automated decision-making systems an ethical risk assessment should considered three main aspects, as suggested by Finlay (2017):

- Beneficiary - Who is going to gain the most from the decision being made? The more the decision maker benefits, the greater the ethical risk is;
- Data Immutability – If decisions are made based on things like age or ethics origin, then this is far more controversial than more dynamic and variable data;
- Impact – What effect is a decision going to have, something like a life-or-death decision or to get a voucher for something?

If a business identifies those kinds of ethical risks, there could be the possibilities to start producing separate score distributions for a different target group or dimension or to construct separate models for each group / dimension, as Finlay (2017) suggests.

By developing and implementing an AI approach, this topic must be considered in business.

2.5. AI Execution - Europe's AI Gap - Ideology and Reality of a business analysis

In Germany, there is a large debate on AI, but so far, AI is hardly used and researched. Every second entrepreneur spurns it completely. PwC stated in cooperation with Kantar Emnid (FAZ, 2019): only 4% of companies in Germany use AI, 2% are currently implementing equivalent systems, 17% are planning or testing them, 28% consider AI to be relevant, but are determined to do without it. Nearly half of all entrepreneurs do not consider AI to be relevant for their own business. PwC speaks of "underdeveloped AI awareness" which could lead to a loss of competitiveness for German companies (FAZ, 2019). Furthermore, McKinsey stated: "*Europe is adding an AI gap to its digital gap.*" (Bughin et al., 2019).

This lack of prioritization and perception of the companies is reinforced by the political framework conditions. From 2019 - 2024, the German government has planned to invest three billion euros in the development of AI to advance research into this technology. Germany is one of the world's leading countries in the field of research, with the entire breadth and diversity of AI. But the USA and China are clearly superior to Germany in the use and investment of this technology (Ilg, 2018). This statement was supported by the report results on the AI investments developed by McKinsey Global Institute that found out that the U.S. and China are leading in this field [19](Word Economic Forum, 2017).

In detail, business requires a talent pool of professionals and interested people who can employ AI tools and handle the complex data world by investing in their employees because only investing in AI will bring no results (Kumar, 2018). Therefore,

[18] As mentioned in the report available on-line: http://rube.asq.org/quality-progress/2019/10/progress-report.html

[19] A debate on these facts is presented in: https://knowledge.wharton.upenn.edu/article/ai-new-electricity/

companies must "recognize that success with AI and analytics requires not just data scientists but entire cross-functional, agile teams that include data engineers, data architects, data-visualization experts, and, perhaps most important, translators[20]" to bridging the technical expertise / analytics initiatives with the operational/business expertise to ensure that organizations achieve real impact (Henke et al, 2018). In a nutshell, it is about "Putting People First" as a strategic approach for companies willing to perform (Kumar, 2018).

All that shows the gap of Europe and Germany in the field of AI execution. Therefore, Europe should consider taking and prioritizing actions to close the gap.

According to a discussion paper by McKinsey and Company titled "Notes from the AI frontier tackling Europe's Gap in Digital and AI"[21], an ambitious aim for Europe is to fulfil the gap with the US and China in the field of AI investment, developments, use and exploitation. Therefore, for Europe, the following five priorities must be considered and implemented (Bughin et al., 2019):

1. "Europe needs to continue developing a vibrant ecosystem of deep tech and AI start-up firms that will use AI to create new business models;
2. Europe's incumbent firms need to accelerate their digital transformations and embrace innovating with AI;
3. Progress on the digital single market is continuing but still incomplete;
4. To capture the opportunity, companies need to build the right talent and skills;
5. Think boldly about how to guide societies through the potential disruption[22]".

With reference to these five points, it becomes clear that this work, independently of the study, also contributes to some core elements. The further advancement of AI technology and the creation of a constant innovation idea in business as well as the acceleration of digital transformation have already been described in the previous chapters. Furthermore, the resulting changes within Society 5.0 as well as Industry 5.0 and the responsibility for companies in this context have been presented as well. Nevertheless, McKinsey stated: "*In short, Europe needs more AI, different AI, and all of it more quickly*" to close the gap to the world leaders (Bughin et al., 2019).

2.6. Knowledge capitalization and preliminary conclusions

This sub-chapter has presented an overview and definition of the term AI. ML and Deep Learning as well as different learning types and further fundamental knowledge have been provided too. Thereby, the learning process as well as the benefits of AI implementation and execution are important to consider.

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[20] As mention in: https://hbr.org/2018/02/you-dont-have-to-be-a-data-scientist-to-fill-this-must-have-analytics-role?referral=00563&spJobID=1200320998&spMailingID=18963894&spReportId=MTIwMDMyMDk5OAS2&spUserID=MzQwODk3MjkyNTc0S0&utm_campaign=dailyalert&utm_medium=email&utm_source=newsletter_daily

[21] Available at: http://doc989.consiglioveneto.it/oscc/resources/MGI-Tackling-Europes-gap-in-digital-and-AI-Feb-2019-vF.pdf

[22] As debates in: https://www.mckinsey.com/featured-insights/artificial-intelligence/tackling-europes-gap-in-digital-and-ai?utm_campaign=AWTI+e-mail+alert&utm_medium=email&utm_source=e-mailnieuwsbrief

The AI maturity model describes the level of implementation and is important for the practical assessment regarding the improvement within the named dimensions. This basic analysis will help the business to become a successful AI business. One significant part to become successful is the AI strategy which is strongly linked to the data strategy. Beyond, Japan and Canada defined a national AI strategy because of the big impact of this technology development. Therefore, it is crucial to understand the importance of a clear formulated Data and AI strategy for business which was aligned with responsible stakeholders and supports the overarching business strategy. Data is the fundament of AI and really matters for the three core areas DMP, improving operations and monetization of data (Marr, 2017).

To reach the improvements in these areas, this chapter described the approach of becoming data-driven and assessed the AI gap in Europe. Compared to other nations, the European AI gap is extremely huge and concrete actions must be defined and executed, otherwise the gap will grow. "*Data is revolutionizing the way companies operate and it will become increasingly critical to organizations in the coming years. Those companies that view data as a strategic asset are the ones that will survive and thrive. With the massive growth in big data and Internet of Things, plus rapidly evolving methods for analysing data, the importance of data across every aspect of business will only increase*" (Marr. 2017).

This underlines the importance of data and a data strategy in today's world, which is developing more and more into a data-driven world. Beyond, Duffy (2019), Global Innovation AI Leader, and Ernst and Young LLP mentioned about AI: "*Placing AI at the heart of your business workflow becomes an imperative. It is an essential tool if you want to keep your business relevant. AI will help you learn quickly, adapt fast and stay ahead of your competition"*.

During the elaboration of this chapter, thesis two and three associated with the present PhD thesis were confirmed. The support of AI in DMP and the possibility to take over assembly line work to improve the qualification of employees are only some of the advantages that confirm the formulated theses.

In summary, AI can support to make products as efficient and safe as possible to generate the highest business value for customers. Internal processes and decision-making can be optimized by the usage of AI too, keep the business relevant and gain a competitive advantage. Therefore, these two areas are analysed in detail within the following chapter.

2.7. AI for the decision-making process – an inventory of aspects to be considered in the present research

"Sometimes you make the right decision, sometimes you make the decision right."
Phil McGraw

This sub-chapter reflects the state-of-the-art research approach on decision-making for business, the DMP in combination with AI. The basis for decisions as well as the DMP is in the foreground of the basic analysis. In addition, the five types of data analytics and the OODA Loop are explained in more detail. Building on this, the DMP is examined with the help of technology. This also represents the transition to the use of AI for decision-making. This sub-chapter addresses the benefits of humans and AI-systems cooperation for achieving a better DMP (Figure 2.13).

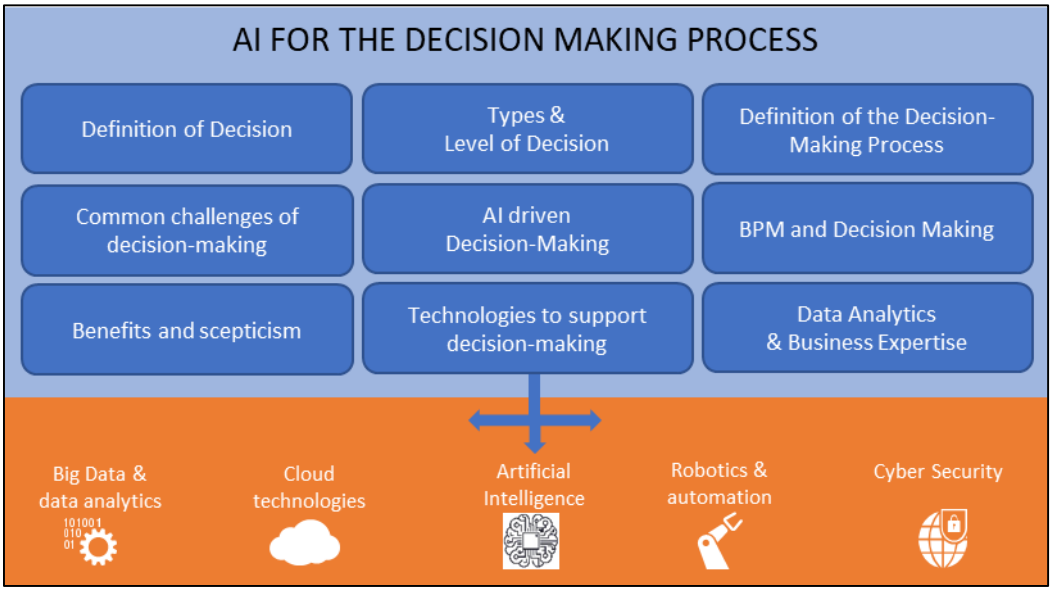

Figure 2.12 Description of the research approach on demonstrating the AI support for the decision-making process

2.7.1. Characteristics and definition

Nowadays, big data enables companies to collect data and put it in proportion to generate insights with the advantage of learning from others and not making the same bad decisions. Therefore, as mentioned by Marr (2017): "*Improving decision-making is probably the most widespread way businesses are using data today*" to support the business to achieve the strategic goals. Beyond, data should be at the core of the DMP because it should generate insights and derive recommended actions to improve the business (Marr, 2017).

With the exponential development of technology, as described within chapter one and two, technologies (computer and running applications) can autonomously learn from data and be executed in various fields like decision-making (Marr, 2017). Furthermore, companies can be described as "networks of decisions" that must be structured to achieve the panned goals and performance (Shrestha et al., 2019).

The decision concept can be defined as a process of scientifically based choice of alternatives, where the quality of the decision depends largely on fortuity and if several people are involved, possibly on their positions of power (Birker, 1997). DMP is a continuing process of assessing relevant aspects and/or situations with different characteristics, considering alternatives, "selecting the best choices among diverse options and following them up with the necessary actions to arrive a solution by a group of people or in an organization" (Paschek et al., 2018; Trewatha and Newport 1982; Vu, 2019).

To take effective, successful, and high-quality decisions, the availability of the right data and information to the right people at the right time must be provided as the key precondition for the entire decision-making process (Paschek et al., 2018). To gain a better understanding about the previously used terms like data, information

and knowledge, Figure 2.14 provides an overview and definition of the differences and hierarchy of the terms (Paschek et al., 2017c).

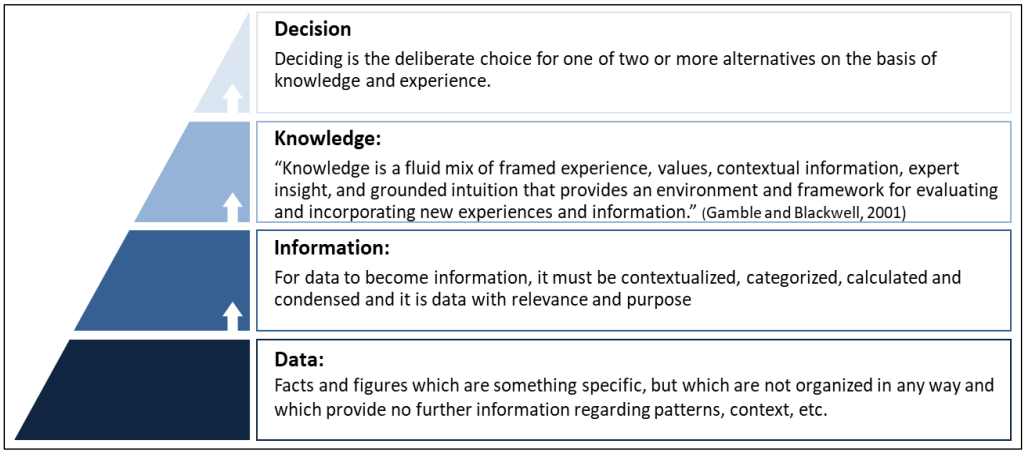

Figure 2.13 The Hierarchy of Data, Information, Knowledge and Decision (Paschek et al., 2017c).

It is important to recognize the evolution of data to information with context and purpose as well as the development into knowledge. On top, the decision is based on the underlying layers. Beyond that, to make any decision, a high amount of data is processed to a great deal of information, compressed to direct knowledge until one final decision (Paschek et al., 2017c).

2.7.2. Level and types of decision

DMPs are developed at any managerial level to ensure that the established organizational/business goals are achieved by different decision structures and information characteristics, as depicted in Figure 2.15 (Marr, 2017).

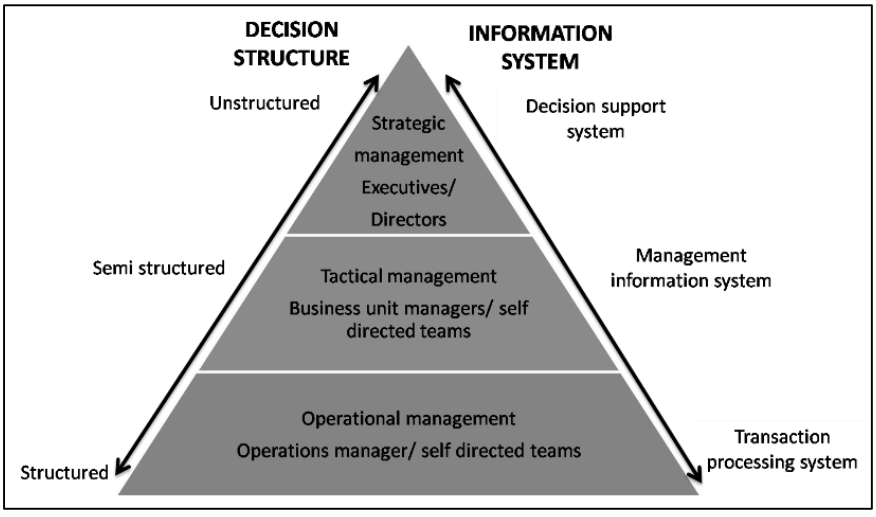

Figure 2.14 Levels of Decision Making (O'Brien and Markus, 2011)

In detail, Figure 2.15 (O'Brien and Markus, 2011) illustrates the three levels of decision (Montana, 2008; Paschek et al., 2018):

1. *"The strategic decisions which set the course of organization and develop overall organizational goals, strategies, policies;*
2. *The tactical decisions* which are about how things will get done;
3. *The operational decisions* which are taken by employees each day to run their processes".

Furthermore, it can be recognized that the operational management operates with structured data, while the level above only has semi-structured data and the level on the top must make decisions by unstructured data. "It can be stated that with the increasing management level, the DMP will be developed in conditions of higher uncertainty, as well as their impact will be with higher risks" (Kontz, 2010; Paschek et al., 2018). In addition, different types of information systems can be used at different levels regarding the type of decision structure. Beyond, the literature differentiates between programmed and non-programmed decisions, as depicted in Figure 2.16.

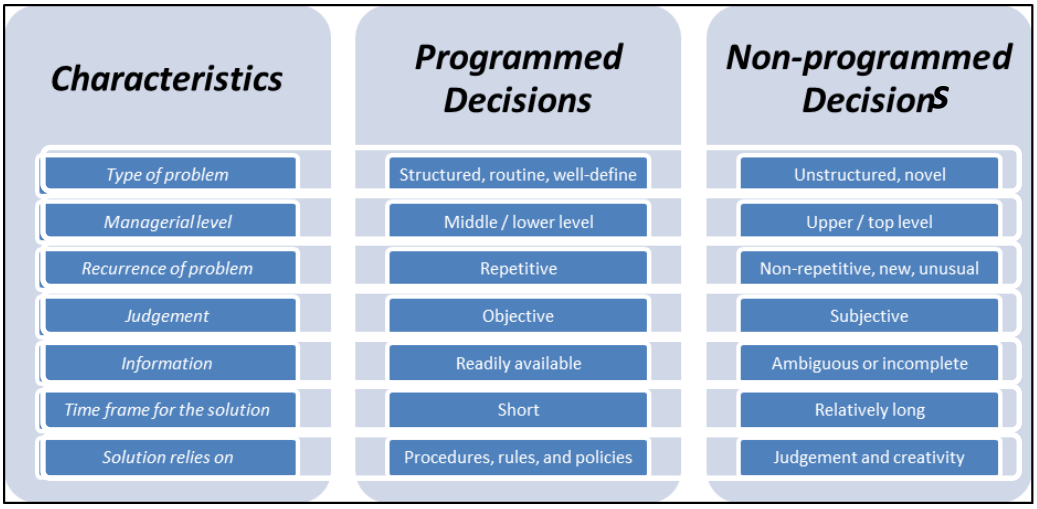

Figure 2.15 Programmed and non-programmed decisions (Paschek et al., 2018)

Repetitive or routine type problems which are solved by standard and automated procedures, the so-called decision rule, are classified as programmed decision (e.g., purchase, supply etc.). Decisions that "are related to difficult circumstances, which are unique and with a high impact, require conscious thinking, information gathering, and careful consideration of alternatives are called non-programmed decisions". Opening a new production plant, launching a new product on the market, or acting in a situation of crisis are all examples of issues that are usually handled by the upper and top-level management (Kontz, 2010; Paschek et al., 2018).

2.7.3. The decision-making process

DMP plays an important role in an organization and "requires solid scientific knowledge coupled with skills and experience in addition to mental maturity by the decision makers" (Marr, 2017). In addition, "*efficient decision-making involves a series of steps that require the input of information at various stages of the process,*

as well as a process for feedback" and cannot be taken abruptly (O'Brien and Markus, 2011; Baker, 2001). The usage of the "step-by-step approach is an efficient and competent way to make thoughtful, informed decisions that have a positive impact on an organization's short- and long-term goals"[23] (Hussung 2017).

Foroux (2018) underlined the importance of DMPs in his statement: "*So instead of focusing on how successful your choices are, focus on how comprehensive your DMP is*". In addition, to optimize decisions, the best decision makers record their decisions and the way they made them to recap and learn from mistakes (Clayton, 2017).

The science distinguishes between 5, 6, 7, 8 and even 9 steps of DMP to solve management and/or administrative problems. The manifold approaches with various steps are caused as each manager adopts a different decision-making model to evaluate his choices to reach the final and best solution (Harcourt, 2016; Paschek et al., 2018). The most applied approach in business is the seven steps DMP as supported by the previous work of (Birker, 1997) and (Hussung, 2017).

In Figure 2.17, the seven steps are shown with a brief description. Following this logical procedure "can help ensure both thoughtful decision-making and positive results". It is important to recognize that if the decision did not work out the way planned; a revisit of some previous steps must be done to identify a better choice (Hussung,2017). This is illustrated by the arrows from step number seven to the previous steps. Science also calls this kind of DMP the rational DMP. Next to this, three further decision-making models exists (Verma, 2009; Paschek et al., 2018):

- *Bounded Rationality* – use with minimal clear criteria, less time to take a decision;
- *Intuitive* – unclear goals, time pressure, expensive analysis, experience with the problem;
- "*Creative* – problem solutions are unclear, new solutions need to be generated, time to analyse"[24].

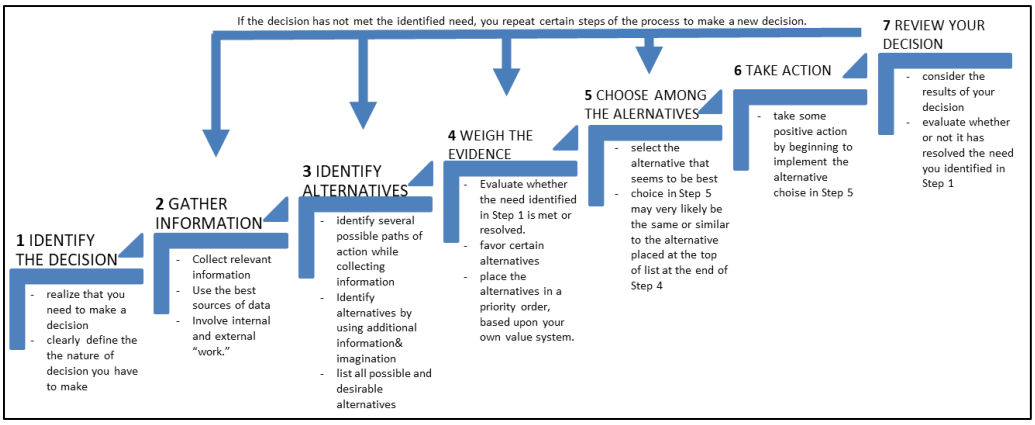

Figure 2.16 7-Step Decision-Making Process (Paschek et al., 2017c).

[23] As stated in the article: https://online.csp.edu/blog/business/decision-making-process

[24] As mentioned in: https://open.lib.umn.edu/organizationalbehavior/chapter/11-2-understanding-decision-making/

2.7.4. OODA Loop – optimization of the decision-making process

In addition to the outlined process, the iterative model for decision-making, the so-called OODA Loop concept, can be applied too (Duffy, 2019). ODAA consists of "four phases: observation, orientation, decision-making and action"[25] (Duffy, 2019) and can be described as a learning system, a method for dealing with uncertainty, and a strategy for winning head-to-head contests and competitions (McKay and McKay, 2019). In addition, OODA can be understood as an incomparable strategic tool to better manage DMPs (McKay and McKay, 2019). More in detail, OODA stands for (Doolittle, 2018; McKay and McKay, 2019; Duffy, 2019; Feloni and Pelisson, 2017):

- *Observe* — pull in all relevant information about the changing environment to gain the knowledge and understanding;
- *Orient* — understand how that information fits into the current situation because orientation shapes the way a business interacts, observes, decides, and acts with the environment;
- *Decide* — follow a DMP on the direction to move forward by the best "educated guess";
- *Act* — implement the decision across teams.

To get a better understanding about it, the four steps combined within one loop can be seen in Figure 2.18. Thereby, time is an important parameter because "the business that goes through the OODA loop in the shortest time gets an advantage over its competitor because the opponent is caught in responding to a situation that has already changed". Derivate from this, the lean production and agile development are results of this. In relation to the present developments and changing conditions, the execution of the OODA loop seems more relevant than before. By the development of Data science and Big Data there was enabling better informed DMP. These technological requirements in conjunction with AI accelerate the OODA loop (Duffy, 2019).

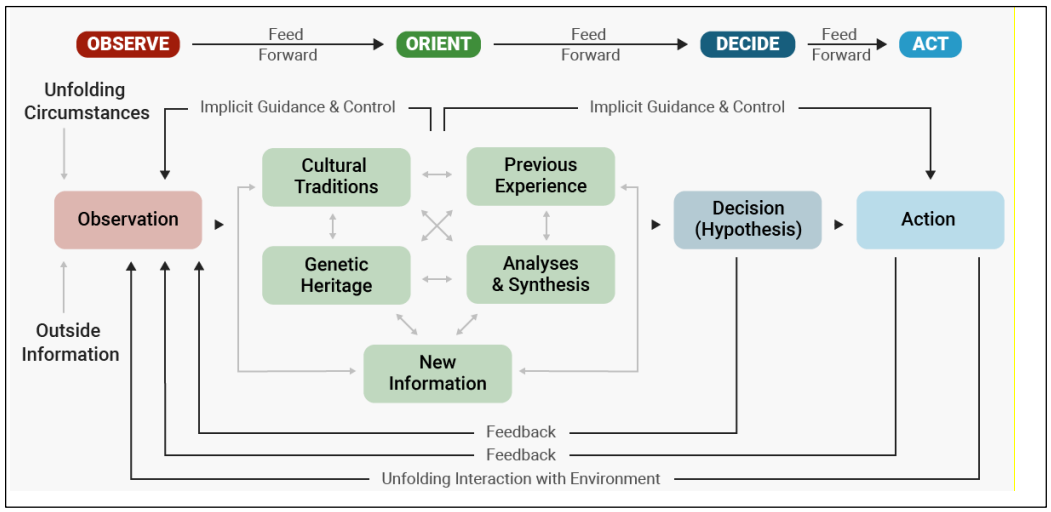

Figure 2.17 The OODA Loop (Feloni and Pelisson, 2017)

[25] Available at: https://artificial-intelligence.cioreview.com/cxoinsight/ai-accelerating-decisionmaking-nid-23303-cid-175.html?utm_campaign=cioreview_topslider&utm_source=google

Executing the OODA Cycle is also a sustainable strategy because each cycle of the loop will create new tactics competitors have not yet exploited (Doolittle, 2018).

2.7.5. The decision-making in business

"Up to seventy-five years ago, human judgment was the central processor of business decision-making based on their intuitions, instinct developed from years of experience"[26] (Colson, 2019). This can be seen in variant A within the following Figure 2.19.

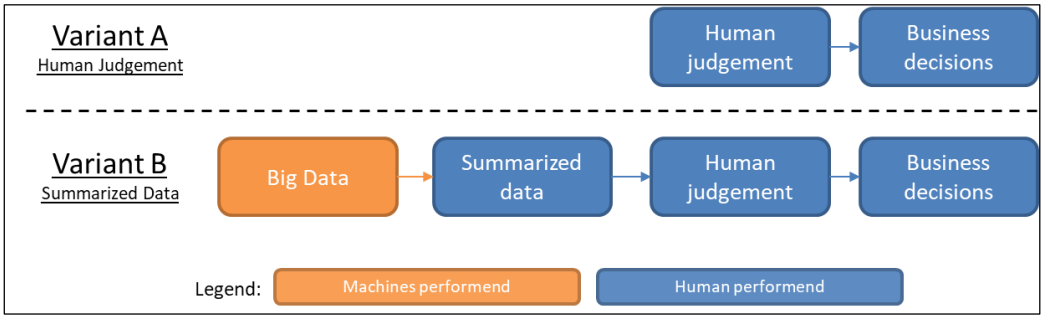

Figure 2.18 Human judgement Decision-Making Models in practice
(own development aligned with (Colson, 2019) findings)

For a few years, many companies have been using a "data-driven" or "data - supported" approach for operational decision-making (Colson, 2019; Duffy, 2019). Companies and Big Data capture a huge amount of data from every transaction or activity to gather information and compact them down to summaries. Human judgment is still the central processor based on an upstream data driven workflow, as depicted in variant B within the Figure 2.19 (Colson, 2019). Already some of the world's most successful enterprises (e.g., Google, Netflix, Amazon, Alibaba, Facebook) have applied and considered autonomous algorithms and not managers/human operators for DMPs. Management by Algorithm (MBA) is the new concept already implemented in companies' practices that empower algorithms (Schrage, 2017)[27]. In addition, following the steps of the DMP, there are some pitfalls and common challenges businesses may face (Outram, 2014; Hussung 2017; Phillips, 2018; Foroux, 2018; Clayton, 2017):

- *Having too much or not enough information* can lead to confusing a wrong decision - collecting and having access to relevant information is a very important aspect in the DMP;
- *Misidentifying the problem* so the business did not know the correct issues surrounding the decision;
- *Misunderstanding the context to the decision*, by just relying on bullet point summaries and not analysing background information;
- "*Overconfidence in the outcome* - if you follow the steps of the DMP, there is still a chance that the outcome will not be exactly what you had in mind.

[26] As supported by: https://hbr.org/2019/07/what-ai-driven-decision-making-looks-like
[27] Supported also by: https://go2karatesites.com/4-models-for-using-ai-to-make-decisions/

That is why it is so important to identify a valid option that is plausible and achievable"[28];

- *Defining solutions before analysis,* implementing solutions before assessing the issue and analysing the possible decisions options will lead to *false* decisions;
- *Emotional business leaders* who make decisions not because of facts, but because of a good feeling, pressure, or panic, often make the wrong decisions.

By avoiding these obstacles, a better decision can theoretically be made (Foroux, 2018).

2.7.6. Types of Data Analytics

The quality of the decisions of decision makers depends on several parameters, as discussed before. Beyond that, "one important skill will be the ability to translate data into insights that are clear and meaningful for the organization to take valuable decisions" (Maydon, 2017). For this, data analysts and decision makers have a wide spectrum of several techniques and approaches from Descriptive, Diagnostic, Predictive to Prescriptive Analytics (Geng, 2016, Sanders, 2019). With the rising amount of data, companies are turning to business analytics solutions to automatically extract insights to help improve decision-making (Sanders, 2019). Therefore, the research firm Gartner added a fifth type of advanced analytics: cognitive and AI (Bull et al., 2017). Thereby, it does not matter if "you rely on one or all of these types of analytics, you as an analyst, a business owner or a data drive company get an answer you need to know from what is happening in the business to what solutions or best course of action to choose to bypass or eliminate future business issues"[29].

In Figure 2.20, all types are described and illustrated with their relation to the analytics focus, business value and difficulty. To better understand the different types of data analytics, the details will be explained in the following starting with *Descriptive analytics* (Bull et al., 2017).

This is the most common and widely used method at the initial stage of analytics to evaluate the data coming in real-time, generally using segmentation, clustering, aggregation, and classification to gain insights and learn from past behaviours. This type of analytics focuses on the "what" – like what are our customers or what is happening in the business to understand what is going on well or not. Descriptive analytics did not explain the root cause behind this, it only provides an idea about how insights will impact possible future outcomes (Bull et al., 2017; Sanders, 2019).

[28] As mentioned in: https://online.csp.edu/blog/business/decision-making-process
[29] Available approach on: https://www.weirdgeek.com/2018/11/types-of-analytics/

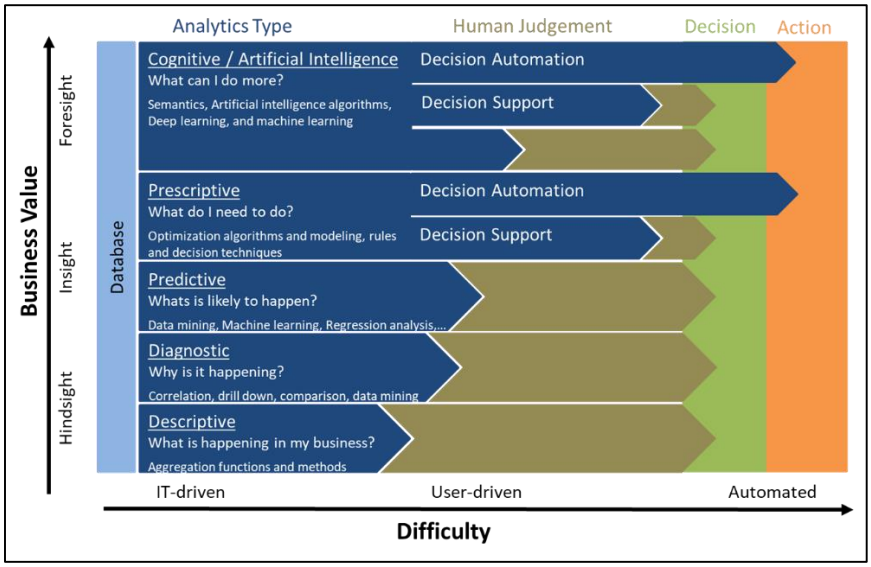

Figure 2.19 Types of Data Analytics
(own presentation aligned with (Bull et al., 2017; Gartner, 2017c))

The next level of analytics is *Diagnostic analytics* which "answers the question of why it happened to find the root cause of an event" and is coupled with descriptive analytics (Geng, 2016; Sanders, 2019). This analytics type provides "an understanding of cross-functional data to find the relation and correlation between things and can be called discovery analytics"[30] (Geng, 2016). Therefore, diagnostic analytical tools will empower an analyst or business owner to drill down the data to isolate the root-cause of a problem and to find the answer by hindsight as they largely concern things which have already happened in the past (Geng, 2016, Maydon, 2017).

The next level of analytics which is more complex is called *Predictive analytics* – it is about forecasting so the organization can take corrective actions (Sami, 2017). In detail, Predictive analytics is based on the findings of descriptive and diagnostic analytics and is used to deliver solutions to questions related to possible future situations, based on previous trends and patterns (Geng, 2016).

It should be noted that these analytics types just estimate a possible future scenario based on the existing data and data quality with an accuracy less 100%. By the digitalization, Internet of Things and the technological advancements, there are more data sources and data all over the globe available than before which allow to perform more complex analytics and gather more data for prediction – this refers to Big Data (Geng, 2016).

The three described types of analytics are performed without any automation for decision-making; it is just about generating insights and recommendations.

Prescriptive analytics is the next step of automation and value generation within the field of analytics. It utilizes the answers from the analytics types before to determine the best way of action to choose the bypass, eliminate future issues or just take the best course of action by the question "what do I / the business need to do?"

[30] Practical aspects are provided by: https://melsatar.blog/2017/07/30/the-evolution-of-analytics/

Prescriptive analytics can be used anytime to advise users on what action to take and to maximize the value / business value (Maydon, 2017).

Applied techniques are optimization algorithms and modelling, rules and decision techniques which are used in decision Support Systems (Sami, 2017).

As depicted in Figure 2.20, the reduction of the human judgement rate within the prescriptive analytics type is based on more automation and application support than in the previous types of analytics. Beyond, prescriptive analytics in business provides general performance improvements, risk mitigation, a higher return on existing assets and addresses new planning challenges using the best method possible (Bull et al., 2017).

The most valuable and complex analytics type is the Cognitive/AI which combines AI, ML algorithms, deep learning etc. "to mimic the human brain by drawing inferences from existing data and patterns and understand the context, draws conclusions based on existing knowledge bases and then inserts this back into the knowledge base for future inferences to answer what to do for the future, how and why" (Sami, 2017)[31]. With the underlying technology data analysis, decision recommendations and actions can be executed automatically by artificial systems as illustrated within the Figure 2.20.

2.7.7. Technologies enable better and more efficient decision-making

Already in Figure 2.15, some information systems are named within the different levels. With each technological evolution, decision-making gets better and more efficient because more information and better data are available to decision makers which leads to informed and knowledgeable decisions (Marr, 2017). The most frequently used technology is the Decision Support System (DSS) which will be considered at the strategic level. DSS is a specific "class of computerized information application that supports business and organizational decision-making activities by examining and preparing business data" Paschek et al., 2018).

A DSS accumulates a large volume of unstructured information from different sources to identify insights, find solutions and support the decision maker. Thereby, it is essential to understand that the DSS only extends the capabilities of the decision makers and does not replace the judgements (Zhang et al., 2015).

The literature differs five terms of the processes and purposes of the DSS, as displayed within the following Figure 2.21.

[31] Available at: https://melsatar.blog/2017/07/30/the-evolution-of-analytics/

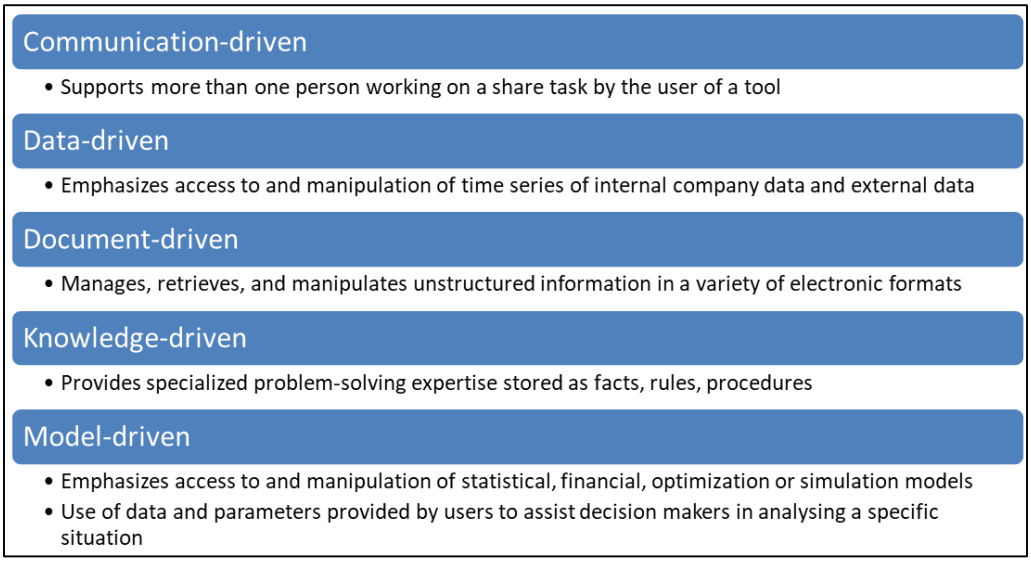

Figure 2.20 DSS Types

The digitalization is moving forward, raw data, information and content in organizations and businesses are being digitized, collected and converted which provides the opportunity to apply analytical techniques to identify patterns and behaviour, learn and understand the patterns and behaviour and prescribe and optimize the patterns and behaviour from businesses, organizations, customers and so on to improve and optimize the existing operation and identify and realize the best opportunities for the future (Bull et al., 2017).

Beyond that, from a data representation perspective, five major classifications can be made, as presented in Table 2.3 (Burstein and Holsapple, 2008).

Table 2.3 DSS Data representation (Burstein and Holsapple, 2008)

Major DSS- data classification	*Definition*
Text Oriented	raw information in text form allowing documents to be electronically created, reviewed, and viewed as needed
Database Oriented	highly structured data driven by a database
Spreadsheet Oriented	contains information in spread sheets which makes it easy to create, view, or modify procedural knowledge
Solver Oriented	based on an algorithm or procedure written for performing certain calculations and executing a programme type
Rules Oriented	follows certain procedures adopted as rules

For a better understanding, the following simplified Figure 2.22 outlines the general architecture of all DSS Systems (Muthoni, 2015).

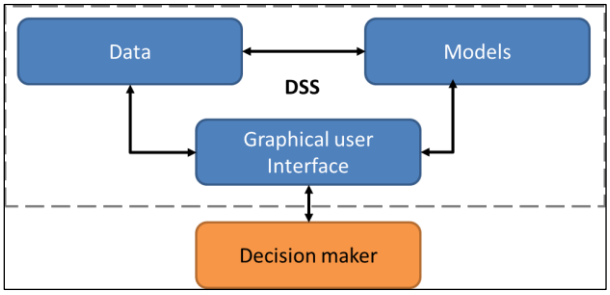

Figure 2.21 General DSS architecture (Muthoni, 2015)

Therefore, AI will change decision-making for business in a positive way (Marr, 2017; Juneja, 2019). The AI-DSS Systems are called Intelligent Decision Support System (IDSS) (Kaklauskas, 2015). Thereby, "IDSS implementations typically combine knowledge of an application domain with an inference capability to enable the system to recommend decisions or diagnoses"[32] (Bosch and Bronkhorst, 2018).

Moreover, the quantum computer technology will have a huge impact on data analytics and predictions in the future. According to Google, the quantum computer used by the researchers is said to have solved a task in about 200 seconds, for which one of the most powerful current supercomputers would have taken 10,000 years (Brien, 2019). Based on this, increasing processing capabilities, prescriptive and cognitive analytics will empower more complex and wide-ranging analytics and more interactions into real-time (Bull et al., 2017).

2.7.8. The decision-making process supported by AI

Taking the ongoing acceleration of technological development as well as data production into account, it can be assumed that humans will not be able to handle the sheer amount of data in real time to act proactively to possible variations or transformations with impact to their business (Kumar, 2018). Colson (2019) added: "*…to fully leverage the value contained in data, companies need to bring artificial intelligence (AI) into their workflows and, sometimes, get us humans out of the way. We need to evolve from data-driven to AI-driven workflows*." In addition, according to PwC: "*There's an immense opportunity to use AI in all kinds of decision-making*" (Sincavage, 2017). There are already several AI applications that enhance DMP like (Sincavage, 2017; Sathik Ali, 2018; Whittlestone, 2019):

- *Automotive Industry* – "smart driverless cars provided with multiple sensors, where the cars can learn the environment, circumstances and identify patterns"[33];
- *Marketing Decision Making* - enables reliable insights into your buyer personas to predict consumer behaviour;
- "*Customer Relationship Management* – to automate contact management, data recording and analyses as well as lead ranking;

[32] Retrieved from: https://www.karelvandenbosch.nl/documents/2018_Bosch_etal_NATO-IST160_Human-AI_Cooperation_in_Military_Decision_Making.pdf

[33] Described in: https://dzone.com/articles/how-artificial-intelligence-will-change-decision-m

- *Recommendation System* - pushes content that fits to user preferences to reduce the bounce rate;
- *Automation Efficiency* - accelerates processes and provides decision-makers with reliable insight;
- *Social Computing* - understands the social dynamics and behaviours of a target market by simulating, analysing, and eventually predicting consumer behaviour;
- *Opinion Mining* - a kind of data mining that searches the web for opinions and feelings to know more about how their products are received by their target audience"[34].

These use cases demonstrate that "AI can enhance people's jobs and allows them to work more efficiently" (Sincavage, 2017). More concretely, the different decision-making models with AI are introduced in the following.

2.7.9. AI driven decision-making models

The technological developments allow the business to evolve from a data driven workflow to AI-driven workflows. A possible field of application is for operational decisions that are only based on structured data because AI is less vulnerable to humans' cognitive bias (Colson, 2019). But before automating everything, the algorithm of the AI application should be tested to get a confidence measure. This is important to compare the result from the neural network to human judgements and get an understanding of how confident it is that it has the right result (McLellan, 2016). Illustratively, a Decision-Making Model with AI utilization can be seen in variant C in the following Figure 2.23 and persuaded by more consistent and objective decisions than humans make. However, removing humans from workflows does not mean that they are obsolete in general (Colson, 2019).

[34] As described in: https://www.shastagmi.com/2018/11/26/how-artificial-intelligence-ai-will-change-decision-making-for-businesses/

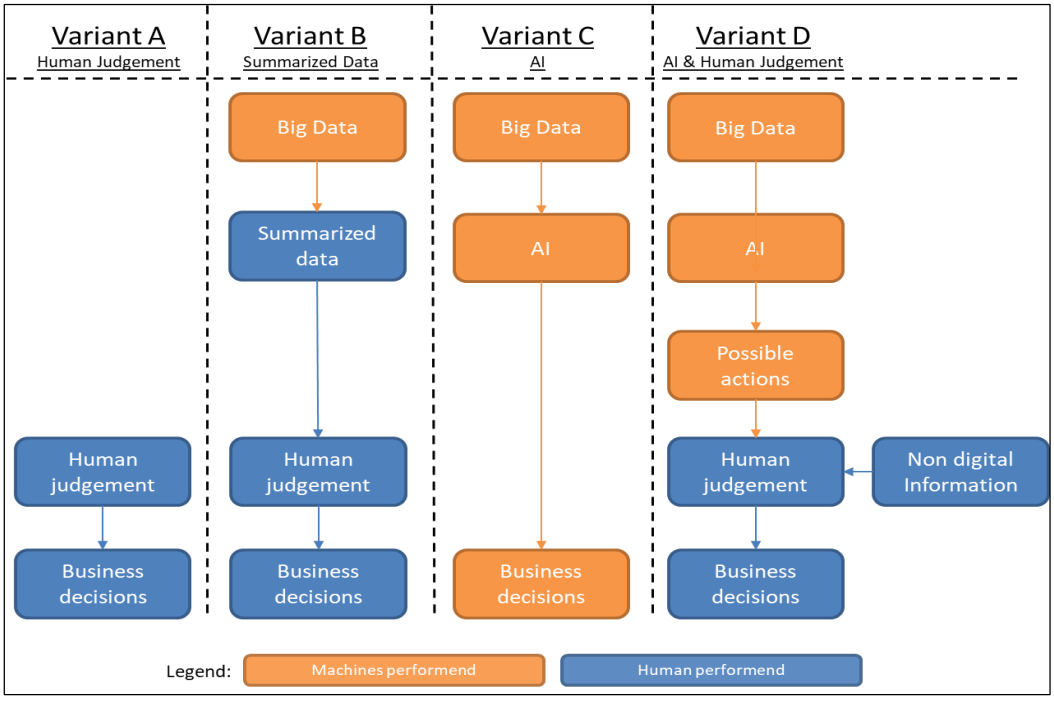

Figure 2.22 Decision Making Models in practice
(own picture, in accordance with the findings of (Colson, 2019))

For a direct comparison to human judgement, variant A and B are added as well to point out the differences. At variant C, the full automation for the data analytics and decision-making takes place by machines. But it must be considered that an AI system should be able to dynamically adapt, by considering the business objectives, preferences, and track record (Bosch and Bronkhorst, 2018).

Thinking about DMP depending on more than just structured data (e.g., vision statements, company strategies, corporate values, market dynamics) are forms of non-digital communication in a specific contextual spirit. Beyond, this kind of information is extremely relevant to business decisions and not easily accessible to the AI (MIT Technology Review Insights, 2016; Colson, 2019). A possible case for other business decisions than the objective rationality of AI suggests: AI may determine that investing more in marketing will have the highest ROI among the options available for business, but the company may choose a slower growth to uphold quality standards (Colson, 2019). Therefore, the combination and collaboration of AI and Human processors in the workflow can bridge the gap of structured and non-digital data. In this case, AI-systems function as a kind of intelligent team players (Bosch and Bronkhorst, 2018). This kind of collaboration could be seen in Figure 2.23, in variant D.

Variants C and D (Figure 2.23) differentiate between full automation and human intervention to include non-digital information in the decision. As shown, AI can be used to generate suggestions and opportunities to humans, and they can choose the best alternative and add other data information (Colson, 2019). Bosch and Bronkhorst (2018) proposed that "the best way to harness and utilize AI for decision-making is to strive towards effective human-AI collaboration". Within the customer

care department, a variation of variant D (Figure 2.23) is used, called Human-Assisted Virtual Assistant (HAVA), where for example any customer raises a question which is received by a virtual assistant (AI) but cannot be solved so the raised issues are handed over to a human agent to do the final call (McLellan, 2016). Human judgment will continue to be realigned, augmented, and amplified by the products of data science and AI, but humans will remain "in the loop" for complex processes and for "judgment based on emotion, empathy, and social norms" in the foreseeable future (Guszcza and Maddirala, 2016; Cooper, 2017; Murphy, 2019).

Colson (2018) summarized: "*By leveraging both AI and humans, we can make better decisions than using either one alone. Moving from data-driven to AI-driven is the next phase in our evolution. Embracing AI in our workflows affords better processing of structured data and allows for humans to contribute in ways that are complementary.*"

The outlook of Murphy (2019), Vice President EMEA of K2, proved two possible scenarios for the next 5-10 years:

- *"Machine learning capabilities will evolve further along the same path – to support managers to make fast, informed and accurate decisions without the intervention of C-Level executives (although the board will still be required for exceptional decision-making situations);*
- *We will be dealing with an AI agent that is able to make decisions on behalf of the team, with the attributes and capabilities of a person running a department"*.

However, the future collaboration looks like as if AI is already enabling business to optimize and accelerate a wide range of business topics.

2.7.10. Benefits and scepticism of AI-business decision-making

Jeff Bezos, CEO of Amazon, once said "*Basically, there's no institution in the world that cannot be improved with machine learning"* (Cooper, 2017). Thereby, many advantages and benefits are seen using AI for decision-making like the following (Cooper, 2017; Finlay, 2017; Murphy, 2019; Juneja, 2019):

1. **Accelerating the DMP -** in the actual competitive market, the ability to speed up the DMP is crucial;
2. **Better handling of multiple inputs -** at once when making complex decisions as well as processing much more data at once;
3. **"Less decision fatigue** - Multiple psychology studies show that as individuals are forced to make multiple decisions over a short period, the quality of those decisions deteriorates over time. Algorithms have no such weaknesses and can help executives avoid making poor decisions borne of exhaustion;
4. **More original thinking and nonintuitive predictions** - AI helps executives spot patterns that may not be readily apparent to human analysis"[35].

Studies from the last 70 years underline the named benefits by the insight "that even simple predictive models outperform human experts' ability to make predictions and forecasts" (Guszcza and Maddirala, 2016). To reach the named benefits, AI-Systems should have the following attributes (Guerlain, Brown, and Mastrangelo, 2000; Prelipcean and Boscoianu, 2011; Bosch and Bronkhorst, 2018):

[35] Retrieved from: https://www.salesforce.com/blog/2017/11/why-ai-drives-better-business-decision-making.html

a) *"Interactivity:* the system works with the human user(s) to explore the 'space of possibilities' in a constraint-based way, instead of just providing the one 'optimal' solution;
b) *Event and Change Detection*: the system recognizes and effectively communicates important changes and events;
c) *Representation aiding*: the system represents and communicates information in a compelling, informative, and human-centred way (e.g., by smart visualization, or 'dashboarding');
d) *Error Detection and Recovery*: the system checks for typical reasoning errors (e.g., bias). Further, the system has knowledge of its own limitations and checks for situations for which it may not be as fully capable;
e) *Information out of Data*: the system uses intelligent algorithmic techniques to infer and generate information from the available data;
f) *Predictive Capabilities:* the system can predict the effect of actions on future performance (what-if analyses);
g) Risk Analysis: Identification of risks and hazards based on the processed data"[36].

Nevertheless, business leaders are extremely sceptical when it comes to handing over decision-making duties to predictive models and algorithms (Cooper, 2017). PwC (2017) has outlined (based on a study with more than 2,000 business leaders) "that their next big decision will rely mostly on human judgment than machines; only 35% of the executives surveyed in 2017 said they relied mostly on internal data and analytics to make strategic decisions"[37]. Mainly, their reservation grounds on three main factors:

1. **"Accountability:** Many algorithms suffer from the black box problem, in which there is no explanation for how that algorithm derived its answers, so business leaders require more accountability and transparency from AI systems than many can currently offer;
2. **Bias:** AI application is the product of humans and susceptible to bias like humans, too. AI is trained on datasets that may contain bias by computer scientists who may be biased. Therefore, there is a risk that algorithms may produce overly biased results;
3. **Pride:** CEOs have become leaders by relying on their own judgment and finding it to be sound"[38].

Therefore, in practice, a collaboration will take place like Anand Rao, innovation lead at PWC, said: "*First, people teach machines what to do, but then the machine advises people what they should do. Because the machine is teaching — telling people what to do —, people get smarter and can tell the machine additional things it should do. Each one is helping and augmenting the other*." (PwC, 2017). This approach reminds of the OODA Loop and will be the key to keeping business leaders finally at the driver's seat (Cooper, 2017).

A Tech Pro Research survey indicated that the "health-care sector has been the leading adopter of AI followed by financial-services and automotive companies" in using assisted, augmented, and autonomous intelligence (MIT Technology Review

[36] As described in: https://www.karelvandenbosch.nl/documents/2018_Bosch_etal_NATO-IST160_Human-AI_Cooperation_in_Military_Decision_Making.pdf
[37] As mentioned in: https://www.salesforce.com/blog/2017/11/why-ai-drives-better-business-decision-making.html
[38] Retrieved from: https://www.salesforce.com/blog/2017/11/why-ai-drives-better-business-decision-making.html

Insights, 2016)[39]. One concrete use case within the health-care sector is: "AI-simulated plans improved patient outcomes by 50%, and did so while reducing healthcare costs by 50%, compared to current treatment regimes, as Cooper (2017) outlines. Another study found that AI algorithms were considerably more successful than human pathologists in diagnosing breast or lung cancers" (Cooper, 2017; Schneider, 2019).

Further on, within the automotive sector AI map, "decisions made from automotive players, such as car buyers, manufacturers, or transportation services providers to predict the adoption of rechargeable and driverless vehicles, and the implementation of non-restrictive pricing schemes that work on their target market. Furthermore, AI application development has provided salespersons with new and more consistent tools in market forecasting, process automation and decision-making, for instance, which are able to run more than 200,000 go-to-market scenarios, instead of just a typical handful in a short period"[40] (Sincavage, 2017).

Only these few examples are "a growing body of evidence to suggest that AI has a powerful role to play in making real-world decisions. Therefore, it is not surprising that Facebook, Google, and Amazon trust in AI algorithms as part of their DMP"[41] and enhance people's jobs to allow them to work more efficiently (Schrage, 2017; Sincavage, 2017). As AI technology will continue to evolve rapidly, companies should look at the strengths and limitations of AI and consider their impact on the collaborative human AI DMP (Shrestha et al., 2019).

2.8. Conclusion

This chapter has presented a theoretical overview and definition as well as a practical business view about the term AI, decision-making and AI-driven Decision-Making. The sub-chapters 2.1 – 2.5 have described the essential scientific and business basics of the theory, implementation, and execution of AI. The different methods and models of application as well as the relevance of data and data strategies were discussed. The sub-chapter 2.6 summarizes the previously gained insights in detail. The sub-chapter 2.7 analyses and describes the fundamentals of the DMP like the converting of raw data to information and to knowledge, and the final judgement. Furthermore, the different levels and types are presented to understand the distinction and urgency between operational or strategic decisions. To finally decide regarding any topic, the seven-step DMP as well as OODA Loop are introduced as well-known practical approaches to decide. In addition, the challenges and evolution of decision-making models are explained to take these findings into account in the model development. For this purpose, it is also advantageous to consider the existing data analytics types to be able to use the required type in the later approach, specifically geared to the need for automation.

The technological development of Big Data and AI has led to AI-supported and fully automated DMP being placed in companies to quickly evaluate large amounts of data and draw the right conclusions. AI is much faster and able to process larger amounts of data than any human could ever process to reach competitive advantages.

[39] Available on-line at: https://www.technologyreview.com/2016/06/20/159529/ai-drives-better-business-decisions/

[40] Information available at: https://www.shastagmi.com/2018/11/26/how-artificial-intelligence-ai-will-change-decision-making-for-businesses/

[41] As mention in: https://www.salesforce.com/blog/2017/11/why-ai-drives-better-business-decision-making.html

The fields of application are manifold and already today there are many use cases that bring a lot of improvements to the practice of companies and industries, even saving people's lives if diseases can be correctly diagnosed and treated early on thanks to AI. Therefore, if "decision makers have reliable data analysis, follow-ups, and recommendations through AI-based decision-making systems, they will make better choices to enhance the work efficiency of every individual team member"[42] and competitiveness of the businesses because of the variety of benefits (Sincavage, 2017; Sathik Ali, 2018).

However, it became also clear that despite technological developments, human input from non-digital information, experiences or other strategic impacts should be incorporated by dealing with critical or strategical decisions. At this point, decision makers will be enriched by the host of information delivered by AI, which they can use to make the best possible choice based on the known information (MIT Technology Review Insights, 2016; Murphy, 2019). To be able to evaluate this for the respective use case easily and quickly, the models described in chapter 2.7.9 as well as the attributes mentioned in 2.7.10 must be considered for a successful AI application.

For the nearest future, there is a need for AI systems that could operate with huge amounts of data because it has been recognized that "data represents the most abundant, valuable and complex raw material in the world" (Sincavage, 2017; Juneja, 2019).

Based on the findings, the **Objective 1a: (Research and synthesis for building a bibliographic overview on AI for the DMP with business and social relations)** has been achieved by the intensive scientific investigation of the subject area.

[42] As supported also in: https://dzone.com/articles/how-artificial-intelligence-will-change-decision-m

3. AN INVENTORY OF ACTUAL BUSINESS PROCESS MANAGEMENT ASPECTS (FOUNDATION OF THEORETICAL RESEARCH)

"The biggest opportunity for big companies has come by far in the digitization of internal processes."
Jack Welch

Objective 1b: Research and assessment of relevant aspects of intelligent Business Process Management (iBPM) and/or Artificial Intelligent - Business Process Management (AI-BPM) (foundation for the present research approach).

This chapter describes the component of an inventory of actual and relevant aspects of BPM that are meant to support the theoretical research approach further. The main concern of the research is related to BPM specifics and the evolution in association with actual digitalization and automation. To provide a common understanding, the definition and core components will be described by the characterization of BPM. It is important to understand the objectives of BPM as well as the advantages and task fields. To gain a comprehensive view, the relation to organizational design and strategic development will be pointed out. Furthermore, BPM Frameworks and the role of technology will be described. Based on that, BPM in agile times of digitalization and AI will be presented. With the purpose of achieving a comprehensible analysis and evaluation of processes and BPM, the performance measurement framework will be explained.

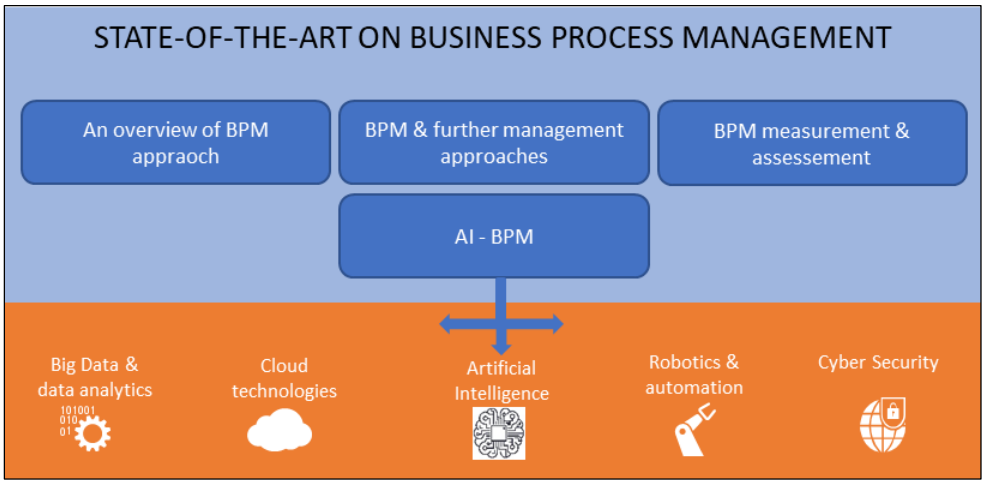

Figure 3.1 Description of the research approach on demonstrating the BPM Evaluation

3.1. An overview of the BPM approach

"*We should work on our process, not the outcome of our process*" said W. Edwards Deming, an American engineer, statistician, professor, author, lecturer and management consultant who established the known PDCA Deming Cycle. He recognized early "that business processes are an essential component of any competitive advantage" (Paschek, et al., 2016). Furthermore, Business Processes are the heart of all work (Osuszek et al., 2018; Paschek et al., 2016).

In most companies, BPM is strongly related and supported by IT (Freund and Rücker, 2014). Even in the future, the BPM industry continues to grow because BPM becomes a primary tool to support the ongoing transformation initiatives. Based on an investigation and estimation by Orbis Research, the global BPM market will beat $13-14 billion by 2021 (Creatio, 2019).

The term Business Process Management consists of the three-word components: Business, Process and Management:

- *Business* describes the economical working organization with the aim of generating profit and serving customer needs underlined by a business strategy and business objectives (Becker et al., 2012);
- *Process* is a set of interactions and correlations based on input and output activities to generate a result, based on the ISO 9000:2005 description. More concrete, the term business process can be understood to be the "cross-functional sequence of value-adding activities that generate services expected by the customer and fulfil the process objectives derived from the business strategy"[43] (Schmelzer and Sesselmann, 2013);
- *Management* is the ability of leadership, organization and planning to optimally position the business or parts of it to react flexibly to external and internal influencing factors (Schmelzer and Sesselmann, 2013; Dumas, et al., 2018).

The management component demonstrates that BPM is about active optimization and the operation of a holistic system (Palmer, 2014; Komus, 2011; Schmelzer and Sesselmann, 2013). The European Association of BPM (EABPM) defines BPM as a "*systematic approach, to capture, shape, execute, document, measure, monitor and steer automatic and non-automatic processes to reach coordinated and sustainable company targets. From this perspective, BPM includes the IT supported assignment, improvement, innovation, and sustainment of End-to-End-processes"* (EABPM, 2017).

Due to further parameters and the important relation of BPM to the customer as well as the corporate strategy, the following description of the term BPM is used for the purpose of the present research approach:

Business Process Management can be defined as Management discipline. Furthermore, it is an integrated system of management, ongoing analysis, design, implementation, execution and monitoring of business processes to increase effectiveness and efficiency in line with corporate strategy. It is designed to meet the needs of customers and other stakeholders and serves to achieve the strategic and operational goals of the organization. Integrated means that tasks, subsystems, methods, tools and

[43] Supported also by: https://link.springer.com/book/10.1007%2F978-3-658-28196-0

IT-support for business process management are planned, controlled and managed in a coordinated manner" (as a synthesis of (Chang, 2006; Snabe et al., 2009; Komus, 2011; Schmelzer and Sesselmann, 2013; Palmer, 2014; EABPM, 2017; Dumas, et al., 2018)).

Based on the description, the following Figure 3.2 shows the relevant dimensions for BPM. In the middle, the BPM-Lifecycle as integrated management discipline oversees the relations and dependencies between business, stakeholders, and technology. From this, it can be concluded that BPM supports (Komus, 2011; Schmelzer and Sesselmann, 2013; Palmer, 2014):

- The coordination of customer reference and strategy reference in the business processes;
- The reduction of conflicting goals improving a company's performance through BPM (done in an efficient way).

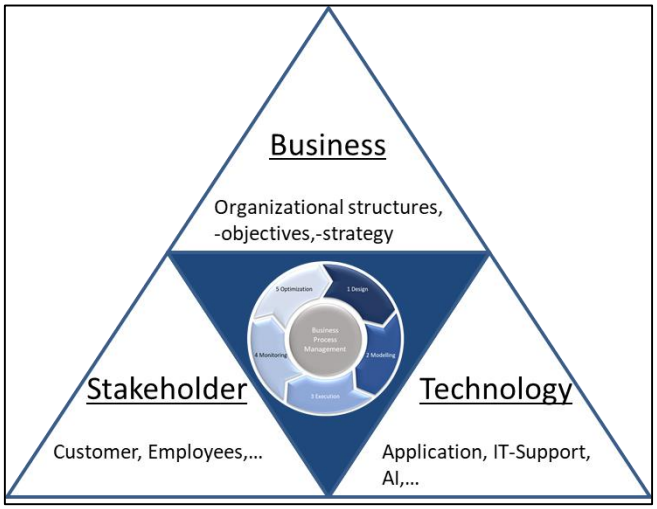

Figure 3.2 BPM Dimension (own presentation)

This is achieved through increasing the effectiveness and efficiency of the company by (Schmelzer and Sesselmann, 2013; Quirk, 2018a; Nixon, 2018):

a) *Cost reduction* by streamlining business operations and collaboration, automating repetitive tasks, improving product quality, and reducing corporate risks;
b) *Agility* by changing or designing new processes with minimal effort based on new regulations, market demands, or company learnings supported by flexible BPM tools;
c) *Customer and End-to-End process focus* by lean processes. Therefore, employees are more focused on the customer and fragmented value chains are merged and optimized through synergies;
d) *Transparency and Compliance* - an integrated compliance set into the process life cycle implies more transparency of processes and the visibility of bottlenecks. Furthermore, the business performance monitoring can be done in real time to identify potentials;
e) *Technology Integration* by using standards and frameworks like Camunda or BPMN in relation to business applications and processes;

3.1.1. BPM Business component – a holistic approach

The overall analysis of the BPM strategic and operational perspectives has indicated that a holistic approach is needed (Schmelzer and Sesselmann, 2013; Paschek, et al. 2016). Furthermore, Palmer (2014) describes the holistic approach with his own words: "*A person doing BPM must consider a process at the scope of interrelated business activities which holistically cooperate to fulfil a business objective. This is the key difference from a functional view of business where each function might be optimized independently of the other functions. In a complex system like a business, it is well known that local optimization of a part of the system will rarely lead to good overall results. A BPM practitioner must consider the metrics of the entire system when evaluating a specific process*".

It becomes clear that processes must be analysed in the overall context to achieve sustainable optimization. Thereby, the context can be influenced by different internal or external sources. For this reason, it is important to coordinate BPM at different levels and maintain a clear focus. The BPM business pyramid can help to structure and align these different levels, as described in Figure 3.3. (Becker et al., 2012; Schmelzer and Sesselmann, 2013; Palmer, 2014).

Figure 3.3 BPM business pyramid (own presentation)

As can be seen, the corporate strategy, with its focus on its customers and the product portfolio and services offered, represents the starting point for all further concretization (Managementmania, 2019). The resulting visions, missions, strategic recommendations for action and operational optimization are based on the corporate strategy (Schmelzer and Sesselmann, 2013; Palmer, 2014). Here it is important to assess whether the necessary competencies and skills for business- critical activities are available in the company or need to be developed to ensure the company's sustainable competitiveness (Becker et al., 2012; Schmelzer and Sesselmann, 2013; Managementmania, 2019).

3.1.2. BPM stakeholder component (important to reflect)

An essential component in business is the *employee*, also for BPM (Gaitanides, 2012; Schmelzer and Sesselmann, 2013). Employees actively participate in the control and optimization of business processes. Rather, the success of BPM depends largely on the skills, creativity, expertise as well as experience and motivation of the employees (Becker et al., 2012; Schmelzer and Sesselmann, 2013). If these characteristics and abilities are not available and thus the strategic goals are endangered, the further training of employees, the recruitment of new employees or external knowledge carriers represent an important component (Becker et al., 2012). This makes clear that BPM cannot be viewed in isolation from other company departments such as Human Resource Management.

Another important stakeholder is *the customer* and their integration into the value chain. Depending on customer requirements and customer interaction, the customer process is also variable. Starting from different customer approaches (portals, web shops, direct sales) as well as customer feedback or customer interactions, a different design of the strategic line and thus a different operational focus in BPM is achieved (Becker et al., 2012; Schmelzer and Sesselmann, 2013).

In the economy, there are many kinds of *suppliers or refiners* of products and services, where we are talking about suppliers and customers on a business- to-business level. Depending on the integration into the own value chain, this stakeholder must be considered in the implementation of BPM (Becker et al., 2012; Gaitanides, 2012). This makes clear that the own company may only implement a sub-process for the creation of a product, but that the entire realization chain could be optimized in cooperation with the foreman to generate a higher efficiency level. The theory knows further stakeholders, but these are not considered further in the following and are therefore not substantiated.

To implement changes sustainably, the culture of the company as well as the process culture are important components. The culture creates security, orientation, trust, but also motivation and identification with the company and conveys common values, norms, convictions, rules of conduct and manners. Employees act and live according to these principles and thus generate an external effect that is also perceived by customers and suppliers (Schmelzer and Sesselmann, 2013). The implementation of the processes depends particularly more on the people and less on structures, processes or methods. In this context, Gaitanides (2012) mentioned: ”*The cultural fit is an important issue since people and processes must combine to produce output*”. Already during the introduction of BPM, measures to support the process culture should be considered (Schmelzer and Sesselmann, 2013).

3.1.3. Information Technology supports BPM

Information Technology (IT) is one of the strongest levers for increasing efficiency in business processes through automation and the use of applications that support, control, execute and measure the business process. The IT thereby supports the whole process lifecycle with tools and applications for the BPM phases. The science distinguishes between Business-BPM and IT-BPM. Business BPM describes the professional and economical BPM, while IT-BPM provides the technical solution (application, BPM-tools) to assist the Business-BPM (Schmelzer and Sesselmann, 2013). The Fraunhofer institute distinguishes three groups of tools for IT-BPM (Frauenhofer IAO, 2011):

1. Modelling and Documentation;
2. Analysis and Simulation;

3. Monitoring and Automation.

Therefore, it is important to know the intended use clearly. During the modelling process, different languages have been developed, which are used in practice, such as (BPMN-Business Process Modelling Notation or UML - Unified Modelling Language, …), to name just a few. The systems help to increase process automation. Beginning with the modelling and execution of a process and ending with its monitoring, so-called workflow management systems are used to trigger work steps and activities without manual intervention. Important prerequisites for the automation of the process to be worthwhile are (Schmelzer and Sesselmann, 2013):

- High repetition rate;
- Strong structure;
- High volume of information;
- Fixed process patterns;
- Cost-intensive and time-critical.

Beyond that, BPM-Systems are integrated solutions and support the entire life cycle from design to definition, functional and technical modelling, integration, control, execution, monitoring, analysis, and optimization (Schmelzer and Sesselmann, 2013). Throughout the digitalization, such tools and systems are more and more cloud based with an IT-Provider delivering a BPM service to the customer which must integrated into the system and process landscape.

3.1.4. BPM lifecycle and methods

A BPM system "has the assignment to manage the execution of a business process at the entire phase step-by-step. By monitoring, evaluating, and identifying issues or crashes within a business process, the BPM System shows where the process had concerns and the business gets the opportunity to optimize their processes to avoid disadvantages" (Schmelzer and Sesselmann, 2013; Paschek et al, 2017b[44]). Thus, BPM covers the strategic process management as well as the process design, modelling, execution, and monitoring, but also process optimization, as displayed in Figure 3.4 (Thome and Papay, 2011; Komus, 2011; Schmelzer and Sesselmann, 2013).

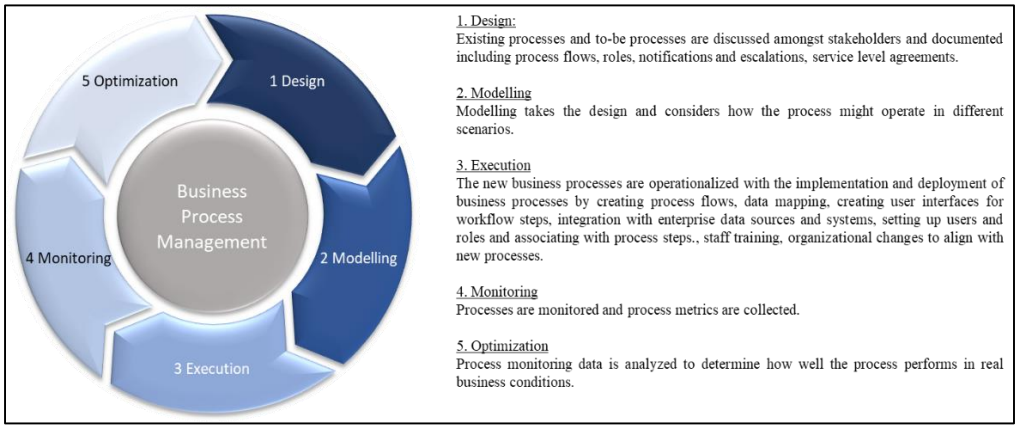

Figure 3.4 BPM Lifecycle (own presentation)

[44] As debated in: http://www.toknowpress.net/ISBN/978-961-6914-21-5/papers/ML17-029.pdf

Figure 3.4 shows the Business Process Lifecycle and explains the theoretical steps of optimizing Business Processes. The business processes should be harmonized with the business strategy, customer needs and business objectives, so that the achievement of process objectives can be measured, controlled, and considered during the design and modelling step (Schmelzer and Sesselmann, 2013). In this context, BPM is the strategic orientation and tactical/operational implementation of the organizational goals through process optimization (Chang, 2006; Paschek, et al. 2016). Furthermore, BPM does not just improve a single step of a process; only those activities that focus on the entire end-to-end process and consider the impact of changes are called BPM (Palmer, 2014).

In addition to the described BPM procedures, the methods in the upcoming chapter 3.2 are also an important dimension, which are influenced by the three previously described components (business, stakeholder, technology) (Schmelzer and Sesselmann, 2013). These methods are used to achieve the set process goals and strategic objectives (Bergsmann, 2012).

3.1.5. Enabler and principles of good BPM

The execution of BPM in practice can have positive and negative effects. For this reason, a concrete analysis of which principles might occur and how they might be implemented should be carried out in advance. In this way, BPM can become a great enabler for the business. Based on scientific studies, ten principles for good BPM were announced in a collaborative work of different universities in 2014 (Dumas, et al., 2018; vom Brocke et al, 2014). The principles shown in Table 3.1 support the understanding of what BPM requires to be applied successfully (Dumas, et al., 2018; vom Brocke et al., 2014).

Table 3.1 Ten principles of good BPM (vom Brocke, et al., 2014)

No.	Principle	Positive manifestation	Negative manifestation
1	**Principle of context-awareness**	BPM should fit to the organizational context	It should not follow a cookbook approach
2	**Principle of continuity**	BPM should be a permanent practice	It should not be a one-off project
3	**Principle of enablement**	BPM should develop capabilities	It should not be limited to firefighting
4	**Principle of holism**	BPM should be inclusive in scope	It should not have an isolated focus
5	**Principle of institutionalization**	BPM should be embedded in the organizational structure	It should not be an ad-hoc responsibility
6	**Principle of involvement**	BPM should integrate all stakeholder groups	It should not neglect employee participation
7	**Principle of joint understanding**	BPM should create shared meaning	It should not be the language of experts
8	**Principle of purpose**	BPM should contribute to strategic value creation	It should not be done for the sake of doing it

9	**Principle of simplicity**	BPM should be economical	It should not be over-engineered
10	**Principle of technology appropriation**	BPM should make opportune use of technology	It should not consider technology management as an after-thought

These ten principles (Table 3.1) offer a framework for a successful implementation in organizational practice (Dumas, et al., 2018; vom Brocke et al., 2014). Therefore, it is important to recognize the positive as well negative manifestation if the principle is not implemented correctly.

Through a detailed view at the principles, it became clear that these are a kind of conclusion of the chapters before like the context awareness of the organization with an intensive linkage to the principle five – the institutionalization. Furthermore, the principle of involvement as well the principle of joint understanding contributes the strategic value creation are important topics of BPM execution. In addition, the economical view by executing BPM as well as the technology dimension are important to contemplate, as depicted as the principles nine and ten in the table.

3.1.6. BPM conclusion. Definition of the Central BPM Elements Framework

"*Eighty-five percent of the reasons for failure are deficiencies in the systems and process rather than the employee. The role of management is to change the process rather than badgering individuals to do better*". (W. Edwards Deming)

This quote underlines the optimization of business mainly around the processes and the systems. BPM can be an effective tool to implement improvements. Therefore, it is important to refer to the 10 principles of good BPM by using and implementing Business Process Management.

Based on the knowledge capitalization from the previous chapters, the model presented in Figure 3.5 summarizes the relevant BPM elements within one general framework.

In Figure 3.5, in the core, the BPM five-step lifecycle is shown. Within in centre of the cycle, the strategical and conceptual part represents the strategic focus and corporate goals as the highest business component, as shown in chapter 3.1.1. It should be noted that strategic management influences the design, organization, and control of business processes. The occurring interaction of the processes for implementing the business strategy should be considered.

In the lower part of the circle is the methodological and cultural part, which has an important influence on the application of BPM. Thus, in the following chapter, the methodological aspects will be described. In connection with the organizational culture, it is important to pay attention which methodologies are used to execute and optimize processes. The cross-connection symbolizes the breaking-down of the strategic goals into the different levels, except for the operational design, as shown in the BPM business pyramid.

The presented framework (Figure 3.5) of the ten principles of good BPM serves as an implementation and optimization guideline to provide the business with guardrails for the application of BPM. Since processes should be considered end-to-end, with suppliers, customers and other stakeholders providing input and having expectations, it is especially important to take this into account in BPM. This is illustrated by the stakeholder input on the left side and output on the right side of the

illustration. In its entirety, this presentation therefore depicts the central BPM elements for the implementation and application of BPM in business.

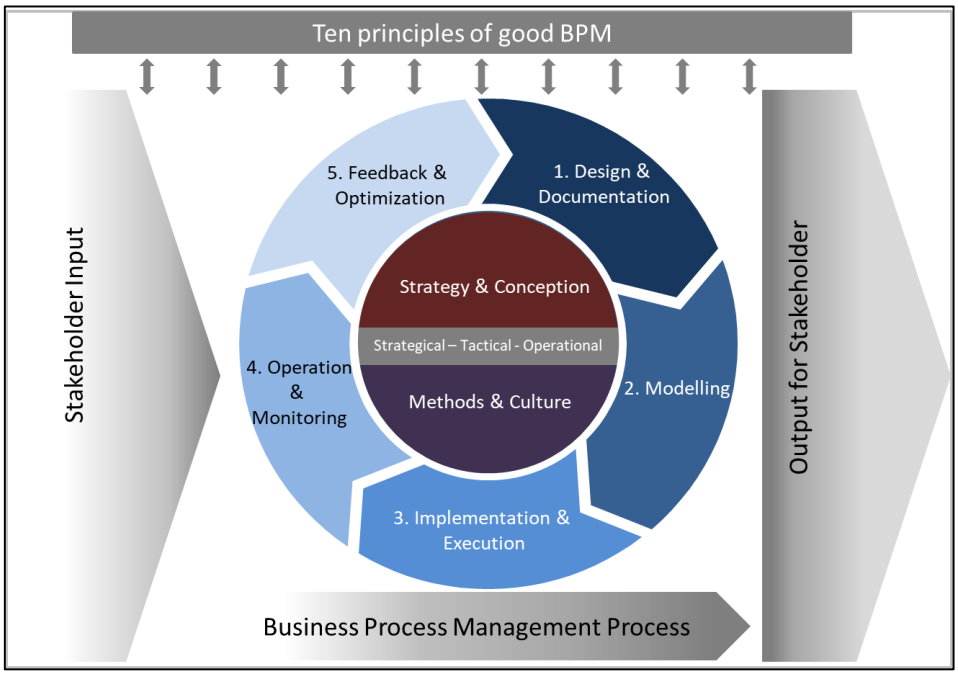

Figure 3.5 Central BPM Elements Model

3.2. BPM and other management approaches

Over the years, various techniques, methods, operational concepts and procedures have been developed to strengthen companies' competitiveness, to solve various problems related to inefficiencies. These are ***closely related to BPM*** and are therefore used in practice in different combinations (Schmelzer and Sesselmann, 2013). In the following, several methods, which are frequently used in combination with BPM, are presented.

Total Quality Management (TQM) is considered a management approach that regards quality as a central component of the corporate philosophy and considers the culture, attitude and organization of a business that strives to provide customers with products and services that satisfy their needs to be competitive (Dumas, et al., 2018; Kiran, 2017; Schmelzer and Sesselmann, 2013; Becker et al., 2012; Grzibowska and Islam,2011; Ross, 2000). Already here, connection points to BPM are recognizable since the components just mentioned must also be considered for BPM execution.

Furthermore, Juran defines TQM as follows: "*Total Quality Management is the set of management processes and systems that create delighted customers through empowered employees, leading to higher revenue and lower cost*" (Kiran, 2017). It becomes obvious that "TQM is a combination of quality and management tools aimed at increasing business by integrating all organizational functions (marketing, finance,

design, engineering, and production, customer service etc.) to focus on meeting customer needs and organizational objectives. Beyond, TQM views an organization as a collection of processes that must try to continuously improve these processes by integrating the knowledge and experiences of workers"[45] (Dumas, et al., 2018; Kiran, 2017; Schmelzer and Sesselmann, 2013; Hashmi, NN). This description shows that there is a very strong link between BPM and TQM.

The central role of processes and continuous process improvement through the knowledge and insights of stakeholders is identical in both methods. The aim of TQM is "*Do the right things, right the first time, every time*" (Kiran, 2017; Ross, 2000). To implement this, the following key principles of TQM should be considered (Kiran, 2017; Ross, 2000; Hashmi, NN):

- *Management Commitment* by support by Plan-Do-Check-Act (PDCA)
- *Employee Empowerment* by training, measurements, suggestions, …
- *Fact Based Decision Making* by a DMP, …
- *Continuous Improvement* by improving standards, …
- *Customer Focus* by customer-driven standards, partnerships, …

The contents of TQM concretize the Model for Excellence of the European Foundation for Quality Management (EFQM) (Schmelzer and Sesselmann, 2013).

In practice, BPM and TQM are often used together, which is known as Business Process Quality Management (BPQM). Grzibowska and Islam (2011) confirmed through their research that processes are key for a successful operation of any organization (Dumas, et al., 2018; Kiran, 2017; Becker et al., 2012; Grzibowska and Islam,2011).

Change Management is described as a holistic approach to steer and manage changes of so-called hard factors like processes or organizational structure as well as soft factors like leadership, organizational rolls and collaboration in order to drive organizational success and outcomes (Becker et al., 2012; Kotter, 2011). Based on an increasingly changing business environment, both internally and externally, the organization is forced to constantly adapt and develop to remain competitive in the long term. This permanent task of change management is therefore indispensable not only during the introduction but also during the execution of business process management (Lauer, 2019; Dumas, et al., 2018; Schmelzer and Sesselmann, 2013; Becker et al., 2012; Kotter, 2011).

Balmes (2019), Business Architect Executive and consultant, summarized the collaboration of BPM and change management in the following statement: "*BPM, by definition, means continuous change. Managing change is important. Managing continuous change is more important if you wish to keep awareness high, impact well within capacity, resistance abated, and adoption an almost certainty*". With reference to the 10 principles of BPM described above, principles 1, 2, 5, 6 and 7 can be referred to in the context of change management. This enables BPM to involve and inform the right stakeholders to create a common understanding and ensure sustainable implementation.

Knowledge Management (KM) is a strategic management concept paying attention to the value and effect of an intangible and sensible asset, the use of knowledge and its purposeful application (Paschek et al., 2017a; Frost, 2017, Milton and Lambe, 2016). Furthermore, KM develops strategies for how knowledge can be

[45] Explained by: https://www.termpaperwarehouse.com/essay-on/Total-Quality-Management/246087

promoted and deployed in a future-oriented way as a value-enhancing resource (Paschek et al., 2017a; Frost, 2017). The goal of KM is to improve the organizational capabilities through better use of the organization's individual and collective knowledge as well as external data and knowledge resources (Paschek et al., 2017a; Milton and Lambe, 2016; Schmelzer and Sesselmann, 2013).

There are close links between BPM and KM because processes support business capabilities and:

- In business processes, knowledge is generated, stored, and distributed;
- In business processes, knowledge is applied to control and improve them;
- Quality and accessibility of knowledge influence the output of processes.

Furthermore, through knowledge management, employees are enabled to develop new capabilities, the third principle of good BPM. In addition, KM also ensures a common understanding and purpose for activities and BPM execution, i.e., principle 7 and 8 of good BPM.

Supply Chain Management (SCM) describes the integration of the supply and delivery chain from start to end over the network of partners and providers and was recognized as one of the key issues for ensuring business success and achieving competitive advantage. There is a close connection between BPM and SCM by bundling all activities required for the complete processing of customer-specific orders (Dumas, et al., 2018; Pradabwong et al., 2015; Schmelzer and Sesselmann, 2013; Becker et al., 2012). Furthermore, researchers examined the connection between SCM and BPM and found out that both are important for improving organizational performance, competitiveness, and internal capabilities (Pradabwong et al. (2015).

Furthermore, the processes are increasingly merging with suppliers and finishers or even major customers because of forward and reverse value integration, which makes the process under consideration for end-to-end optimization much more complex. Here, SCM uses BPM capabilities frequently. By combining SCM and BPM, two essential principles of good BPM are also applied, Principles 4 and 6, which refer to the holistic view, i.e., the complete supply chain and the principle of participation to involve all relevant stakeholders for improvement.

Kaizen or Continual Improvement Process (CIP) is the Japanese management philosophy with focus on continuous and incremental improvements. It is about focusing on the process, and less on the result itself, to achieve a permanent increase in process performance (Dumas, et al., 2018; Dahm and Brückner, 2017; Schmelzer and Sesselmann, 2013). The CIP is extremely helpful regarding the incremental approach as it is also used in agile project management. By using increments, one avoids the danger of over-energizing to deliver economic added value without overburdening the organization. This reflects the 9th principle of good BPM, the principle of simplicity as well as principle two.

Six Sigma is a statistical-based and data-driven approach for continuous improvement and eliminating defects in a product, process or service (Melzer, 2019; Dumas, et al., 2018; Schmelzer and Sesselmann, 2013; Becker et al., 2012). Six Sigma approaches business processes from an analytical point of view and aims at improving an organization's overall customer satisfaction by tracking/decreasing process variability and defects within those processes (Melzer, 2019; Dumas, et al., 2018; Quirk, 2018b).

The execution of BPM in combination with Six Sigma creates a harmony that instils the entire business with a focus on operation quality and performance (Quirk,

2018b). This helps to ensure the principle of context awareness and the principle of institutionalization to embed it within the organization structure.

As this section shows, the range of methods and procedures for process improvement is very diverse. BPM itself enables the optimization of processes in a company, which leads to an increase in efficiency. In combination with TQM, Change Management or Knowledge Management, weak points of a method are clearly reduced by combining them. It can also be seen that the management approaches mentioned here all have a certain overlap in content and dependency, which must be considered in practice. The knowledge management should always be a central component to realize optimizations and efficiency increases. The end-to-end view of a supply chain is also closely correlated with TQM and thus also with BPM. Therefore, in practice, not only BPM but an optimal mix and interaction of the named methods should be applied to achieve the best possible result.

In summary, it can be stated that BPM evolved from the continuous improvement philosophy of "TQM, Lean and Six Sigma and combines them with the capabilities offered by modern information technology, in order to optimally align business processes with the performance objectives of an organization"[46] (Dumas, et al., 2018).

3.3. BPM measurement and assessment methods

Warren Buffet, the chairman and CEO of Berkshire Hathaway, said once: "*It is better to be approximately right than precisely wrong*." (Dumas, et al., 2018). Controlling and measuring processes is necessary to find out whether the processes run effectively and whether changes fulfil their desired purpose. Therefore, the organization can use key performance indicators (KPIs) to evaluate the success. Within the BPM Lifecycle phase "Operation and Monitoring", the process controlling takes place. Process controlling is the entirety of tasks, methods and techniques for target planning and target control of business processes. Process controlling supports the management and the employees of an organization to control and optimize the business processes in a target-oriented way (Schmelzer and Sesselmann, 2013; Dumas, et al., 2018). Based on the KPI's analysis and findings, the decision-making can be optimized.

To evaluate a process, the basic determination of process objectives with clear target values and named process key figures and their measured is required beforehand (Schmelzer and Sesselmann, 2013). These process objectives should be derived from the business objectives and analysed regularly, if possible, in real time (Dumas, et al., 2018). To ensure that the input and output variables, the attributes and activities of a related process are known, a profile activity in a knowledge database should be used (Komus, 2011).

3.3.1. Maturity of processes and organizations

To constantly develop processes and organizations further, the analysis, monitoring, steering and control of processes are an important function to gain a higher return on investment in the development of BPM capability. To implement this, it is advantageous if the organization has a high level of maturity (de Waal, 2017).

[46] As mention in: https://link.springer.com/book/10.1007%2F978-3-662-56509-4

For process assessments in practice, scientific maturity models are used to create an object-based basis for comparison of different levels like business processes, Business Process Management Systems or the whole organization (de Waal, 2017; Looy, 2014; Schmelzer and Sesselmann, 2013).

The most common maturity models are (Schmelzer and Sesselmann, 2013):

- *CMMI* (Capability Maturity Model Integration);
- *SPICE* (Software Process Improvement and Capability Determination);
- *ITIL* (IT Infrastructure Library);
- *BPMM* (Business Process Maturity Model).

All models can be differentiated between various stages of maturity where high maturity is the prerequisite for high process effectiveness and efficiency (de Waal, 2017; Looy, 2014; Schmelzer and Sesselmann, 2013).

The examination of the organizational maturity with CMMI as well as the process management maturity with BPMM are the focus of this work. Within the following Figure 3.6, CMMI and BPMM are depicted in comparison to each other to gain an understanding of the similarities and differences.

At first glance, CMMI and BPMM are similar in design and structure - however, there are differences in the process areas of the different maturity levels, as illustrated in Annex 3 and 4. A maturity level is reached when the objectives and the required degree of implementation of the level are met (de Waal, 2017; Looy, 2014; Schmelzer and Sesselmann, 2013). By verifying the objectives for each stage, strengths and weaknesses can be derived to define measures to increase process maturity (Schmelzer and Sesselmann, 2013).

Capability Maturity Model Integration			Business Process Management Maturity		
Maturity Level		Characteristics		Maturity Level	
5	Optimizing	Processes are continuously and systematically improved based on metrics	Processes are proactively controlled, innovated & continuously improved, & meet internal & external requirements	Innovating	5
4	Quantitatively Managed	The control of processes is based on detailed measurements with predictable process results	Process results and performance are quantitatively controlled, they deliver predictable results	Predictable	4
3	Defined	Extensively documented standard processes exist, process experiences are used throughout the organization	Standardized processes & process measurements are introduced, employees have process know-how	Standardized	3
2	Managed	Processes are planned, monitored and controlled and deliver controllable results	Processes exist on working level, Mgmt. ensures stable working conditions, process management is planned	Managed	2
1	Initial	Processes are controlled ad hoc and the results depend on the know-how carrier	Processes are barely defined, no process or organizational support, results that are difficult to predict	Initial	1

Figure 3.6 CMMI vs. BPMM (own development)

3.3.2. Process performance analysis

In addition to the evaluation of process maturity regarding the process areas, an important component of BPM is controlling and performance measurement, i.e., measuring the processes with the help of pre-defined KPIs. This is called Process Performance Analysis (PPA) and described the measuring and analysing of the

business processes performance by Key Performance Indicators (KPIs) (Hornix, 2007). In practice, different performance indicators are used to obtain a statement about the processes like (Schmelzer and Sesselmann, 2013; Hornix, 2007):

- "*Time-related* (e.g., throughput time of a process, service time of an activity, waiting time, synchronizing time, process flow time);
- *Cost-related* (e.g., process costs, material costs);
- *Quality-related* (e.g., visiting frequencies, error rates)"[47].

It is important to note that different indicators can be relevant for each company and for each process. Therefore, "KPIs that best represent the mission and strategy of an organization reflect the critical success factors of the organization and help to measure progress towards its organizational goals". PPA can be supported by process monitoring tools through observing "large deviations between the planned and actual values of KPIs" and by analysing the causes of these deviations (Reh, 2020; Hornix, 2007).

The possibilities to analyse processes are complex and offer already in theory a variety of models. It is important that the frameworks such as CMMI or BPMM are adapted to the organization and that the objectives are clearly formulated (Schmelzer and Sesselmann, 2013; Hornix, 2007). The reference to the previous chapters must be established here. Only when the goals and strategy are clearly formulated and known, it is sustainable to use KPIs, to monitor them regularly, for example through PPAs, and to adjust in case of deviations.

3.4. An intelligent automation using AI-BPM

Ever shorter innovation cycles, many new business ideas and the digital evolution and disruption lead to constantly changing market conditions (Schoormann et al., 2016; Siebuhr, 2016). Continuous change creates the need for continuous improvement of processes to remain competitive. Furthermore, BPM Systems must increase their level of automation to ensure the flexibility and necessary agility for business optimization (Osuszek et al., 2018). Digitization is currently one of the most urgent challenges and at the same time one of the most promising opportunities. To meet this challenge, companies need a strategy that maps technology components such as the cloud or AI as well as process-related requirements (Dahm, 2018; Siebuhr, 2016). That means digital transformation is about changing the way processes, people, and technology work to create efficiencies, new insights into the business and derive new innovations by putting the customer at the centre stage (Rogers, 2016).

3.4.1. BPM in the time of digital transformations

Digital transformation is becoming increasingly integrated into business processes, with AI leading the way in business technology (Dahm, 2018). Therefore, digitization requires a balancing act between agility and flexibility as well as robustness of business processes and the right mindset (Dahm,2018; Rogers, 2016; Siebuhr, 2016).

"*Clearly, no one can predict the future – however, there is a significant difference between a guess and an informed estimate*", BPLogix (2019) stated on the

[47] Retrieved from: http://www.processmining.org/_media/publications/hornix2007.pdf

webpage by introducing BPM trends. Based on research, business topics, customers, analysts, and influencers, some trends in BPM can be analysed:

Championing Simplicity: Organizations will use processes that can be easily built and changed on demand, updated as needed, and managed by business users themselves to generate the highest possible flexibility for the unpredictable. Managers will search for solutions to enable productivity of their employees and to have real-time impact on business operations with Agile BPM (BPLogix, 2019). This allows to deal with unstructured work and changing processes to current conditions without changing the model (Roe, 2010).

A Prediction about Predicting: More organizations will be claiming on using analytics based on historical references and current operations to generate holistic insights (BPLogix, 2019).

The Value of Collaboration within the supply chain: Platform-supported collaboration not only enables an intensive exchange of information within the organization, but also allows customers and suppliers to be involved in a holistic view, which makes the collaboration even more valuable and enables the change from business processes to customer processes focus. Beyond that, it is about a learning journey with customers and supplier with successive iterations based on experimentation (BPLogix, 2019; Jesus and Rosemann, 2017). Therefore, to become more efficient, customer-focused, and agile, the top supply chain drivers are Big Data, Digitalization, Internet of things and AI (Markoff and Seifert, 2018).

The use of Robotic Process Automation: To automate high-volume, repeatable tasks that are most often performed by humans, RPA will be used more frequently to gain cost savings through the elimination of redundancies, increased employee productivity and optimized resource allocation (Hanna, 2019; Jesus and Rosemann, 2017). In addition, humans, machines, and things will co-exist and lead to hybrid resourcing which creates entire new process capabilities (Harmon, 2020; Hanna, 2019; Mayank and Neelam, 2019; Sambandam, 2019; Mendling et al. 2018; Robledo, 2018; Jesus and Rosemann, 2017).

Executing of AI: AI has been and will be crucial for facilitating BPM goals, such as improved customer experiences and increased efficiency (Harmon, 2020; Hanna, 2019; Sambandam, 2019; Creatio, 2019; Robledo, 2018; Osuszek et al., 2018; Jesus and Rosemann, 2017). For instance, AI supports RPA to influence data, process transactions, trigger responses to improve processes (Hanna, 2019; Mayank and Neelam, 2019). Furthermore, it is about anticipation and prediction of customer needs or environmental impacts (Harmon, 2020; Hanna, 2019; Mayank and Neelam, 2019; Sambandam, 2019; Robledo, 2018; Mendling et al. 2018; Osuszek et al., 2018).

Subject-oriented Business Process Management (S-BPM) is a comprehensive method for designing processes (Friedl, 2018; Neubauer and Stary, 2017). Thereby, the central questions are:

- Who communicates with whom?
- What information is transferred between whom?
- What activities are carried out and in what order?

In contrast to the classical process view, it is not the abstract process itself that is primarily in the foreground, but the actors and processors involved in a process. As the name implies, S-BPM is a methodology from a process point of view (Friedl, 2018; Neubauer and Stary, 2017).

Each trend already aims at improving BPM and its application in practice. In combination of the trends, even their mutual dependency kit and combinatorics become present, because RPA is difficult to predict without AI, predictions without basic data and is also difficult. The intensive cooperation between humans and

machines represents a further milestone, which was already taken up in the chapter on Industry 5.0. As the technology component, especially AI, has a strong focus in the context of digital transformation and is also frequently picked up on as a trend in BPM, the AI-BPM topic will be analysed in more detail below (Harmon, 2020; Hanna, 2019; Mayank and Neelam, 2019; Sambandam, 2019; Mendling et al. 2018; Robledo, 2018; Jesus and Rosemann, 2017; Kospanos, 2017; Koplowitz, 2017).

In practice, this is referred to as intelligent automation, which "describes a holistic solution for digital transformation based primarily on BPM to orchestrate users, tasks, systems, and robots (RPA) according to business requirements"[48] by using analytics and AI to make automated and intelligent decisions by an integration into the business- and IT landscape (Chas, 2019; Gene et al., 2018).

3.4.2. AI-BPM use cases

AI-BPM and "intelligent automation are changing the way organizations will operate by using innovative technologies to optimize processes, personalize customer experiences and enhance decision-making"[49] (Gene et al., 2018; Durairaj, 2018). The main reasons organizations have historically invested in BPM are cost reduction as well as efficiency improvements (Hanna, 2019; Sambandam, 2018; Koplowitz, 2017).

Nowadays, the primary drivers are customer experience and improvement of the productivity of "the employees to focus on tasks that add value for the company (creative improvements, new strategies and solutions, decision-making)" (Chas, 2019; Hanna, 2019; Sambandam, 2018; Kospanos, 2017; Koplowitz, 2017). "While cost reduction is easy to focus on, business process analysts must weigh many factors when trying to also optimize customer experience, digital transformation, regulatory compliance, and many other elements. AI makes computing and evaluating these changes much more manageable", said Sambandam pointing to the large number of rapidly changing parameters that can have a strong influence on the processes and process operation (Sambandam, 2018).

AI-BPM will enable the user with several options to guide the optimal decision on how to best proceed forward (Kospanos, 2017). Furthermore, Kospanos mentioned: "*So even though technology is the driving force behind these processes, humans are still in the centre of decision-making and action. In this collaborative environment, processes run faster, better decisions are made, and the business outcomes are far greater*" (Colson, 2019; Kospanos, 2017). This description underlines the collaboration between humans and machines, as described in chapter 1.2 about Industry 5.0.

Sambandam (2018) also has the same understanding of this collaboration with a focus on BPM. He mentioned: "*AI will have a drastic long-term impact on business processes, but even the short-term outlook is quite impressive. As AI moves forward, business leaders can expect to partner closer with machines to make better decisions in a changing world*".

Digital transformation and the processes responsibility shift from humans to technology and generate the potential to redesign the way work processes are developed in companies (Gene et al., 2018). In a nutshell, it can be stated: "*If you digitize a shit process, then you have a shitty digital process*" (Dahm, 2018; Feldmann, 2017). This quote points out that it is important to redesign the process

[48] As retrieved from: https://www.auraportal.com/what-is-intelligent-automation/
[49] Supported also by: https://www.ibm.com/downloads/cas/QAQMRGVN

with all the new possibilities and do not turn a bad paper process into an *even worse* digital process (Dahm, 2018; Feldmann, 2017).

The scientific literature coined yet another and very similar term in dealing with the use of AI and BPM: Intelligent Business Process Management (iBPM). Activities such as process simulation, validation, optimization and process performance analysis and evaluation are carried out. IBPM also describes the social collaboration between man and machine and the topic of real-time decision-making (Castro, 2018). Due to the large capability overlaps, there is no separation between AI-BPM and the iBPM approach in the following.

In a nutshell, BPM and AI can be crucial to organizational success (Durairaj, 2018). The integration of AI into BPM gains a lot of power for countless benefits and very soon will have an impact on how processes can be better optimized (Sanbandam, 2018).

Using Natural Language Processing will be a key step in getting to the next level of BPM. It will allow changes in the process on low-code platforms by saying something like "*Add an approval step after a report is generated*" or "*delete the task 04*" (Preez, 2019; Sanbandam, 2018; Osuszek et al., 2018; Gene et al., 2018). This type of functionality, where language makes changes to processes and the system, will make BPM increasingly accessible and relevant to business leaders in the future (Preez, 2019, Sanbandam, 2018). The simplicity of this approach is convincing, allowing the business to intervene directly.

A basic component of BPM is the *monitoring of processes*. By using an AI-BPM system, business processes can be analysed around the clock to make recommendations for process optimization. In addition, AI will continue to evolve and implement process *optimizations automatically and autonomously* in real time (Chabanoles, 2018; Sanbandam, 2018; Osuszek et al., 2018; Gene et al., 2018).

AI enables *contextual analysis* for instance of logistics data to predict and mitigate risks in the supply chain, to search public social data, to detect congestion, thereby realigning just-in-time delivery with the production process (Wellers, 2017).

The usage of AI will lead to *putting people on places where they can perform more valuable tasks*. Automatable release workflows, purchase orders or similar processes can be taken over by the AI system based on previous patterns (Durairaj, 2018). For example, decisions that people make over time are analysed. This way, the system learns exactly the situations where different decisions are made. Furthermore, redundant tasks are taken over by the system and relieve the human workforce. In addition, the system will be able to recognize where there are complexities that people need to spend time on to find the best solution (Preez, 2019; Osuszek et al., 2018; Sanbandam, 2018). For example, McKinsey and Company estimate that AI will automate more than 45% of any specific job to empower workers to focus on higher-level, mission-critical activities (Preez, 2019; Chui et al., 2015).

The *prediction of trends*, delivery bottlenecks or other changes regarding the company and its processes can be executed by using AI and its pattern recognition (Preez, 2019; Sanbandam, 2018; Osuszek et al., 2018; Gene et al., 2018). Above all, the early recognition of dangers of any kind and the identification of possible business opportunities contributes a considerable added value based on the fundamental data analysis by AI.

As stated before, the *improvement of customer experience* will be one focus point of AI-based BPM. The system will gain accurate insights into customer behaviour based on historical inputs and current activities. The use of chatbots, RPA or other similar techniques like IoT are common examples of AI-based customer service (Chas, 2019; Hanna, 2019; Sambandam, 2018; Crismundo, 2017).

All the cases above have one point in common, it is about the acceleration of the DMP in assorted characteristics to optimize the process and the human workforce assignment as well (Chabanoles, 2018; Murphy, 2019). Furthermore, by using AI-BPM, the use cases can be linked and summarized as: from data to prediction, from prediction to decision and from decision to action (Pandey, 2019). At this point, the cross-reference to the advantages and use cases of AI in chapter 2 as well as decision making in chapter 4 can be drawn.

3.4.3. AI-BPM and the level of automation

Talking about AI-BPM and the automation of workflows requires the discussion about the level of automation as well as nature of the process tasks because not all processes are good candidates for automation or AI (Johnson, 2020; Gene et al., 2018). Three levels of automation can be distinguished, as illustrated in Figure 3.7.

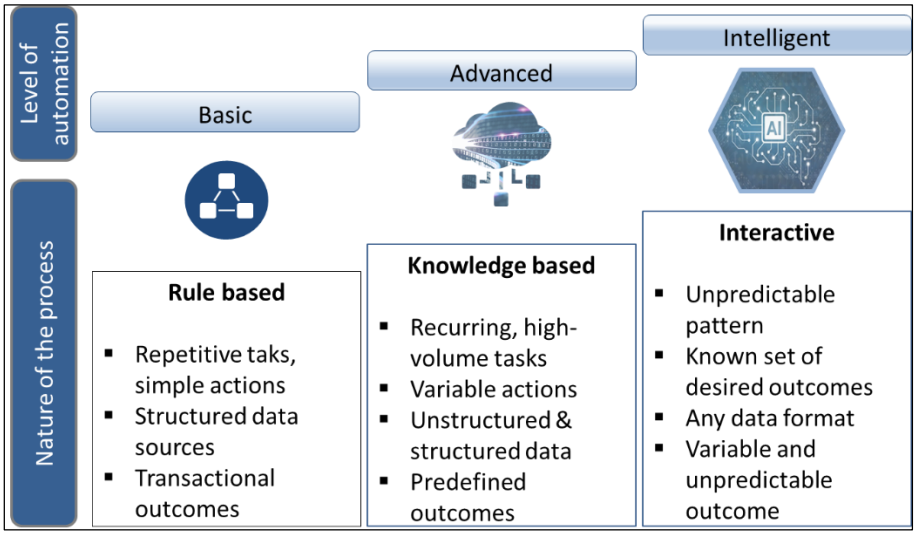

Figure 3.7 Level of automation (own development)

The *Basic level* represents a functional perspective which is characterized by "rules-based, repetitive tasks with well-structured activities"[50], from structured data sources (Johnson, 2020; Gene et al., 2018).

The *advanced level* manages more complicated tasks and processes which are recurring, with a high volume and variable actions. Advanced automation is "based on a combination of unstructured and structured data, in relation with large amounts of data and often rely on huge knowledge bases. Ideal processes for advanced automation are those that fluctuate in demand and where automation is scalable" (Gene et al., 2018; Johnson, 2020).

Intelligent automation describes the *highest level* of automation. Unstructured data as well as unknown and unpredictable pattern characterize these levels. These levels with a high amount of multiple AI-driven properties can be used to extend or *autonomize* business processes (Chas, 2019; Johnson, 2020; Gene et al., 2018). As

[50] As mention in: https://services.hbsp.harvard.edu/api/courses/728383/items/H03OET-PDF-ENG/sclinks/0dc2b6811be6afcf9c49485a17e77f2f

mentioned before, the integration of AI-BPM and RPA into the organization shapes the term intelligent automation (Chas, 2019).

3.4.4. Key processes to automate

Countless individual tasks map process activities that result in hundreds of processes within today's companies. Each of these small tasks could have the potential to be automated and optimized and thus provide a value contribution for the whole process. Therefore, the question for managers is where to start.

1. It is important not to start without an automation strategy to prioritize important resources and make investment decisions;
2. In the following, care must be taken to strike a balance between the cost of automation and the potential gain in efficiency through optimization;
3. Therefore, the core as well as business-critical processes of the company should first be identified and correspondingly considered in the strategy (Gene et al., 2018).

Based on research, IBM found out "that the most automatable business process categories have the most transactional work like support managing financial resources, managing customer services, and delivering physical products. Furthermore, IBM found out that the least automatable process is most strategic and judgement oriented, involving activities like developing vision and strategy and managing external relationships"[51] (Gene et al., 2018).

It is therefore important to consider the use of AI-BPM and intelligent automation in advance and to use an appropriate approach for implementation. Based on the scientific and practical analysis, only hints and single steps for the implementation of AI-BPM are shown. For example, it is repeatedly referred to the need to develop and use a sufficient data subset, as already referred to as the basis for AI (Busy, 2018; Sundblad, 2018; Kumar, 2018; Marr, 2017; Wellers, 2017).

However, this is not related to BPM. In addition, simply using processes to start generating success is only a motivation and does not represent a step in the implementation process. No matter which process is started, it is important that these optimization projects are aligned with the existing strategy, possible platform strategy, data strategy or process strategy, to avoid innovation islands and misfocused developments. Maybe the most helpful idea is to select a suitable vendor to support the implementation. The vendor provides implementation and application support, but rarely addresses the corporate culture. But especially the cultural barriers should not be underestimated. Employees can be concerned about the impact of this technology on their roles (Wellers, 2017; Busy, 2018). Therefore, a holistic and meaningful implementation approach for in-house implementation and execution has not yet been published and identified.

3.4.5. Preliminary facts and knowledge capitalization

Based on technological development and the continued strong focus on BPM, a merger of the two is currently taking place. The pure BPM focus on optimizing costs and processes towards an end-to-end view, which allows to improve the customer experience and additionally devour the supply chain, is an important goal for companies. The analysis has shown that the areas of application are manifold, but a

[51] Retrivede from: https://www.ibm.com/downloads/cas/QAQMRGVN

concrete approach has not yet been identified how to successfully merge within the company.

The consideration of automation levels forms the basis for describing the delimitation and further development in dealing with unstructured data and unforeseeable results using AI. Therefore, the value of AI-BPM can be summarized by adjusting and tuning processes automatically as data patterns reveal opportunities to make small changes identifying trends in data to highlight inefficiencies within processes and to fix them (Osuszek et al., 2018).

How should an AI-BPM model be built and what is to be considered in times of digital transformation? References are often made to the underlying basics of BPM and AI. A comprehensive model or a structured approach is not yet available.

3.5. Conclusion

Digitization is currently one of the most pressing challenges. To meet this challenge, companies need a strategy on the different levels that maps basic technology components and process requirements. The combination of AI with flexible process management provides companies with central competitive advantages to assert themselves in the ever faster moving markets.

In the upcoming years, "the digital transformation movement continues to gain traction forcing business leaders to constantly optimize and reinvent their organizations to remain competitive and ensure a high-quality experience for their customers[52]" (Creatio, 2019). Thereby, AI-BPM becomes a valuable tool for business in general, and for supporting the DMP in particular.

As the literature research has shown, BPM already looks back on a long tradition in business. Different enablers must be considered to implement successful BPM, as the 10 principles of good BPM have shown. To check whether BPM has been successfully introduced, the BPMM can be used to classify the current BPM status and strive for the next level. It offers concrete recommendations for action to achieve full integration and thus the highest level.

The close integration with other methods such as Kaizen, TQM, KM and SCM shows that BPM is a holistic approach with several dimensions and intersections. Furthermore, BPM shows that it uses other management approaches to be able to take a holistic view. In combination with the technological developments in AI and RPA, clear trends become visible, which will continue to influence the BPM application and the sustainable success of companies.

The chapter on merging AI and BPM shows the various potentials. The combination of different technologies is a key feature of this process. The portfolio of a mature AI-BPM system also includes a wide range of applications and linking possibilities, starting with Natural Language Processing, ML, Image Analyses, Deep Learning, Predictive Analysis and Recommendation Engines (Gene et al., 2018).

Furthermore, the literature does not describe a holistic approach to the design, implementation, and execution of an AI-BPM approach (Revina, 2018). Aleksandra Revina comes to a similar conclusion. She states that mainly consulting firms use different models and evaluation options for AI automation in practice, but that up to now, knowledge-based studies and holistic models do not exist (Revina, 2018).

The analyses and considerations carried out have led to the achievement of objective 1c, research and assessment of relevant aspects of intelligent Business

[52] Supported by: https://www.successwithcrm.com/blog/5-bpm-trends-essential-in-2018

Process Management (iBPM) and/or Artificial Intelligent - Business Process Management (AI-BPM) Approaches as a foundation for the present work.

Different building blocks are touched upon and are often mentioned, but without a view to an AI-BPM approach. In addition, Osuszek et al. (2018) also concluded that there is a research gap in the application of AI for business process optimization. Therefore, the concrete question about the "*How to implement AI-BPM*" has been well documented to be answered by the proposed approach that will be described in the next chapter.

However, the fourth thesis of the work could be confirmed and substantiated that BPM is the means of choice to reduce complexity in the process landscape, to have efficiencies and to increase automation. This makes BPM an essential component and building block on the path to the next Industrial Revolution.

4. A PROPOSED MODEL OF USING ARTIFICIAL INTELLIGENCE FOR BUSINESS PROCESSES MANAGEMENT

"The best way to predict the future is to create it."
Peter Drucker

Objective 2: Create an AI-BPM approach (the AI-BPM Diamond Model including a methodology, methods, and tools) for the implementation in different organizations (as a necessary precondition and framework parameter in small- and large-scale business environments, in order to create an understanding by the organizational management and offer the possibility of strategic orientation to generate business value).

This chapter describes the structure and the procedure for designing the AI-BPM Approach and Diamond. The already presented literature review and tendencies have created a knowledge base for the theoretical research focus on creating a model to better support business process management by introducing and using AI. The analysed and discussed aspects are not limited to the state-of-the-art of the research approach. The following Figure 4.1 describes the knowledge field and the intersections of different scientific topics or subjects. Furthermore, the scope of this chapter is to design and establish the systematic approach of using and implementing AI for BPM within the actual Industry 4.0 context, and easy to be adapt for Industry 5.0, also. All this, while considering important framework dimensions with high relevance for the implementation model.

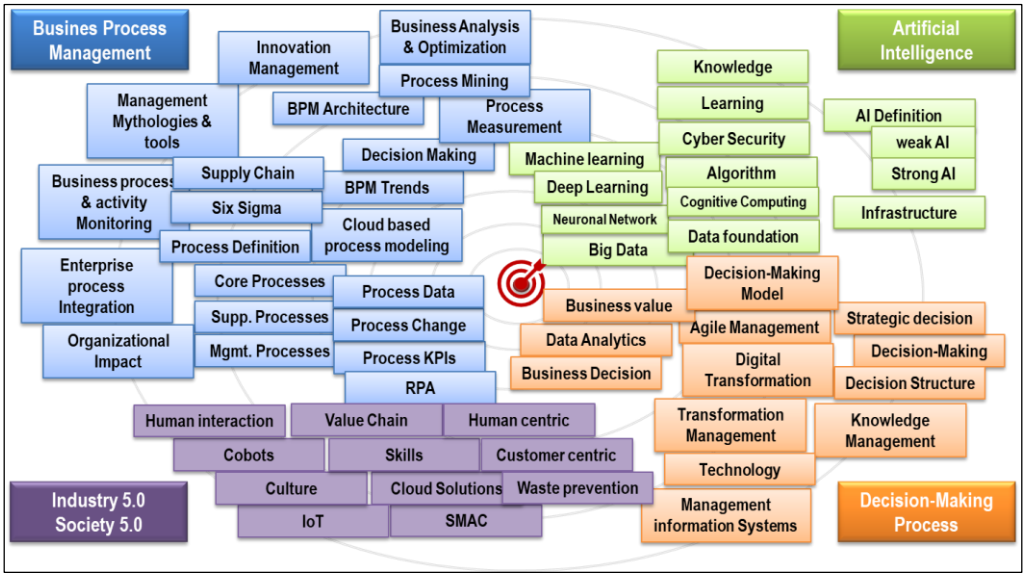

Figure 4.1 The research topic's knowledge field of interest and its localization

By linking the theoretical discussion with practical insights in chapters 1-3 and the preceding scientific studies, the AI-BPM Diamond is created and concretely described. Before, a short procedure description is given to provide a common understanding. To generate an almost holistic view, necessary basic conditions are taken up and requirements are pointed out, which should be applied during the implementation and execution in small and large-scale business environments. Each dimension of the Diamond is specifically described and related. In addition, the requirements for the application are specified and important basic conditions are pointed out.

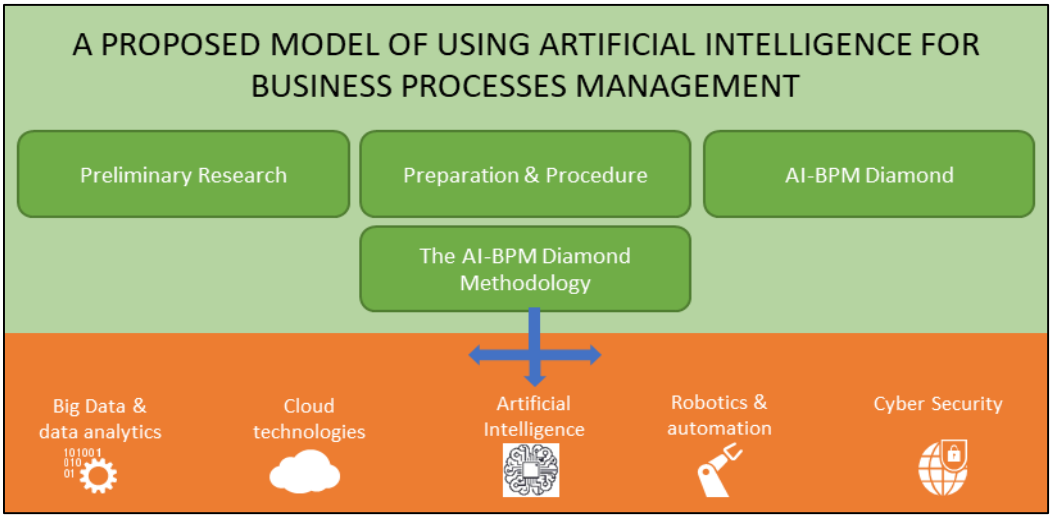

Figure 4.2 Topics addressed in chapter 4

4.1. Preliminary research: AI-BPM design process and first important insights

Previous scientific analyses and studies have provided important insights into the topic to be examined. In the following, the concrete results based on the relevance are presented and the respective core findings are extracted, which are important for the design and use of the AI-BPM system. The pre-conclusion consolidates the concrete aspects and thus leads to the derivation and concrete design of the AI-BPM approach.

4.1.1. Enterprise development with agile business process modelling

As early as 2016, the digital transformation had a strong impact on companies and processes. Initial analyses have shown that processes are rarely updated after the initial establishment and design as could be concluded from some studies. Based on these conditions, the scientific study dealt with the establishment of an agile process approach to be able to react flexibly to trends and corporate decisions. To meet the need for more flexibility, the theoretical approaches BPM and SCRUM (an agile approach to manage projects) were combined (Paschek et al., 2016). On this basis, the "*Holistic agile BPM model*" was created.

The centre of the model represents the phases of BPM, from design to optimization. In the second phase, the modelling, the link to the SCRUM process is established, through which the agile management of the process backlog takes place. Once the process has been optimized and is in execution, monitoring and verification take place. This should be done by five general controlling steps to make the adjustments and impacts measurable and thus be able to make an assessment (Paschek et al., 2016).

Within the scope of the scientific study, 242 participants from 68 different companies and six different industries were interviewed on the topic of agile BPM and the model created (Paschek et al., 2016). In summary, it has been shown that:

- "The primary objective of BPM in practice constitutes the increase flexibility;
- BPM is mainly applied to the value-adding processes and not holistically to all processes in the company;
- Most respondents work without performance indicators, making it difficult to compare and evaluate a process;
- Less than 20% perform regular process analyses and evaluations and do not improve the processes continuously;
- Organizations which do regular process controlling are using IT support and evaluate on average the collected process data on a monthly or weekly base to identify possible reasons for deviations shortly".

The study has shown that insufficient attention is paid to "the process of process controlling, which is established as a fundamental step and regular task in the BPM process model". The focus should be on the core processes, but the support processes should not be forgotten (Paschek et al., 2016). An important key message is that BPM must be carried out continuously to be able to react to new organizational circumstances. Methods like the PDCA cycle or the developed "Holistic agile BPM model" can provide a helpful guard rail for orientation and implementation.

4.1.2 Automated Business Process Management – in times of digital transformation using Machine Learning or Artificial Intelligence

The purpose of the scientific investigation was to analyse the consequences of the digital transformation on BPM while using methods like machine learning and AI. The framework conditions of the Industry 4.0 age and other technological developments such as Big Data or Cloud computing were considered. To obtain a high degree of validation, first a survey with interview characteristics and second a shadowing in so-called "digital companies" have been conducted. This made it possible to benchmark the findings of the survey directly in shadowing results. Attendees of the guided survey were 65 C-level and process managers from 25 different companies. It became clear that (Paschek et al., 2017b):

- "51% rate data as strategic assets and the foundation of the optimization;
- 85% want more process optimizations and automated BPM applications;
- 75% of the respondents know the terms AI and machine learning but only 29% assess machine learning actually;
- 2% execute deep learning".

Furthermore, the survey showed that "process optimization is the most important and best evaluated application of AI in 2017, with 29%. The outlook to 2020 shows the increased position up to 61% for more process optimization and more automation. Regarding the use of AI and machine learning, it became clear that process optimization and automation have been the focus topic of managers until 2020" (Paschek et al., 2017b).

Based on the survey results, a threshold value was calculated, which was set in comparison to the shadowing results. This comparison regarding the degree of data analysis, data collection, process automation and application of BPM shows a clear divergence between the interview results and the business evaluation by shadowing, as depicted in the following Figure 4.3.

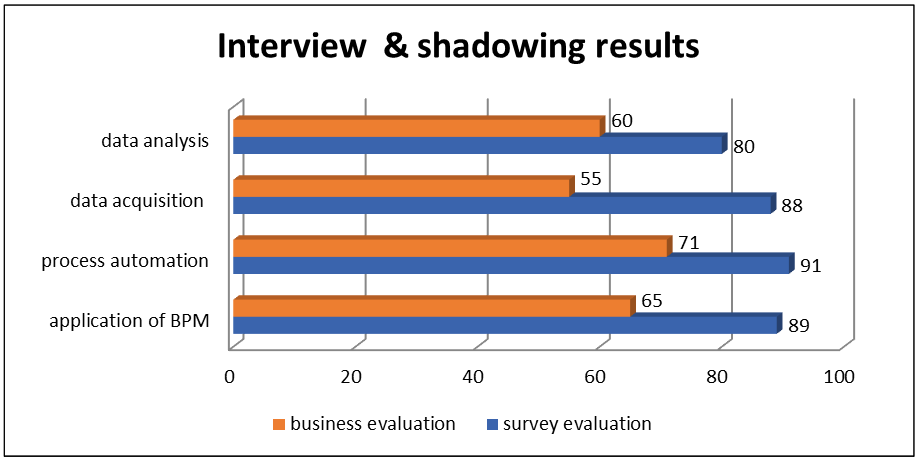

Figure 4.3 BPM AI - Interview vs. shadowing results

Furthermore, two main findings can be derived from the scientific study (Paschek et al., 2017b):

1. "The participants' self-assessment is on average 24.25 points better than the actual business assessment;

2. About 45% of the compiled data from the companies are not used or controlled effectively".

Based on all the collected data and the important findings from shadowing research, it becomes clear that the monitoring and controlling of BPM are not well set up in practice, otherwise, the depicted deviations would be much smaller. In addition, a large part of the available data and information is not used (Paschek et al., 2017b). From this, clear optimization potentials can be derived for the use of AI and ML with Big Data in practice to use the power of their data to drive smart and profitable decisions.

4.1.3. Business Process as a Service (a cloud-based process management)

As presented in chapter three of this work, theory knows a variety of different approaches to optimize processes. The focus was on examining a "special form of cloud process management - Business Process Management as a Service (BPaaS) in relation to the SMAC (Social, Mobile, Analytics, Cloud) trend" (Paschek et al., 2017d).

The scientific study showed that the IT architecture and integration into the existing IT landscape make an important contribution to the successful implementation of cloud-based process management. Furthermore, based on over 100 managers from different organizational sizes interviewed, it came clear that 68% estimate the organizational process transformations skills as bad in consequence of (Paschek et al., 2017d):

- No insight into the organizational processes;
- Paper-based processes;
- Missing information and communication about processes.

Furthermore, the survey of the participating managers showed that there are five concrete requirements for cloud-based process management in terms of its functionality (Paschek et al., 2017d):

- "Process design, implementation, analysing and monitoring components;
- Integration and Connectivity to all systems and one central data lake;
- Workflow management with business rules and target management;
- SMAC integration with a business intelligence module;
- Mobile device usability to interact and adopt processes in real time".

The study has shown that a holistic view of processes "is a necessary reaction to increasing market competition and growing complexity. This reveals optimization potentials" that can be adapted at any time by means of cloud-supported process management (Paschek et al., 2017d[53]).

4.1.4. Organizational Knowledge Management with Big Data (the foundation of using AI)

The basis for the use of AI is a basic set of data and information as well as corresponding algorithms of the AI system. Up to now, it has been unclear to what extent knowledge management in relation to big data and its execution plays a role for AI in times of digitalization (Paschek et al., 2017c).

[53] Retrieved from: http://www.toknowpress.net/ISBN/978-961-6914-21-5/papers/ML17-029.pdf

A knowledge model of AI was developed based on the current state of scientific knowledge. It has been designed based on the "theoretical study to provide the AI systems with all necessary data to drive the best and correct decision without human interaction. Core and basis of the approach will therefore be the compilation of the available data and information by Big Data" at the right site and the organizational KM on the left site of the Figure 4.4 (Paschek et al., 2017c[54]).

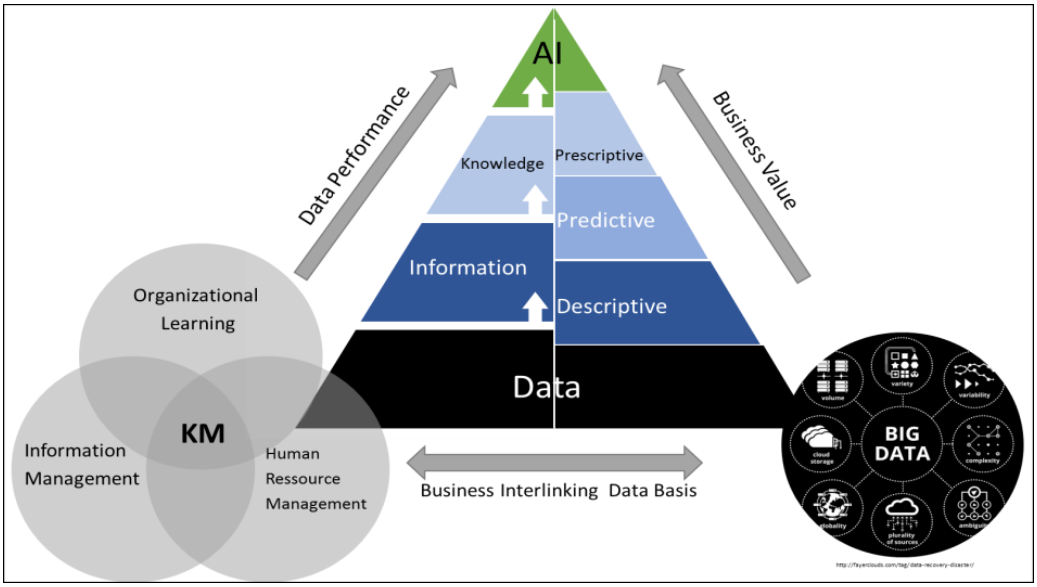

Figure 4.4 The AI-KM Model (Paschek et al., 2017c)

Through the combination of KM and Big Data, the AI System at the top of the pyramid will be able to provide the best decision. The model also points out that the company contains a large amount of information and knowledge, which is often not included in important business decisions. When using big data, care should therefore be taken to ensure that data, information, and knowledge in the company have a decisive influence on the decisions to be made. In conjunction with Big Data, this can create an important advantage for identifying trends in advance and making the right decisions in the company. The research shows that (Paschek et al., 2017c):

- "18% of the companies surveyed have not established a KM;
- 68 % agree with the opinion: Knowledge is the result of perception because it is fleeting, obsolesces, sometimes loses its truth content or can be lost;
- 58% do not have the information they urgently need for processing their work;
- 91% of respondents would integrate and combine Big Data and KM;
- 85% are interested about using AI to operate and process the data and information of the KM and Big Data;
- The biggest challenge will be to settle the level of quality of content".

The analysis has shown that there is a strong correlation between KM and Big Data. So far, the application has been rather limited in practice. The potential to be

[54] Available also at: https://www.scribd.com/document/382614913/Proceeding-Brcebe-icebe-2017

developed from this is all the greater, considering that one of the most important skills of a future successful company will be the flexible handling of data and knowledge. Beyond that, managing this data and collecting, selecting, enriching, and transferring knowledge are becoming increasingly important. But "the main task is to analyse the wealth of data in connection with individual business perspectives and experience backgrounds and to transform it into an *objective* knowledge package for a basis for decision-making" (Paschek et al., 2017c).

4.1.5. Knowledge Management (the foundation for a successful Business Process Management)

Previous scientific studies have shown that organizations often do not have enough information about their processes. Since this is an important basis for the application of BPM and for the optimization of processes, it was necessary to examine the influence of knowledge management on BPM more closely. Therefore, the previously gained knowledge as well as the process for building knowledge were examined in detail and the link to BPM was established (Paschek et al., 2017a)[55].

The analysis has shown that KM and BPM are in a dual relationship. KM and BPM are interdependent and have come together because knowledge must be absorbed within the organization through business processes. Without knowledge and KM, process optimization and the definition of new processes would not be possible (Paschek et al., 2017a). Zhu (2015) underlines this by the following statement: "*It is a fair statement to say that in an environment where knowledge and processes are managed separately, they quickly become obsolete and will not be competitive against organizations that allow their teams a synergistic approach of KM and BPM*".

To support the business for the usage of KM for BPM, the KM-BPM Model was introduced and evaluated. As shown in Figure 4.5, the different databases for knowledge generation are mapped as input for the KM process.

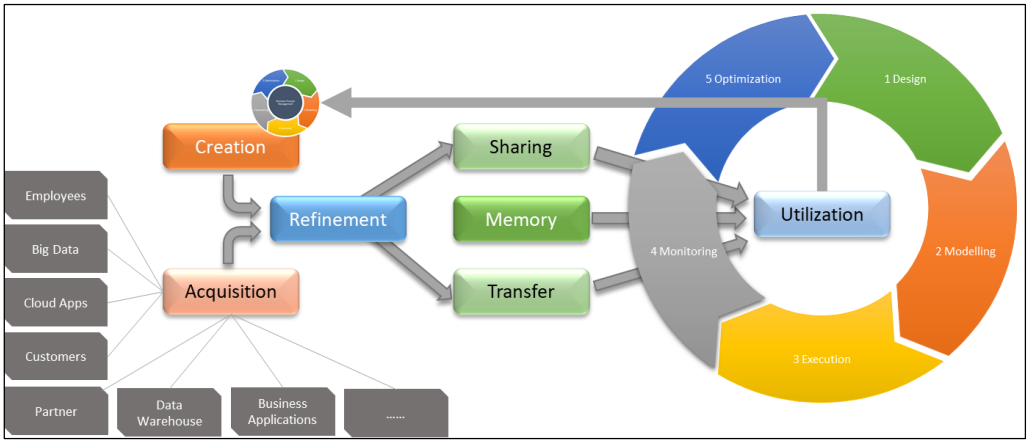

Figure 4.5 KM-BPM Model (Paschek et al., 2017a)

The output of KM is used for the BPM. It is important to note that the experience and knowledge generated by BPM generates knowledge that flows into KM

[55] Retrieved also from: https://www.scribd.com/document/382614913/Proceeding-Brcebe-icebe-2017

as input. This establishes a cycle that allows the continuous knowledge from BPM and knowledge from other resources to be used for process optimization. During the evaluation of the model in practice, the following insights were gained (Paschek et al., 2017a):

- 60% of the participants see a hazard in using incorrect or outdated information in KM;
- 12% have the problem of not capturing focus information within KM;
- 72% recognized that the own business can be optimized by a meaningful KM as basis for BPM;
- 16% think about automated information and management with new technologies like AI.

Based on virtualization, customers, suppliers, and other parties involved will come closer together and will be able to manage and edit processes in real time. The execution of KM leads to improved organizational capabilities by better use of individual and collective knowledge. Therefore, BPM and KM must go hand in hand to be competitive in times of faster changing business conditions and global competition (Paschek et al., 2017a).

4.1.6. AI impact on the decision-making process

Based on the underlying models of the DMP and the hierarchical levels of decisions, it was found that with the help of AI and DSS, an important foundation for adequate decision management in the age of digitization can be established in the company. To support the business, an AI-DSS approach was developed, which is shown in Figure 4.6 (Paschek et al., 2018).

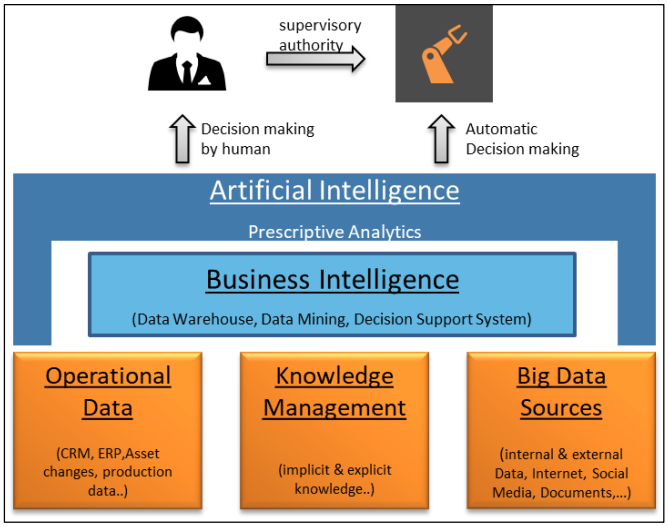

Figure 4.6 DSS -AI Implementation Approach

The approach describes the underlying databases, starting with Operational Data, Knowledge Management Data, and a Big Data Source. The Business Intelligence component above it processes the data from the various sources and thereby generates relevant information for the enterprise. The AI module searches for certain patterns in the data and calculates possible decisions and the resulting probabilities

of occurrence based on predefined logarithms. It is important that the decisions in the model are ultimately validated and made by a human being. Only when the AI model is sufficiently supplied with data and information and the machine learning component has been successfully tested can the system be released for automated decisions (Paschek et al., 2018).

The application of the underlying approach in three companies showed that (Paschek et al., 2018):

- "24/7 machine-based data gathering, processing, evaluating and preparation for decisions without any human led to resource savings, lower costs in the following and free resources for skill shifting;
- 35% fewer "bad business decisions" as opposed to before;
- Less human weakness by feelings, emotional habits and concentration on clear facts led to 15 % more revenue;
- Identification of customer and product correlations which led to better sales activities, more revenue and a 9% higher customer satisfaction"[56].

During the application, it could also be established that the possibility of intervention was particularly important for small and medium-sized enterprises to diminish their dependence on the system. The understandable and noticeable effect results from possible wrong decisions or interpretation of the data situation due to a faulty algorithm. In addition, it was noted that not only figures and facts must be analysed and interpreted. In addition, human behaviour and emotions must be considered in business decisions, which influences the DMP. Moreover, the context of data and certain influences can play an important role and must therefore be considered by the system in some way (Paschek et al., 2018).

The scientific analysis as well as the implementation of the AI-DSS approach show that the combination of Big Data, AI and DSS systems has a positive impact on the business decisions of a company in the Industry 4.0 and 5.0 era (Paschek et al., 2018).

4.1.7. Prerequisite for the AI-Decision-Making Process

Chapter two of this thesis has already pointed out that an AI implementation should always be accompanied by a data strategy. The core issues here are data quality and data quantity and their preparation, storage, analysis, and processing into information to be able to develop a DMP on this basis. In addition, "three specific implications for companies to create effective and valuable AI-decision-making systems should be considered" (Paschek et al., 2019b):

a) "Differentiated data is the key to a successful AI game;
b) Meaningful data are better than comprehensive data;
c) To know what is most important for the DMP".

Based on interviews conducted in 22 companies, it has been shown that "59% of them used all possible data sources and data to obtain as many evaluations and analyses as possible". In addition, 32% of companies interviewed perform data analysis but do not derive any actions because of (Paschek et al., 2019b):

- "30% -lack of strategy for data and AI;
- 29% - insufficient data quality;
- 16% - sense to use wrong data;
- 15% - lack of skills to adopt the system;
- 10% - other reasons".

[56] Retrieved from: https://link.springer.com/book/10.1007%2F978-3-030-44711-3

The analysis of the findings shows that by establishing a data strategy in the company, 75% of the uncertainties could already be reduced to create greater confidence in the company's data. To obtain a scientific comparison, eight major, important companies were selected. A data strategy for the company was developed, implemented, and communicated with the management and the respective custodians. This made it possible to carry out a before-and-after comparison of the organizations. As can be seen in Figure 4.7, the two evaluations were compared.

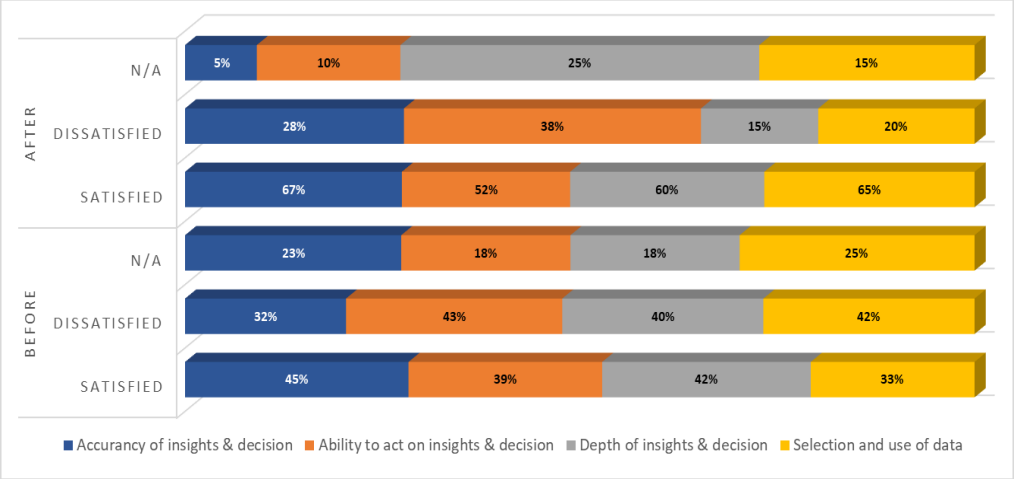

Figure 4.7 Data Strategy Implementation - Interview results (Paschek et al., 2019b)

"Before" maps the values of the evaluation before the data strategy is implemented. As can be seen in the Figure, four main questions were identified and analysed (Paschek et al., 2019b):

- "The satisfaction and accuracy of insights and decisions;
- The ability to define activities based on insights and decisions;
- The depth of insights and decisions or whether they were superficial;
- The satisfaction of data selection and use".

The analysis has shown that a clear and focused handling of data within the framework of an established data strategy generates advantages for the company. Specifically, it has been shown that (Paschek et al., 2019b):

- "50 % - more efficient and effective decisions and insights;
- 25 % - better process optimization and customer satisfaction;
- 10% - better information consistency;
- 5 % - higher employee satisfaction;
- 5 % - decrease in wrong decisions and bad money investments".

Only 5% could not record any increase in value. This study shows that by establishing a data strategy in the company, 75% of the uncertainties are reduced and at the same time the value added by various gains increases by 95% (Paschek et al., 2019b).

4.1.8. Expected impact of Industry 5.0 for business management

Already in chapter 1 of this scientific work, the fifth industrial revolution and the resulting Society 5.0 were discussed from a theoretical and ethical perspective. The study dealt specifically with the analysis of the status quo of digitization in the context of Industry 4.0 as well as with the transformation challenges. The assessment of 85 companies confirms "the assumption that the digital transformation into Industry 4.0 is still running"[57]. The main reasons for these are depicted in Figure 4.8, based on the interviewed respondents (Paschek et al., 2019a).

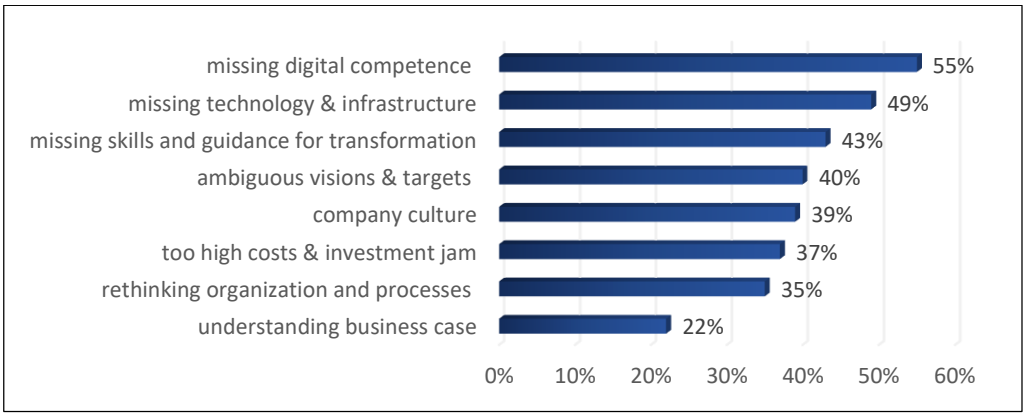

Figure 4.8 Transformation issues and threads into Industry 4.0 (Paschek et al., 2019a)

As can be seen, there is mainly a lack of employees with the corresponding competence. Therefore, "well-trained employees and an open culture could overcome the lack of knowledge. The second biggest problem, with 49%, is the lack of infrastructure provided by cities and countries, and excessively long waiting times for products and services. Nevertheless, a lack of transformation and technological competence, combined with excessively high costs and an investment backlog, together form a transformation issue for the business. Not to forget that clear corporate visions as well as unformulated corporate goals lead to an unclear roadmap at 40% and impede the transformation". It must be pointed out again that the strategy of a company and the data and AI strategy derived from it are an essential prerequisite for successfully establishing AI in the company (Paschek et al., 2019a).

In addition, the participants and participating companies were asked about their experiences and assessments of the application of the 5th Industrial Revolution. The answers, as shown in Figure 4.9, show that especially the manufacturing, technology and communication industries are already partly in the transformation to Industry 5.0.

On the other hand, other sectors have so far had little or no contact with the term Industry 5.0 and the associated potential. This picture can also be presented for Industry 4.0, as many companies and sectors have not yet completed their transformation (Paschek et al., 2019a).

[57] The information is available at: http://www.toknowpress.net/ISBN/978-961-6914-25-3/papers/ML19-017.pdf

"It is disturbing that not all companies and industries are looking ahead and are still at the beginning of Industry 4.0 and digital technologies, as the technologies used and applied there are the basis for the fifth industrial revolution". "It can be expected that the next revolution will also have an impact on the economy and management in terms of collaboration between people and intelligent technologies. On this topic, it is important to remember that the definition of the industrial revolution includes the use of advanced machines to make people's work easier and faster" (Paschek et al., 2019a).

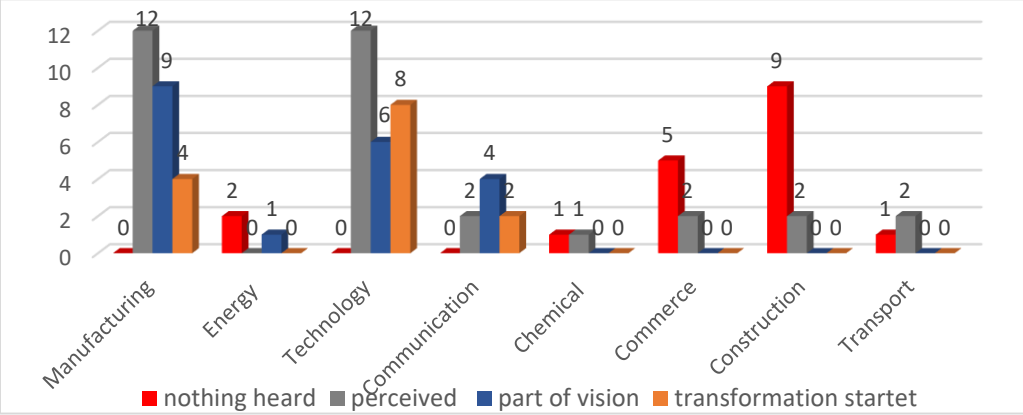

Figure 4.9 Industry 5.0 readiness (Paschek et al., 2019a)

4.1.9. Facts and key findings – preliminary conclusions

The various scientific studies have shown that the different branches of industry deal differently with digitization. It should be noted that small and medium-sized companies have more difficulties with digitization than big companies. Two emerging reasons are that large corporations have a broader range of know-how and usually also a significantly larger budget for innovative topics.

Based on the knowledge gained in each case, a solution design and approach for the problems were developed. The testing and implementation showed the advantages and disadvantages relatively quickly and thus provided important key findings for the AI-BPM Approach as listed in the following:

- Process management and the optimization of the process chain from an end-to-end perspective show a strong future demand in business;
- In the future, the value chain of a company will increasingly be extended by end customers and suppliers, making a different way of integration necessary;
- Digitization is still being implemented in many companies, but some industries are already ahead and recognize Industry 5.0 Revolution and its benefits for people and companies;
- The establishment of a corporate strategy and the derivation of goals and tasks to the management and operative levels are an important prerequisite for sustainable success and the pursuit of a vision in the organization;
- There is often a lack of clarity in the organization about fundamental issues, which gives employees and managers room for interpretation when performing tasks. This reduces business value and entrepreneurial success;

- The application and implementation of AI and the sustainable implementation of digitization require the right people and skills, supported by an innovative corporate culture;
- For employees to focus on the right issues, management and their leadership skills are of great importance. Without motivation and backing of the employees, mistakes are avoided and the step towards the new one is not taken;
- The drive to do something new and to develop efficient and effective approaches to become constantly better and to have sustainable success is characterized by the innovative spirit of a company;
- The use of AI for BPM is characterized by a strong dependence on Big Data, Knowledge-Management, Decision-Making and BPM implementation in the enterprise. For this reason, integration into the established IT structure and technology assessment is an essential component for establishing a successful AI-BPM model;
- The AI-model is not to be established only once by a lot of available historical data, but to be constantly trained by new data sets to keep the system up to date and to achieve the best results in the analyses;
- The company understands and can measure the causal factors and provide context information. Without context information, the AI system may fail to interpret the data (Pucher, 2016);
- The possibility to manually intervene in an automated decision system creates a better acceptance in business;
- The use of mobile devices as well as the possibility to receive a continuous status report on process KPIs will strengthen the SMAC trend;
- The information of the employees and a constant communication about the introduction of new technologies and methods support the well-being of the employees (Gene et al., 2018);
- Business Process Management is an integrative and important task in a company supported by a multitude of dimensions. By focusing on BPM, a company can generate sustainable success;
- In addition, the surveys and interviews at the C-level have shown that managers and entrepreneurs find themselves in a dilemma between two worlds shaped by:
    - Break down barriers and tradition vs. enforce policies;
    - Fail fast vs. be defect free;
    - Ability to change vs. ability to stand firm;
    - Predictive and prescriptive insights vs. rear view KPI handling;
    - Establish MVPs vs. fully ready products;
    - Customer first vs. people first.

Regarding these key findings, it can be stated that, from an aggregated perspective, various levels are influenced by the developments and findings shown in the context of digitization and industrialization. This refers to the changes at several levels, including the following:

- *Business Level* – by changing E2E value chains and new ecosystems;
- *Organizational level* – new strategy approaches combined with new product offerings and services;
- *Process Level* – by fostering automation and AI throughout new approaches;
- *Society level* – by Industry 4.0 and 5.0 and changing society structures.

The research of Parviainen et al. came to the same conclusion that digitization shows a strong influence on these four levels. Furthermore, the previous analyses and theoretical discussions show that further levels are influenced in the business context (Parviainen et al.,2017).

- *Management Level* – by new leadership approaches;
- *Employee Level* – by people and culture development;
- *Technology Level* – by executing new technologies and integration into existing IT landscapes.

These key findings are the essential part of the AI-BPM Approach, which is complemented by the AI-PBM Diamond.

4.2. Preparation and procedure of the design

Based on my own experience in the IT consulting, it has been shown that similar questions and problems occur again and again in business. The preliminary studies carried out in advance have confirmed the problem picture, so that at the beginning the analysis of the business was the focus. In concrete terms, this means understanding the business and its requirements to subsequently identify possible solutions. After it became clear that most companies are not able to manage their processes properly and that this is due to various causes, and that digitalization has only rudimentarily entered the companies, it was possible to formulate the problem as a thesis with a view to the future. This is indicated in Figure 4.10 in the first step, "Set up and Model design".

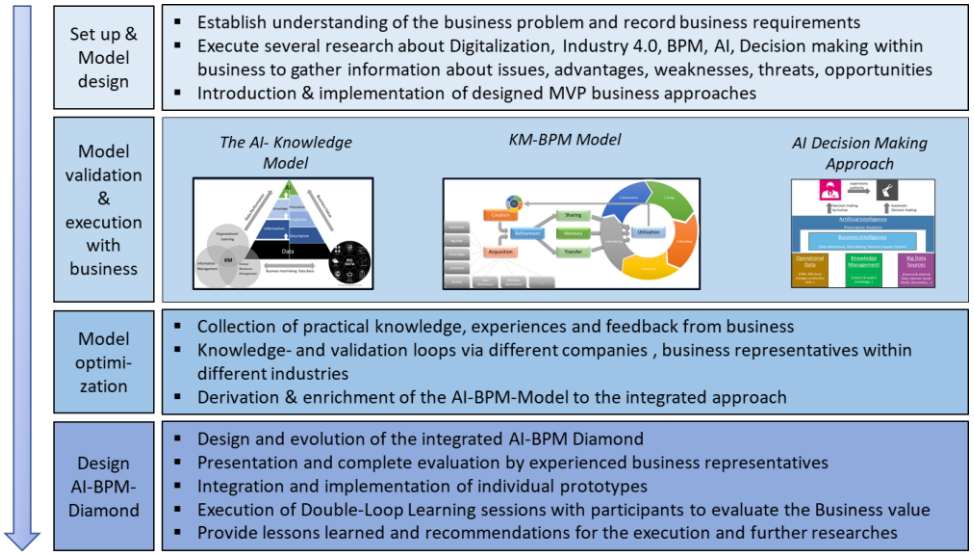

Figure 4.10 Procedure and preparation of the model design

In addition, further studies were carried out and models developed that were validated and tested in use with companies. These MVP Approaches have been continuously developed and have remained in use with companies for a longer period to allow for relevant before-and-after comparisons, as can be seen within step two in Figure 4.10. The results can be found in the respective preliminary studies and chapter 4.1.

The knowledge gained and the experienced knowledge have led to the derivation of a holistic approach for the AI-BPM model. The previously collected feedback, the ideas gained, and the advantages and disadvantages identified were applied in the third step, the "model optimization". Furthermore, it became clear that

the sole concentration on the AI-BPM model, without a reflection of the environmental parameters, will only lead to the desired sustainable success to a limited extent.

Therefore, in the last step, the "Design AI-BPM-Diamond Model", the AI-BPM model was enhanced by different dimensions to the AI-BPM Diamond, which addresses the different company levels and environment parameters by executing AI-BPM. In this step, one use case was selected where the AI-BPM Diamond is applied to generate sustainable business success with AI process management.

4.3. The AI-BPM Diamond Model

The AI-BPM Diamond describes the approach of a holistic view of the process-oriented enterprise. It serves as a thought model, process model and framework for the analysis, planning and management of process-oriented enterprises and consists of the following dimensions: Strategy and Governance, Organizational clarity and Leadership, Competence and Methods, Culture, Technology Acumen and at the centre of the Diamond from the AI-BPM Implementation Model, as the core for implementing and using AI for BPM, as can be seen in Figure 4.11.

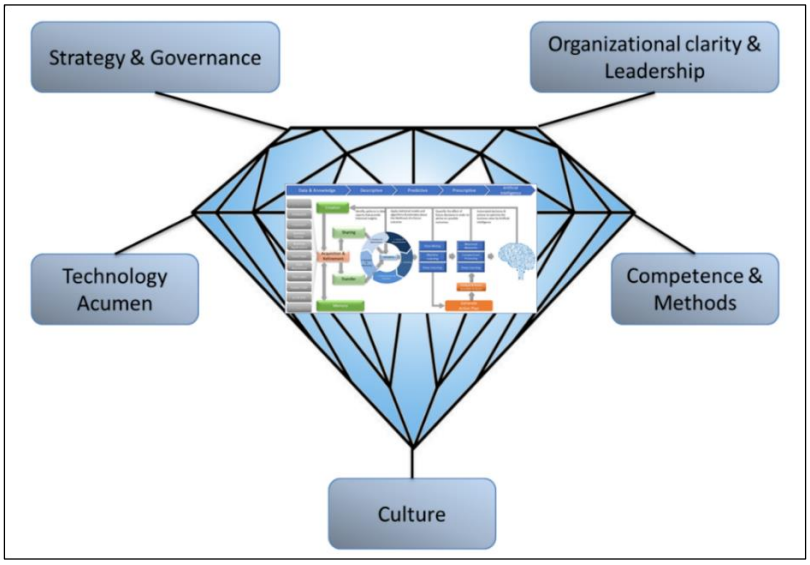

Figure 4.11 The AI-BPM Diamond Model (own development)

The discipline of BPM, and thus organizational development, is, along with the basic elements, the main driver through which a goal-oriented development of the organization is kept going. It supports a continuous reflection of the status quo in the company and accompanies the implementation of planned changes. There is a reciprocal relationship between the various elements, which in metaphorical parlance can influence the composition and purity of the Diamond. It should be noted that an isolated change of individual elements without considering the interrelationship can lead to subsequent problems and thus to an only partially successful AI-BPM implementation. Especially the holistic view is an essential lever for a sustainable implementation and the desired business success. The AI-BPM Diamond is used as a useful approach in several ways:

- In the context of establishing an AI-BPM oriented organization, the model is used to analyse the initial state of the organization to determine necessary measures for developing process orientation;
- If the process orientation is already established to a certain degree, further necessary developments and changes of the organization can be aligned with the Diamond to ensure a sustainable and effective implementation;
- Furthermore, the AI-BPM Diamond supports the reflection about the current state of a company and furthermore the exchange about the concretization of a future target state.

To better understand the interaction of the dimensions as well as the central components, these are explained in the following.

4.3.1. The AI-BPM Implementation Model

The AI-BPM Diamond provides the global framework which enables the execution of the AI-BPM implementation model. As depicted in Figure 4.12, the proposed AI-BPM model is deployed on five various stages, which are illustrated on the top and can be characterized by the following ideas that were considered in the design process.

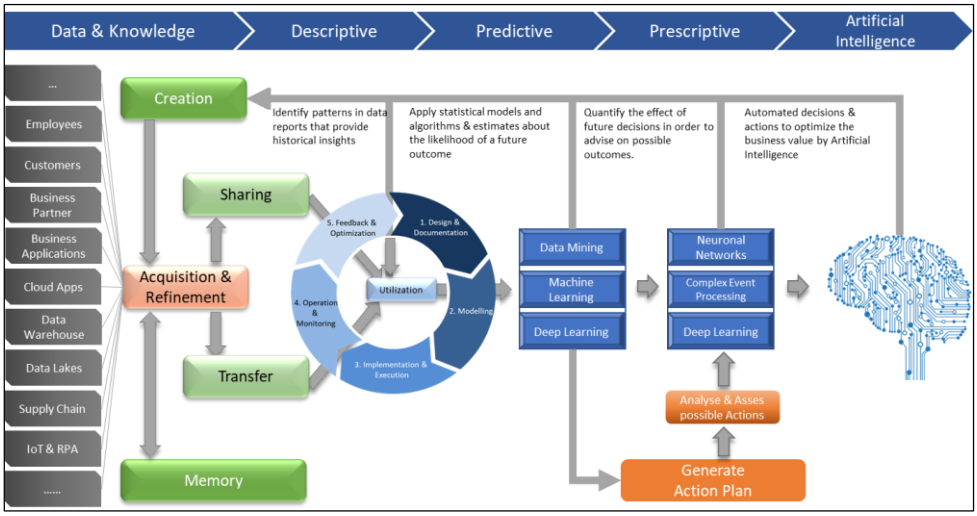

Figure 4.12 The AI-BPM Model (own development)

Within the first stage, the "Data" stage, all the required and different specifications and data from several sources like employees, customers, internal databases like Data Warehouses or Data Lakes as well as data from business applications and whole supply Chains have to be collected. Within the next step, the raw data will be refined by memory data, information, or knowledge. In addition, new created and improved data from previous enhancement sessions refine the delivered one too. This new set of data awareness will be shared within the required departments of the company. With the transfer and sharing section, the next stage is obtained. The "Descriptive" stage is characterized by analytics based on data aggregation and data mining for the descriptions and summarization of raw data to make it interpretable by humans. These deliverables grant insights into the past. The past refers to any point of time that has occurred. "Descriptive" analytics are useful

because they answer the question: "What has happened?" to learn from past actions. The outcomes are identified patterns by data reports, averages, percent changes and arithmetic sums, which provide historical insights regarding different fields within the company like the supply chain from the purchase over production to sales or process adaption rate as well as customer or operational insights. Based on this data, the goal is to understand how the relationships, patterns, collected data and information could affect the future results of the company. Therefore, the distinct phases of utilization (Design, Modelling, Execution, Monitoring, and Optimization) are carried out to deviate operation as well as strategic recommendations for the improvement of the company in various fields. To use these newly developed insights and findings, the lean back loop transfers these to the "Creation" part. Within the next "Acquisition and Refinement", these insights will be used.

In the following, the so-called "Predictive" stage, the analysed data, patterns, insights, developed findings and statistics are used to predict what might happen in the future. The statistics take the data that have been gathered to "apply statistical models and algorithms to capture relationships between various data sets in addition to previously identified patterns to gain an outlook and understanding to the future to answer the question: "What could happen?" Predictive analytics can be used throughout the organization, from forecasting customer behaviour, identifying trends or forecast demands for inputs from the supply chain"[58]. Therefore, Data Mining as well as weak AI like ML or Deep Learning methods are used. In this connection, ML "at its most basic is the practice of using algorithms to parse data, learn from it, and then make a determination or prediction about something in the world" (Copeland, 2016). Concisely, ML uses statistics and algorithms to analyse data, which are learnt from that and make informed decisions based on the underlying data. Deep Learning is a part of Machine Learning structures algorithms in layers to create a "neural network" that can learn and make intelligent decisions. It is important to recognize that the foundation of predictive analytics is based on probabilities. Based on the different predictions, an action plan will be generated, which is an input for the fourth stage of the AI-BPM Model. Next to the action plan, all predictions and forecasts will be transferred via the lean back loop to the "Creation" part to enrich the next "Acquisition and Refinement loop". The actual state of science regarding supply chain simulations refers to "three classes of software tools (all-purpose discrete event simulation tools; specific supply chain simulation software and supply chain management software with simulation functionality) and two classes of dynamic models (continuous and discrete models)"[59] which can be included in the predictive stage (Ivanov, 2018).

Within the "Prescriptive" stage, the possible activities from the action plan are analysed and assessed regarding their probability of occurrence as well as impacts and consequences concerning the company. By the combination and execution of Deep Learning, Neuronal Networks as well as the Complex Event Processing Method, business rules, algorithms, the effect of future decisions will be quantified to advise on multiple possible outcomes based on their actions before the decisions are made. These complex courses of action can generate a significant impact on business decisions as well as the future strategy of the company to optimize the supply chain, for example improving the customer experience as well as the turnover. The "Prescriptive" analysis should not only predict what would happen, but also why it will

[58] As mentioned also in: https://www.logility.com/blog/descriptive-predictive-and-prescriptive-analytics-explained/

[59] As presented in: https://link.springer.com/book/10.1007%2F978-3-319-69305-7

happen. Therefore, it generates recommendations regarding actions that will take advantage of the predictions. Based on the recommended perception, a strong AI will be executed and assesses the best prediction for the company within the fifth stage of the model. To generate and save the outcome of this stage, the defined predictions and recommendation will be handed over to the "Creation" part the via lean back loop, as described within the stages before.

An implemented AI characterizes the final stage of the AI-BPM Model, called the "Artificial Intelligence" stage, which will be able to assess and execute the recommended perceptions by its own. This implies the interconnectedness of the AI module as well as a fully digitized AI-BPM Model. The executed decision and changes within the supply chain will be logged and saved carefully to have the opportunity to track and roll back the AI actions by human. Next to the logging, all data and information will be transferred via the lean back loop too.

These five stages are performed consistently by gathering internal and external data, whereby new indicators, incidents, occasions, or problems can change the outcome. Referring to the supply chain, many specific use cases like supplier management, procurement improvement, inventory optimization, increase of logistics efficiency as well as production enhancement, reduction of waste and increasing sustainability by optimal material usage and many more can be optimized by the model. The big advantage will be the holistic approach of analysis and execution. Not only the described model will focus on specific use cases, rather, the whole supply chain can be analysed and evaluated regarding positive and negative impacts by any changes.

The described advantages of using AI are comfortable but also linked with risks. For instance, falsely interpreted data and programmed algorithm can lead to wrong patterns and statistics, which will have an impact on the recommended actions. Furthermore, fake news may lead to incorrect actions and negative adjustments of the business process. Next to this, the degree of independency of the AI system must be analysed and programmed carefully. If there is no intervention approach by humans, the machine or maybe the hacked machine via cyber criminality can ruin the whole business. In exaggerated terms, this can be described *as shit in shit out*, considering the data sources. If the programming of the algorithm is only one-sided or if only certain data is used for training, a decision can only be made on this basis.

4.3.2. Organizational clarity and leadership

"There is no question about it: technology is the driving force behind the new style of leadership", said Holger Arians, co-founder of PLDx.org and CEO of Dominet Digital Corporation (Arians, 2017). Furthermore, successful leaders have understood these paradigm how much connected devices and AI can aid to manage and develop people and empower companies. Therefore, the most meaningful ways are (Arians, 2017):

- Giving your employees more flexibility by a positive work-life balance through collaborative working by a decentralized business environment to force a positive behaviour and a comfortable feeling for being creative and engaged;
- Be an influencer and inspire employees, motivate the sales teams, build customer loyalty, and connect with peers through various social media platforms and blogging.

In addition, Klaus Schwab calls for leaders, "… *putting people first, empowering them and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people"* (Marr, 2018b;

Schwab, 2017). Leaders must understand and adapt the spirit of change by digitalization and take out the fear of employees regarding the predicted job loss in the age of automation and IA where 800 million people might be out of a job by 2030 because of automation (Malito 2017; Marr, 2018a; Kroker, 2019; Wazed, 2019). Therefore, leaders should be equipped with the skills to lead organisations through these changes, to act proactively to better prepare people for the changes and the critical thinking skills they will need in their future workplace. (Marr, 2018b).

While Leadership 4.0 was "doing the right thing, but for the wrong reason" like Empowerment, high motivation of employees but totally profit driven, at the expense of the customers, Leadership 5.0 is doing the right things well for the right reason (Cope et al., 2018). This simple approach can be supported by the three principles for augmenting leadership (Aurik et al., 2018):

1. *Human centricity:* using technology to boost human qualities of ingenuity, judgment, contextualization, creativity, and social interaction by putting human beings in the centre of the approach;
2. *Full circle:* Strategy without action is just fantasy. To fulfil strategy, people must be able to effectively collaborate, and their experiences must be captured to create a source of shared learning that improves future efforts;
3. *Followership*: Leadership is ultimately defined by its ability to create followership by setting a goal, be authentic, be part of the team as well as coach in one person to requires of the people to be truly engaged with the tasks at hand, and to have a greater collective role in defining the organization's future.

By the faster changing frameworks of business and economy as well as social implications, a new style of leadership has to be executed to generate a positive and focused team who is able to adapt to the changes and to shape them in a positive way for the organization. Therefore, the leader should be able to show the sense of the tasks and have a vision in which the team and the organization can participate.

Industry 5.0 recognizes that man and machine must be interconnected which will lead to a human and robot workforce (Østergaard, 2018). This will call for a new executive role, the chief robotics officer (CRO), who will be responsible for planning and managing all actions related to robotics and intelligent systems (Fazzi, 2018). This assumption can be underlined by a report from Myria Research which forecasted that by 2025, more than 60 percent of manufacturing, logistics and supply chains, agri-farming, and the oil, gas and mining sectors will have CROs (Fazzi, 2018).

The core value of a company is derived from the services or products and the value the organization offers to the customers. Organizational clarity is one of the most important prerequisites for creating an insight into the value of a company, which includes your competition, your position in the market and your clear and strong vision, purpose, core beliefs and goals (Prichard, 2018; Gore, 2017; Kochhar, 2016). At this point, reference can be made to the BPM business pyramid in Chapter 5, which already draws attention to the importance of having a vision, strategy and the goals and tasks derived from it. Gore and other authors describe clarity as the most important competence a manager and organization must possess (Prichard, 2018; Gore, 2017; Kochhar, 2016). Clarity can be understood as a clearness, lucidity, and simplicity as to perception or understanding; a freedom from indistinctness or ambiguity (Gore, 2017)

Beyond that, Gore (2017) describes: "*Organizational clarity is the greatest strategic advantage the organization can have. Initiated in strategy, embodied by leadership, and delivered by teams, clarity provides the foundation for bottom line results. The main function of a leader then is to provide clarity around six basic questions: who, what, when, where, why, and how*. *An absence of clarity on these*

questions will result in confusion about expectations and mistrust. It impacts results and influences the speed at which an organization can move".

The results of the preliminary research have shown that often these six basic questions cannot be answered. This lack of clarity means that companies are not aware that their employees and managers do not work in a business goal-oriented manner, but only interpret the goals or visions and have not clearly understood what is important. Accordingly, two important things are needed to create clarity within the company. On the one hand, the management and leadership must be aware of what they are doing and answer the basic questions, and on the other hand, the results must be communicated and made known and, moreover, understood by the employees. To achieve this clarity in the company, the following three steps can be helpful, as also shown in Figure 4.13. First, the organization should create an understandable vision and mission to answer the questions of where, when, and why for itself. This is about the purpose of the organization by asking questions like: Why does your organization exist? Why do you deliver those goods or services? (Prichard, 2018).

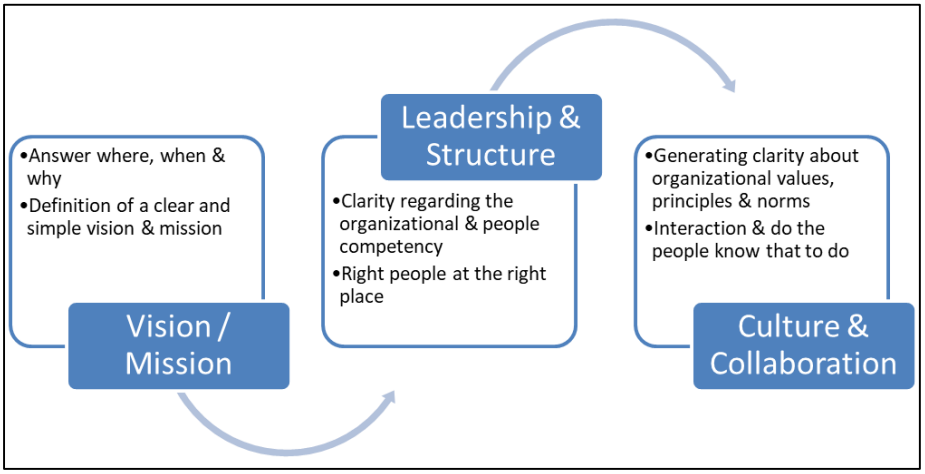

Figure 4.13 Steps to organizational clarity

The purpose provides people with the context they need to understand how the organization's strategy, resources and priorities are moving them in one direction. It also enables employees, customers, and partners to focus on why they do what they do and to be proud of their contribution to that goal (Prichard, 2018; Gore, 2017). The definition alone is not enough. A central component of this step, but also in general, is the communication of the findings to enable the entire organization.

The second step is characterized by leadership and the resulting organizational structures. A leader in the true sense of the word is interested in motivating his colleagues and employees and reducing all problems (Gore, 2017). It is about putting the right people with the right skills on the right tasks and positions to achieve the highest possible business outcome. Leadership can only work with communication to take employees along on the path to optimization and to understand their problems or fears. Leadership also means being authentic, making transparent decisions and empowering people (Sinek, 2011). Within chapter 3.3., the Leadership 5.0 approach has already been explained.

The third and final step focuses on the culture of the organization and the resulting collaboration model. The focus is on the values and norms as well as the

principles of cooperation, which are also shaped by steps one and two (Gore, 2017). In addition, in this step, it becomes visible whether the leadership components and the comprehensibility of the answers to the basic questions have reached the teams to pull together.

With the help of these three steps, it should be possible to create the necessary organizational clarity. However, this alone does not necessarily help, because it requires the support of leaders in the company to publish this clarity, to promote the employees and their cooperation to achieve the vision and mission of the company. So, the main responsibility of the leader is: to be clear about where the organization is going, and then to influence the head, hands, and hearts of others to follow (Gore, 2017).

The *Golden Circle* by Sinke (2011) represents a similar approach, which can also be used to achieve organizational clarity with support of leadership. The *Why, How, What* model is composed of three concentric circles that work from the inside out starting with (Sinek, 2011):

- Why - Why and for what actually?
- How - How exactly?
- What - What do we do?

The simple formula behind is: if you do not know what it is for and what has changed when you have been successful, then you have not yet sufficiently questioned the *Why*. And without a good *Why*, strategies or operational measures are far from being as effective and promising as if you support them with a convincing *Why* (Sinek, 2011).

4.3.3. Strategy and governance

Doug Palmer, principal of Deloitte Consulting, has aptly summarized the following in 2015: "The importance of having a clearly articulated digital strategy was a major finding. Those companies developing enterprise-level digital strategies are moving ahead, while those that are not struggling. These digitally maturing companies embrace innovation and collaboration and have leaders who understand both technology and its potential impact on the business" (Kane et al., 2015). In a focused and successful company, the business and data strategy alignment are the most important places to start (Dennis, 2017; Saxena, 2019). Therefore, it is recommended to develop an aligned strategy by business and data parameters. Saxena (2019), CEO and chairperson of Future Technologies Inc. and CEO and chief innovation officer of ACULYST, points out: "*Every company should have the goal of evolving into a digitized and data-centric business. What is crucial for this to happen is understanding the need to treat data as 'corporate asset' and maximize it as a source to benchmark and analyse their progress and core-competitiveness*"[60]. However, the research of challenges and risks indicates a missing strategy as one key challenge with a huge impact on the whole business.

Within the literature, there are many different views and definitions on strategy. A widely used definition comes from Porter (1996), who "defines strategy as a creation of a unique and valuable position, involving a different set of activities to be different and use a different set of activities to deliver a unique mix of value"[61] which requires to execute a trade-off in competing to choose what not to do.

[60] Retrieved from: https://www.dataversity.net/why-your-data-strategy-needs-to-align-with-your-business-strategy/

[61] As mentioned in: https://pdfs.semanticscholar.org/8916/03ec7819b8a36926544613caffd1d76664df.pdf

Therefore, the value chain activities developed by an organization generate competitive advantage. Furthermore, Porter points out that strong leaders are essential to make trade-offs, are willing to make decisions and define and communicate the unique company's position (Porter, 1996).

In brief, the business strategy could be developed with the following steps: (Pahwa, 2020; Saxena, 2019):

- Establishing the mission, vision (+ long-term goals), objectives and core values;
- Diagnosing the AS IS situation with a SWOT or PEST or PESTLE analysis;
- Estimating, forecasting the TO BE situation with trend analysis, including the understanding of the macro trends;
- Performing risk analysis;
- Analysing and evaluating capability gaps with a business unit.

It could be pointed out that strategy sets priorities and shows how to achieve the mission or vision of companies. Today, strategy represents a goal-oriented holistic approach, a long-term plan, as opposed to short-term tactics as part of a strategy (Müller, 2017). This also applies to the BPM lifecycle, in which the strategy plays a relevant role, as shown in Figure 3.5 in Section 3.1.6.

An individually unique corporate strategy is important because it is the orientation that sets the course for the future business. However, a strategy concept can only work if it pursues a clear goal. If it is precisely tailored to visions and a mission, if it brings on board all those involved in the necessary processes, if it takes all relevant aspects fully into account and if it is embedded in a sensible communication concept. The use of methodical strategies is an effective instrument to implement entrepreneurial objectives in practice and at the same time remains within the planned target in terms of costs, time expenditure and quality standards. An essential part of strategy development in companies consists in practice of breaking down objectives at the company level to all hierarchical units and harmonizing them with the culture and philosophy of the company. This creates a holistic process that ultimately leads to the goal (Pahwa, 2020; Müller, 2017).

The business objectives are achieved through the effective implementation of business strategy. The literature distinguishes between the following three levels (Pahwa, 2020):

1. The corporate level;
2. The business unit level;
3. The strategies at the functional level (department or area level).

Furthermore, it also makes sense to have specific strategies for corporate divisions and to derive these from the corporate strategy. For example, the strategy already described for handling data or certain technologies. The steps described for developing the respective strategies for each level represent a supportive instrument for implementation.

In addition to the strategy, a company also needs the potential management to implement and execute the strategies. Corporate governance can be described as the system of rules, practices, and processes by which a company is managed and controlled (Chen, 2019; Smith, 2017). Thus, it is important to apply governance in the company at the important points and to set the direction of development.

In a nutshell, the strategy and governance dimension aim to optimize the way the organization works by defining the policies, rules, and framework for different functions of the cooperation.

4.3.4. Competence and methods

Today's society is extremely fast moving. To be prepared as a company, it is therefore more important than ever to meet the skills and methods requirements of a digital world. Digitalization will radically change the requirements profile of company's employees and shift existing hierarchical levels by a necessary cultural change (Bitkom, 2017). This can be underlined by an extensive global research that include over 1,300 executives, that only 39% of the company's employees have the digital capabilities required and only 35% have the leadership capabilities required (Capgemini Research Institute, 2019). A company should pay special attention to the existing employees by continuous information sharing about all relevant changes and in addition ensure with further trainings and necessary additional qualifications to not lose the connection to the company and economic development (Bitkom, 2017; Probst et al., 2018).

To adapt to the change triggered by digital transformation, the employee of tomorrow must have leadership and entrepreneurship skills combined with research and innovation skills (Probst et al., 2018). This will include a range of (Probst et al., 2018):

- "Hard skills from technical, academic, sectoral, and digital skills;
- Softer skills like problem solving, creative and design thinking, communication, emotional intelligence, multicultural openness, leadership, managerial and interaction skills"[62].

The need for skilled and well-trained people has already attracted attention in the EU. To meet the demand for new qualifications, the EU has launched "*A New Skills Agenda for Europe: Working together to strengthen human capital, employability and competitiveness*" by upskilling pathways, reskilling actions for adults with low-skill level as well as digital skill and job coalitions "to train million young unemployed people for vacant digital jobs by traineeships and further activities" (Probst et al., 2018).

Already "information and data will be the basic elements the skilled labourer works with, using all kinds of new devices, robots, cobots and assistance systems" (Rossi, 2018). Workforces must be upskilled to provide value-added tasks and able to work next to collaborative cobots to increase in quantity and quality (Rossi, 2018; Østergaard, 2018). Regarding the ongoing decentralization of teams and global workforces in different countries, "Teamwork will be essential, not only throughout the vertical and horizontal levels within the organization and along the value chain, but also at the actual working place with new kinds of collaboration and assistant systems" (Rossi, 2018; PEGA, 2018)[63].

Chapter 1.2 also deals with the topic of skills in the context of the fifth Industrial Revolution and refers to Society 5.0. In addition to the generally required method competence, it becomes clear that methods and skills also play a relevant role in the BPM Lifecycle. This correlation must therefore be considered, and the BPM Management Approaches in Chapter 3.2 must be addressed.

Already here it becomes clear that competences and methods are aimed at the employees and their promotion in the company and strategic context. The strong reference to the topic of leadership must also be made here because leaders develop

[62] Resource available at: https://unctad.org/meetings/en/Contribution/ecn162019c03_EuropeanUnion_en.pdf

[63] Information available in the report: http://www.vdi.eu/fileadmin/vdi_de/redakteur/karriere_bilder/VDI-ASME_2015_White_Paper_final.pdf

and promote employees and ensure that the right employees do the work that suits them best. In this way, the greatest possible business value can be achieved. In addition, it is important to focus and concentrate the attention of the teams and individual employees on what is essential. The organizational clarity as well as the strategies and goals must therefore be known and comprehensible so that the personnel can be deployed correctly and trained and educated for the important and correct topics.

In the context of concretizing the competence character, literature distinguishes between social, personal, professional and methodological competence; often these are summarized as decision-making and responsibility competence. Beyond, there is the organizational competence which reflects the internal organizational-specific knowledge like business types, culture, policies, procedures or objectives and so on (Sanghi, 2016).

Ultimately, it is a matter of applying working techniques, procedures, and learning strategies appropriately, situationally, and purposefully to generate the best possible output. Furthermore, it is about applying the acquired knowledge and experience from completed projects and avoiding past mistakes (Sanghi, 2016). To apply evaluated methods, but not to close oneself off from new approaches and thus to be open for new things. These actions can be supported above all by a suitable corporate culture and leadership.

Henry Ford said once: "*Success lies in having the exact skills that are needed right now.*" In times of the upcoming fifth industrial revolution and digitalization, these are above all methods and competencies that enable the company to react flexibly to new requirements and to establish forward-looking technologies like AI in the company. The use of these new technologies leads to the need to upgrade the skills of talents in terms re-tooling, re-skilling and re-educating as the industry moves into AI (Shukla, 2019; Crismundo, 2017). Companies should be aware that their profitability will fall before it rises, because investments will be made in technology and people, but this will pay off in the long run (Crismundo, 2017).

Based on the findings of this chapter, it is recommended that companies of all types establish a talent management system that deals with the identification of the required skills and the acquisition and development of the required employees.

4.3.5. Technology Acumen and IT-Architecture

In times of digitalization and ongoing industrial revolution, technology is a central component for the further development and survival of companies. Increasing automation in process chains, global supply chains and the use of smart and connected devices, robots or AI increases the implementation of technologies in companies.

Digital technologies like AI can be understood as focus technologies in the context of digitization. In addition, the further development of these technologies is ongoing. Augmented Reality, Blockchain technology, IoT, wearables, virtual reality and robotic process automation are just a few of these developments that have an impact on companies, their processes, products, services, organization, and IT architecture.

To select the right technology for the company, it is important to know the respective advantages and disadvantages, the status of the mature technology and the area of application. Furthermore, it is essential to know whether the company has the necessary skills and resources to introduce and correctly apply the respective

technology. Already here the correlation to the organizational clarity, but also to the strategy, the leadership as well as the competence and culture dimension can be seen.

It is often not possible to use new technologies in the company in silo operation. As a result, the new technology must be integrated into the existing IT landscape and thus must merge with the existing organization at various levels. The different levels can be translated more concretely with the help of TOGAF (The Open Group Architecture Framework) (Josey, 2018). The framework describes the levels as domains and distinguishes *Business Architecture*, *Information Systems Architecture* and *Technology Architecture* and then subdivides the information systems architecture into *Information Architecture* and *Applications Architecture* as illustrated in Figure 4.14. "TOGAF is a framework for enterprise architecture that provides an approach for designing, planning, implementing, and governing an enterprise information technology architecture" (Josey, 2018)[64].

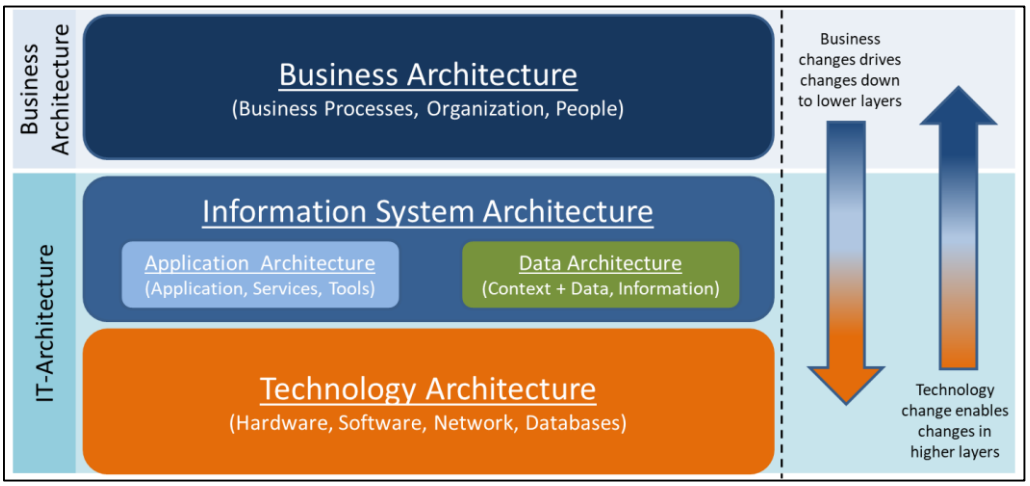

Figure 4.14 Integration of new technologies with TOGAF (adapted from (Josey, 2018))

TOGAF can be a helpful framework for the integration and further development of the IT architecture mentioned above. The reference to the different domains allows the abstraction of the requirements and creates a focus on the respective level. An implementation without consideration of the business architecture is not recommended in practice, as often business processes, the affected employees, and the organization are not properly involved and mapped. The right-side arrows in Figure 4.14 illustrate the two change drivers once again. On the one hand from the business, where new requirements generate effects on the IT architecture, and on the other hand, the implementation of new technologies and their effects on the business. This must be considered especially regarding integration. The striking representation of the two layers of business and IT architecture on the left side indicates the necessary coordination between business and IT and requires a close alignment and cooperation model.

It can already be seen that the automation of AI processes will require the development of special application architectures for other types of enterprise applications. These could be built using components that can be turned off, such as

[64] Retrieved from: https://link.springer.com/book/10.1007%2F978-3-319-24306-1

micro services running on docker containers. This type of IT architecture can make it easy to design and deploy a machine learning algorithm and then quickly turn it off when a better algorithm emerges (Lawton, 2018).

As mentioned before, the connection and integration between the systems are big challenges for a company, as each system or software has its own specific characteristics. They usually provide an Application Programming Interface for interaction. In addition to traditional integration tasks such as the integration of proprietary programmes into existing systems or the integration of legacy systems into custom solutions, the Internet and the cloud as well as IoT platforms, mobile applications or different data bases play an increasingly important role in integration. The organizational IT integration approach must consider the need for flexibility and change because Integration is the core technology that provides access to all company applications (TIBCO, 2015).

4.3.6. Culture

Even business management research has now recognized corporate culture as a success and risk factor in cooperation. Culture is not a fixed system with rigid patterns of behaviour and structures but is in a *cultural flow* (MacQueen, 2020; Dyer, 2018). A living culture is therefore characterized by constant change, which can be triggered by the culture itself or from the outside.

More simply, organizational culture can be described as the personality of a company including the values, norms, beliefs, the work environment, company mission, ethics, expectations, and goals lived and shared by the members of the organization. Consequently, culture is a social phenomenon that is functional, learnable, and changeable (Doyle, 2020; MacQueen, 2020; Shukla, 2019; Dyer, 2018). These diverse influences on the culture are exemplary summarized in Figure 4.15.

Figure 4.15 Elements of Organizational Culture

The elements that influence the culture in the company are, as already indicated, complex. The selection in the picture supports this insight and shows parallel the connections to the other dimensions of the AI-BPM Diamond. Methods as

well as leadership, but also values and norms as well as technology integration are reflected in the characteristics of the corporate culture.

An organization embodies a certain culture, just as a person has a personality. Therefore, organizational culture can be described as the reflection of the company. It shows "the actual health, productivity, talent utilization, employee satisfaction, ethics, and compassion of the workforce in response to the internal and external environment. If a company's culture does not reflect a healthy, safe, productive, efficient, ethical, and compassionate workplace, its workforce - and its workplace - is undeniably at risk"[65] (MacQueen, 2020; Shukla, 2019; Dyer, 2018).

This shows, in summary, the importance of corporate culture. Regarding the establishment of new technologies such as AI, culture plays a special role, since it is the culture of innovation in the company that counts. Fears and worries caused by the implementation of new technologies and approaches are significantly lower in innovative companies and organizational cultures than in others.

Simon Sinek said about corporate culture: "*Corporate culture matters. How management chooses to treat its people impacts everything for better or for worse*." In addition, Patrick Whitesell, CO-CEO of WME, said: "*You can have all the right strategy in the world; if you don't have the right culture, you're dead*." (Cole, 2014). These quotations underpin the insights gained and reinforce the need to always consider the organizational culture to develop the company holistically. Furthermore, the environment in which companies operate is changing at such a pace that there is no time for excessive contemplation and waiting. What organizations need is agility. Agility can be created through a strategy based on a clear and simple mission, on creating a workforce of people with character and competence and on building a culture of shared values and norms (Gore, 2017).

But evaluating the culture is a challenge. Corporate culture cannot be measured with classical business management instruments and methods, because culture is about soft factors such as human behaviour, values, and beliefs. A different approach should be taken here: Instead of numbers, people should be directly in the focus and qualitative methods should be applied (MacQueen, 2020).

4.4. The methodology related to the AI-BPM Diamond Model

The application of the AI-BPM Diamond and its various dimensions does not seem clear at first glance. The application and introduction of the AI-BPM implementation model should be carried out as a project and after successful implementation should become more and more relevant through the application of the continuous improvement process. The different dimensions of the Diamond represent the relevant framework conditions that should be given for a successful and sustainable implementation.

Depending on the company, attention should be paid to whether one dimension is particularly important and thus overweighs compared to the others. First, an analysis should be carried out as to why this is the case and what effect a particularly pronounced dimension can have. Ongoing digitization and the results of preliminary research have shown that there is still a great need for digitization and optimization of processes to achieve the main core arguments of faster processing, higher quality and lower costs in the company (Dahm, 2018).

[65] Explained at: https://satrde.com/culture-creation

The process model, as shown in Figure 4.16, is used to support and consider the respective dimensions as implementation and application guideline.

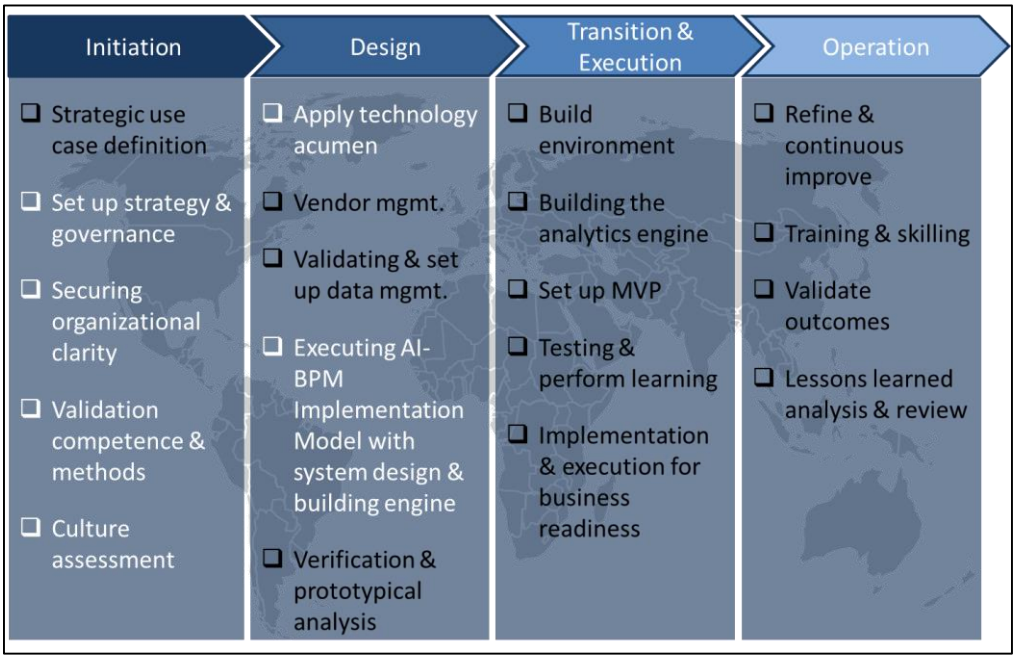

Figure 4.16 AI-BPM Implementation and application guideline

The implementation and application guideline are characterized by four sequentially arranged phases with different work steps. The core elements of the AI-BPM Diamond are highlighted in white, which shows that these elements occur mainly in the initiation and design phase (i.e., rather early in the process). This is because the prerequisites for the implementation (the different dimensions) and the validation of the AI-BPM implementation model should be completed before implementation and operation can begin.

4.4.1. The Initiation Phase

At the beginning of the project and already during the first preliminary considerations, it should be approximately clear which process and more specifically which use case is the focus of the implementation. Why is this so important? To achieve quick wins, to use the right data sources and to develop the appropriate algorithms, the focus must be on a specific process, even a specific use case (Dahm, 2018; Smith, 2017). The key to success is to find the right use case and have realistic expectations of the result (Smith, 2017). The crucial factor should be cost savings. Questions like: Which process has the highest savings potential? Which is the one that is used most often? Or the ugliest process? The one with the highest percentage of manual work? Or the process with the highest dependencies on stakeholders and other departments? The AI-BPM Diamond and the underlying implementation model should create benefit.

Therefore, the first step before a decision is made is to collect data, for example, hardware and software costs, working hours, wage and ancillary wage costs, consumables or fees (Dahm, 2018).

Further, McKinsey found that the real-life use cases can be of three different categories (Saxena, 2019):

1. "*Top line use cases:* improving customer facing activities - pricing, churn prevention, recommendation engines, promotion optimization;
2. *Bottom line use cases:* leverage data-driven insights to enhance internal processes – supply chain optimization, predictive maintenance as well as fraud prevention. IOT applications and the data they collect have triggered business process improvements;
3. *New business model use cases:* is the sector of analysing data beyond improving processes to using the insights to launch new portfolios of business offerings, services, offerings, products or services"[66].

Processes with few exceptions or those with low dependencies are particularly suitable. If it is still unclear where to start, it is best to ask the employees who operate these processes. Ultimately, the aim is to relieve them of work so that they have more time for more strategically relevant tasks such as customer service or product development (Dahm, 2018).

After identifying and prioritizing the processes and use cases, it is important to formulate an objective. Which result should be achieved with the AI-BPM model for the process? The SMART method (Specific, Measurable, Achievable, Realistic, and Timely) can be used to formulate concrete goals.

Equally important is the classification of the current state of development of the company in terms of AI and the other dimensions described. The AI Maturity Model or CMMI, for example, can be used for this purpose. The use case selection and implementation should be based on this. The next step is to ensure organizational clarity. Therefore, it is important to have an intuitive and clearly formulated strategy.

Simple checklists can help here to examine the vision, mission, leadership and structure, culture, and collaboration. It is important to question the penetration in the company and not just to set a hook. In addition, the actuality and the challenges of the vision and mission can be helpful to determine the current situation. A correlation with the use case should be clear. This should be based on the vision and mission of the organization.

A further task in the initialization phase is to review the existing strategy at the various levels and implement it with the help of governance. Particular attention must be paid to deriving strategies for the different levels and the different priorities. The focus should be on the data and AI strategy, but of course also on the corporate strategy. If one of the above-mentioned strategies does not exist, it should be created first and then continued with the project.

The third and fourth dimension of the AI-BPM Diamond focuses on the validation of competencies and methods in the company, i.e., the focus on the employees and the culture that is shaped and lived. With the help of the employees and their commitment and skills, the implementation and realization can be successful and sustainable. If the employees are sceptical about the increasing automation and use of AI due to a culture of fear or uncertainty, it is important to reduce this. The application of change management, which focuses on the employees, can be helpful in this respect. Communication is the means of choice to educate employees and

[66] Retrieved from: https://www.dataversity.net/why-your-data-strategy-needs-to-align-with-your-business-strategy/

above all to understand their concerns. In connection with the leadership component, it becomes clear once again that the employees are in the focus and that they contribute to a large extent to the success of the AI-BPM model.

Perhaps also the introduction of a new role, the translator, with special knowledge can help to achieve advantages in implementation and bridging the gap between different knowledge fields in business. "At the beginning of an analysis initiative, translators draw on their expertise to help business leaders identify and prioritize their business problems, which can help them create the highest value in solving them. Translators use their working knowledge of AI and analytics to communicate these business objectives to the data experts who create the models and solutions. Finally, translators ensure that the solution generates insights that the business can interpret and execute, and that they ultimately communicate the benefits of those insights to business users to drive adoption. Given the diversity of potential use cases, translators can be part of the corporate strategy team, a functional competence centre, or even a business unit charged with executing analytical use cases[67]" (Henke et al., 2018).

4.4.2. The Design Phase

The design phase is characterized by the selection of the required technologies. In connection with the methods and competencies of the employees as well as the cultural component of the initialization phase, it is important to consider whether the required skills exist in the company, whether training or education should be attended and whether the employees are interested in the introduction of new technologies from a cultural point of view. Thus, out of intrinsic motivation, new technologies and processes are adopted. If this is not the case, careful consideration should be given to whether a partner or vendor can help with the introduction and implementation with external staff and then train the employees. A task in the design phase is to validate and establish the correct data management for the AI-BPM implementation model.

It is important to focus on the previously prioritized use cases to establish specific requirements to ensure that only relevant data is collected. This should already include the formulation of initial *prediction models*, the definition of *intelligent variables* and the evaluation of the data required "to operationalize the use cases. Some of these use cases require a significant *time series* of data to be analysed, while others depend on the *freshness* or real-time access to the data"[68] (Saxena, 2019). Data management in a company is primarily about defining how the data strategy is designed, how technologies such as Big Data are applied and how data is to be used as an enterprise value.

With the technology selection and the evaluation of resources, methods, and skills as well as the important foundation of the data, the implementation of the AI-BPM model can take place. Simply put, the first step is to create a solution design with the required systems, data sources, and previously created variables. With the design of the solution under integrative aspects regarding data, existing IT applications and new technologies, the connection to the BPM system can be planned. IT architects of the different levels (Solution, System Enterprise) should be involved to consider the requirements of the different domains according to TOGAF. It must

[67] Retrieved from: https://hbr.org/2018/02/you-dont-have-to-be-a-data-scientist-to-fill-this-must-have-analytics-role?autocomplete=true

[68] Retrieved from: https://www.dataversity.net/why-your-data-strategy-needs-to-align-with-your-business-strategy/

then be ensured that the solution effectively eliminates the business problems. To this end, a prototypical analysis can be performed to verify the patterns found, to adapt the meta-model of the data, and to establish computational hypotheses to evaluate the influencing factors. Initial analyses and verifications should be mapped against SMART objectives. In addition, a business case for implementation and operation should be created to check the cost view.

4.4.3. The Transition and Execution Phase

With the creation of the final solution design, considering the necessary framework conditions, the transition to the transition and execution phase can take place. The AI-BPM Model serves as a basis and blueprint to bring the solution design to life. The implementation can be done by own employees or with the help of partners and pre-selected vendors. Communication in the individual work steps is important. It is important to inform the employees about the status and the knowledge gained and to let them participate in the new developments. The core component is the analytics engine, which is designed to perform analyses and make decisions based on algorithms, different data sources and the company's knowledge to flexibly adapt processes and generate the greatest added value. The comprehensive distribution of data must be ensured. In this step, it is important to set up machine learning correctly so that the system can adapt the patterns and results for subsequent decisions based on decisions made and other contextual information.

An MVP can be helpful here, as it makes it easier for employees and the project team to validate the decisions made by the AI system. The formulated SMART objectives are used as a benchmark. The essential part of the continuous improvement process should lead to the fact that the knowledge gained flows directly back into the solution design and the algorithm and is applied (Figure 4.17).

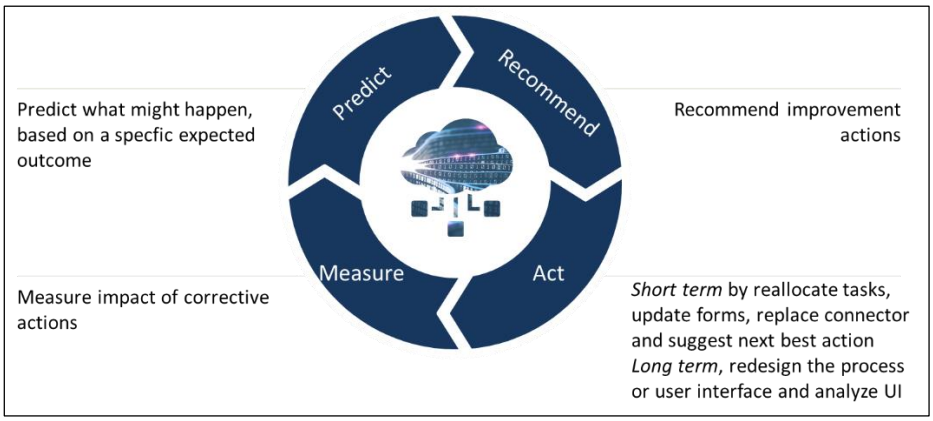

Figure 4.17 Continuous improvement process

Several iterations can be helpful to achieve the desired results. As soon as the results are satisfactory, the Go Live setting can begin. This involves the transfer of the MVP from a test environment to the live environment. It is important to consider the integration as well as the necessary process flow changes due to new interfaces, APIs etc. These should have been tested beforehand, but increased caution is required in the live environment. For this reason, further testing is recommended.

4.4.4. The Operation Phase

The operation of the AI-BPM application is characterized by refinement and continuous improvement. This should be done by always new data that the model receives for training the AI. In addition, it is important to include further important contextual information and thus to continuously develop the AI-BPM system.

The training of the employees and reskilling are important parts of the operation phase. The dissemination of knowledge about the model and the experience gained and efficiency increases are an essential part of communication in the Operation Phase. The results of the monitoring and controlling sessions, in which the KPIs are collected for tracking, serve as support. Benchmarks are the SMART goals. These can now be set higher after the first iterations. Furthermore, the changed process paths and flows must be validated, and feedback must be obtained from the stakeholders to ensure that the operation has advantages and that the measured efficiencies and quality improvements are also recognized in practice. The project team should also agree to accompany the Get-Well phase. This means that if errors or problems occur, the project team will be available to provide advice and support to the operation.

As with any project, at least one Lessons Learned event should be held at the end of the project to bring together the positive and negative findings and learn from them for the next project. It is important that these experiences are digitally recorded in the company's knowledge database and can be accessed by everyone, including the AI-BPM system.

4.5. Conclusion

The conducted scientific analyses and literature research have shown that a model for the introduction of AI-BPM in practice does not yet exist, but the need is there. With the help of the conducted analyses, it was possible to create a model that enables the implementation and names and describes the important dimensions in the context of AI-BPM Diamond. These findings from the scientific work were complemented by the application model and the provided instructions and guidelines.

With the help of the AI-BPM Diamond and the implementation model, it is possible to enable business departments and the IT of the organization to react to problems and new organizational impacts or even to foresee them and thus to implement new processes, business models and strategies agilely and in a short time. The focus is on the customer, who is satisfied by an optimal product experience and an incredibly good service. Furthermore, it is about ensuring continuous process improvement through maximum transparency of processes and IT-applications. With the help of the AI-BPM implementation model, direct execution and adaptation of processes are possible in an agile and almost real- time manner, allowing for the implementation of timely optimizations and innovations. One of the most important prerequisites for successful implementation is communication. This should start early and be carried out as often and intensively as the employees need to be well-informed and feel comfortable with the new ways of working (Gene et al., 2018).

As a synthesis on the theoretical research results, in Table 4.1, the advantages and disadvantages of the proposed approach (criticism and assessment) are presented by considering the ICT perspective and managerial implications.

Table 4.1: Conclusions synthesis of the proposed AI-BPM Model and Diamond

Strength / Advantages	Weaknesses / Disadvantages
The model is based on validated findings about business requirements for process optimization based on preliminary research.	The implementation with AI is based on a solid data structure. Missing data strategies or AI knowledge led to difficult application and possibly suboptimal implementation results.
The 5 dimensions of the diamond represent the essential framework dimensions which must be considered for a successful implementation.	Not taking a dimension of the AI diamond into account can lead to incorrect transformations and undesired effects.
The AI-BPM Approach uses the combination of AI and BPM and other management methods in various easy-to- understand steps.	The company and its employees should be ready for the use of AI-BPM. Lack of understanding and lack of education by the management can lead to incalculable risks up to project termination.
The Model application is not limited to a specific industry or company.	The decisions of the AI-BPM system are only as good as the provided data and the programmed AI system.
Compliance with the Implementation and Application Guideline creates guidelines that facilitate the implementation based on the presented framework providing the responsible persons with an overview of the required fields of activity and different phases.	Belly decisions based on feelings, social implications or other basic conditions are difficult to convey to the AI system. Therefore, an interface to manual decision revision is useful.
The orientation of the AI-BPM approach is always based on the business value to be generated. This allows potentials to be raised while taking customer centricity into account.	The implementation scenario should be aligned and must be compatible with culture and ethics of the business.
Independent of working hours and availability of resources, the data can be analysed, and decisions can be made 24/7.	
Employees who were previously involved in the processes or responsible for data analysis can be trained for higher qualified and more creative jobs.	
The Agile approach allows increments to be realized and continuous improvements to be achieved. Long process reengineering and gut decisions are a thing of the past. The decisions are data-based.	
New skills, roles and work activities will emerge that are not yet apparent today – but already introduced by the AI-BPM Approach (Translator)	

5. EXPERIMENTAL RESEARCH ON THE ANALYSIS AND EVALUATION OF THE AI-BPM DIAMOND MODEL

"Move out of your comfort zone. You can only grow if you are willing to feel awkward and uncomfortable when you try something new."
Brian Tracy

Objective 3:	Implementation and Execution of the AI-BPM Diamond Model in a large-scale business environment.
Objective 4:	Performing an analysis and assessment of the Use Cases outcomes (strategic and operational) to balance economic and social responsibility, visualization of the obtained results, and formulation of recommendations for improvement.

Starting from the theoretical approach of the AI-BPM Approach and Diamond, a practical implementation for a company is performed to evaluate and further develop the described approach and implementation model. Focusing on one complex use case and one process has helped to optimize the analysis and approach. The evaluation of the model and its implementation is carried out under consideration of the reference to Industry 5.0 and technology development. This places the AI-BPM Diamond into the given multidisciplinary framework of strategic management and corporate governance and social responsibility. The topics related are presented within the following chapter overview of Figure 5.1.

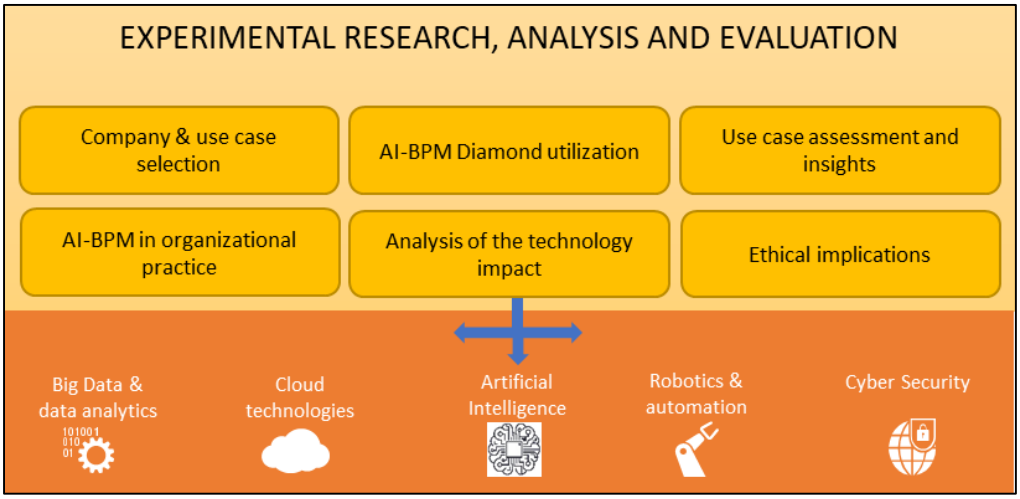

Figure 5.1 Structure of the experimental research

5.1 Company and use case selection

To pilot the methodology of the AI-BPM Diamond and to test it in practice, it is necessary to find a company that supports this approach and provides staff and budget. Based on the preliminary research already done, contacts were established and used for this scientific work. It was important to fulfil the following characteristics:

- The company generates more than € 50 million in sales per year;
- The company has more than 5000 employees;
- The company already uses a BPM suite;
- The company is already providing staff and budget for the project;
- The company has European supply chains;
- Delays in the processes can lead to contractual penalties;
- Process delays have a direct customer impact;
- Requests of any kind can be placed via different channels;
- Unplanned downtimes of systems and processes have a significant impact on customer and stakeholder satisfaction.

These minimum requirements should be given so that the implementation has a certain relevance. Experience from previous analyses has shown that if there is insufficient support from the company and a lack of relevance in the market, the management's focus varies greatly and implementation projects already underway are stopped in times of economic tension. To avoid this obstacle and to be able to generate a noticeable effect, these minimum requirements were established. In addition, it is important to record the prerequisites for further applications and tests to make deviations and scientific investigations more comparable.

5.1.1. Company description

A large technology company in the communications industry in Europe was selected for the testing and validation phase of the research (similar with the implementation phase of the methodology). "The company offers products and services in the areas of fixed net/broadband, mobile communications, Internet, and Internet TV for private customers, as well as information and communications technology solutions for large and business customers. The company is represented worldwide, specifically in more than 40 countries with more than 150,000 employees"[69].

As a result of digitization, the company has developed steadily over the past few years. Already today, a rethinking and a strong orientation towards the service company of the future has taken place. At the same time, the company is aggressively engaged in business areas in which new growth opportunities are opening. In addition, it is the leading service provider for information and communication technology and offers "integrated solutions for business customers ranging from the secure operation of existing systems and classic ICT services to transformation into the cloud, including demand-oriented infrastructure, platforms and software, and new business models and innovation projects in future fields such as data analysis, the Internet of Things, machine-to-machine communication (M2M) and Industry 4.0"[70].

[69] Retrieved from: https://www.nrw-international.de/mitglieder/veranstaltungen/nrw-goes-to-china-2018/english

[70] Retrieved from: https://www.telekom.com/en/company/company-profile

Interesting in relation to this elaboration is above all the company's belief in the compatibility of economic, social, and ecological aspects. This is a topic that is already being taken up by Industry 5.0 and Society 5.0.

5.1.2. Use case description

As described above, the definition and prioritization of use cases and the associated realistic goals are half the battle. Already during the first discussions, great importance was attached to the analysis of the use cases. This task represents the beginning of the initiation phase according to the AI-BPM Diamond method. Since understanding the use case and its background is an important prerequisite, the use case is already described in this section.

The pilot use case is related with the optimization of post-processing orders, called NBA, in the service area of the company to reduce manual tasks and actions and to make automated adjustments to processes and post-processing orders. Since the use case is mainly about the optimization of an internal process and customer interaction is not always necessary, this use case can be called a bottom-line use case. At the beginning of the processing, the NBAs were manually entered by employees, scanned in your first step, and sorted according to various grouping rules. Because these NBAs can be captured from various upstream tools, but also manually, the descriptions of the NBAs are always different and sometimes only assigned after further inquiries. To gain an impression, some NBAs are shown as examples in Annex 5. Afterwards, the NBAs were processed, also manually. The actions for processing are very different. Sometimes further clarification information is required, which results in a communication thread via e-mail or telephone call. Other NBAs can be processed directly, and others have been created, but do not lead to any changes. As can be seen in Figure 5.2, the NBAs are supplied from six different systems with different procedures. Due to the different systems with separate interfaces as well as different data formats and synchronization and relocation intervals, the use case can be classified as highly complex.

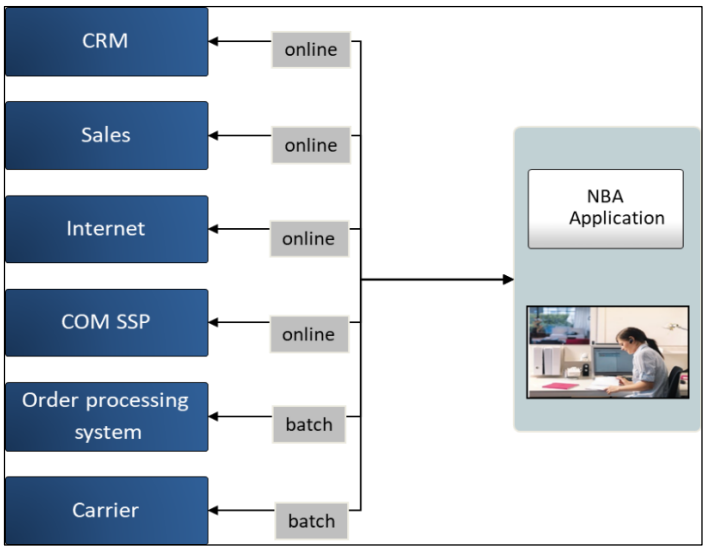

Figure 5.2 NBA Architecture overview (manual processing)

To understand the use case context, it is important to know the applications involved:

- The CRM system is the company's central customer relationship management system, in which all relevant customer information is stored. Changes to the customer data can lead to post-processing orders that affect the other applications;
- Sales symbolizes direct and indirect sales. Sales writes manual NBAs to the NBA Team. Indirect sales, for example, via a web shop or other portal, always automatically creates an NBA with every transaction that takes place;
- Internet describes the possibility for customers to deliver disturbances, changes or adjustments directly to the company via a central mask provided on the company's website;
- COM SSP is the core system for customer and order management as well as for the support of service processes (move, transfer, credit, block, ...). It supports the Private Customers, Business Customers and Wholesale segments. It also offers a call centre interface for employees and automated interfaces for private customers, major customers, service providers and B2B major customer portals;
- The order processing system is the central comprehensive order processing system in which customer, customer stock, invoice, and product, as well as resource data are stored and managed as stocks;
- The carrier application is a web-based application for business partners and carriers to automatically exchange commercial information and service orders.

Most NBAs and data are transferred via online transfers. Only the order processing system and carriers make the NBAs available via a batch run. This means that NBAs and data are processed automatically, completely, and sequentially. The batch call is directly triggered by the NBA system to create the csv files. This already shows that the NBAs from the different systems are delivered at different times, in different forms and quantities. Since the team, which consists of 15 people, can only ensure processing during the working week, a backlog of NBAs is always created during the night and on weekends. The relevance of the NBAs varies. At this point, it should be mentioned that due to customer priorities, processing is not sequential but based on urgency. The resulting processes for initiating queries, sending out technicians, commissioning service providers or checking the products and technical integrity are carried out manually. This causes downtime, duplicate work and other inefficient actions that need to be optimized. Every week, the NBA Team receives about 1700 NBAs and must work through them accordingly. The processing time of an NBA can vary from 45 seconds to 2 days. On average, however, the processing of an NBA takes 25 minutes. The analysis has also shown that there is no knowledge management system in place by categorizing the NBA cases and providing a kind of solution and problem description. As a result, the team members, from three different countries, must question themselves and generate the solutions for NBAs themselves.

After the NBAs have been resolved, the information is pushed back into all listed systems. This is not done in real time, but once during the night so as not to influence the system during daytime operation. However, since the information collected and processed can be highly relevant to the service and sales units, the NBA changes should be sent to these units first.

The goals for the implementation of the use case to the AI-BPM Diamond Model were defined according to the SMART principle and are:

- The processing of an NBA must be reduced to less than 15 minutes;

- The controlled processes must be carried out in real time;
- Prioritized NBAs must be routed directly to the sales and service area for further processing;
- Automatic validation and process routing of 85% of NBAs (approx. 1.445 per week) with correct execution;
- The team should have 70% of its capacity available for new tasks (team reduction, up to 4,5 team members in total working for NBA tasks);
- The implementation should take place within three months and first findings.

Subsumed, an aggregation can be made on the three relevant business parameters of the magic triangle, cost, time, and quality. The Magic Triangle is a visualization model for the interaction of these factors. The target values of the parameters are defined at the beginning of the project. If one of these parameters is changed, this immediately affects the other two factors of the Magic Triangle. To achieve the project goals, the project leads must compensate the changes of one factor by adjusting the other two factors. As can be seen in Figure 5.3, the status quo of the three parameters and the planned target values after the implementation of the AI-BPM Approach for the processing of NBAs are given.

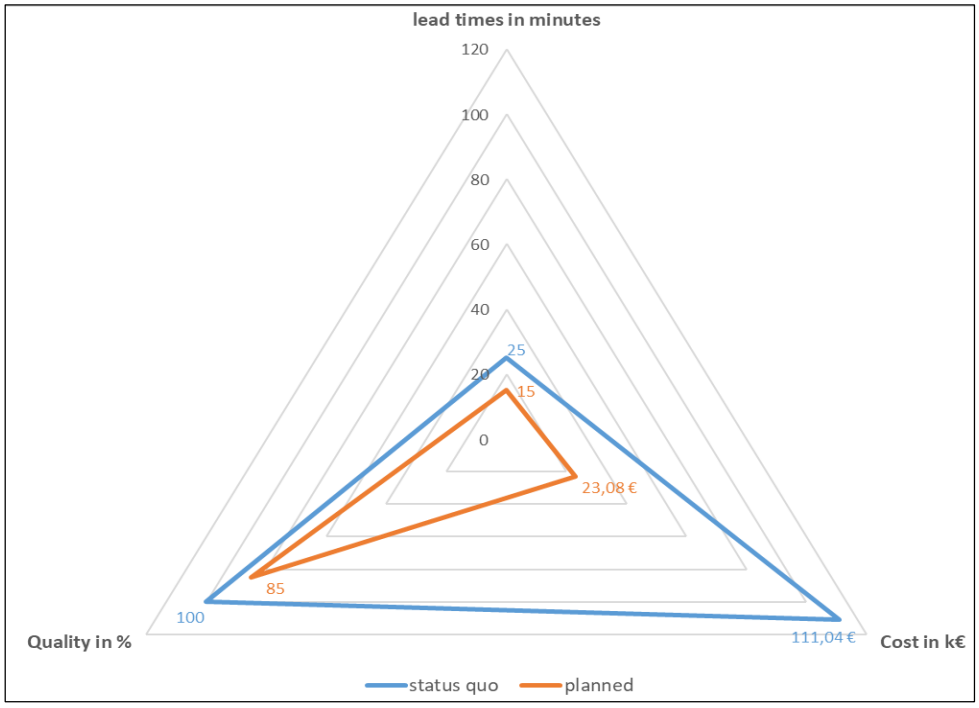

Figure 5.3 Magic triangle of implementation (AS IS and planned)

A reduction in costs and time is also accompanied by a reduction in quality. This is due to possibly unknown NBA structures the system must still learn and recognize. To clarify these, the three scheduled resources are needed. With reference to the target picture, it should therefore be noted that the triangle should become smaller in terms of lead times and costs and maintain 100% in terms of quality.

5.1.3. Implementation planning

The implementation follows SCRUM, the agile process model for agile software development, to be able to react flexibly to changing requirements or problems. The product owner creates a story, which is processed by the team. The implementation takes place in so-called sprints in a cycle of two weeks. After the two weeks, the increments, i.e., the results, are presented to the relevant stakeholders and any changes are adopted as a story in the following sprint. The team itself is led by the Scrum Master. He is there to eliminate possible problems and to enable the team to produce the best possible results. The implementation of the AI-BPM implementation model considering the AI-BPM Diamond dimensions should be completed within three months. This is followed by a one-month get-well phase, during which the project team actively supports operations. The company and the implemented solution were accompanied for over a year to carry out regular spot checks and to collect further insights and lessons learned.

5.2. AI-BPM Diamond Model utilization

The presented use case shows already by the initial description different optimization potentials. In the following, the four phases for the application of the AI-BPM Diamond and the implementation approach are described in detail.

5.2.1. Initiation Phase

In general, the Initiation Phase is initially characterized by the selection of the Use Case. In coordination with the supporting company, the use case for the pilot was quickly identified as described in chapter 5.1.2. The background of the selection is that the NBA process shows potential for optimization and should therefore be digitized.

The next step in the initiation phase is the analysis and review of an existing and current strategy at various levels. In the discussion with the management and the review of the documents, it became clear that strategies exist at various levels and that they contribute in their aggregation to the main goal of the company, as shown in a simplified way in Figure 5.4.

The strategies presented are a subset of the existing ones and serve as a basic understanding of the inheritance in the organization. The overlap of Business Unit Level and Functional Level, as shown on the left side, should symbolize the use of the functional strategies in the different Business Unit levels. It is important to understand that the functional strategies also apply across business units and are not only executed and pursued in one business unit. In the detailing with some departments, it could be determined that for various topics such as AI or Big Data, concrete strategies and benchmarks also exist to show the employees a supportive way in their daily work.

It was noticeable that the governance of the company is lived differently. While central units such as the IT architecture exercise only limited governance, the customer units for business and private customers are equipped with strong governance. This can be seen, for example, in the fact that the customer units carry out technology selection or similar tasks and thus take over tasks from other units. This represents a clear risk for the use case, as the units responsible for integrating the approach into the existing IT architecture could be left out. To mitigate this risk,

communication with all necessary stakeholders was carried out and with the help of a RACI matrix, the responsibilities for the use case were clearly named. In general, it can be said that strategies exist at different levels, and that governance within the company is perceived and accepted to varying degrees.

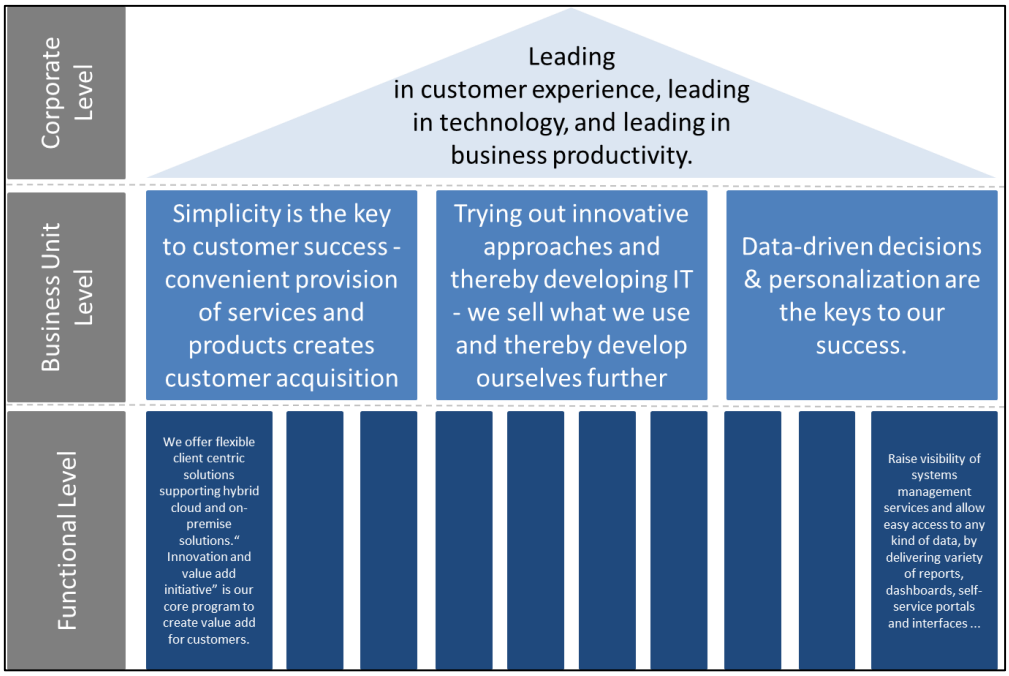

Figure 5.4 Strategy derivations of the use case company

When analysing the maturity of the company regarding the various dimensions, it was found that the company regularly carries out maturity reviews to measure itself. In terms of the processes, the company is, for example, at level 4 - quantitatively managing. So, there is still room for improvement. The AI Maturity Model is similar. There, the company reaches the level *AI Ready* and can thus improve in two stages.

The next step is to validate and ensure organizational clarity and leadership. For this purpose, employees were interviewed, the company's intranet was searched, and the management was asked about their views on organizational clarity. The question of why, how, and what could be answered very quickly by both the management and the employees. In addition, the vision and mission and the strategy derived from them are clearly communicated, so that the organizational clarity is given, as shown in the following:

- *Overall Strategy:* leading in customer experience, leading in technology, and leading in business productivity;
- *Vision:* We are creating added value for our internal and external customers through innovative and flexible Systems Management Solutions;
- *Mission:*
  - We increase availability of services and efficiency for IT operations by:

        - Proactive monitoring and event automation with zero outage;
        - Auto discovery of config data and SW assets;
    - We offer flexible client centric solutions by delivering variety of reports, dashboards, self-services portals and interfaces to easily access any kind of data (customer success)."

On the strategic BPM level, objectives were also defined jointly by the different departments. This also provides a general commitment. The goal is to achieve Maturity Level 5 based on CMMI and BPMM and thus to digitize, record, regularly control and standardize all processes in the best possible way, enabling the company to react faster than the competition to changing consumer, market and regulatory requirements and thus to create a competitive advantage. According to a current BPMM analysis, the company is at level 3 - standardized -and thus still has potential for improvement.

The operational BPM level shows concrete projects and goals in different areas. One of them is the digitalization and standardization of processes with high frequencies and a strong demand for human resources.

As described above, the topic of leadership and structure is also an important component to communicate the goals, strategies, and missions in the organization, but also to deploy employees correctly. The analysis of this topic already shows very good leadership approaches in the company. The company has set up an initiative called *People and Skills* to put the global strategy with a focus on people at the heart of the teams. "*The main goal is to have satisfied, motivated and skilled employees to tackle future demands and challenges by acting as one global team and using agile methods and reliable engineering for high performance*". Concrete measures have been set up with the management for this purpose, for example:

- Improvement of communication between all units and teams;
- Recognition of work;
- Guidelines for employees and management;
- Future and perspectives;
- Better knowledge transfer;
- Overarching skilling and training platform;
- Reducing work intensity, stress, and pressure;
- Cutting red tape and formalism.

To implement these initiatives correctly and to deploy and develop employees in the best possible way, existing management was trained accordingly, and new managers were recruited under the aspect of leadership. The options set up and the use of agile working methods such as SAFe or SCRUM also promote the exchange of information via communities and place a stronger focus on the employee. Thus, the organizational clarity, as an important basic component for the AI-BPM approach, can be confirmed.

The examination of the required skills and methodological competence is important to understand which additional skills are required for the application and implementation of AI or other technologies in the company. Due to the use of a central skill-based system, where each employee must declare his or her skills, methods, and experience and these are then confirmed by the management, it was easy to get a good overview. At all levels, social, personal, professional, and methodological competence, concrete information was available. Among them were the necessary ones to successfully implement the Use Case:

- *Abstract thinking*, to identify corresponding patterns or connections between supposedly incoherent objects;

- *Agile work*, with the willingness and ability to develop topics in cross-functional teams on your own responsibility using agile methods;
- *Analytical thinking*, to break down complex questions into smaller topics and promote effective analysis;
- *Work in detail* to bring understanding and attention to accuracy;
- *Disruptive thinking*, to challenge established ways of thinking and procedures;
- *Effective communication* to convey information in a way that is appropriate for the addressee;
- *Innovative ability* to develop new ideas and initiatives;
- *Strategic thinking* to holistically grasp thinking and planning processes and align them with the business strategy;
- *Teamwork*, to work effectively as a member of a team;
- *Architecture*, knowledge of functions, processes and their interaction with business, application, and technology architecture;
- *Market understanding*, and thus knowledge of a specific market in terms of products, services, cost structures and customers;
- *Application design*, for the transformation of business requirements and logical models into a technical application design;
- *Business intelligence*, knowledge, and skills to leverage business processes and technologies to collect, store, analyse, and deliver data;
- *Cloud computing*, knowledge of cloud concepts and technologies;
- *Business process design*, take a critical and innovative look at current business processes to identify problems and opportunities and implement improvements;
- *Artificial Intelligence*, understanding and application experience of AI methods and technologies;
- *Requirements management* to understand business requirements and translate them into IT requirements as a kind of transformer.

Employees were requested based on their skills and, after consultation with the resource managers, reserved for the use case implementation. This also made it possible to check off the dimension of competence and methods.

The last step in the initiation phase is a culture review. As written in chapter 6.3.6, this is difficult to measure because the organizational culture is also made up of different elements. Together with the management, a recapitulation was made of how the company deals with its employees. What opportunities the organization offers and how the general communication is implemented and accepted. In addition, the noticeable motivation for new topics and the processing of problems were addressed and discussed as well as the application of methods and tools and the lived values of the company. For this purpose, employee surveys were also anonymously evaluated and compared with the feedback from management. Taking these various elements into account, the company can be certified as having an open, innovative, and employee-friendly culture.

This concludes the initiation phase. The analyses and evaluations show a positive trend for the implementation; only the issue of governance needs to be adjusted in parallel by additional measures. To stay on schedule for the implementation, the design phase was started in parallel.

5.2.2. Design Phase

In the design phase, it is about selecting the appropriate technology for the project and integrating it into the existing business, BPM, and IT landscape. If the right resources cannot be found within the own organization and the training takes too long, it is advisable to consult specialists about vendor management. During the design process, the data and AI strategy for the AI-BPM model must be specifically validated. In contrast to the strategy set-up in the initiation phase, this involves the direct reference to the AI-BPM Implementation Approach. Based on this, the solution design and the first model creation take place to concretize the business case for the prototype based on the theoretical knowledge.

Based on the use case descriptions and analysis, it became clear that the following AI elements of the AI periodic Table are affected in the use case:

- *Assess*: Text Extraction, Image Recognition, Data Analytics;
- *Infer*: Predictive Inference, Explanatory Inference, Synthetic Reasoning, Problem Solving, Decision Making, Knowledge Refinement, Relationship Learning;
- *Respond*: Communication, Control.

Based on these requirements, the requirements of the Use Case and the restriction of available resources, a technology selection was made. For this use case, the TensorFlow framework was chosen as the basis for the AI deployment because of:

- Previous knowledge with this open-source solution and the existing ecosystem in the company already exists;
- TensorFlow is a platform-independent programme library under an open-source license;
- The framework offers a wide range of possible applications and allows the creation of learning neural networks;
- It is characterized by its good scalability and can be operated on different systems from smartphones to clusters with many servers.

As programming language Python, an interpreted, high-level, general-purpose programming language, was used, since there was also a lot of previous knowledge and Python represents the state-of-the-art in the AI sector. Since the existing skills for the concrete design of the solution as well as the construction of the AI-BPM model were available, no further vendors had to be tendered.

After the technology selection and required skills analysis, the analysis and modelling of the integration and the link to the various data sources as well as the anticipation and review of the existing AI and data strategy of the company took place in parallel. This is important because the use of certain data repositories, objects or the use of AI may be limited by the strategies, digital guidelines, or ethical reasons. The AI Guideline of the company consists of nine principles and can be summarized as follows: "*We need a stop button and no black boxes of vendors*." The Guidelines can be consulted in detail in Annex 6. In dealing with Big Data, there are also specifications and restrictions, but these do not hinder the Use Case. A guiding principle from the Big Data Guidelines is: "*Decisions (Next Best Actions) based on all information available will improve our customer experience and our service*." More specific details are given in Annex 7. Based on the seven data management domains presented in chapter 2.3, the evaluation of the data management and the analysis of the individual dimensions were carried out. The result shows that the domains presented were very intensively considered by the company and therefore a clear

understanding and picture of the use of data prevail. Therefore, a concrete ambition and key requirement along the data architecture was developed (Figure 5.5).

The Figure shows the runway for the processing of data on different systems and their preparation via streaming and batch procedures considering the data quality in the data preparation phase. The data is then stored in the target in the data lake, which is accessed by the System of Intelligence (SoI) via APIs. There, the data is then analysed and processed by AI applications and other data science tools to integrate the achievements into the daily business and processes.

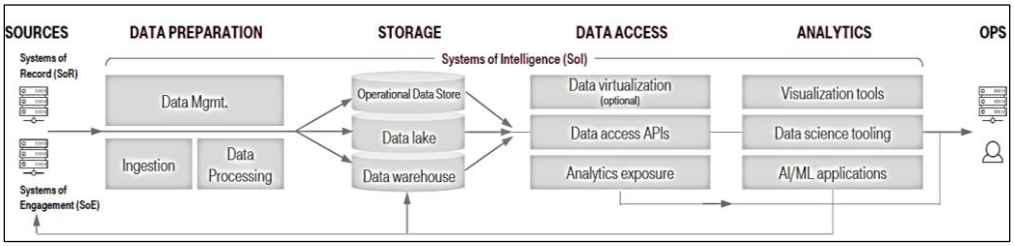

Figure 5.5 Data Architecture requirement

The challenge in the first step was to determine the required system connections and to access the required data. Due to the existing data architecture, it was possible to obtain a large part of the information from a few data sources. By ensuring integration at the various levels, it became clear what impact this would have on the data and application architecture. Building on this, the implications on the business level were examined in more detail. To ensure the technological foundation and scaling, it was necessary to take the next step, to design a model based on the occurring cases and to feed it with training data. It is not only important to collect actual data but also to make statements for the future based on past values and actual values and thus to generate forecasts from insights with the help of prediction and prescriptive analytics.

Figure 5.6 shows a simplified representation of the solution design for the integration of the AI-BPM approach based on the TensorFlow framework.

To highlight the change in blue compared to the actual design, the two colours green and orange are used for the new "applications" and connections. In orange, the AI application is set up with the required AI elements or capabilities that are used for the use case. The connected applications of the company are shown in green. The focus is also on the Integration Layer, which distributes the data quickly and purposefully, thus avoiding the need to build peer-to-peer interfaces. The connection via Rest APIs enables a decoupled development of the respective applications and thus a fast exchange of applications. However, this is only possible with the help of the company's very well-thought-out data management. The connection of the BPM Suite to the carrier and the order processing system should also be emphasized. Thus, the possible process steps are automatically adapted (based on the knowledge from the neural network) to process critical activities and NBAs as quickly as possible. In more concrete terms, the results of the analyses are to be transferred to the BPM Suite, where they will automatically lead to an adaptation of the process steps. These adaptations will be switched live, allowing bottlenecks in processing to be bypassed and a focus on the relevant jobs and NBAs to be achieved. In theory, this enables optimal control of the carriers and execution of the order processing system.

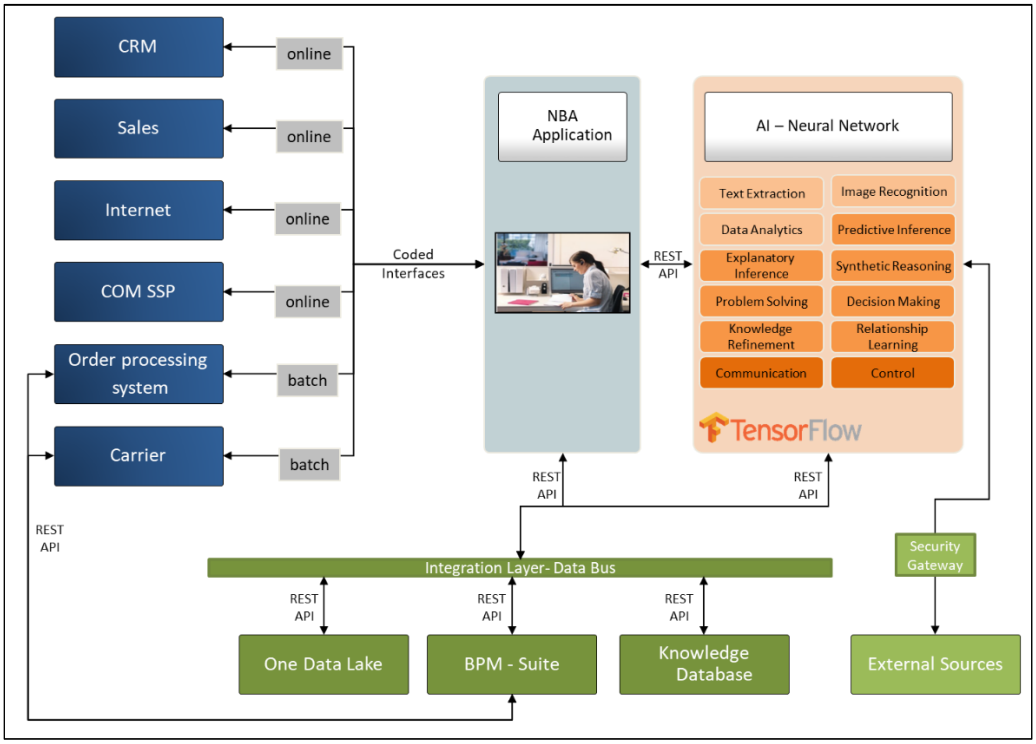

Figure 5.6 Solution Design AI-BPM Use Case Implementation Approach

In addition, further data sources from the world wide web are to be connected to the AI component via a security gateway to obtain further training data, for example from the manufacturer of the BPM Suite, a processing of unknown information and data is to be integrated to find out causal relationships and thus recognize an early impact on the NBAs. The colour differentiation of the AI-Capabilities reflects the group assignment according to Assess, Infer and Respond and thus provides an impression of how the structure is to be understood. For the implementation based on TensorFlow, the Open Telecom Cloud will be used as infrastructure. The deployment will take place via docker container. To also take the technical aspect into account, the use of the text extraction capabilities is described exemplary in more detail in Annex 8 as an example. Annex 9 also includes a code excerpt from the implementation to concretize the technical design.

To verify the model and the possible integration, desk tests were carried out to examine the procedure and consistency in detail. This involved a detailed examination of the data objects and the dataflow. Core aspect is the company's BPM Suite and planned connection to the carrier and the order processing system. The AI model is not yet programmed, only the text extraction component could be validated by training data. Before automating everything, it is therefore important to recognize the algorithm of the AI application should be tested to get a confidence measure. It is essential to compare the result from the neural network to human judgements and get an understanding of how confident it is that it has the right result (McLellan, 2016).

Based on the model and the solution design, the employees now involved and the planned duration of the project, it was possible to concretize the business case. Since costs and efficiencies are important components in the management domain, the business case was detailed separately in chapter 5.3.

An essential part of this project is also communication. During the initiation phase, first articles were written on the company's intranet and the employees were made aware of the upcoming use case implementation. Now that an essential component, the solution design, and integration have been outlined and further information about the technology etc. is known, weekly information calls have been set up. The status of the procedure was presented transparently, and the employees were given the opportunity to ask questions and make comments and suggestions. In addition, they have decided to create a community for the use case to get help with open questions. Both the Status Meeting and the Community Meetings take place virtually. With the help of these two meetings and the additional intranet articles, a transparent and comprehensible communication is possible. This supports the positive and open cultural expression of the company.

Thus, the second phase of the AI-BPM Diamond is completed, and the transition and execution phase begin.

5.2.3. Transition and Execution Phase

The Transition and Execution phase mainly take place through the design and implementation of the various APIs, the Integration Layer and the realization of the AI model. It quickly became clear that the successful instantiation of the AI model could have a temporal impact, as resources did not progress as quickly as originally planned. The agile approach according to SCRUM was helpful here, which made it possible to convert smaller increments and not to wait like a waterfall project for a result. Due to the open communication and the resulting developer community, additional employees could be acquired to join the development team. The regular open calls in which the individual completed increments of the MVP were presented and thus gave an ever-better impression of the project were also supportive.

An essential part of this phase is the training of the AI model with corresponding data, so that the text recognition and processing, the recognition of patterns, the derivation of recommendations for action and the control and modification of subsequent activities in the BPM Suite work. This training is important because: "*The machine learning model is not a static piece of code you're constantly feeding with data," says one Google engineer*[71]*. "We are constantly updating the models and learning, adding more data, and tweaking how we're going to make predictions. It feels like a living, breathing thing. It's a different kind of engineering*" (Schrage, 2017).

As shown in Figure 5.7, the aim is to convert the required data into the necessary form and prepare it accordingly so that the model can be trained. It is important to evaluate the respective results, otherwise, the model is a black box, and this should be general and is prohibited within the company's AI guideline. If the model is optimized, the developments must be transferred to the running system. In accordance with the agile approach, increments are thus created that constantly improve the quality of the AI approach. In the context of performance measurement, regular controlling should be carried out, like process controlling in BPM, to monitor

[71] Retrieved from: https://go2karatesites.com/4-models-for-using-ai-to-make-decisions/

the changes and, if necessary, to trace back to an earlier, better implementation container. Regular training of the model with ever new data creates trust and subsequently enables the successful and automated execution of decisions and process adjustments. Since data sets, content or other attributes can change constantly, regular training is a necessary activity to operate an AI model successfully and sustainably.

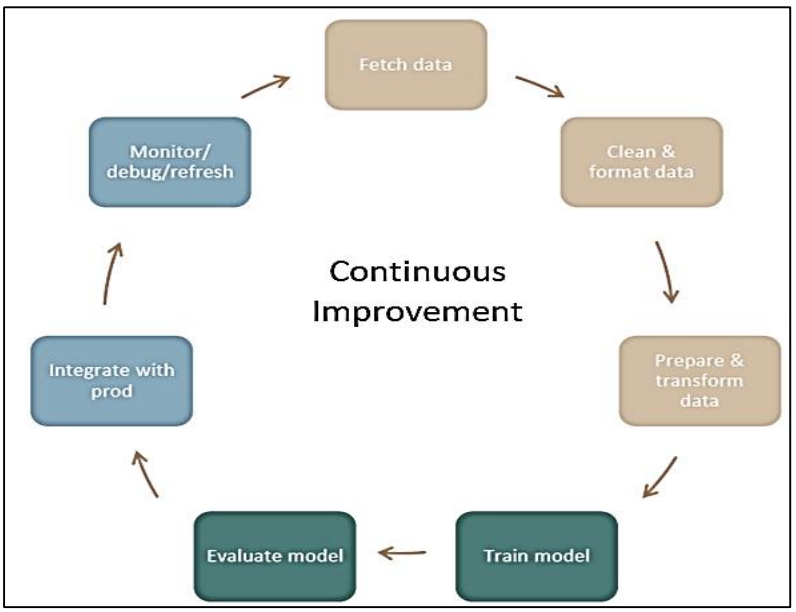

Figure 5.7 AI Model training via continuous improvement

The open communication rounds continued to be held and helped to identify possible impediments such as version changes or developments to affected applications of the solution design at an early stage and to react to them.

After about three and a half months, the designed AI-BPM implementation approach was put into operation as an MVP. The employees of the previous NBA processing department closely monitored the grouping and the activities carried out to be able to intervene if necessary. Each action was recorded in a backlog, which allows for complete traceability. Randomly, the AI application was used to check and validate the processing carried out and, if necessary, adjustments were made. It was important that these adjustments were recorded as lessons learned and fed back to the developers to be considered for the next increment. The control of the BPM suite and the triggering of automated process changes was switched to manual during the go-live. The AI model controlled the necessary process adjustments via an email interface. After these had been checked by expert employees, appropriate actions were taken. Subsequently, the integration of external corporate sources was considered as an add-on. The processing of inconsistent and different prepared data has been a challenge for the AI model and the developers. For this reason, no fully automated integration was performed. Instead, the knowledge gained from external data sources was stored in a separate backlog and viewed daily by designated colleagues and managers.

Thus, the AI-BPM implementation model went live with the NBA Use Case as MVP. The communication for this took place in a created intranet article with the

naming of the supporting colleagues. To do so, it was made sure that learned and individual development successes made the implementation possible in the first place. Errors and problems were also communicated, as well as the approaches to solving them, to pass this on to everyone as an experience. A central component is the recording in the knowledge database, in which the organization records such points centrally.

5.2.4. Operation Phase

The operation phase is characterized by the continuous improvement of the AI-BPM model. After one week in operation, the results were so promising that 50% of the employees were assigned to other topics. After the second week, only one employee was left to partially support the AI-BPM automation from the business department to be able to react in case of possible problems. The development team works with ever new data sets to optimize the model according to the continuous improvement approach. The resulting improvements are recorded by the controlling department to be able to perform comparative analyses.

After four weeks in operation, the management decided to release the automated control and implementation of the process engine in the BPM Suite through the AI model and to inform a group of employees in parallel in case of changes through an email outbound control. The respective backlogs are further described to enable complete tracking in case of a claim.

As part of the Get-Well Phase, some optimizations were made and an overarching Lessons Learned event was held. The company recognized the need to document the experiences of all kinds and make them available to the organization. As praise and recognition, the company sponsored a final dinner to thank the employees once again. The developer community has been established and still exists; the open calls were suspended after two months in operation.

5.2.5. Conclusion after testing the AI-BPM Diamond Model and methodology

The testing process on the NBA use case has shown that the dimensions as well as the four phases represent an important framework for the introduction in practice. The company has strongly oriented itself towards this and has worked through the individual activities in the respective phases as a kind of checklist. It turned out that some refinements to the approach are also necessary. These are addressed and presented separately in chapter 5.4: Lessons Learned.

With the establishment of the AI-BPM Diamond and the derived process model, the second goal of this work could be achieved.

5.3. Use case assessment and insights

The following section presents the initial business case and the actual performance measurement based on the cost structures. In addition, it shows the concrete improvements that the company and specifically the business unit has achieved by using the AI-BPM Diamond Model.

5.3.1. Business Case

A business case is a scenario for assessing an investment from strategic, business management and other aspects. A project also represents an investment from the perspective of the client. The business case of a project describes how and in which period its results benefit the ordering enterprise.

Currently, 15 members of the NBA Team are working on the topics. The employees are allocated internationally. The team consists of 5 German colleagues, 8 Hungarians and 2 Brazilians. The country assignment is important to understand the cost differences. Table 5.1 shows the monthly and hourly costs of the NBA Team members. The team leader is not included. Based on 160 working hours per month and 40 per week, the costs shown result from the hourly rates stated in each case. The costs in the amount of 111,040.00€ are accrued monthly and are to be borne centrally by the company. Annual costs of 1.332.480,00 € arise from this.

Table 5.1 Personnel cost overview of the NBA Team

	Country	Ø costs per employee		Headcount	Total amount
		per hour	per Month		
NBA Team	Germany	62,00 €	9.920,00 €	5	49.600,00 €
	Hungary	41,00 €	6.560,00 €	8	52.480,00 €
	Brazil	28,00 €	4.480,00 €	2	8.960,00 €
Total		**43,67 €**	**6.986,67 €**	**15**	**111.040,00 €**

Table 5.2 Anticipated expenses for AI-BPM Use Case implementation

Phase	Activity	Headcount	Duration estimation in h	Ø costs per employee per h	Cost expectation in €	Costs per phase
Initiation	Strategic use Case definition	6	5	90,00 €	2.700,00 €	13.760,00 €
	Set up Strategy & Governance	5	8	70,00 €	2.800,00 €	
	Securing organizational clarity	6	8	70,00 €	3.360,00 €	
	Validation competence & methods	5	6	70,00 €	2.100,00 €	
	Culture assessment	5	8	70,00 €	2.800,00 €	
Design	Apply technology acumen	6	40	75,00 €	18.000,00 €	57.000,00 €
	Validating & set up data mgmt.	6	20	75,00 €	9.000,00 €	
	Executing AI-BPM Implementation Model with system design & building engine	5	60	75,00 €	22.500,00 €	
	Verification & prototypical analysis	5	20	75,00 €	7.500,00 €	
Transition & Execution	Build environment	8	30	75,00 €	18.000,00 €	120.400,00 €
	Building the analytics engine	5	120	80,00 €	48.000,00 €	
	Set Up MVP	8	40	80,00 €	25.600,00 €	
	Testing & perform learning	4	60	80,00 €	19.200,00 €	
	Implementation & execution for business readiness	6	20	80,00 €	9.600,00 €	
Operation for the first month	Refine & continual improve	5	40	80,00 €	16.000,00 €	74.813,41 €
	Training & skilling	5	30	70,00 €	10.500,00 €	
	Validate outcomes	8	50	80,00 €	32.000,00 €	
	Lessons learned analysis & review	25	8	80,00 €	16.000,00 €	
	Technology infrastructure for three months				313,41 €	
Get Well	First level support	3	80	80,00 €	19.200,00 €	19.200,00 €
Total		126	653		285.173,41 €	285.173,41 €

For the release of the implementation of the use case according to the AI-BPM model by the company, a business case had to be created beforehand, which gives an indication of the expected costs. The implementation costs and the running costs

were compiled in the best possible way. Table 5.2 provides the anticipated expenses for the use case initiation, design, implementation, and operation.

As shown in the table, the cost estimate was based on the AI-BPM project phases, and the required number of employees was calculated with their hourly rates and the expected effort. The different hourly rates are based on the required skills, whereas a developer or manager has a higher hourly rate than an employee for the survey according to the cultural perception or the methods used. Most expenses are calculated for the construction of the model and for the validation of the results. To get a better understanding of which phase will incur the most costs, the right column is the aggregation of the individual activities in a phase. It becomes clear that the creation and commissioning of the AI-BPM implementation model generates the most effort compared to the other phases.

Furthermore, the operation of the AI model after implementation was also estimated, as shown in Table 5.3. These costs are made up of the infrastructure costs and the planned three monitoring staff from Hungary and a developer who will also feed the model with training data. In a comparison of both cost approaches, as shown in the following Table 5.4, it becomes clear that the operation of the AI-BPM model in one-year costs about 1,000,000.00 € less than the operation of over 15 employees.

Table 5.3 Anticipated running costs on a monthly basis

Phase	Activity	Headcount	Duration estimation in h	Ø costs per employee per h	Cost expectation in €
Operation	Infrastructure (OTC with Computing Server, 2 CPU, 8 GB RAM, Open linux, 200 GB storage)				104,47 €
	Operation team - FTE	3	160	41,00 €	19.680,00 €
	Developer for data training	1	40	85,00 €	3.400,00 €
Total		4	200		23.080,00 €

In concrete terms, 87,960.00€ can be saved per month and the employees can be used for other qualifying activities. With the implementation of the model and the running costs, 770,346.59€ in savings could already be generated in the first 12 months after commissioning, which means that the implementation costs and the first months of operation have reached the break-even point after five months.

Table 5.4 Expected Business Case comparison - Manual vs. AI-BPM Model

AI-BPM Implementation Cost Model			
	One-time costs	monthly recurring expenses	anual costs
Expected implementation costs for a term of three months	285.173,41 €		285.173,41 €
Operational running cost after 3 months of implementation		23.080,00 €	276.960,00 €
			562.133,41 €
NBA Team costs			
	One-time costs	monthly recurring expenses	anual costs
Personnel costs of the NBA Team	- €	111.040,00 €	**1.332.480,00 €**

5.3.2. Profit and loss account

During the project, all participating and active employees were asked to record their working time for their activities within the scope of the use case implementation.

The company has provided a tool for this purpose, which allows activities to be recorded precisely in terms of hours. It was relevant to analyse the deviations from the business case and to get an assessment for the respective phases. In Table 5.5, the values recorded, and the corresponding hourly rates were presented in the same logic as in the business case calculation to better identify the deviations from the initial estimate.

Table 5.5 Implementation effort for AI-BPM Use Project execution

Phase	Activity	Headcount	Duration estimation in h	Ø costs per employee per h	Cost expectation in €	Costs per phase
Initiation	Strategic use Case definition	8	6	90,00 €	4.320,00 €	13.140,00 €
	Set up Strategy & Governance	5	8	70,00 €	2.800,00 €	
	Securing organizational clarity	5	9	70,00 €	3.150,00 €	
	Validation competence & methods	5	5	70,00 €	1.750,00 €	
	Culture assessment	4	4	70,00 €	1.120,00 €	
Design	Apply technology acumen	7	45	85,00 €	26.775,00 €	86.975,00 €
	Validating & set up data mgmt.	6	38	85,00 €	19.380,00 €	
	Executing AI-BPM Implementation Model with system design & building engine	6	63	90,00 €	34.020,00 €	
	Verification & prototypical analysis	5	16	85,00 €	6.800,00 €	
Transition & Execution	Build environment	7	28	75,00 €	14.700,00 €	126.040,00 €
	Building the analytics engine	4	145	80,00 €	46.400,00 €	
	Set Up MVP	9	43	85,00 €	32.895,00 €	
	Testing & perform learning	5	49	85,00 €	20.825,00 €	
	Implementation & execution for business readiness	6	22	85,00 €	11.220,00 €	
Operation for the first month	Refine & continual improve	6	42	80,00 €	20.160,00 €	73.513,41 €
	Training & skilling	4	38	70,00 €	10.640,00 €	
	Validate outcomes	8	47	80,00 €	30.080,00 €	
	Lessons learned analysis & review	22	7	80,00 €	12.320,00 €	
	Technology infrastructure for three months				313,41 €	
Get Well	First level support	2,5	65	80,00 €	13.000,00 €	13.000,00 €
Total		124,5	680	79,74 €	312.668,41 €	312.668,41 €

Due to the additional work required in the design and Transition and Execution phase, the overall project costs have also increased. Specialist resources with a higher skill level and thus also hourly rates were used to successfully realize the design and implementation. This means additional costs of about 30,000€ in the design phase, 5,640€ in the implementation phase and 1300€ in the operation phase. On the other hand, savings of 620€ in the initiation phase and 6,200€ in the get-well phase have been recorded. In total, the company has spent 27,495€ more than in the original cost estimate, a total of 312,668.41€. The running costs for the AI-BPM model on the Open Telecom Cloud are calculated below. Contrary to expectations, only 2.5 resources are required for control and manual readjustment, which means that 3,280€ per month can be saved in operation. Nevertheless, 19,800€ per month must be calculated for the operation of the AI-BPM implementation model, as shown in Table 5.6.

Table 5.6 Realized running costs on a monthly basis

Phase	Activity	Headcount	Duration estimation in h	Ø costs per employee per h	Cost expectation in €
Operation	Infrastructure (OTC with Computing Server, 2 CPU, 8 GB RAM, Open linux, 200 GB storage)				104,47 €
	Operation team - FTE	2,5	160	41,00 €	16.400,00 €
	Developer for data training	1	40	85,00 €	3.400,00 €
Total		3,5	200		19.800,00 €

In direct comparison to the running costs of the previous NBA Team, this results in the following monthly and annual comparison, as shown in Table 5.7.

Table 5.7 Expected Business Case comparison - Manual vs. AI-BPM Model

AI-BPM Implementation Cost Model			
	One-time costs	**recurring expenses**	**anual costs**
Expected implementation costs for a term of three months	312.668,41 €		312.668,41 €
Operational running cost after 3 months of implementation		19.800,00 €	237.600,00 €
			550.268,41 €
NBA Team costs			
Personnel costs of the NBA Team	- €	111.040,00 €	**1.332.480,00 €**

Despite an increased project effort, the monthly monetary savings of over 90,000€ represent an essential savings potential. Projected on the year, the AI-BPM implementation is 782.211,59€ cheaper than the NBA Team of 15 employees.

In the comparative evaluation of both approaches, the calculation of the break-even point (Figure 5.8) is an important benchmark in the economy to calculate as from when an investment is successful. As can be seen in the following figure, the break-even occurs after only 3.5 months. This can be seen from the fact that the cost tangents of the NBA Team and the AI-BPM model intersect at this point. The project costs for the implementation were charged in full in the first month of the AI-BPM model, which explains the high initial value.

This proves under the cost aspect that the introduction and operation of the AI-BPM model after the AI-BPM Diamond for the NBA Use Case are amortized after only 3.5 months. As the employees have been assigned to a different area in this case, no further costs of the previous team had to be included in the calculation.

If savings are included as profit in relation to the costs of the project over one year, the return on investment is therefore 0.42 and 0.98 over two years, i.e., the return on investment is the percentage of profit on an investment and thus the value that will flow back from an investment.

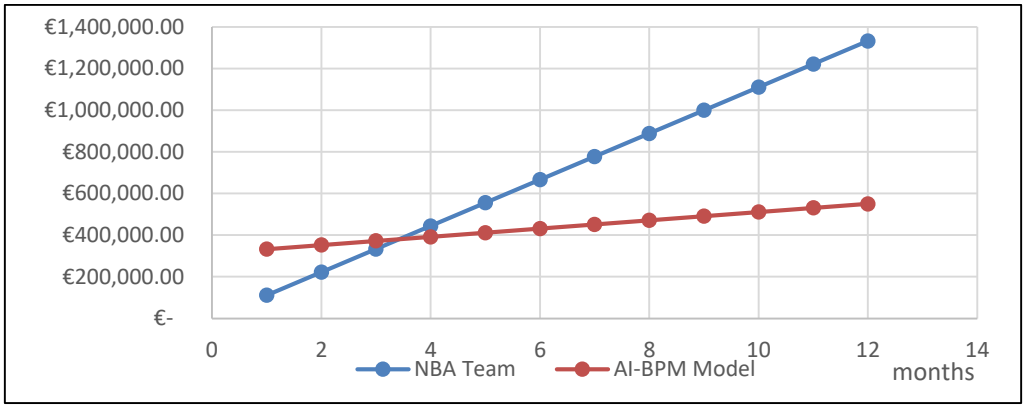

Figure 5.8 Breakeven Point calculation

If the Return on Investment is greater than 0, then the profit of an investment is higher than the costs incurred for it and the investment is profitable.

In summary, the use of the AI-BPM Diamond and the AI-BPM implementation approach have shown, considering the costs, that a fundamental savings potential is possible using AI and the control of subsequent processes.

5.3.3. Time and quality improvements

The two other parameters, quality and time, are specifically considered below. Based on the random samples taken and regular validations, a positive trend in quality could be recorded for over a year.

Starting with throughput times, already after the implementation and use of the AI-BPM approach, there has been a significant shift in throughput times compared to manual processing. Figure 5.9 shows the annual development of lead times in red colour.

Already in the first month, the implementation of the manual processing outperformed with an average of 13.8 minutes. In addition, the original target value of 15 minutes was already undershot in the first month. For consideration, the NBA Figures were also highlighted in blue per month. The development shows that the regular optimization and training of the AI component have helped to steadily reduce the Lead Times over time. On average over the year, it was therefore possible to achieve a lead time of 7.66 minutes per NBA. This corresponds to a reduction of lead times by approx. 69.36 % and thus represents an essential component for the optimization of the area. The number of NBAs has fluctuated within the normal distribution. No correlation could be found.

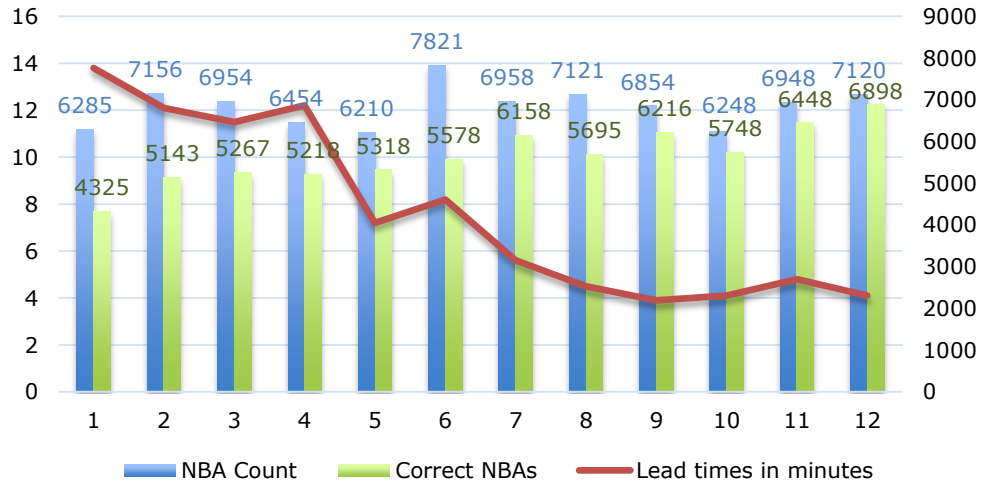

Figure 5.9 Lead Time and NBA count after AI-BPM Implementation

At the same time, a reduction in the workload of the service staff was noted. Employee surveys have shown that the automated control and assignment of NBAs help the relevant employees to be informed in time and thus their work can be better structured and prioritized. Another advantage was that the backlogs were also processed by the system over the weekend, so that the service staff had the prioritized NBAs available for further processing on Monday when work began.

Based on the NBA numbers, the analysis of the correct and successfully processed NBA was tracked, as shown in the figure as a green column. The target value of 85 % could not yet be reached in the first year and was undercut by 2 %.

The 83% correspond to 68167 successfully processed and correct NBAs. In contrast, 13961.93 NBAs had to be corrected manually by the 2.5 FTE.

During the analysis, a correlation between the processing times and the number of correctly processed NBAs could be established. With the training of AI, more NBAs were processed automatically. The forecast suggests that within the next 2-3 months, the 85% target will be reached and exceeded. In general, however, it is expected that a certain percentage of NBAs will still have to be processed manually in the future.

5.3.4. Use case conclusion

The evaluation has shown that the implementation using the AI-BPM Diamond has generated enormous cost savings for the business in the specific use case as well as a reduction of the lead time, with a slightly reduced but constantly increasing quality. With reference to the Magic Triangle, this results in the following Figure 5.10.

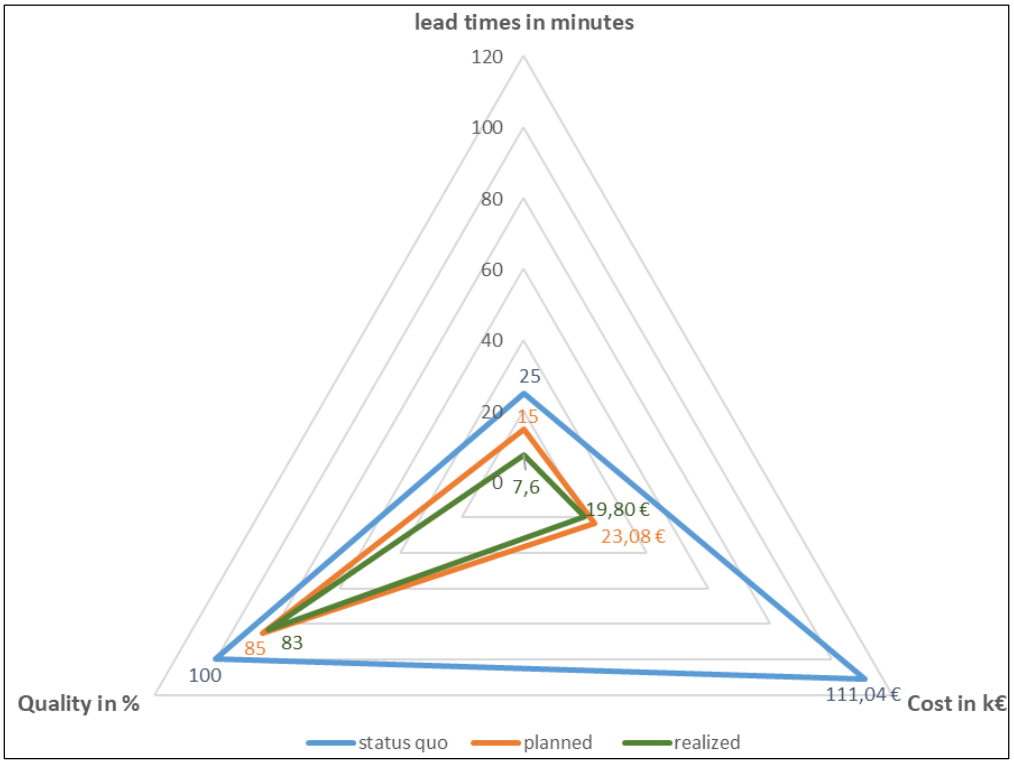

Figure 5.10 Use Case results via the Magic triangle

As the illustration shows, the cost and lead time parameter is lower than planned and thus corresponds to a goal over fulfilment by the project. The planned quality parameter could not yet be achieved over the year. However, a quality of approx. 93% was achieved in the last three months. In short, it can be stated that the following results can be achieved by using the AI-BPM Diamond and the implementation approach:

- Reducing NBA lead time from 25 minutes to 7.66 minutes;
- Process controlling and adaption are performed in real time;

- Service teams and sales departments receive the important NBAs promptly and prioritized for further processing;
- Automatic validation and process routing of 82.8% on an annual average;
- 83.3% of the resources of the original NBA Team were allocated to other value-added activities, 13.3% more than planned, and thus the team was reduced from 15 to 2.5 members;
- The cost saving is 91,240 € per month after amortization in the 4th month after implementation (if the project costs are spread over the first 3 months);
- The Return on Investment in the first year is 0.42 and in the second 0.98;
- Employee satisfaction has been sustainably increased from 68,3 % up to 78,1% as the service and sales teams can plan better, and the NBA Team members have been able to develop (separately measured and analysed in the organizational areas concerned);
- The implementation effort was 27 hours higher than originally planned, whereby a buffer was already built in during the planning.
- The evaluation of the CMMI level has shown that level 5 has been reached regarding the use case end-to-end process. Thus, the AI-BPM model could contribute to the development of the company;
- The AI-Maturity has also risen to the next level - AI Proficient. This increase to the next level can be explained by the Use Case and the associated awareness and visibility of the topic of AI within the company as well as the improved technology familiarity and experience in the operational area.

5.4. AI-BPM Model and methodology in organizational practice. Lessons learned, execution feedback and insights

In the context of the use case implementation, there were some essential learning experiences and hints which should be considered in the further and for the following model. These are briefly described and evaluated in the following.

Already during the project, a retrospective was conducted with all relevant stakeholders. During this process, the team members looked back together, evaluated the individual successes, and discussed general improvements. Furthermore, generic findings were also discussed, which are presented below. This helps to better understand the approach and its impact on the business.

It became clear that the dimensions defined in the AI-BPM Diamond Model and the associated methodology represent an important and holistic approach. Above all, the topic of communication should be emphasized more strongly to give all employees the opportunity to be informed and not to create a defensive attitude against new approaches or technologies. In particular, the company's management made dedicated reference to the process model an important support for implementation.

It turned out that the used BPM software and the necessary know-how were basic components for the successful realization of the project. Without a suitable BPM software, which provides the functional components for integration etc., a realization

within three months will not be possible. A current BPM software would have to be introduced before.

In addition, the company's management understood that IT governance is very important for the successful implementation, to proceed holistically from a business perspective and to enable integration. Concrete measures were already taken during the implementation of the project and IT architects were established in all projects and given the responsibility of implementing the guidelines and specifications from an IT architectural perspective.

In addition to communication, it became clear that change management would have to be carried out more intensively in the future. Employees should be better adapted to changing circumstances and new developments and, above all, the company wants to encourage employees to dedicate themselves intrinsically to new topics and technologies. The management has recognized that the increase in automation will make employees unqualified, and that appropriate programmes will have to be set up. For this purpose, the findings from chapter three of this work were made available to the company.

At first, it should be possible to understand the complexity of the problem to be addressed. The use case to be derived from this and realistic expectations are half the battle. It is important to start small, not to turn the big wheel directly, but to start with concrete use cases and so-called low-hanging fruits to quickly show positive results, as Eric Johnson mentioned as well (Johnson, 2020).

Furthermore, the company sees the need for the newly described role of the transformer to understand business requirements and to work with the business to translate them into IT requirements.

The culture and leadership dimension show how important these soft factors are for the successful implementation and introduction of new methods and technologies in a company. In addition, an IT or technology organization should forget the historical silo thinking and promote interdisciplinary cooperation to use AI widely and successfully. A basic component for this is open communication.

Involving frontline staff is important because they can provide direct and informed feedback and bluntly point out bottlenecks and obstacles, which is also Johnson's insight (Johnson, 2020).

The use of agile project methods has increased the performance and transparency of the project. A transparent Kanban and the concentration of the team at one location on one topic support the delivery on time, budget and in the right quality.

Data is the important prerequisite for successfully applying AI and BPM. If it is not clear what data is available in the company and different data structures are used, a comprehensive analysis is difficult. Therefore, a uniform data strategy and governance in the company are advisable. The same applies to setting up Governance AI systems and rules that provide security and guard rails.

In addition to governance issues, the security of the system against hackers and other attacks must be ensured and considered in the construction. It is important that the results are comprehensible and verifiable. If the AI-BPM application is a black box and the results are random, its use is not recommended.

Through automated analysis, it is possible to prioritize critical elements and tasks and thus optimize the process flow of the business to reduce internal efforts and generate customer satisfaction. This approach also allows to derive next-best offer and next-best-action activities to enable additional sales.

Through a 24/7 analysis via AI, the company creates almost real-time event processing, which enables a more customer-specific approach. By integrating external

context, market and political factors are also included in the DMP, which enables a detailed customer focus.

The central mapping and storage of AI-BPM use cases and their structure can help to reduce duplication of work in larger companies. Therefore, a repository should be created and linked to the knowledge database. Here, it is important that all employees can access it. This saves resources.

The company's CIO has summarized the AI-BPM model as follows: "*All in all, the five dimensions of the AI-BPM Diamond and the Implementation Approach represent a valuable and business-supporting approach that allows an organization to adapt the procedure easily and quickly and to process the mentioned work and validation steps in a kind of checklist. The addition of the existing BPM suites as a selection and comparison step in the initialization phase would complement the model in my view. Finally, it should be mentioned that the strong focus on people, leadership, transparency and culture was somewhat surprising, but in the course of the project it became clear that without the focus on these dimensions, the project would probably have failed*" (CIO Use Case Company, 2020).

A thought experiment is the extension of the use case, in which speech recognition and communication with customers are performed directly by the AI system and thus service and sales staff could also be used for other topics. This must be checked in another approach.

To successfully realize follow-up projects in the AI-BPM area in the company, three steps are necessary to build an intelligent organization:

1. Automated processes that are enabled by the technology and supported by skilled employees. Therefore, a core team should be equipped with management attention, project prioritization and budget to realize efficiency increases through intelligent automation projects;
2. For this purpose, specific talents and knowledge carriers are recruited and knowledge is built up;
3. Sharing is caring, therefore supported by communication to inform employees conveniently.

5.5. Analysis of the new technology impact

The use of the new technologies shows a kind of displacement of employees into other fields of activity. The NBA Use Case also shows the increase in man-machine collaboration and the optimized use of human labour. With the increasing amount of data and digitized processes, the probability of its evaluation also increases. This creates new opportunities, new products and new services, even new business models to attract customers and deliver added value to people. Not only customers, but also employees are in focus. As previously shown in this research, the emerging Industry 5.0 creates a trend reversal in human work. The combination of intelligent devices, intelligent systems and intelligent automation is merging completely with the human world (Nahavandi, 2019).

In addition to AI and ML, other technologies are on the rise to influence the BPM world, for example, Robotic Process Automation (RPA) as a core technology of Industry 5.0 and BPM (Mendling et al. 2018; Kospanos, 2017). The block chain, virtual realities and many other technologies under development can also have a significant impact on BPM, people, and business. It is important not to close oneself off from innovations out of fear, but to deal with something new like innovations and other changes and to evaluate them for oneself.

A helpful method used in manufactories is the Digital Twin. This is a simulation model that combines and steals various innovative technologies like IoT, AI and AR/VR in a complex way. It collects data from all processes using IoT sensors and analyses information in real time via AI to significantly improve forecasts and processes (Samsung SDS BrandVoice, 2020). In other words, digital twins are a kind of virtual models of a real environment that reflect the physical state of an object or system in real time. The analysed data then leads to improvements in production processes and reduces risks.

It is also clear that the influence of technology will change today's job profiles. New roles are created, and others expire and are no longer needed. It is up to the people and the companies to notice this early on and to re-orientate if necessary. The blurring of work and leisure time will also continue. Social integration and social interaction on different platforms do not only support digital working, but also create freedom and transparency for potential customers (Mendling et al., 2018). In difficult times, such as the Corona crisis, the use of digital technologies is more important than ever to maintain business continuity and not to endanger health. This shows the positive impact of the new technologies in an impressive way. The rapid changeover and acceptance of people worldwide to collaborate digitally will change collaboration forever and create new ways of thinking and working.

Nevertheless, clear lines of authority and responsibility must be guaranteed and established to prevent constant conflicts between humans and AI. Otherwise, there will be long discussions about "how much power and authority super smart software should have"[72] (Schrage, 2017).

Overall, the technological development of the last years and decades leaves a large footprint in history and certainly also in the future. All areas are touched, changed or optimized in a certain way and therefore bring innovation and advantages, but also negative aspects. To sum up, the only thing that applies here is: "*From a different point of view, things sometimes look completely different*".

5.6. Ethical implications

In the research context, the application of AI must not end in a black-box scenario, but the results must remain comprehensible. But what if the algorithms become independent, which sounds impossible at first, but happened in some cases:

- In 2017, Facebook had to shut down its AI because it was developing a kind of secret language in dialogue with another AI (Nagels, 2017). Consequently, the "black-box scenario was born";
- A year earlier, Google had experienced a similar fate when neural networks developed their own encryption to cryptographically secure their communication (Beuth, 2016);
- Knight (2017) wrote: "*No one really knows how the most advanced algorithms do what they do. That could be a problem";*
- Facebook AI scientific researcher Dhruv Batra expressed himself critically:" *We already do not generally understand how complex AIs think, because we cannot really see into their thinking process*" (Nagels, 2017).

These facts show that uncertainty can also prevail among the large technology companies when it comes to AI. For this reason, it is important to think about ethical

[72] Retrieved from: https://go2karatesites.com/4-models-for-using-ai-to-make-decisions/

approaches and AI governance in the company and to formulate corresponding guidelines or guard rails. The central guardrail could be there, every AI system has a stop button and no use of black boxes. Based on the discussions in the use case company, nine AI guidelines have already been defined, as shown below.

1. "We are responsible – clear definition of who is responsible for which AI System;
2. We care – AI Systems and their usage obey human-defined rules;
3. We put our customer first – Using AI to simplify our customers lives;
4. We are transparent – Transparency about how we use customer data and AI;
5. We are secure – Our customer data is protected against unwanted external access;
6. We set the framework – Good preparation precedes an excellent outcome;
7. Continuous readiness to interfere in AI systems to prevent and reduce damage;
8. We foster the cooperative model – get advantages out of a cooperative and complementary model of human-machine interactions;
9. We share and enlighten – Spreading knowledge about AI"[73].

A survey on the use of AI has already shown in 2018 that companies that consider the ethical views when using AI are 92% successful in implementing AI. In addition, 63% of companies reported having an Ethics Committee to review the exploitation of AI, and 70% reported having "ethics training for their technologists" (Accenture 2018).

It is important to consider that even though every company looks at the issue of ethics and formulates corresponding guidelines, the ethical principles can be quite different in the different regions of the world. What is therefore common sense in Region A of the world could be exactly the opposite in Region B. This therefore leads to a higher complexity in the context of introducing AI as well as sharing knowledge and collaborating across regions, as described in rule seven and eight.

Overall, this shows the complexity of ethics in dealing with AI and represents a separate topic area for concrete work. It is important to take this into account during the introduction and the application in practice.

5.7. Conclusions on AI-BPM Diamond Model execution

This chapter described the application and execution of the AI-BPM Diamond Model and the AI-BPM implementation approach contained therein and evaluated the findings. With the support of a company from the real economy and a practical problem, it was possible to derive a use case for this research, which describes the automated processing of follow-up orders using AI-BPM. The application of the AI-BPM Diamond Model, its four phases, and the process model were the framework that enabled the implementation and holistic view.

One of the most important components and basis at the same time is the use of data and data analysis to generate added value for customers and employees. Marr (2015) states the following: "*If we can use data analysis to find patterns and correlations between personality traits, behaviour and capabilities that turn out to 'fit' with particular roles, jobs or corporate cultures that would then translate into more of the right people in the right jobs, then productivity, employee engagement and*

[73] As mentioned at: https://www.welove.ai/en/blog/post/deutsche-telekoms-policy-for-the-use-of-ai.html (statements from the company that has provided the use case)

happiness will increase and that's got to be a good thing for everyone" (Marr, 2015). This quote describes the experiences from the use case in an excellent way. By analysing the data and using AI to optimize the follow-up processes, not only productivity was increased, but the customer approach was optimized, and employee satisfaction increased, as the previous analyses have shown.

According to the calculation of the business case, the expectations of the company management were extremely high and could even be exceeded thanks to the rapid achievement of the break-even point and the immense savings potential. In addition, the quality target was almost reached, at least the outlook bodes well considering the solution rate of the AI-BPM system of the last three evaluated months.

The agile procedures and the retrospective ones performed have helped to identify and adapt errors quickly. Positive approaches and implementations were shared so that everyone in the team and in the organization could participate.

Important is the open communication in all parts of the company, true to the motto: "Sharing is caring!".

Three adjustments to the process model result from the lessons learned:

- The first is the integration and establishment of ethical guidelines for the use of AI. This was previously considered in the Securing Organizational Clarity Phase and is now highlighted separately;
- Another issue addressed by the management is the selection of the BPM Suite vendors, which was previously discussed in the Apply technology Acumen framework. The focus here is on the existing market solutions and the benchmark to the solution established in the company. The background is that the vendor selection of BPM Suites can be questioned by the implementation of use cases and the famous view over the edge of the plate takes place, to reduce the dependence on the existing vendor or to build up corresponding pressure;
- The third insight is to use and build a digital twin in the Transition and Execution phase to avoid jeopardizing operations. This makes it possible to try out new scenarios and to gain knowledge without replicating risks to the business. If the results are satisfactory, this can then be adopted accordingly.

As shown in Figure 5.11, these findings and insights have been incorporated into the process model. This is still a framework that can be adapted as required.

The application and evaluation of the AI-BPM Diamond Model have shown that the main goals are to improve customer focus and satisfaction, to support employees in the best possible way and at the same time save time and costs. The whole should be implemented via incremental steps. For the company, the following question should be in focus: *Are we working on the biggest and most important problems in the company?*

It should be noted that this model describes the first version of the AI-BPM implementation, "derived from synthesis of diverse industrial cases carried out and existing literature. However, this model is currently quite generic, and further studies are needed to add detail and bring it closer to practice with further insights"[74] (Parviainen et al., 2017).

Separately, technology integration is to be emphasized once again as an important prerequisite. The application and integration of emerging technologies such as SMAC, VR, AI or Blockchain enable immense development potential through adaptation, which can have a positive effect on all areas of the company and society.

[74] Retrieved from: http://www.sciencesphere.org/ijispm/archive/ijispm-050104.pdf

From the practical perspective, it is up to people, entrepreneurs, and customers - to society as a whole - to use AI and new technologies in the framework that offers the best benefits to society. This also re-establishes the link to Industry 5.0, where society is at the forefront and machines and technologies support people in their activities in a variety of ways.

With reference to the goals of the work, the fourth goal could now also be achieved positively, in which the performance analysis and the resulting results were presented transparently, and the following ones were shown for the employees and the business.

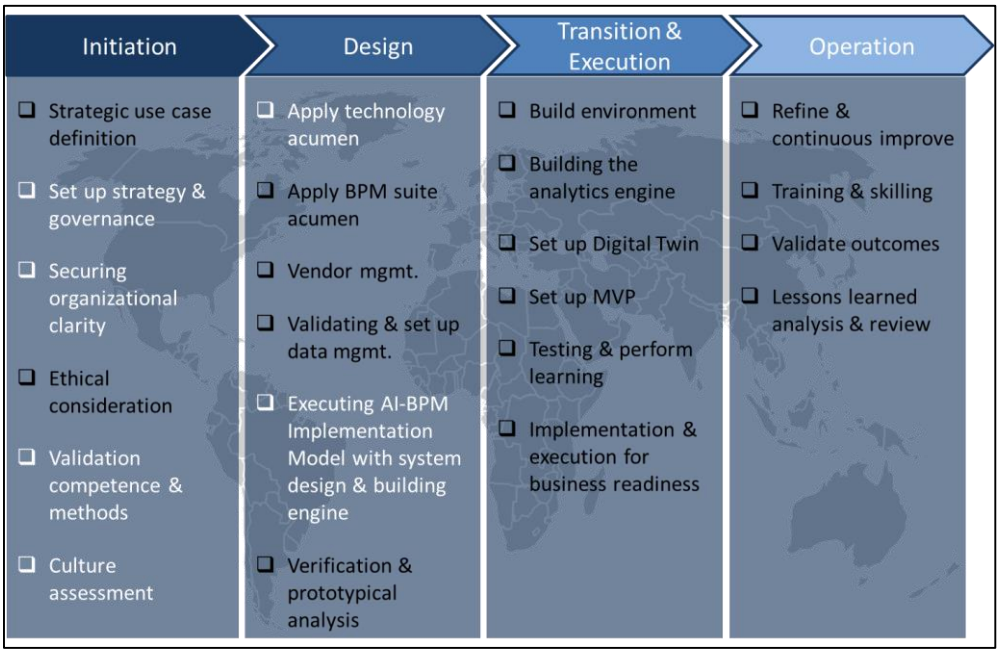

Figure 5.11 Final AI-BPM Implementation and application guideline

As a synthesis of the above-mentioned and debated aspects on the experimental research results, in Table 5.8, the advantages and disadvantages of the proposed approach are presented, from the ICT perspective and managerial implications in the considered organization practice (limited to the use case).

Table 5.8 Conclusions synthesis of the experimental research

Strength / Advantages	**Weaknesses / Disadvantages**
Placing the AI at the centre of the company's workflow makes it an essential tool for generating relevance. AI helps to learn and adapt quickly and stay ahead of the competition.	Poorly prepared and defined use cases and unclear responsibilities and problems slow down the transformation.
With the help of the AI-BPM approach, the agile working method in an organization is supported.	Employees are overwhelmed by the new way of working with machines and close themselves to further changes and optimizations.
The AI-BPM Approach encouraged the company's goal to conserve its resources, keep the environment clean and create added value for people with the products and services it offers to be successful.	Transparency about processes and activities in the company can lead to resentment and finger-pointing and thus endanger the working atmosphere and the transformation process. This risk must be managed through leadership and open communication.
The AI-BPM Diamond and the implementation model enable business and management to react to problems, organizational impacts, or even future risks by foreseeing them and thus to mitigate them before rising.	The necessary skills and know-how of the employees are to be built up for implementation or procured externally. In this case, early intervention and analysis should be carried out.
The five dimensions of the Diamond are Industry 5.0 aligned and allow companies to already prepare for the upcoming industrial revolution.	The culture of the company and the established cooperation at the different levels are an important prerequisite for a successful transformation. A culture change takes years, is very complex and can only be actively implemented by change management activities.
The AI-BPM approach focuses on the cooperation between man and machine as predicted for the Industry 5.0. Therefore, the business will get already experiences in that case.	
Leadership is an essential dimension of the diamond and will also be the focus of servant leadership in Industry 5.0. Organizations are thus prepared and familiar with the required characteristics.	
The use of AI and the AI-BPM model is designed for business sustainability to conserve resources, keep the environment	

clean and create added value for all stakeholders.	
Using the AI-BPM model provides organizational clarity and creates transparency about missing strategies, visions or communication problems. This enables the company to focus on the identified Pain Points.	

6. CONCLUSION, CONTRIBUTION AND RECOMMENDATIONS

"The question is not whether it will work. The question is, if it does work, how important will it be."
Marc Andreessen

In this final chapter of the doctoral thesis, the research results are presented. Subsequently, the transfer and completion of the latest research in this field are discussed. Finally, a critical appraisal and delimitation of the research results are presented. The overall structure of the chapter can be seen in Figure 6.1.

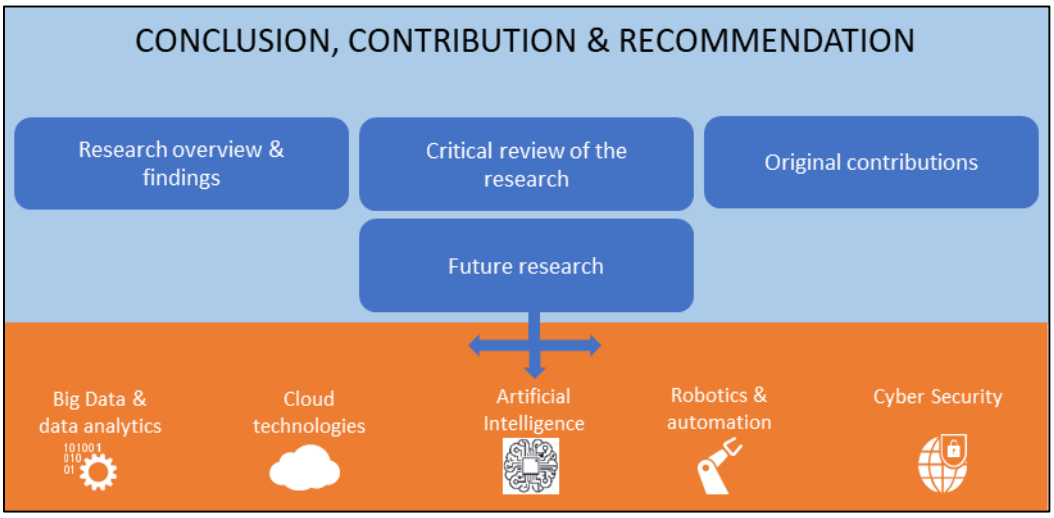

Figure 6.1 Conclusion structure

6.1. Research overview

The present PhD thesis offers an approach and research methodology applicable within business environments. AI-BPM is a topic of the present and will be even more a topic of the nearest future, as the present research on the literature has shown. First of all, companies and industries are already preparing for the next Industrial Revolution and are recognizing the signs of the times, which will lead to companies working more closely with new technologies; new technologies will also bring problems that mankind has not yet fully recognized, and discovered, but do we want to close ourselves off from them? In other words, a balance must be found between the question of how much technology is optimal and how far man should let go of his previous nature to accept the new technologies (Juneja, 2019).

Second, the scientific analysis of the topic areas shows that a high degree of change is to be found in the socio-economic environment due to the fast-transforming framework conditions. For this, digitisation is one of the most important.

The speed with which markets today continue to be shaped by disruptive technologies shows the explosive nature of the issue. In the digitalised economy, innovations are setting a completely new pace. Long-established business models are becoming less important, and new concepts are helping companies to become big players within a very short time. Those who are not able to understand the requirements of the market and adapt to them will sooner or later fall by the wayside.

The creation of more and more complex products, service structures and organizational networks leads to more complexity in coordination and synchronization of the corresponding business processes within a company and supply chain (Müller, Reichert and Herbst, 2006). Therefore, the ongoing digital transformation automation creates the opportunity to rethink the way work gets done.

Furthermore, BPM works very well with multivariate technologies and digital platforms such as IoT, AI or robot-based process automation and other open-source communities. Organizations should be willing to experiment with the AI-BPM combination to learn and pursue until they find a breakthrough. As they do so, they should form new partnerships and collaborate with other companies. In addition, it has turned out that AI and BPM are an exciting combination that can foster innovation at the grassroots level, as the use case has shown. Because the process is an extremely important component of business transformation, it can trigger changes that can be carried throughout the organization and in some cases beyond the boundaries of the enterprise (Durairaj, 2018).

One of the most important prerequisites is data centricity. Data is seen as a company asset and supports the competitiveness of the company by generating Insight. "Data-driven companies use advanced analytics, ML and AI to optimize business processes, functions, and their models. All this helps in the search and exploration of new and disruptive business models that can lead to more growth and market relevance" (Saxena, 2019).

Based on the company's data, supplemented by additional dimensions, the successful application of the *AI-BPM Diamond Model* could be proven. Furthermore, based on the theoretical and preliminary research results, a process model for the design and implementation of AI-BPM in a company has been established. The results from the practical implementation confirmed the procedure and led to a concretization in some areas. In addition to the confirmation of the model as well as the approach, the use case company was shown the way to Industry 5.0 and the previously examined core elements were given for internalization. This enables the company to look ahead to the future and to be well-prepared for the upcoming changes by appropriate programmes and strategies.

The scientific elaboration started with a theoretical analysis of the basic building blocks of the topic. The concept of Industry 4.0 and digitization is the foundation. A core component of the respective developments can be traced back to the technological innovations. The technologies discussed in this paper, such as AI or Big Data, Robots, Human-Computer Interaction, are among the most important technologies of the current decade (RRI, 2019; Chhabra, 2019). This underlines the focus and sustainability of the approach, as the technologies will soon have a major impact, too (Husain, 2020). The triumvirate of Industry 4.0 and digitization consists of Process, People and Technology. Technology enables the automated execution of processes and thus creates added value, while people follow the process and use technology in a leveraged manner.

Based on the emerging changes due to digitalization and the industrial revolution and the resulting further development of technologies, the emerging Industry 5.0 was examined and described. Society 5.0 already exists in Japan, and this development is slowly but steadily becoming apparent in the rest of the world. A characterization of the Industry 5.0 was carried out which allows to evaluate the impact on the future business and society. The core component is again the technological development and the close cooperation with people. This correlation also puts more emphasis on the leadership component in companies. It is all about taking people into account and ensuring that everyone is deployed in the right place to achieve the greatest possible efficiency.

The AI to be assigned to the technology was then explicitly considered theoretically. The different forms of AI and their gradations were explained in detail. In comparison to machine learning, the learning types and the learning process were presented in a dedicated way. Based on previous scientific studies and AI applications, the advantages of AI could be worked out and the resulting influence on business transformation could be deduced. To ensure a holistic perspective, the use of AI in European companies was investigated. It turned out that there are often extreme gaps in knowledge and skills compared to other countries.

In addition, the emerging changes require comprehensible decisions. These decisions are increasingly automated by systems through data centration. Frameworks such as the OODA Loop are an aid to orientation. Due to technological developments, it can already be determined that AI will make many decisions in the future based on the collected data. The approach, advantages and disadvantages were discussed in the context of the analysis of future business decision-making with AI.

As the process is an essential part of every company, it is important to place special emphasis on it in addition to people and technology. Within the framework of BPM, the process and the management of processes were described in detail. For a better and comprehensive understanding, the different management approaches were presented, all of which are used in BPM in a certain way. This supports the formation for the measurement of successful BPM and shows the connection possibilities for AI-BPM in theory. This was underpinned by the BPM trends and the changes already realized in the BPM area due to digitalization.

With the conclusion of the extensive theoretical consideration, due to the large number of relevant components for the topic, the first goal of the work could thus be successfully achieved.

By taking a long-term view of the topic, scientific treatises have already been written beforehand, which represent an essential thematic reference. In chapter six of the paper, these previous studies were described, and the findings and models obtained from the studies were presented. Overall, this allowed access to a substantial pool of data to derive the AI-BPM Diamond. This is the core of the work and consists of five dimensions and an AI-BPM implementation model. The mentioned dimensions (Strategy and Governance, Organizational clarity and Leadership, Competence and Methods, Culture, Technology Acumen and at the centre of the Diamond the AI-BPM Implementation Model) were described in a dedicated way and the core contents and requirements were presented in a theoretical way. For a better practical application, a procedure model was created as a framework, which is subdivided into four phases and characterized by concrete activities, which are related to the five dimensions. With the conclusion of the sixth chapter, the second goal of the scientific work has also been achieved.

The practical validation and evaluation of the theoretical model was then implemented in a use case at a large company. Each activity was dealt with in a dedicated way according to the process model. Through open communication, interested parties could participate and become members of the team. The implementation was centrally monitored by the management and validated against previously established SMART objectives. The cost savings achieved were the most striking advantages, along with the increase in efficiency. In addition, regular lessons learned events were held to suggest improvements, which were then incorporated into the final process model. With the realization of the use case through the application of the AI-BPM Diamond and the subsequent performance analysis, goals three and four of this work could also be achieved.

6.2. Conclusions and research findings

The far-reaching analysis to clarify AI-BPM relation, as an important success factor and business need of Industry 5.0, has shown that many topics must be considered in the investigation and processing. Accordingly, many interesting results could be formulated. Within the framework of the clear design, the most important ones are:

- A lack of strategy is one of the biggest hazards for the implementation of Industry 5.0. Companies should formulate clear objectives and strategies from the overall objectives to achieve the desired goals. Further, strategies can be established for each area (e.g., AI, data, human resources etc.). With this approach, companies generate clear directions for employees and can avoid poor data quality, wrong skills in the company or other problems that can hinder a transformation;
- Data is the fundament of AI and for the three core areas of interest in the present research: decision-making, improving operations and monetization of data;
- Placing AI at the centre of the companies' workflow makes it an essential tool for generating business relevance. AI supports quick learning, adaptation, and creates a real and sustainable competitive advantage;
- Industry 5.0 will provide consumers with the products and services they want, giving workers jobs and tasks that make more sense than what they do today. Workforces must be upskilled to provide value-added tasks and are able to work next to intelligent machines;
- The entrepreneurs and managers of the nearest future must therefore be able to generate visions (ideas) for further development and use of new and emerging technologies on the one hand, and to motivate employees for new goals and approaches, despite the increasing of automation, on the other;
- The AI use for DMP can be applied in all areas and not only for process optimization (the basis for this is the available data);
- AI-BPM becomes an irreplaceable tool in the daily operations of businesses;
- The defined dimensions of the AI-BPM Diamond Model and its Industry 5.0 affinity allow companies to face the ongoing Industrial Revolution;
- For the AI-BPM Diamond Model execution, focusing on one problem makes implementation easier and creates clarity about the defined goals and their achievement;
- The IT department is the central organizational unit to design and execute the integration and implementation of an AI-BPM approach. Accordingly, this unit must be equipped with governance and budget;

- The corporate or organizational culture plays a central role in implementing AI-BPM projects and in supporting employees. In the context of cooperation between intelligent machines and people, culture will continue to increase in relevance;
- All is about trust in man – machine cooperation; trust that intelligent machines will have to earn in the future;
- In addition to the upskilling of the employees to provide value-added tasks, new roles and work activities will emerge (not yet identified!). In the social development context, care must be taken to ensure that this is compatible with culture and ethics. Active talent management is therefore recommended to support and build up the right skills at an early stage and bind them to the company;
- The use of AI and the AI-BPM Diamond Model should always be customized with respect to sustainable development principles and values in the organization. A company's goal must be to preserve an efficient use of resources, keep the environment clean and create added value for people through the offer of the products and services;
- To establish the right use case ideas, it has been shown that implementation and analysis can be carried out in four steps: (1) analysis of the status quo; (2) derivation of ideas for improvement; (3) validation of the impact of the expected changes and (4) development of a roadmap of use cases;
- For a successful practical implementation of the AI-BPM project (based on the proposed Model), four rules should be used:
    1. Establishment of clear responsibilities and agreement on objectives as well as transfer of budget responsibility;
    2. Alignment should be based on the use cases and not on technology. KPIs are advisable for tracking, to be transparent and to be able to show the progress;
    3. In the foreground of the projects are the results that can be achieved through leadership and digital strategies and thus organizational clarity;
    4. Fail quickly and cheaply and learn from this within the framework of the trial-and-error principle. Building prototypes saves costs and reduces risk;
- It has been shown that agile projects are well-suited for the development and implementation of the AI-BPM Diamond Model, due to the flexible handling of topics in the backlog. Furthermore, agile methods, like SCRUM, are also designed for qualitative work;
- AI-BPM has been recognized as an important approach for improving the overall efficiency of employees through the elements of process adaptations, predictive analytics, and operational decision management. It requires intelligent process modelling to build a seamless business process;
- The practical use and exploitation of AI and the AI-BPM Diamond Model can provide added value to business processes;
- The AI-BPM Diamond Model enables business and the IT departments of the organization to quickly react to problems and new organizational impacts or even to foresee them and thus to implement new processes, business models and strategies agilely and in a short time;
- AI and the AI-BPM Diamond Model can better support the customer-centric processes and they considered/integrated customers in the process component.

6.3. Original contributions

From the scientific point of view, the original contributions are reflected by the research results achieved in different stages of the PhD programme that were described in the PhD thesis as follows:

1. Based on the thesis that Industry and Society are constantly changing by technological developments with a huge impact on business and organizations. Therefore, the next Industrial Revolution will take place in the nearest future. Under this hypothesis, an analysis and synthesis of the main and relevant references on the 5th Industrial Revolution step to Industry 5.0 have been realized. Furthermore, the scientific characterization of Industry 5.0 and the interplay of Society 5.0 to be prepared for the step beyond Industry 4.0 have been developed as an original study (like the state-of-the-art overview in the field) – Chapter 1;
2. Through the research done, an analysis, research and evaluation on the future-oriented AI technology have been provided and important framework conditions with business and social relation have been created. This study has provided the scientific basis and practical proof that AI will enable humans to focus on their missions' role that add the most value to business processes execution. This contribution is a potential source for future research and approaches in this area, too – Chapters 2.1 – 2.6;
3. Another original contribution of the research done is related to the diagnosis, analysis, and synthesis of the underlying DMP in business and its characteristics in the different dimensions with the interplay with AI. This study provides guidance and fundamentals for the present theoretical development and experimental research; this has proven the thesis that AI is the core transformative technology by which we are rethinking and optimizing human decision-making and BPM - Chapter 2.7;
4. Further, an original contribution of the research is the assessment of the state-of-the-art on intelligent BPM, AI-BPM and further management approaches on a theoretical and practical basis creating the foundation for the theoretical development of the model that combines AI and iBPM to break new ground and evaluate that BPM has become the method of choice as one of the most effective tools to execute business transformation and change into the next Industrial Revolution and simplify complex process structures – Chapter 3;
5. From the research and publications perspectives, eight original preliminary studies have been designed and implemented in the AI-BPM field in the Industry 5.0 context (research results being subject of published articles, as seen in Annex 10), having the following topics:
    - Organization development with agile BPMM as a guarantee for success;
    - Automated BPM in times of digital transformation using ML or AI;
    - BPaaS - a Cloud BPM;
    - Organizational knowledge management with Big Data - the foundation of using AI;
    - Knowledge Management – the foundation for a successful BPM;
    - AI and the way of changing decision-making for business;
    - The important prerequisite for AI-DMP;
    - Expected impacts of Industry 5.0 for business management.

These preliminary studies enabled a better understanding of the research field and assessed the possibility of applying the developed AI-BPM approach and AI-BPM Diamond Model for the real company use case - Chapters 4.1 and 4.2;

6. An important original contribution is the development of an AI-BPM approach with an associated methodology based on the core business dimension and tools for the implementation of the AI-BPM approach in consideration of necessary preconditions and framework parameters in small- and large-scale business environments, to create an understanding by the organizational management offering the possibility of strategic orientation to generate business value – Chapters 4.3 and 4.4;
7. From the practical point of view, original contributions are related to:
    - The implementation and execution of the AI-BPM Diamond Model in complex and large-scale business use case environment to check the practical feasibility and outcoming business value as well as process optimization – Chapter 5.2 and 5.3;
    - Performing an analysis and assessment of the use cases outcomes (strategic and operational) to balance economic and social responsibility, visualization of the obtained results, and formulation of recommendations for improvement – Chapters 5.4;
    - Develop an analysis of the new technology impact together with an inventory of ethical aspects implications – Chapters 5.5 and 5.6;
    - Proving the thesis that the developed AI-BPM Diamond Model will successfully guide the organizations' transformation to generate high business value and optimize existing process structures into Industry 5.0. – overall developments and debates in chapters 4 and 5.

Different research approaches with their respective results have been the subject of several ***dissemination activities*** (accompanied by a peer review process). Thus, 17 articles were published from which 10 index in the ISI Thomson / Clarivate Analytics database (from which 2 are published in journals) and 7 articles are published in journals and proceedings that are index in international databases. All articles were published between 2016 and 2020. The complete list of articles can be found in Annex 10 of this thesis.

Finally, the ***original contribution and the use of these research results for didactic purposes*** have been considered, mainly within the master's degree program "Engineering and Management for Competitiveness and Quality" (developed at the Politehnica University of Timisoara, Faculty of Management in Production and Transport, since the academic year 2019-2020).

6.4. Critical review of the research

This doctoral thesis was based on practical research carried out in a large company in the telecommunications industry. The company consists of different organizations that can act autonomously. The organizational unit especially selected for the analysis and implementation was already familiar with the previous scientific work and implementations. The resulting advantages for the use case implementation can lead to the fact that a realization in other departments or companies can be more complex and protracted, especially in the initiation phase. Therefore, it is possible that the temporal indication is not completely representative. Future research should repeat the implementation and analysis in other companies with different framework

conditions. Furthermore, additional studies with more participants would improve the validity of the results.

Due to the complexity of the NBA use case and the investigation and integration of the various upstream systems with different input parameters, it was not possible to optimize and validate another process and use case with the AI-BPM Approach and AI- Diamond in the selected organization. A comparable complex use case should be repeated within the organization of the company to assess the efficiency of the model and the approach and to compare the improvement within the CMMI and AI maturity model. According to the results, the improvement in the models should be adjusted and reassessed for the organization and processes.

In accordance with the AI-BPM approach, all defined and intended steps of the model were run through. This means that the interaction between the omission of individual steps and the result achieved in this thesis were not examined. It shall thus be investigated whether the omission of single steps of the approach or of one dimension of the diamond shows a correlation with the result presented in this thesis.

The savings potentials shown are not to be understood generically for the different use cases. The optimization of processes and the re-qualification of employees are not to be assumed. This must always be analysed in relation to the general conditions of the company and the use case. However, optimization and savings are to be assumed.

Finally, the AI approach and the AI-BPM Diamond Model were only applied to the use case in the ICT environment. The validity of the explained concepts should be tested in different environments to evaluate their weaknesses and to suggest possible improvements/modifications. For this purpose, companies in different industries as well as different sizes, countries, customer groups and other general conditions should be considered. In addition, companies that have had little or no contact with AI so far.

6.5. Future research

The results have shown that the AI-BPM Model is viable and applicable and gives companies the necessary framework in uncertain times. The implementation model even goes one step further and brings a kind of solution design out of the box by including the most important components for AI-BPM. For further detailing and optimization of the Diamond, it is possible to apply it in other companies in the context of future scientific work. In addition, questions such as example:

- How should performance be assessed when decisions are partly taken by the AI?
- What impact do algorithmic decisions have on management responsibility?
- How can the type of decision context influence the appropriateness of different approaches?
- How can concerns about trust and accountability be mitigated in a world where AI is becoming increasingly important in decision-making?
- "How can the loss of decision-making authority to the AI influence motivation and performance of human decision makers?"
- How will BPM suites evolve, and will technologies cannibalize in the future through their own AI?"[75]
- What is the impact of the intensive cooperation of humans with machines?

[75] As already research by:
https://journals.sagepub.com/doi/abs/10.1177/0008125619862257?journalCode=cmra

- Moreover, if AI can learn from mistakes and identify process gaps, can AI be a kind of self-healing system?
- Which wrong decisions and resulting business problems are possible due to misinformation and fake news?

Just as exciting to investigate is the influence of low code thoughts on BPM and the tool suites in the future.

With the status quo in the present and the future firmly in view, further changes in the economy and society are already emerging. Companies preparing for the fifth industrial revolution should thus be prepared for these changes.

A Charles Darwin once used to say: "*It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change*." In terms of the economic situation, this quote has never been as accurate as it is today.

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ANNEXES

Annex 1: Strategy pillars and associated criteria for AI maturity (Pringle and Zoller, 2018)

Annex 2: Business questions to address - brief interview protocol

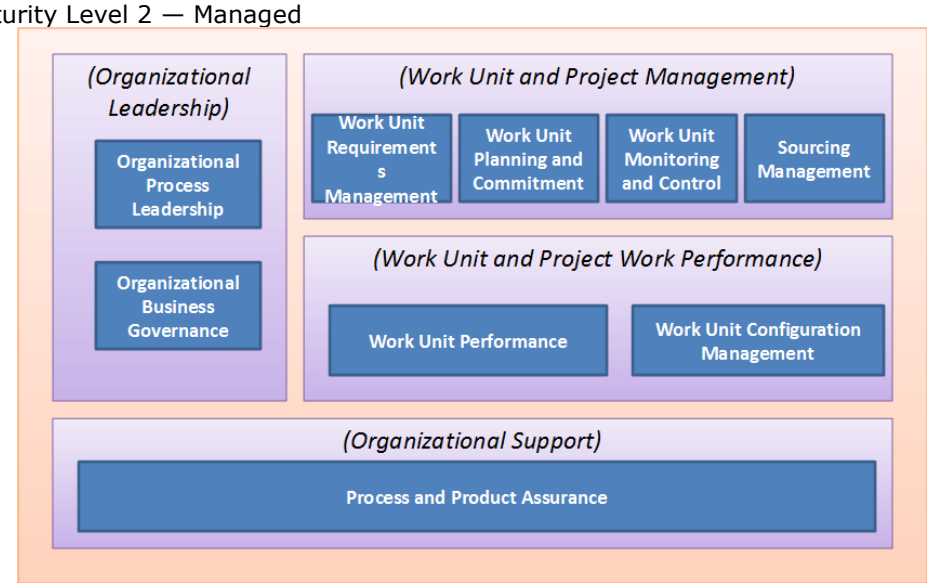
Extract from questions related to customers, markets and competition:

- What are some of the key trends in our market?
- Is there any upward or downward trend in demand for our product or service offerings?
- Where there still be demand four our product over the next five years?
- What are the three most critical drivers of success in your business this year?
- In an ideal world, what will your business look like in 3 years?
- Which markets should we abandon, and when?
- How much power do my customers have?
- Do I have the right customers?
- How much power do my suppliers have?
- Does my business have a moat around it?
- Am I outsourcing the right tasks?
- Am I measuring the right things?
- Do I have the right people and right skills?
- Are incentives aligned with business goals?
- Are my assumptions still reasonable?
- What values and beliefs define your brand?
- What are the pain points you solve for customers?
- What sources bring in the highest value customers?
- How strategies are in place to retain customers?
- From an overall business standpoint, what is your biggest challenge?
- What are your biggest marketing challenges?
- What are your biggest sales challenges?
- For these challenges, why have they not been solved?
- What has been the negative effect of these challenges/problems on your business?
- What are you most important processes?
- How does these processes look like?

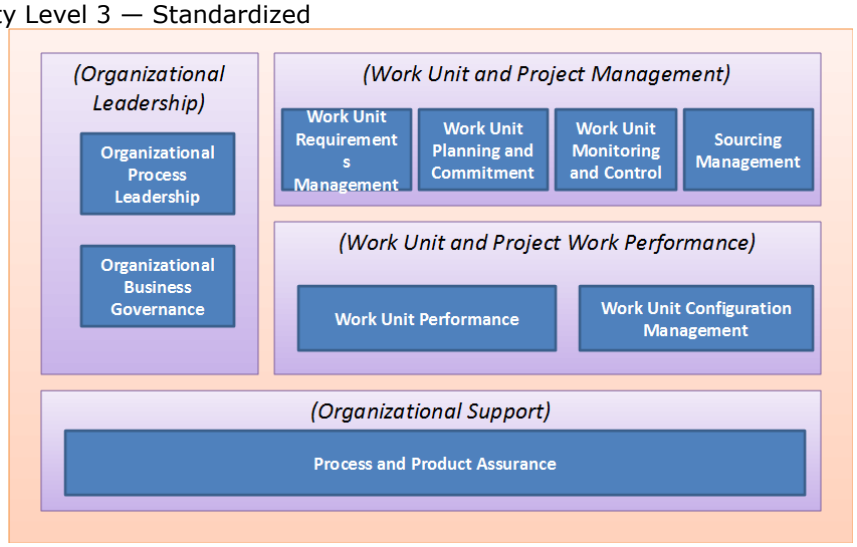
Annex 3: BPMM process areas of the Maturity Levels, Focus and Process Areas (BizBlog, 2018)

1 Initial	2 Managed	3 Standardised	4 Predicable	5 Innovating
Individual efforts with no explicit process or organizational support	Managers establish a stable work environment in their work unit	Organization establishes standard processes and assets for performing the product and service work	Work processes are managed quantitatively to establish predictable results	Organization's processes are continually improved
	· Organizational Process Leadership · Organizational · Business Governance · Work Unit Requirements Management · Work Unit Planning and Commitment · Work Unit Monitoring and Control · Work Unit Performance · Work Unit Configuration · Management Sourcing · Management Process and Product Assurance	· Organizational Process Management · Organizational Competency Development · Organizational Resource Management · Organizational Configuration Management · Product and Service Business Management · Product and Service Work Management · Product and Service Preparation · Product and Service Deployment · Product and Service Operations · Product and Service Support	· Organizational Common Asset Management · Organizational Capability and Performance · Management Product and Service Process Integration · Quantitative Product and Service Management · Quantitative Process Management	· Organizational Improvement Planning · Organizational Performance Alignment · Defect and Problem Prevention · Continuous Capability Improvement · Organizational Innovative Improvement · Organizational Improvement Deployment

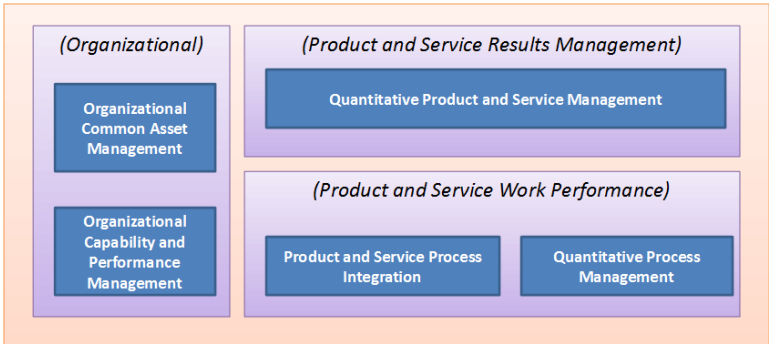
Maturity Level 2 — Managed



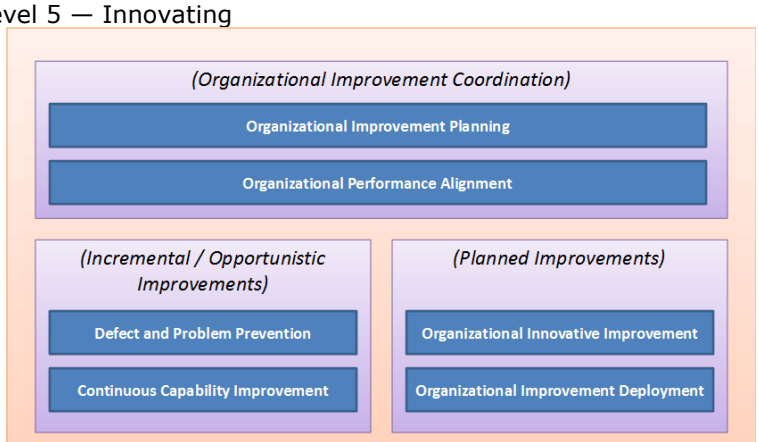
Maturity Level 3 — Standardized



Maturity Level 4 — Predictable



Maturity Level 5 — Innovating



Annex 4: An indicative list of the general maturity level characteristics (Leonardo, 2019)

Achieving Maturity

An indicative list of the general maturity level characteristics is shown below.

LEVEL	CHARACTERISTIC
1	**No organized processes No organized processes** • very little structured, proactive process work • dominant organisational view is functional • no consistent use of BPM methodology and tools • no reliable funding for process activity • low penetration of process thinking • low levels of executive involvement • decision making without reference to process implications
2	**Some organized processes** • growing acceptance of the importance of processes • some documented processes • process improvement projects becoming common • process improvement scope still quite limited • process work remains siloed • initial attempts to document a consistent methodology • limited executive support • limited focus on process performance management
3	**Most processes organized** • process architecture is in common use • extensive process improvement activity with proven benefits • significant, frequent, meaningful executive involvement • measures assigned to the top three levels of the architecture • well developed, and consistently used, process tools • process training as part of new staff induction • process owners appointed to at least the top 2 process levels • initial form of process support • well understood, compelling reasons for the use of BPM
4	**Processes are managed** • the "process of process" is actively managed and improved • effective process ownership across the process architecture • process support services for the whole organisation • improving business processes is everyone's job • much reduced need for external support • genuine process improvement culture discernible
5	**Processes continuously improved** • high penetration of process thinking in all daily work • process thinking, and working is integrated into everything • process issues covered in all job descriptions • central support service in guidance / compliance role only • process-aware decision making is ubiquitous • consistent BPM methodologies

Annex 5: Examples of NBAs (own illustration)

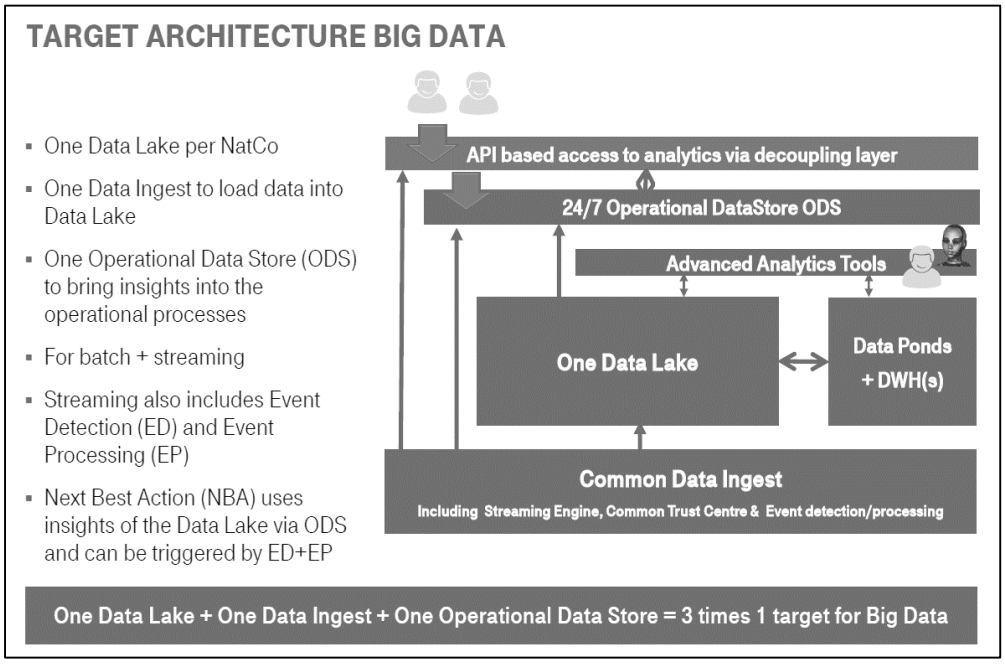
3	T-Com	GRK	0711	xxxxx	03.07.2017	HINWEISTEXT_ANGEGEBEN GESPERRTER_WERT_VERWENDET HINWEISTEXT_ANGEGEBEN	[NA188] - Zur Stornierung einer Kündigung wurde kein passender Eintrag gefunden. Der Eintrag muss ggf. erneut angelegt werden. Name 'Frauen helfen Frauen Filder e.V.' verletzt gesperrten Wert 'Frauen helfen Frauen' [NA074] - Eine Kündigung kann nicht mehr storniert werden, wenn der Eintrag bereits passiv geworden ist.		16.07.2018	5675
3	T-Com	GRK	0711	xxxxx	03.07.2017	HINWEISTEXT_ANGEGEBEN GESPERRTER_WERT_VERWENDET HINWEISTEXT_ANGEGEBEN	[NA188] - Zur Stornierung einer Kündigung wurde kein passender Eintrag gefunden. Der Eintrag muss ggf. erneut angelegt werden. Name 'Frauen helfen Frauen Filder e.V.' verletzt gesperrten Wert 'Frauen helfen Frauen' [NA074] - Eine Kündigung kann nicht mehr storniert werden, wenn der Eintrag bereits passiv geworden ist.		16.07.2018	5675
3	T-Com	GRK	0711	xxxxx	03.07.2017	HINWEISTEXT_ANGEGEBEN GESPERRTER_WERT_VERWENDET HINWEISTEXT_ANGEGEBEN	[NA074] - Eine Kündigung kann nicht mehr storniert werden, wenn der Eintrag bereits passiv geworden ist. Name 'Frauen helfen Frauen Filder e.V.' verletzt gesperrten Wert 'Frauen helfen Frauen' [NA188] - Zur Stornierung einer Kündigung wurde kein passender Eintrag gefunden. Der Eintrag muss ggf. erneut angelegt werden.		16.07.2018	5675
3	T-Com	GRK	0711	xxxxx	24.07.2017	HINWEISTEXT_ANGEGEBEN	[NA188] - Zur Stornierung einer Kündigung wurde kein passender Eintrag gefunden. Der Eintrag muss ggf. erneut angelegt werden.		16.07.2018	5675
3	T-Com	GRK	06848	xxxxx	23.01.2017	HINWEISTEXT_ANGEGEBEN HINWEISTEXT_ANGEGEBEN	[NA074] - Eine Kündigung kann nicht mehr storniert werden, wenn der Eintrag bereits passiv geworden ist. [NA188] - Zur Stornierung einer Kündigung wurde kein passender Eintrag gefunden. Der Eintrag muss ggf. erneut angelegt werden.		16.07.2018	5715
3	T-Com	GRK	04105	xxxxx	06.02.2017	HINWEISTEXT_ANGEGEBEN	Beratung!!! VZE konnte nicht geladen werden, hat aber Eintrag.			
3	T-Com	GRK	02841	xxxxx	08.11.2016	HINWEISTEXT_ANGEGEBEN	wie bisher			
3	T-Com	GRK	0365	xxxxx	23.08.2017	HINWEISTEXT_ANGEGEBEN	Osterlandgymnasium Gera			
3	T-Com	GRK	02801	xxxxx	08.11.2016	HINWEISTEXT_ANGEGEBEN	wie bisher			
3	T-Com	GRK	06339	xxxxx	09.03.2017	HINWEISTEXT_ANGEGEBEN	Eintrag wie bisher			
3	T-Com	GRK	036603	xxxxx	23.08.2017	HINWEISTEXT_ANGEGEBEN	Grundschule Hohenölsen			
3	T-Com	GRK	02151	xxxxx	21.12.2016	HINWEISTEXT_ANGEGEBEN	wie bisher			
3	T-Com	GRK	07704	xxxxx	08.03.2017	HINWEISTEXT_ANGEGEBEN	[NA188] - Zur Stornierung einer Kündigung wurde kein passender Eintrag gefunden. Der Eintrag muss ggf. erneut angelegt werden.		17.07.2018	5676

3	T-Com	GRK	0221	xxxxx	06.04.2017	HINWEISTEXT_ANG	[NA008] - Es existiert bereits mindestens ein Eintrag mit der Rufnummer xxxxxxxx zum Zeitpunkt 2018-08-01 00:00:00.0. [FA103] - Unbekannte Auftragsart 47/04. Bitte wenden Sie sich an den Anwendungssupport.		24.07.2018	5721
3	T-Com	GK	030	xxxxx	08.04.2017	HINWEISTEXT_ANG	[NA008] - Es existiert bereits mindestens ein Eintrag mit der Rufnummer xxxxxxxxx zum Zeitpunkt 2018-07-25 00:00:00.0.		13.07.2018	5734
3	T-Com	GK	030	xxxxx	08.04.2017	HINWEISTEXT_ANG	wie bisher			
3	T-Com	GK	0931	xxxxx	05.04.2017	HINWEISTEXT_ANG	Eintrag wie bisher			
3	T-Com	GK	040	xxxxx	13.02.2017	HINWEISTEXT_ANG	[NA011] - Nebenstellen gefunden, deren Rufnummer manuell geändert werden muss.		16.07.2018	5735
3	T-Com	GK	07394	xxxxx	04.11.2016	HINWEISTEXT_ANG	[FA103] - Interner Fehler in der Eintragsgeschichte [NA008] - Es existiert bereits mindestens ein Eintrag mit der Rufnummer xxxxxxxx zum Zeitpunkt 2018-07-18 00:00:00.0.		16.07.2018	5675
3	T-Com	GK	0711	xxxxx	07.04.2017	HINWEISTEXT_ANG	[FA103] - Interner Fehler in der Eintragsgeschichte [NA008] - Es existiert bereits mindestens ein Eintrag mit der Rufnummerxxxxxxxx zum Zeitpunkt 2018-07-18 00:00:00.0.		16.07.2018	5675
3	T-Com	GK	06784	xxxxx	22.06.2018	HINWEISTEXT_ANG	Eintrag wie xxxxxx			
3	T-Com	GK	0241	xxxxx	10.03.2017	HINWEISTEXT_ANG	Bitte den Eintrag mit dem Kunden Herrn Christian Otto unter xxxxxxx absprechen!			
3	T-Com	GK	06781	xxxxx	22.06.2018	HINWEISTEXT_ANG	wie bisher			
3	T-Com	GK	06196	xxxxx	10.02.2017	HINWEISTEXT_ANG	Beratung!			
3	T-Com	GK	09221	xxxxx	07.02.2017	HINWEISTEXT_ANG	Eintrag/Nichteintrag wie bisher			
3	T-Com	GK	09269	xxxxx	08.02.2017	HINWEISTEXT_ANG	wie bisher			
3	T-Com	GK	07351	xxxxx	04.11.2016	HINWEISTEXT_ANG	wie vorher!!			
3	T-Com	GK	040	xxxxx	13.02.2017	HINWEISTEXT_ANG	[NA002] - Hinweis : Eintrag wie Auftraggeber: xxx GmbH Spezialgroßhandel		17.07.2018	5736

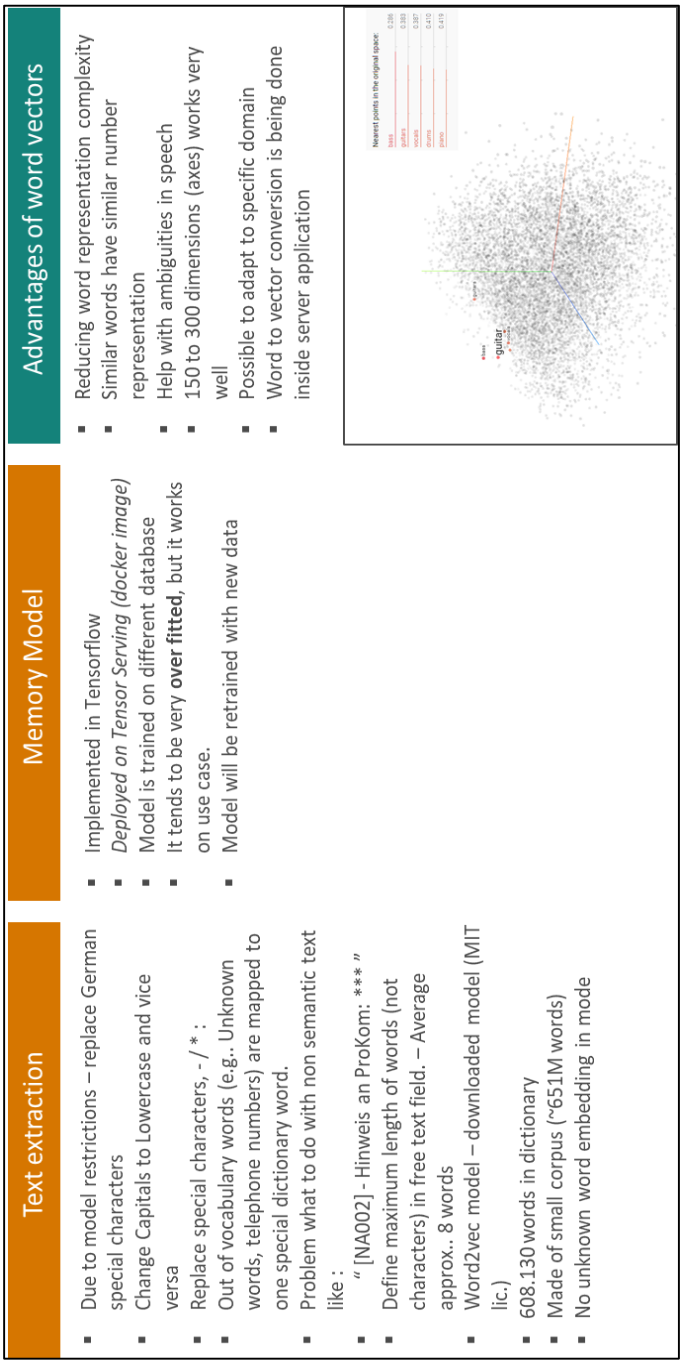
Annex 6: AI Guidelines of the use case company

1. **We are responsible.**
   Clear definition of who is responsible for which AI system.
2. **We care.**
   AI systems and their usage obey human-defined rules.
3. **We put our customers first.**
   Using AI to simplify our customers' lives.
4. **We are transparent.**
   Transparency about how we use customer data and AI.
5. **We are secure.**
   Our customers' data is protected against unwanted external access.
6. **We set the framework.**
   Good preparation precedes an excellent outcome.
7. **We maintain control.**
   Continuous readiness to interfere in AI systems to prevent and/or reduce damage.
8. **We foster the cooperative model.**
   Get advantages out of an cooperative and complementary model of human-machine interactions.
9. **We share and enlighten.**
   Spreading knowledge about AI and teaching relevant skills.

Annex 7: Big Data Architecture Guideline of the use case company



Annex 8: Draft view of AI capability usage



Annex 9: AI-BPM Implementation Code expert for the AI Text extraction capabilities

```
# coding: utf-8
import numpy as np
import tensorflow as tf
wordsList = np.load('w2vgerman-wordsList.npy')
#wordsList = wordsList.tolist() #Originally loaded as numpy array
wordVectorsfull = np.load('w2vgerman-wordVectors-200.npy')
numDimensions = wordVectorsfull.shape[1]
wordVectorsfull[0] = np.zeros((numDimensions,), dtype=float)
#wordVectorsOne = wordVectorsfull[0:1,0:numDimensions]
wordVectors = np.vstack((wordVectorsfull,wordVectorsfull[0]))
#to delete
positiveSamples = 'del - v2.txt'
#to keep
negativeSamples = 'nondel - v2-extended.txt'
numWords = []
with open(positiveSamples, "r", encoding='utf-8') as f:
	content = f.readlines()
	for line in content:
		counter = len(line.split())
		numWords.append(counter)
print('Positive files finished')
with open(negativeSamples, "r", encoding='utf-8') as f:
	content = f.readlines()
	for line in content:
		counter = len(line.split())
		numWords.append(counter)
print('Negative files finished')
sumSamples = len(numWords)
print('The total number of samples is', sumSamples)
print('The total number of words in the files is', sum(numWords))
print('The average number of words in the files is',
sum(numWords)/len(numWords))
lineCounter = 0
#for debuuging only
textdatabase = []
#for debuuging only
notfoundwords = []
with open(positiveSamples, "r", encoding="utf-8") as f:
	content=f.readlines()
	for line in content:
		textdatabase.append(line.rstrip())
		lineCounter = lineCounter + 1
with open(negativeSamples, "r", encoding="utf-8") as f:
	content=f.readlines()
	for line in content:
		textdatabase.append(line.rstrip())
		lineCounter = lineCounter + 1
```

```
print('Samples loaded')
batchSize = 24
#batchSize = 3
#number of hidden states
lstmUnits = 16
numClasses = 1
iterations = 151
maxSeqLength = 25
#workarround
#if this overflow error will occure !
maxInputWords = 250


import math
percentTestSamples = 0.1
numTestSamplesPerCls=
math.floor(sumSamples*(percentTestSamples/numClasses))
numTrainSamplesPerCls = sumSamples/2 - numTestSamplesPerCls
# corrected
cls1min = 0
cls1max = cls1min + numTrainSamplesPerCls - 1
cls1min_test = cls1max + 1
cls1max_test = cls1min_test + numTestSamplesPerCls - 1
cls2min_test = cls1max_test + 1
cls2max_test = cls2min_test + numTestSamplesPerCls - 1
cls2min = cls2max_test + 1
cls2max = cls2min + numTrainSamplesPerCls - 1
from random import randint
def getTrainBatch():
      labels = []
      out = [None] * batchSize
      for i in range(batchSize):
            if (i % 2 == 0):
                  num = randint(cls1min,cls1max) # act as closed interval for
raidint<cls1min,cls1max>  (0,240)
                  labels.append([1])          # Delete lables
            else:
                  num = randint(cls2min,cls2max) #(293,533)
                  labels.append([0])          # Keep lables
            out[i] =(textdatabase[num])
      return out, labels
def getTestBatch():
      labels = []
      freetext = []
      out = [None] * batchSize
      for i in range(batchSize):
            num = randint(cls1min_test,cls2max_test)  # <241,292>
            if (num <= cls1max_test):              # 12499
                  labels.append([1])              # delete
            else:
                  labels.append([0])              # keep
```

```
                out[i] =(textdatabase[num])
        return out, labels
import tensorflow as tf
tf.reset_default_graph()
#labels = tf.placeholder(tf.float32, [batchSize, numClasses], name='targets')
#
wordList = np.load('w2vgerman-wordsList.npy')
wordListTensor = tf.convert_to_tensor(wordList, dtype=tf.string,
name='wordListTensor')
Table =
tf.contrib.lookup.index_Table_from_tensor(mapping=wordListTensor,
num_oov_buckets=1, default_value=-1, name='lkpTable')
###
### Fix variable batch size
labels = tf.placeholder(tf.float32, [None, numClasses], name='targets')
input_str = tf.placeholder(tf.string, [None], name='inputs')
res = tf.strings.regex_replace(input_str,'ä','ae')
res = tf.strings.regex_replace(res,'ö','oe')
res = tf.strings.regex_replace(res,'ü','ue')
res = tf.strings.regex_replace(res,'Ä','Ae')
res = tf.strings.regex_replace(res,'Ö','Oe')
res = tf.strings.regex_replace(res,'Ü','Ue')
res = tf.strings.regex_replace(res,'ß','ss')
res = tf.strings.regex_replace(res,'^\[NA[0-9]+]',' ')
res = tf.strings.regex_replace(res,'^\[FA[0-9]+]',' ')
res = tf.strings.regex_replace(res,'^"*\[NA[0-9]+]',' ')
res = tf.strings.regex_replace(res,'^"*\[FA[0-9]+]',' ')
res = tf.strings.regex_replace(res,'[^a-zA-Z]',' ')
res = tf.strings.regex_replace(res,' +',' ')
res = tf.strings.strip(res)
input_split = tf.string_split(res)
# tf.string_split output explained:
#For example: N = 2, source[0] is 'hello world' and source[1] is 'a b c', then
the output will be
#st.indices = [0, 0; 0, 1; 1, 0; 1, 1; 1, 2] st.shape = [2, 3] st.values =
['hello', 'world', 'a', 'b', 'c']
#Max sequence lenght should be maximun allowed words on input. Sex
lenght is hyper parameter.
#as here some padding (maxSeqLength)!!!
#input_dense = tf.sparse_to_dense(input_split.indices,
[batchSize,maxSeqLength], input_split.values, default_value='f00b4r')
input_dense = tf.sparse_to_dense(input_split.indices,
[batchSize,maxInputWords], input_split.values, default_value='f00b4r')
# returns desired shape and the rest of (we don't care about "_" )
input_split_maxSeq, _ = tf.split(input_dense, [maxSeqLength,
(maxInputWords-maxSeqLength)], axis=1)
 #convert words to word ids
ids_long = Table.lookup(input_split_maxSeq)
#workarrond to reduce empty samples (empty lines in tensor)
intermediate_tensor = tf.reduce_sum(tf.abs(ids_long), 1)
zero_vector = tf.zeros(shape=(1,1), dtype=tf.int64)
```

```
bool_mask = tf.squeeze(tf.not_equal(intermediate_tensor, zero_vector))
ids = tf.boolean_mask(ids_long, bool_mask, name='ids')
data = tf.placeholder(tf.float32, [None, maxSeqLength, numDimensions])
#convert word ids to wordvectors
data = tf.nn.embedding_lookup(tf.cast(wordVectors,tf.float32,
name='CastedWordEmbeddings'),ids) #edited cast
#dropout settings training and inference settings
is_training = tf.placeholder_with_default(False, shape=(),
name='is_training')
keep_prob = tf.cond(is_training, lambda:tf.constant(0.75),
lambda:tf.constant(1.0))
#lstmCell = tf.contrib.rnn.BasicLSTMCell(lstmUnits)
lstmCell = tf.nn.rnn_cell.LSTMCell(lstmUnits)
#lstmCell = tf.contrib.rnn.DropoutWrapper(cell=lstmCell,
output_keep_prob=0.75)
lstmCell = tf.contrib.rnn.DropoutWrapper(cell=lstmCell,
output_keep_prob=keep_prob)
#value = The RNN output Tensor , _ the last state (last output)
#If time_major == False (default), this will be a Tensor shaped:
[batch_size, max_time, cell.output_size]
value, _ = tf.nn.dynamic_rnn(lstmCell, data, dtype=tf.float32)
weight = tf.Variable(tf.truncated_normal([lstmUnits, numClasses]))
bias = tf.Variable(tf.constant(0.1, shape=[numClasses]))
#[batch_size, max_time, cell.output_size] ----> [max_time, batch_size,
cell.output_size]
value = tf.transpose(value, [1, 0, 2])
last = tf.gather(value, int(value.get_shape()[0]) - 1)
#output layer
prediction = (tf.matmul(last, weight) + bias)

#apply activation funtion
sigmoid_prediction = tf.nn.sigmoid(prediction, name='prediction')
#check this
correctPred = tf.equal(tf.round(sigmoid_prediction), labels)
accuracy = tf.reduce_mean(tf.cast(correctPred, tf.float32))
#debug
accuracy_test = tf.reduce_mean(tf.cast(correctPred, tf.float32))
# loss function
loss =
tf.reduce_mean(tf.nn.sigmoid_cross_entropy_with_logits(logits=prediction,
labels=labels))  #edited _v2
loss_test =
tf.reduce_mean(tf.nn.sigmoid_cross_entropy_with_logits(logits=prediction,
labels=labels))
optimizer = tf.train.AdamOptimizer().minimize(loss)
import datetime
tf.summary.scalar('Loss', loss)
#fix this
tf.summary.scalar('Loss_Test', loss_test)
tf.summary.scalar('Accuracy', accuracy)
#fix this
```

```
tf.summary.scalar('Accuracy_Test', accuracy_test)
merged = tf.summary.merge_all()
logdir = "tensorboard/" + datetime.datetime.now().strftime("%Y%m%d-
%H%M%S") + "/"
writer = tf.summary.FileWriter(logdir, tf.Session().graph)
print('tensorlogs should appear!')
sess = tf.InteractiveSession()
#max_to_keep  = how many newest checkpoints to save
saver = tf.train.Saver(max_to_keep=0)
sess.run(tf.global_variables_initializer())
sess.run(tf.Tables_initializer())
 #nextBatch, nextBatchLabels = getTrainBatch()
#sess.run(optimizer, {input_str: nextBatch, labels: nextBatchLabels})
#print("Accuracy for this batch:", sess.run([pred_label_location, labels,
accuracy], {input_str: nextBatch, labels: nextBatchLabels}) )
for i in range(iterations):
        print(i)
        #Next Batch of reviews
        nextBatch, nextBatchLabels = getTrainBatch();
        sess.run(optimizer, {input_str: nextBatch, labels: nextBatchLabels,
is_training: True})
                    #print(sess.run([tf.rank(input_str), tf.shape(input_str),
input_str], {input_str: nextBatch, labels: nextBatchLabels}))
        #Write summary to Tensorboard
        if (i % 2 == 0):
                #summary = sess.run(merged, {input_data: nextBatch, labels:
nextBatchLabels})
                            summary = sess.run(merged, {input_str: nextBatch,
labels: nextBatchLabels})
                nextBatch, nextBatchLabels = getTestBatch()
                summary_test = sess.run(merged, {input_str: nextBatch, labels:
nextBatchLabels})
                writer.add_summary(summary, i)
        #Save the network at the end
        #if (i % (iterations-1) == 0 and i != 0):
        if (i % 150 == 0 and i != 0):
                save_path = saver.save(sess, "savecls1/pretrained_lstm.ckpt",
global_step=i)
                print("saved to %s" % save_path)
writer.close()
for i in range(10):
        nextBatch, nextBatchLabels = getTestBatch()
        #print("Accuracy for this batch:",
sess.run([sigmoid_prediction,prediction, labels, accuracy], {input_str:
nextBatch, labels: nextBatchLabels}))
                    print("Accuracy for this batch:", sess.run(accuracy, {input_str:
nextBatch, labels: nextBatchLabels}))
```

Annex 10: CV and publication list

Contact

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www.xing.com/profile/Daniel_Paschek

Personal information

date of birth	15.03.1988
place of birth	Mühlhausen / Germany
family status	married
kids	one girl & one boy (*2018 & *2019)

Key skills

- Complex Project Management
- Business Partner Management & Business-IT alignment
- Business Process Management
- IT Architecture Management
- Strategy development, transition & implementation
- Innovative - interested & open for new things
- Courage to move the way ahead & assume responsibility
- Dynamic, energetic & resilient
- Critical thinking

Daniel Paschek

Project Manager | Solution Architect | Product Owner

Profile

An experienced and professional digital native with the skills and entrepreneurship to be innovative and disruptive to enhance efficiency and customer experience. High personal standards and a strong self-motivation to achieve business goals and to generate the best performance. Hands on team-player with excellent analysis skills to derive business transformation strategies to drive international customer success. A positive and excellent communicator with an emphasis on utilizing the strengths of colleagues and creating an environment of forward-thinking solutions. A conscientious dedicated professional who is strongly resilient, flexible and energetic with interest in making organizations successful.

Work experience

2018 – now — [Deutsche Telekom IT GmbH – Business Solution, Erfurt/ Germany]
Project Manager | Solution Architect | Product Owner

- Project Manager for the implementation of new applications
- Solution Architect for Business Customers T-Systems International & Telekom Deutschland
- Product Owner for architectural digitalization of T-Systems International
- Head of IT-Portfolio Management - optimization via different architecture approaches e.g. AI, cloudification, API management, retirement
- IT Stream lead for internal Transition & Transformation Projects with LBUs & POPs
- E2E responsibility for Artificial Intelligence Use Cases & implementations within Business Solution
- Responsible for >10 internal / external near-/offshore resources

2014 – now — [University of Cooperative Education / Eisenach]
Lecturer

- Instruction of students in the field of project-, process- and organizational management
- Identification of practical problems and future digital & innovative adaptations

Language

German (nativ)	★ ★ ★ ★ ★
Englisch (fluent)	★ ★ ★ ★ ★
French (school)	★ ★ ★ ★ ★

Awards

2018	Chief Technology and Innovation - Talent
2017	Telekom IT Talent

Advanced trainings

05/2019	SAFe4 Practitioner *certified*
12/2018	Business Process Framework (eTOM) *certified*
10/2018	TOGAF
09/2018	Information Framework (SID) *certified* Application Framework (TAM) *certified*
11/2017	Professional Scrum Master *certified*
08/2016	PMP – Project Management Professional
09/2015	SCRUM Product Owner *certified*
06/2014	ITIL V3 Service Transition *certified*
09 - 12/ 2013	Management Training ▪ Intercultural awareness ▪ Crisis management in projects ▪ Consulting in projects
04/2013	ITIL Foundation V3 *certified*
05/2009 - 03/2010	Vocational and pedagogical qualifications "AEVO - training for trainers *certified*

[T-Systems International GmbH, Telekom IT, Darmstadt/ Germany]

2013 - 2017 **Business Partner Manager/ Project Manager - Business Transformation & Deals/Global Accounts**

- Responsibility for Product sizing, onboarding and implementation of cloud products e.g. Salesforce, Open Telekom Cloud
- Development and Implementation of the existing collaboration model for cloud products between different legal entity's within different dimensions e.g. purchasing, marketing, customer onboarding, master data management, revenue management, complaint management
- Business Process Consulting for internal and external customers of different industry's e.g. Request to offer Contract, Order to Cash, Usage to Cash
- Responsible Project Manager for functional & technical IT-solutions in complex big & major deals of T-Systems International from the bid over the transformation until get well and customer trainings (IT design, development, realization & rollout)

[T-Systems International GmbH, Darmstadt/ Germany]

2010 - 2013 **Project Manager - Big Deals**

- Management of Big Deal Projects through the full project life-cycle
- Documentation, analyzing and optimization of ITSM processes for external customers

[ALDI GmbH & Co.KG, Weimar/ Germany]

2010 - 2010 **Store Manager**

- Accountable & responsible for management of a retail store with up to 10 employees and several trainees
- Responsible for daily managing of staff and the assigning of duties
- Managing and motivating staff to increase sales and ensure store efficiency.
- Analyzing store sales figures & optimize them
- Manage budgets set by Retail Area Managers
- Maintaining accurate records of all pricings, sales, and activity reports
- Ensuring all corporate and local regulations and procedures are met and complied with

[ALDI GmbH & Co.KG, Weimar/ Germany]

2007 – 2010 **Dual student & Deputy Store Manager at ALDI GmbH & CO.KG**

- Passing through all business-related areas e.g. Purchase, Marketing, Sales, HR, Logistics, Finance & Accounting
- Deputy store manager in different stores
- Sales activities next to the study

Interests

- Digitalization – trying new technology
- Traveling - get to know new cultures
- Playing guitar & listening music
- Riding motorbike with friends
- Cycling – road bike (Bodensee Radmarathon)
- Fitness – doing different types of sports

Education

2016 - now
[Politehnica University of Timișoara/ Romania]
Study: PhD - Management
- Investigation of the use of artificial intelligence for automated process optimization next to the work
- > 10 publications in this area
- Finalizing planned end of 2019

2011 – 2013
[School of International Business & Entrepreneurship Steinbeis University, Berlin /Germany]
Study: General Management
- Degree: Master of Arts in General Management
- Application-oriented study in different fields e.g. Economics, Project Management & Organization, Entrepreneurship, Strategy, Market Analysis, International Management, Objectives & Strategy Plan
- Care Company: T-Systems International GmbH

2007 - 2010
[University of Cooperative Education / Eisenach]
Study: Economics at the vocational academy in Eisenach
- Degree: Bachelor of Arts
- Focus: wholesale and retail
- Care Company: ALDI GmbH & Co.KG Weimar

1998 - 2006
[Albert Schweitzer Gymansium / Mühlhausen]
Abitur (secondary school)

1994 – 1998
[Staatliche Grundschule Forstberg / Mühlhausen]
Grundschule (primary school)

12 June 2020

PUBLICATIONS LIST

1. Papers published in journals index in the Web of Science / Clarivate Analytics

1. Rennung, F., **Paschek, D.,** Dufour,C.M., Draghici A. (2018) Managing Complexity in Large-Scale Business Projects. A Theoretical Model. *Acta Technica Napocensis Series-Applied Mathematics Mechanics and Engineering,* 61(3), Special Issue: SI ICPR-AEM 25.-26.07.2018, pp. 169-178 WOS:000451702200022
2. Rennung, F., **Paschek, D.,** Dufour, C.M., Draghici A. (2018) Managing Complexity in Large-Scale Business Projects. Experimental Validation of the Proposed Model; *Acta Technica Napocensis Series-Applied Mathematics Mechanics and Engineering,* 61(3), Special Issue: SI ICPR-AEM 25.-26.07.2018, pp. 179-190 WOS:000451702200023

2. Papers published in proceedings index in the Web of Science (WoS)

1. **Paschek, D**., Luminosu, C. T., & Draghici, A. (2017). Automated Business Process Management in Times of Digital Transformation Using Machine Learning or Artificial Intelligence. In *MATEC Web of Conferences* (Vol. 121, p. 04007). EDP Sciences. WOS:000435283800059
2. **Paschek, D**., Rennung, F., Trusculescu, A., & Draghici, A. (2016). Corporate Development with Agile Business Process Modeling as a Key Success Factor. *Procedia Computer Science (Conference on ENTERprise Information Systems / International Conference on Project MANagement / Conference on Health and Social Care Information Systems and Technologies, CENTERIS / ProjMAN / HCist 2016, October 5-7, 2016)*. *100*, 1168-1175. WOS:000392695900148
3. **Paschek, D.**, Draghici, A., Rennung, F., Trusculescu, A. E. (2016). Individual Risk Early Warning Systems as a Management Instrument to Handle Crises. *Review of Management and Economic Engineering, 5th International Management Conference, "From Management of Crisis to Management in a Time of Crisis",* pp. 140-147. Cluj-Napoca: Todesco. WOS:000385997200016
4. Mateescu, A., Draghici, A., Gaureanu, A., **Paschek, D.** (2016). Competition – An Essential Market Feature. Debate on Market Structures and Business Incubators. *International Conference on Production Research - Regional Conference Africa, Europe and The Middle East (ICPR-AEM 2016) and 4th International Conference on Quality and Innovation in Engineering and Management (QIEM 2016). UTPress,* pp. 1-5. WOS:000436122900001
5. Draghici, A., **Paschek, D.,** Mateescu, A., & Weinschrott, H. (2016). A Proposed Model for University-Industry Collaboration To Support Synergies In RIS3. *International Conference on Production Research - Regional Conference Africa, Europe and The Middle East (ICPR-AEM 2016) and 4th International Conference on Quality and Innovation in Engineering and Management (QIEM 2016). UTPress,* pp. 59-68. WOS:000436122900011
6. Rennung, F., **Paschek, D.**, Draghici, A. (2014). A Complexity Management Model for Industrial Services. *Review of Management and Economic Engineering, 4th International Management Conference, "The Management*

between Profit and Social Responsibility", pp. 439-449. Cluj-Napoca: Todesco. WOS:000367105500058

3. Papers published in journals index in international databases

1. **Paschek, D.**, Mocan, A., Dufour, C. M., Draghici, A. (2017, December). Organizational knowledge management with Big Data. The foundation of using Artificial Intelligence. *Balkan Region Conference on Engineering and Business Education, vol. 3(1)*, pp. 301-308. De Gruyter Poland (eISSN: 2391-8160). (SCOPUS, EconPaper, Google Academic etc.) https://doi.org/10.1515/cplbu-2017-0039
2. **Paschek, D.**, Ivascu, L., Draghici, A. (2018). Knowledge management–the foundation for a successful business process management. *Procedia-Social and Behavioral Sciences (SIM 2017: 14th International Symposium in Management27-28 October 2017, Timisoara, Romania)*, *238*, 182-191. (ScienceDirect, Google Scholar) doi: 10.1016/j.sbspro.2018.03.022
3. Truşculescu, A., Drăghici, A., **Paschek, D.** (2018). The development over time of valuation bases and drivers in the online retail industry. *Procedia-Social and Behavioral Sciences (SIM 2017: 14th International Symposium in Management27-28 October 2017, Timisoara, Romania)*, *238*, 720-728. (ScienceDirect, Google Scholar) doi: 10.1016/j.sbspro.2018.04.055

4. Papers published in proceedings index in international databases

1. **Paschek D.**, Luminosu C.T., Negrut M.L. (2020). *Data - The Important Prerequisite for AI Decision-Making for Business*. In: Prostean G., Lavios Villahoz J., Brancu L., Bakacsi G. (eds.) Innovation in Sustainable Management and Entrepreneurship. SIM 2019. Springer Proceedings in Business and Economics (pp. 539-551). Springer, Cham. https://doi.org/10.1007/978-3-030-44711-3_40 (Google Scholar)
2. Trusculescu A., Albulescu C.T., **Paschek D.** (2020). *Historical Valuation Bases and Drivers of Large Internet-Enabled Companies*. In: Prostean G., Lavios Villahoz J., Brancu L., Bakacsi G. (eds) Innovation in Sustainable Management and Entrepreneurship. SIM 2019. Springer Proceedings in Business and Economics (pp. 283-296). Springer, Cham. https://doi.org/10.1007/978-3-030-44711-3_21 (Google Scholar)
3. **Paschek, D.**, Mocan, A., Draghici, A. (2019). *Industry 5.0 – The Expected Impact of Next Industrial Revolution.* Proceedings of the MakeLearn and TIIM International Conference 2019 - Thriving on Future Education, Industry, Business and Society (MakeLearn & TIIM 2019), pp. 125-132, ToKnowPress. (EconPaper, RePEC, Sematic Scholar, Google Scholar)
4. **Paschek, D.,** Draghici A., Luminosu C., Mateescu A. (2018). *Artificial Intelligence and the Way of Changing Decision-Making for Business*. Proceedings of the MakeLearn and TIIM International Conference 2018: Integrated Economy and Society; Diversity, Creativity, and Technology (MakeLearn & TIIM 2018), pp. 451-459, ToKnowPress. (EconPaper, RePEC, Sematic Scholar, Google Scholar)
5. **Paschek, D**., Trusculescu A., Mateescu, A., Draghici A. (2017). *Business Process as a Service – a Flexible Approach for IT Service Management & Business Process Outsourcing*. Proceedings of the MakeLearn and TIIM International Conference 2017: Management Challenges in a Network

6. Economy (MakeLearn & TIIM 2017), pp. 195-203 (EconPaper, RePEC, Sematic Scholar, Google Scholar)
7. Rennung F., Luminosu C., Draghici A., **Paschek D. (**2016) *An Evaluation of Strategic Methods of Complexity Management to Manage Large Outsourcing Projects Sucessfully*. Proceedings of the MakeLearn and TIIM International Conference 2016: Managing Innovation and Diversity in Knowledge Society Through Turbulent Time, pp. 79-88 (EconPaper, RePEC, Sematic Scholar, Google Scholar)