Business Process Management Using Artificial Intelligence – An important Requirement, Success Factor and Business Need for Industry 5.0

PhD. thesis – Summary

for obtaining the scientific title of PhD. at

Politehnica University of Timisoara

PhD field *Engineering and Management*

author M. A. Daniel PASCHEK

PhD Supervisor Prof. univ. dr. ing. Anca DRĂGHICI

month 08; year 2020

1. Summary of the PhD Thesis

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; Marr, 2018a).

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

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

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.

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.

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 179 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.

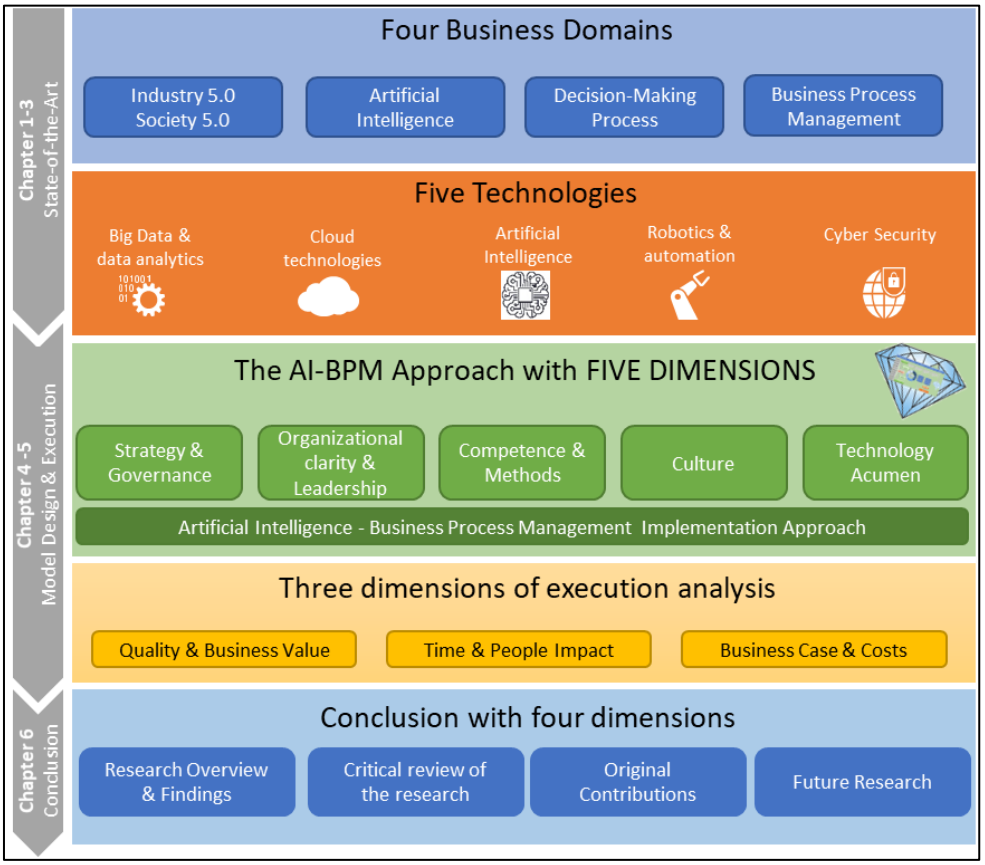

Figure **Error! No text of specified style in document.**. Overview of the research approach

(the PhD thesis structure)

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. 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. The chapter highlights the original contributions claimed because of the research conducted as well as a critical review of the work.

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.

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 policies from the general strategy 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.

3. The Original Contributions of the Research

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). 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). Last but not least, the ***original contribution and the use of these research results for didactic purposes*** have been considered, mainly within the Master's Degree Course "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).

List of Selective References

[1] Atwell, C. (2017). *Yes, Industry 5.0 is Already on the Horizon*, Retrieved from: https://www.machinedesign.com/industrial-automation/yes-industry-50-already-horizon (Access on: 08.06.2019)

[2] Beims, M. and Ziegenbein, M., (2014). *IT-Service-Management in der Praxis mit ITIL®: Der Einsatz von ITIL®* Edition 2011, ISO/IEC 20000:2011, COBIT® 5 und PRINCE2®, Carl Hanser Verlag GmbH and Co. KG

[3] Beste, D. (2018) *Welche Sorgen bereitet die Industrie 4.0?* Retrieved from: https://www.springerprofessional.de/industrie-4-0/welche-sorgen-bereitet-die-industrie-4-0-/15948554 (Access on: 13.07.2019)

[4] Bpmonline (2018) *5 BPM trends essential for your Digital transformation in 2018*, https://www.bpmonline.com/5-BPM-trends-that-will-be-critical-for-your-digital-transformation (Access on: 20.01.2020)

[5] Fahr, P. (2016). *Business Optimization*, BearingPoint process Advisory.

[6] Höhne, M. (2015). Business Process Management-Studie 2015. Retrieved from: https://www.bearingpoint.com/de-de/unser-erfolg/insights/business-process-management-studie-2015/ (Access on: 15.06.2020)

[7] IBM (2018). *Cloud computing: A complete guide*. Retrieved from: https://www.ibm.com/cloud/learn/cloud-computing (Access on: 14.02.2020)

[8] Kerkmann, C. (2019). *124.000 offene Stellen – Mangel an IT-Spezialisten nimmt dramatisch zu*, published on: 28.11.2019. Retrieved from: https://www.handelsblatt.com/technik/it-internet/bitkom-statistik-124-000-offene-stellen-mangel-an-it-spezialisten-nimmt-dramatisch-zu/25278122.html?ticket=ST-1008334-

tTz1JzqgbYma9I4NOwWg-ap4 (Access on: 25.09.2020)
[9] Knitterscheidt, K., (2019). *Deutsche Firmen verlieren den Kampf um die besten IT-Köpfe*. Retrieved from: https://www.handelsblatt.com/meinung/kommentare/kommentar-deutsche-firmen-verlieren-den-kampf-um-die-besten-it-koepfe/23809764.html?ticket=ST-568771-53VpUJwcikYWUrtsU6QB-ap4 (Access on: 24.09.2019)
[10] KPMG (2017). *Digitales Prozessmanagement*. Retrived from https://home.kpmg.com/de/de/home/services/branchen-und-maerkte/financial-services/kreditinstitute/digitales-prozessmanagement.html (Access on: 14.07.2019)
[11] Marr, B. (2018a). *How Much Data Do We Create Every Day? The Mind-Blowing Stats Everyone Should Read*, Retrieved from: https://www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-the-mind-blowing-stats-everyone-should-read/ (Access on: 11.11.2019)
[12] Marr, B. (2018b). *The 4th Industrial Revolution Is Here - Are You Ready*? Retrieved from: https://www.forbes.com/sites/bernardmarr/2018/08/13/the-4th-industrial-revolution-is-here-are-you-ready/#2b6b3e2628b2 (Access on: 12.11.2019)
[13] Matarelli, M. (2018). How Can Businesses Adapt to A Rapidly Changing World? Retrieved from: https://www.forbes.com/sites/quora/2018/01/05/how-can-businesses-adapt-to-a-rapidly-changing-world/#4af774725930 (Access on: 14.11.2019)
[14] McBride, M. (2018). *AGILE FOR EVERYONE*, Retrieved from: https://www.cio.com/article/3304276/agile-development/speed-adaptation-and-the-pace-of-change.html (Access on: 24.09.2019)
[15] **Paschek, D.**, Mocan, A., Draghici, A. (2019a). Industry 5.0 – The Expected Impact of Next Industrial Revolution, MakeLearn 2019: Thriving on Future Education, Industry, Business and Society, Proceedings of the MakeLearn and TIIM International Conference, 15-17 May 2019, Piran, Slovenia (pp. 125-132). ToKnowPress. Available at: https://pdfs.semanticscholar.org/3007/06e2ee34fe3b6348a05a8d4608a7a3a59044.pdf
[16] Probst, L., Lefebvre, V., Martinez-Diaz, C., Bohn, N.U., PwC, Klitou, D., Conrads, J., CARSA (2018). *Digital Transformation Scoreboard 2018: EU businesses go digital: Opportunities, outcomes and uptake*, European Commission, Directorate-General Internal Market, Industry, Entrepreneurship and SMEs; Directorate F: Innovation and Advanced Manufacturing; Unit F/3 KETs, Digital Manufacturing and Interoperability
[17] Thanh Dat. N. (2017). *Six Sigma-Based Knowledge Management and its Application in IT Systems Management*, PhD Thesis, University "Lucian Blaga" of Sibiu, Romania, Retrieved from: http://doctorate.ulbsibiu.ro/wp-content/uploads/2017FinalThesisSummary-ThanhDatNguyen-v2017.07.11.pdf (Access on: 13.10.2019)