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BLOCKCHAIN NAVIGATOR

APPROACH FOR PRIORITIZATION OF DATA PROCESSING OBSTACLES

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The Blockchain Navigator publication series provides insights into current research results of the Blockchain Europe project. It presents scientifically sound insights as well as practical guidelines and methods as a toolbox to enable the effective and targeted use of Blockchain technology in the business processes of different industries - from the initial consideration to the actual implementation. In the spirit of an open community and the open-knowledge approach, we make our results freely available via this format and invite for discussion.

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ABSTRACT

This whitepaper concerns a prioritization procedure for data processing obstacles. The reduction of data processing obstacles which goes along with an increasing availability of valid data can be seen as a basis for the implementation of blockchain technology. Companies need to be enabled to collect and prepare data in a suitable way to fully use the potential of the technology. In practice, many companies struggle to process data in any kind based of the several described obstacles what hinders the implementation of blockchain in the first place. The prioritization procedure supports the evaluation of each single obstacle of a specific field of action and a concrete data processing activity as well as it enables a ranking of the evaluated obstacles.

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DATA PROCESSING OBSTACLES

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Introduction to the field of research

To benefit from the increasing amount of available data in the recent years, it needs more than just the existence of these data. Data must be processed, and decisions must be drawn from it. Value adding of companies can be supported by data processing in various ways e.g. by increasing digitization of business processes. [1] According to Wüst and Gervais, for blockchain technology to be executed usefully, valid data must be available in companies to take advantage of its capabilities. When sensitive, valuable data needs to be processed and stored securely, blockchain technology with its inherent properties offers a way to secure a database. In a decision model by Wüst and Gervias, for testing a particular use case for its suitability for the use of blockchain technology, the first question is already directed towards the existence of stored states, a suitable database. If this does not exist, the use of blockchain technology is not recommended. [2]

There are several ways to define and interpret the term data processing. That is why it is important to agree on a commonly accepted definition for this research. Data processing includes all operations of data acquisition, -collection, -organization, -storing, -sorting, -changing, -modification, -extraction, -application, -requesting, -publication by transferring or other kinds of data supply, -linking, -comparison, -restricting, -destruction or -deleting, regardless of their degree of automation [3]. The proper execution of data processing provides a great potential for optimization in companies [4]. However, there is a huge gap between the theoretical potential offered by data processing and the realized potential observed in company practice. A survey by Nikelowski et al. (2021) supports this statement, with 46% of the participants responding that the gap is high or even very high [5]. Various obstacles create a reluctance to process data, even when the benefits, such as easy access to relevant data along the supply chain (SC), are well known in companies. To create an acceptable environment for an improved data processing, obstacles need to be identified and reduced.

Comparing different positions in the SC shows, that not all of them dealing with data processing on the same level. An example is the commerce sector, which has a high level of data processing compared to the production sector [6]. Companies with a low level of data processing usually have a low knowledge level regarding their production processes, even in times where methods and technologies for an improved data processing exist. Large optimizations can already be achieved by small enhancements of the data collection [7]. For these reasons especially the production sector requires the focus for an improved data processing.

To break down the obstacles of data processing and thereby address the gap between theoretical potential and actual use, two research questions are linked to this research.

1) Which obstacles inhibit the data processing in supply chains down to the manufacturing company level?

2) How does an application-specific prioritization of obstacles for data processing possibly look like?

To address the problematic of lacking processing of data in this research an overview of literature-based data processing obstacles is derived by a systematic literature review (SLR). As a preparation for mitigation of those obstacles, a prioritization procedure is developed. By executing this procedure, it is possible to evaluate influences, that obstacles have on the data processing, and allows a raking for a prioritized action afterwards. Companies can start to deal with the most impacting obstacles to start dealing with the highest potential for an increased data processing.

It is not advisable, to execute the research regarding data processing obstacles just on a specific field of action in the supply chain and production. Rather, a general approach needs to be developed, that can be specified for various sectors during the execution phase of the procedure itself. Otherwise, this focus limits the value adding for science and practice.

In addition to the general improvement of data processing, the reduction of obstacles to the implementation of data processing will increase the suitability of a blockchain solution. The identification of existing data processing obstacles and providing a way of evaluation and prioritization, the procedure can be taken as a preparation step for the implementation of technologies like blockchain. For the decision making regarding the implementation of the blockchain technology it is important to have an idea about the actual problem the blockchain can solve. Especially regarding data processing activities like data sharing or data organizing blockchain can support the mitigation of data processing obstacles.

Systematic literature review on data processing obstacles

This chapter presents the process of the SLR. This process is executed in this research to provide a literature-based overview on data processing obstacles on a high scientific level. A comprehensive literature database on data processing obstacles is being created with the help of the SLR, to increase transparency on the steps taken to identify suitable literature and sort out obsolete literature. Compared to more simple literature review procedures, where undocumented personal decisions can affect the outcome, the SLR enables neutral results and the analysis of these [8;9]. Afterwards, the research framework can be extended, regarding the kind of data bases used, the order and inclusion of rejection rules, the time frame or the identification keywords. The extension of the results is a time saving opportunity for future research in this field.

In figure 1 the SLR is presented including the steps, which are executed to receive a final group of sources. The upcoming description supports the understanding of the procedure and the outcome.

Before starting with the execution of the SLR preparation is required. First, suitable databases must be selected. For this SLR Web of Science, IEEE Scopus and EBSCOhost were chosen. All these databases provide peer-reviewed and scientifically proven specialized literature, which is thematically appropriate. Included sources are contributions to collective publications, monographs, conference papers and journal articles. No ties to specific publications or publicists and no legal obligations are present for these data bases, what increases the independency of the resulting literature. The used data bases represent the current state of research on an international level, since most of the included literature is written in English. This supports the coverage of scientific literature for this research field.

THE IDENTIFICATION TERM USED FOR THE DATABASES IS:

(manufacturing OR production) AND (company OR enterprise OR »supply chain«) AND (»data use« OR »data processing« OR »data transfer«) AND (hurdle OR obstacle OR problem*)

Searching for results with the presented term in the different databases results in 4,547 publications. Since most of the given results do not meet the requirements, rejection rules are executed to sort out the unimportant publications. The rejection rules are presented in figure 1. In the first rejection rule »A« the sources are grouped in batches of 20 based on the order these sources are provided in the databases. A batch is in scope for further review if more than 10% of this batch are sources with relevant keywords or titles. This procedure is executed with all selected databases and the number of included batches is merged in the end of this step. In total 26 batches with 520 publications are included for further review after step A. Still the 26 included batches can contain sources with an irrelevant title or keywords. Therefore, all leftover single sources of the included batches are reviewed concerning keywords and title and rejected, if not needed for step C. In this rejection step, further 379 sources are rejected. 141 publications are left after step B and are reviewed in more detail in rejection step C.

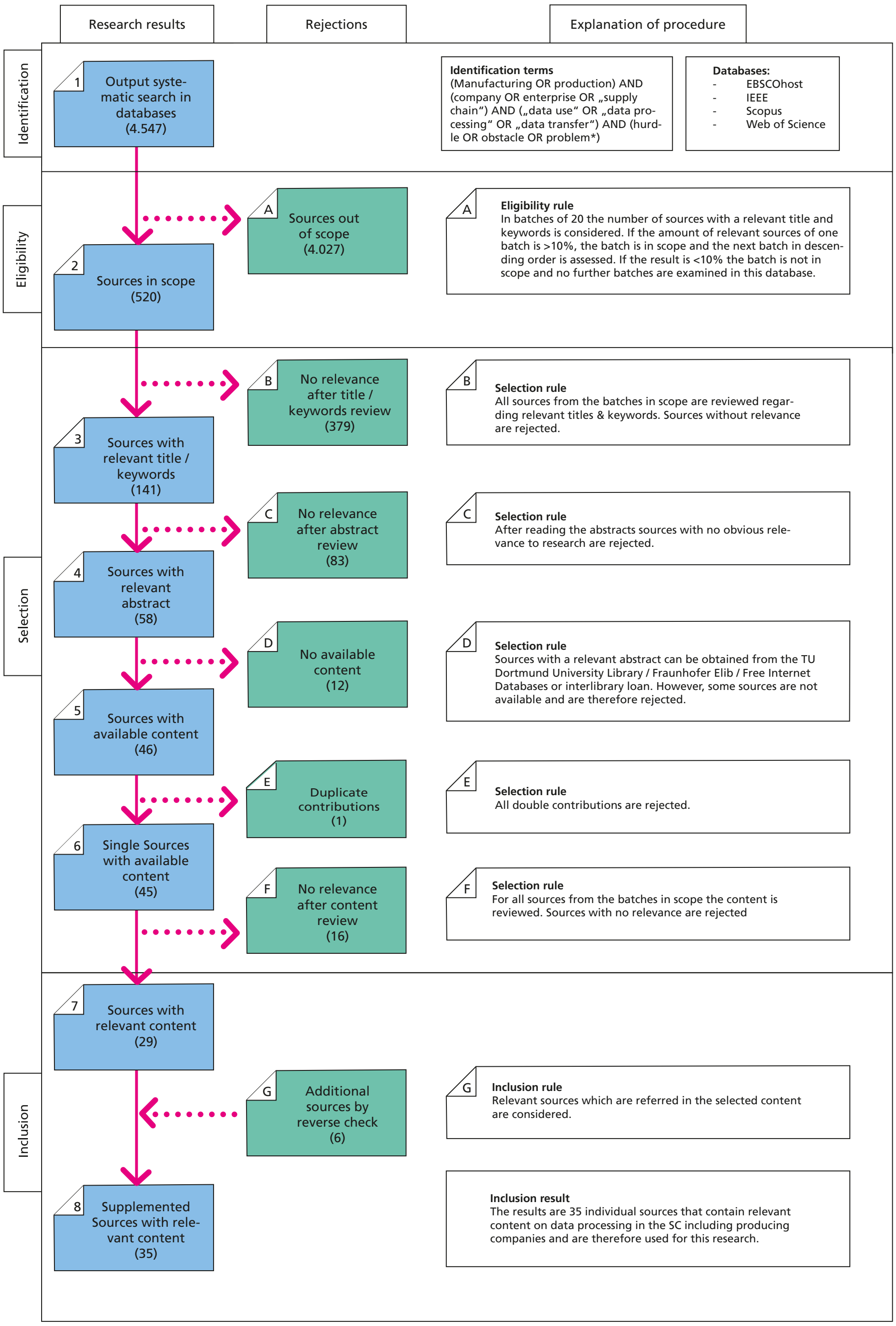

Figure 1:
Systematic literature review for data processing obstacles

In step C all abstracts of the 141 publications are scanned and further sources are rejected, when no relevant content concerning data processing obstacles is present. 83 sources are rejected in step C. The leftover 58 publications are further reviewed in rejection step D, which concerns the availability of the full text. For this research the Fraunhofer Elib, the library of TU Dortmund University and free internet databases or interlibrary loan are used to get access to the publications. However, for 12 sources the access is not possible, what leads to a rejection of these publications. Afterwards, all remaining double contributions are sorted out in rejection rule E. In this case just one double contribution needs to be rejected. Now, 45 publications are still included for the final rejection rule F. Here, the full texts were reviewed for relevant input regarding data processing obstacles, with a result of 16 rejections and 29 included contributions. Before the SLR is completed, a reverse check for the leftover sources is executed, which leads to an additional 6 sources. The remaining 35 publications of the SLR are used as important input for the further research process.

Identified obstacles for data processing

The 35 relevant sources from the SLR are further reviewed to create an overview of data processing obstacles mentioned in literature. In total 15 obstacles are identified, which are presented in table 1.

Table 1:

Data processing obstacles based on the SLR

#of sources including the obstacle	#of obstacles include dper author	Data processing obstacles (15)														
		Poor data quality	Heterogeneous systems (software)	Lack of data security	Insufficient standards (hardware)	Lack of know-how	Infrastructural barriers	Lack of capacity	Lack of corporate strategies	Low level of automation level	Unstructured data	Insufficient data quantity	Lack of application scenarios	Lack of documentation	Lack of critical mass of participants	Lack of acceptance
		14	10	7	7	6	4	3	3	3	3	3	2	2	2	2
Anjum, Sporny & Sill 2017 [10]	1				S											
Berners-Lee & Hendler 2001 [11]	1										C					
Chatterjee, Parmar & Pitroda 2019 [12]	2			S											S	
Chen, Fan & Chang 2016 [13]	1	C														
Cui, Jones & O´Brien 2001 [14]	1					C										
Demyanova et al. 2018 [15]	2	C				C										
Finck 2019 [16]	1			S												
Geng & Hu 2011 [17]	3				S		C		C							
Govindaraj & Pejtersen 1995 [18]	1	C														
Groggert et al. 2018 [19]	7	C	C	C		C				C	C		C			
Groggert et al. 2017 [20]	6	C	C					C				C	C			C
Hollocks 2001 [21]	2					C			C							
Jia, Zhang & Tain 2007 [22]	3				C	C		C								
Joppen et al. 2019 [23]	1											C				
Kraiem 2001 [24]	2	C		S												
Kudinov, Markov & Veyber 2013 [25]	1		C													
Kutin et al. 2018 [26]	1		C													
Liandong & Qifeng 2009 [27]	1										C					
Limantara & Jingga 2017 [28]	2						C							C		
Madhikermi et al. 2016 [29]	1	C														
Mao & Yu 2009 [30]	1									S						
McMillan et al. 2017 [31]	3	C			C							C				
Meilin, Xiangwei & Qingyun 2010 [32]	3	C	C		C											
Merlo, Vicien & Ducq 2014 [33]	1		C													
Mustafee et al. 2012 [34]	2			S		S										
Orr 1998 [35]	1	C														
Shao & Guo 2008 [36]	2							C	C							
Shimei et al. 2020 [37]	1				C											
Tang & Liu 2020 [38]	3	S	S												S	
Vegetti et al. 2008 [39]	1		S													
Wang & Huang 2010 [40]	1				C											
Wang, Hulstijn & Tan 2018 [41]	1	C														
Wang et al 2008 [42]	7	C	S	S			C			C				C		C
Yamakami 2019 [43]	3		C	C			C									
Zhang & Dang 2019 [44]	1	C														

Number = # Company related = C Supply Chain related: = S

As shown in table 1 a differentiation is made concerning obstacles mentioned in a supply chain relation and mentioned in relation to an internal company environment. The reason is, that obstacles can have a different level of impact depending on the field of action. 19 out of the 35 sources (54,3%) are dealing with just one specific obstacle. The highest number of mentioned obstacles in one publication is seven [19;42]. Currently, there is no contribution among the sources considered compared to the state of research, which contains even half of the 15 identified obstacles, what supports the right of existence of this research. Furthermore, the division of obstacles mentioned regarding the SC level and the company level is not given in literature so far. In total 71 times obstacles are mentioned within the 35 publications. 15 times obstacles are related to the SC level and 56 times the obstacles are related to the company level. The high number of obstacles mentioned for company level fits to the general definition of data processing. Therefore, most of the included activities are executed within a company i.e. the collection, storage, or modification of data. Just a few activities like sharing of data is also done on the SC level. Figure 2 visualizes the analysis.

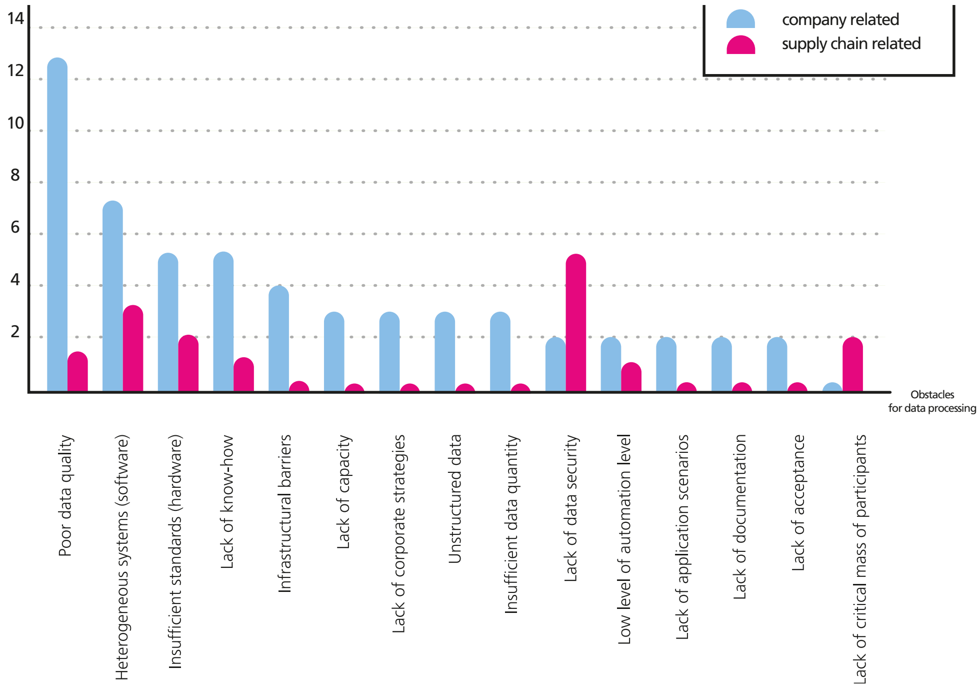

Figure 2:
Bar chart concerning SC- and company related obstacles

Company related data processing obstacles are the poor data quality, which is the obstacle with the highest ranking with 13 out of 56 mentioned obstacles (23,2%), followed by heterogeneous systems (software) (12,5%) and insufficient standards (hardware) (8,9%). The visualization shows that the SC related obstacles have a different focus. Here, the lack of data security is mentioned five times (33,3%), followed by heterogeneous systems (software) (20%) and critical mass of participation (13,3%) as well as insufficient standards (hardware) (13,3%). The high ranked obstacle of insufficient data security on the SC level underlines, that data sharing i.e. with external parties is a more present data processing activity in this environment. In this case missing trust can exist, what increases the focus on data security by the companies. In case, no division is made between SC level and company level, the poor data quality is the highest ranked obstacle (19,7%), followed by heterogeneous systems (software) (14,1%) and lack of data security (9,9%) as well as insufficient standards (hardware) (9,9%).

The following section presents a short description of all 15 data processing obstacles based on the definitions presented in the results from the SLR.

1. HETEROGENEOUS SYSTEMS (SOFTWARE):

Often systems do not have the right interfaces to be linked together [26;39]. Even on department level in companies communication can be difficult, because software tools just partly concern a specific application area [25;43]. Further, there are different methods for processing data, so the existing data cannot always be aggregated and further processed [41].

2. INSUFFICIENT STANDARDS (HARDWARE):

Using various hardware in companies can be an obstacle for processing data. The products of different manufacturers can use different ways of communication, what complicates data transfer. [37] On the one hand different technologies for communication are used and on the other hand these technologies do not work with standards in provision of data [10;31;40].

3. LACK OF DATA SECURITY:

Mainly missing trust in data security is an obstacle for data processing. Losing information i.e. through malware on company hardware leads to uncertainties regarding data processing. [41;43] This uncertainty and the missing trust in data security for new technologies especially stops companies from using them [20].

4. INFRASTRUCTURAL BARRIERS:

Radio waves i.e. can interrupt wireless-LAN frequencies or influence the coverage range in a negative way. Further, the infrastructure planning needs to provide enough charging opportunities, otherwise a lack of power plug capacity can lead to local limitations for the use of smart devices. [43] Software failures, server breakdowns or hardware failures are further examples for effects of infrastructural barriers [41].

5. LOW LEVEL OF AUTOMATION:

A lack of automation in data processing for suitable processes gets visible by a high degree of manual activities [20]. Manually data processing generates problems, because compared to automated data processing the vulnerability for mistakes made by employees is increased [41]. The low level of automation triggers negative impact on the cooperation of organizations within the SC [30].

6. LACK OF DOCUMENTATION:

Especially concerning the implementation of information systems like ERP or MES, documentation of procedures and transactions is very important. In case this documentation is missing the transfer of manual- into automated processes is difficult to realize. [28;41]

7. POOR DATA QUALITY:

The term data quality can be seen as a collective term for the reliability, validity, relevance, accuracy and actuality of data [20]. Poor quality of data affects results of analysis in a negative way. It can i.e., lead to loss of information [13;20;29;44]. IT-systems like enterprise resource planning systems (ERP) also have difficulties to process this kind of data [15].

8. UNSTRUCTURED DATA:

Especially in companies with a low digitization level, data are only collected and not stored in a well-defined structure, what inhibits data processing afterwards [20]. The creation of information based on the processing of data, without having a structure, is difficult to execute [27]. A requirement for a successful data processing is structured and usable data, especially for the systems using the data [11].

9. INSUFFICIENT DATA QUANTITY:

Successful data processing cannot be executed by companies, in case the quantity of data is too low or the data are incomplete [19]. Further, in case of missing context information, linked to data, it is difficult to reconstruct the origin of data, which leads to invalid information regarding the evaluation of processes [23].

10. LACK OF KNOW-HOW:

Employees in companies do not always have the ability of identify relevant data and they are missing fundamental understanding regarding data processing [20;21]. Due to this situation, implemented IT-systems are not properly used or not used at all. Reasons for that are i.e., a lack of financial resources or insufficient training of the employees. [15]

11. LACK OF CAPACITY:

For a sufficient processing of data also sufficient capacity like for staff is needed to avoid reduced data usage. Is the staff capacity too low, methods for the development of knowledge cannot be executed. In this case, the data processing remains off. [19]

12. LACK OF ACCEPTANCE:

In case data processing is i.e., not included in the range of usual activities in a company, using these data and by required technologies might be rejected by employees. The system is not used appropriate by the employees on purpose, conventional procedures are executed or even false data are reported to sabotage the system. [41]

13. LACK OF CRITICAL MASS OF PARTICIPANTS:

Currently readiness of companies for processing data, in case of sharing data in the SC environment, is rarely given. This leads to absence of a critical mass of participants regarding the exchange of data and network effects within the SC cannot be created. [38]

14. LACK OF CORPORATE STRATEGIES:

Based on an insufficient digitization strategy a target-oriented data processing is not possible [17;36]. During the master planning, information systems are not sufficiently integrated, so these systems are not considered for the development of company processes. This results in redundant soft- and hardware as well as redundant data, what increases response time to process changes. [17]

15. LACK OF APPLICATION SCENARIOS:

In case a company has no idea regarding specific application scenarios for data processing, these companies struggle by identifying benefit of using data. Further, without application scenarios, it is difficult to decide, whether specific data are relevant, and the potential is difficult to identify. [20]

Categorization of data processing obstacles

The categorization of the derived obstacles in four groups helps to connect the obstacles with its characteristics. These four groups are based on the four dimensions presented by Stich et al. (2018) concerning categorization of requirements regarding the implementation of platforms [45]. These groups fit also for data processing obstacles, since platforms are tools for data processing. However, some obstacles have characteristics, which relate to more than one groups. In this case the obstacle is assigned to groups, which represent the obstacles in the highest degree. In figure 3 the allocation of obstacles to groups is visualized and groups are shortly described afterwards.

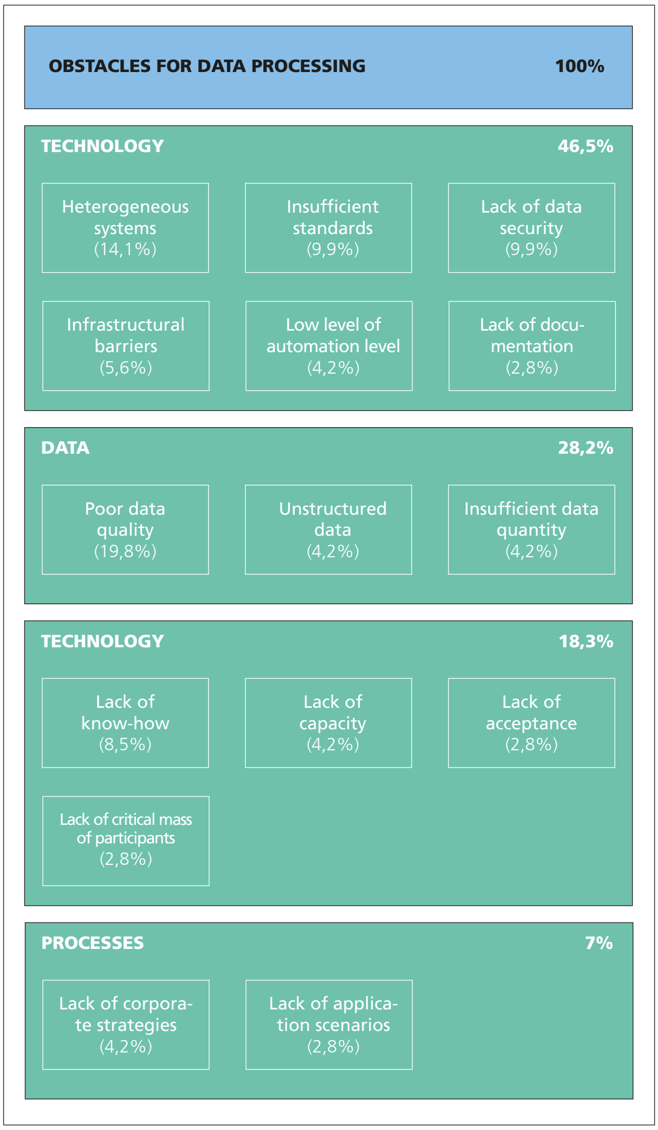

Figure 3: Classification groups of obstacles for data processing

Obstacles allocated to the technology group concern existing hardware, software, its documentation, system interfaces, given infrastructures and data security. The group of data includes conditions of data like quality, quantity or degree of given structure of data. The organization group includes all obstacles connected to executing staff regarding data processing. Included are obstacles, concerning know-how, capacity, acceptance and critical mass of participants regarding data processing. The last group deals with processes. In case no application scenarios, or a corporate strategy regarding data processing exists, processes cannot be defined. The grouping supports the overview about the obstacles and its orientations as well as it can be further used for the prioritization procedure.

Evaluation criteria for data processing obstacles

Derivation of data processing obstacles supports companies to get an idea of fields of action. However, the obstacles can also be used to derive criteria used to evaluate and prioritize these obstacles. In this case, the evaluation criteria for the upcoming prioritization procedure are derived based on the identification and clustering of possible impacts of the obstacles a company can face. These impacts can be compared by companies to the individual situation in the own company. The evaluation of the impacts supports the evaluation of connected obstacles. After the derivation of evaluation criteria, scale of dimensions can be defined. Seven out of eight evaluation criteria derived from clustering of impacts. In case the seven impact-based criteria are determined as high, the negative influence of these obstacles on data processing is high. The last criterion is based on the awareness of causes for an obstacle. For the reduction of an obstacle, the causes for an obstacle's existence need to be known to deal with the origin and not just with the effects of this obstacle. If significant causes are already known by the company, the effort to identify the origin of the problem is lower than in case the causes are unknown. The awareness should be included for the prioritization procedure since it influences the effort needed to reduce the obstacle. Since it is not possible to identify all causes of an obstacle, the focus should be set to find large influencing causes.

Figure 4 presents a way of identification and clustering of impacts as well as the derivation of the eight evaluation criteria used.

Since the evaluation criteria are not measurable in a quantitative way, a five-point likert scale is used to determine e.g. the level of impairment. In this case 1 has a very low and 5 a very high impairment on the company. Regarding the criteria of required resource effort for data processing, 1 has a very low and 5 a very high required effort. Regarding the awareness of significant causes of an obstacle 1 is a very low and 5 a very high awareness. The higher the scale number, the higher should be the focus on the obstacle.

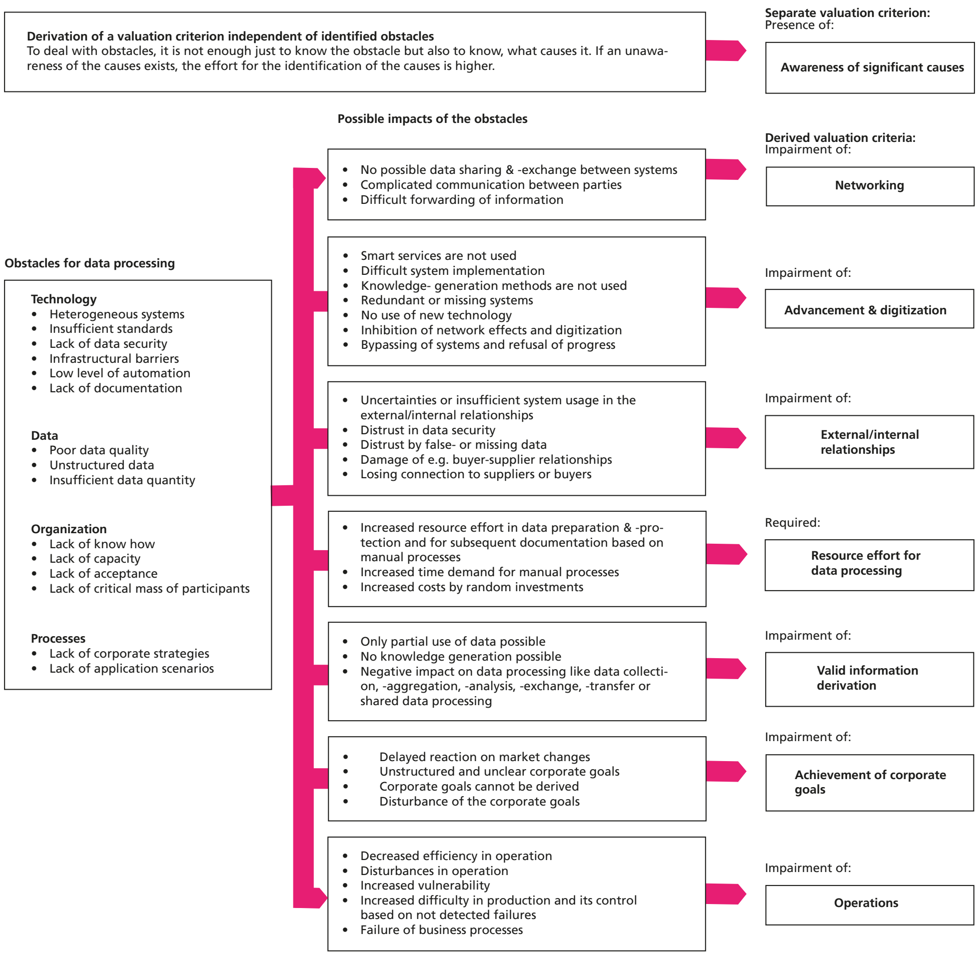

Figure 4: Derivation of valuation criteria for data processing obstacles

Development of a prioritization procedure for data processing obstacles

This chapter deals with the development of the prioritization procedure for data processing obstacles using the obstacles identified during the SLR as well as the derived evaluation criteria. Further, the procedure uses a modified evaluation matrix to enable weighting of single obstacles. This step is relevant, since in practice not all obstacles affect a company on the same degree e.g. depending on the field of action or the type of data processing. The prioritization procedure is separated in four sheets dealing with different steps of the procedure. Sheet 1 includes the first steps of the pre-selection procedure (A). First, in step 1.1 the most urgent field of action concerning the lack of data processing is selected. Here, it is possible to choose between the three levels, beginner, advanced and extended. Depending on a company's knowledge regarding the specific field of action, in which the lack of data processing is most urgent, the level should be selected. The specification includes the selection of supply chain, company branch, department or further areas in level 1, followed by a specific part of the supply chain like the supplier- or customer side, secondary branch or further partners in level 2 down to a concrete mentioned field e.g. a specific supplier, customer or department. This selection helps connecting the results of the whole procedure to a field of action. In case data processing is a problem in general, the company should start with level 1. If the company has increased data processing but has a lack in a specific field of action, level 2 or even 3 are appropriate.

After field of action is selected, a similar step is taken for the most urgent data processing activity (1.2). Again, one of three levels can be selected based on the knowledge in data processing. In this case, data processing in general can be chosen as level 1. Further, a data processing activity group can be selected called data sourcing, -analysing and -handling in level 2 or a concrete activity like data requesting, -modifying, -transmission or -destruction can be chosen in level 3. The classification of possible actions into levels increase the practicability since the procedure can be adapted to the individual situation of the executer.

Figure 5 presents part of the prioritization procedure including the described sub-steps 1.1 and 1.2. To increase the practicability of the procedure additional information sections are included i. e. a section with execution date, operation number, department as well as a section with information texts, a short explanation of each step and a closing text with information of the upcoming steps. The text boxes support the usage of the procedure without reading the whole paper. This makes the process more transparent for the end user. The pink markings and text represent a exemplary execution of the procedure.

Figure 5: Prioritization procedure: 1.1 field of action / 1.2 data processing activity

Pre- Selection procedure sheet 1 of 4

Execution date: 24.10.2022 **Operation No:**1 **Department:** Strategic purchasing

General introduction A:
This procedure supports the definition of a specific focus area and data processing activities with the highest urgency for action. During the execution the process can be adjusted based on experience and knowledge to meet the requirements of the sub-steps. Before and after each sub-step an advise is given on how to continue the procedure.

1) Definition of the most urgent focus area / -activities regarding data processing

Introducing 1.1:
Based on the insights about specific fields of action regarding the lack of data processing three detail levels can be chosen. Companies which lack in general with data processing should follow level 1, whereby companies who have a high degree in data processing but lack in a specific relationship with a partner should follow level 3. The supply chain related fields of action concerning data processing in the relationship between the own company and the given parties. Company branch and department concerning the data processing from an internal company perspective.

1.1) Selecting the most urgent field of action:

Level 1: Beginner
Chose between supply chain, company branch, department or add a further area.

Level 2: Advanced
If selected, specify the supply chain relationship of supplier side, customer side, secondary branch or further partner.

Level 3: Extended
Specify the selected area of level 1 or 2 for a specifiy supplier, customer, secondary branch or partner

Specification: lvl.3

lvl. 1 ☒ **Supply chain**
lvl. 2 ☒ **Supplier side**
☐ **Customer side**
☐ **Secondary branch**
☐ **Company branch**
☐ **Department**
☐ **Further area**

Closing 1.1:
Regardless which level is chosen in step 1.1, step 1.2 should be executed next.

Introduction 1.2:
Data processing activities describe how data are used. Based on the insights about specific lacking data processing activities three detail levels can be chosen. In case the level of data processing is low, level 1 should be taken. In case data are frequently- or highly used level two or three can be taken to focus a activity group or even a single activity. Level 1 results cover a wide range of activities and are therefore less specific than level 3 results. Based on the individual situation of the company the level influences the value added by using the procedure results.

1.2) Selecting the most urgent activities:
Level 1: Beginner (all activities included)
☒ data processing

Level 2: Advanced (activity groups)
☐ data sourcing (requesting, collecting, transmission)
☐ data analysing (modifying, fusion, application, comparison)
☐ data handling (organizing, storing, restricting, destructing)

Level 3: Professional (single activities)

☐ data requesting ☐ data application
☐ data collecting ☐ data transmission
☐ data organizing ☐ data comparison
☐ data modifying ☐ data restricting
☐ data fusion ☐ data destruction
☐ data storing

Closing 1.2:
Regardless which level is chosen in step 1.2, step 2 should be executed next. The results of step 1.1 as well as 1.2 support the focus of the procedure for which the further steps are executed.

After most urgent activity and most urgent field of action regarding data processing is determined, the selection of most impacting data processing obstacles must be done on the second sheet. Again, a level based execution is possible for beginner which are choosing a group of obstacles and an advanced level where single obstacles are selected. In level 1 the group selection can be made based on the presented categorization including technology, data, organization, and processes. Companies with more knowledge about concrete obstacles for data processing can select a maximum of five impacting obstacles. After the selection is done in step 2 a weighting of the selected obstacles needs to be done. This is relevant in combination with the field of action and the predetermined data processing activity, since obstacles have a different degree of impact depending on the different situation a company focus on. One example is, that obstacles of a lack of data security have a bigger impact with focus on transferring data within supply chains than on the department field of action. Figure 6 presents the second sheet of the prioritization procedure including step 2 and 3 of section A.

Figure 6:
Prioritization procedure: 2. data processing obstacles / 3. weighting

Pre- Selection procedure

sheet 2 of 4

Execution date: 24.10.2022 **Operation No:**1 **Department:** Strategic purchasing

2) Selecting most impacting data processing obstacles for the chosen activities in the focus area:

Introducion 2:
Step 2 presents literature based data processing obstacles. In case the level of knowledge about the obstacles for data processing is low, the beginner level should be taken. In case specific obstacles are already known, level two can be taken to focus on single obstacles. To compare the impact of the obstacles, more than one obstacle or group need to be chosen as preparation of the following steps. The more obstacles are chosen, the more effort is required for the following procedure. Therefore, limit the number to the five most impacting obstacles.

Level 1: Beginner (obstacles groups)

- ☐ Technology (heterogeneous systems (software), lack of data security, -documentation, -standards (hardware), infrastructural barriers, low level of automation)
- ☐ Data (poor data quality, -quantity, unstructured data)
- ☐ Organization (lack of know how, -capacity, - acceptance, -critical mass of participants)
- ☐ Processes (lack of corporate strategies, -application scenarios

Level 2: Advanced / Professional (single obstacles)

- ☐ Heterogeneous systems (software)
- ☐ Insufficient standards (hardware)
- ☐ Lack of data security
- ☐ Infrastructural barriers
- ☐ Low level of automation
- ☐ Lack of documentation
- ☒ Poor data quality
- ☒ Unstructured data
- ☐ Insufficient data quantity
- ☐ Lack of know-how
- ☐ Lack of capacity
- ☒ Lack of acceptance
- ☐ Lack of critical mass of participants
- ☐ Lack of corporate strategies
- ☐ Lack of application scenarios
- ☐ ____________________
- ☐ ____________________

Closing 2:
Regardless which level is chosen in step 2, step 3 should be executed next.

3) Weighting of the most impacting obstacles

Introducion 3:
After the obstacles are chosen, a rating needs to be done, to get the first idea about the leading obstacles concerning the impact on the data processing in the selected field of action and the chosen activity. The 100% impact the obstacles have on data processing should be allocated to the obstacles. Minimum rating is 5% and 5% steps are recommended for obstacles with higher impact.

Obstacle (-group)	Weighting factor	Total
Obstacle (-group): Poor data quality	Weighting factor: 35%	100%
Obstacle (-group): Unstructured data	Weighting factor: 20%	
Obstacle (-group): Lack of acceptance	Weighting factor: 45%	
Obstacle (-group): ______________	Weighting factor: _________	
Obstacle (-group): ______________	Weighting factor: _________	

Closing 3:
After the weighting factors are determined, the pre-selection procedure (A) is finished. In case the knowledge about the data processing obstacles in the own company is low, the weighting factors can be taken as a first indication about the prioritization of the obstacles. In this case the obstacle with the hightes factor should be addressed first.

Attention: This results are highly based on personal opinion. No concrete criteria for evaluating the obstacle are taken into account, yet, so the validity of the results is low to medium. In case a first impression about the different intensities of impact is sufficient, the procedure can end here. To increase the validity of the results, section B) Evaluation procedure should be executed to evaluate the single obstalces.

In case the knowledge about data processing obstacles is low the company can stop the procedure after step 3 and start dealing with the highest weighted obstacle. However, the weighting is done without evaluating concrete criteria, validity of the results is low to medium depending on the knowledge of the executer. To increase validity, the evaluation procedure in section B should be executed.

In section B the scoring of evaluation criteria needs to be done. Further, results are multiplied with the related weighting factor from section A. In section B, each obstacle is evaluated separately to receive the final weighted score, which can be compared afterwards. Step 4.1 covers scoring of the eight criteria between one and five depending on the impact the obstacles have on specific criteria fields. As mentioned awareness of significant causes has a different focus than the other criteria. After the scoring is done each scoring number is multiplied with the pre-determined weighting factor for the specific obstacle to receive eight weighted scores which are summed up for the final weighted score in the end of step 4.2. Now, each obstacle has a final weighted score, which allows a comparison of the single obstacles. Figure 7 presents sheet 3 of the prioritization procedure including section B with step 4.1 and 4.2.

B) Evaluation procedure

sheet 3 of 4

Execution date: 24.10.2022 **Operation No:**1 **Department:** Strategic purchasing

General introduction B:
The evaluation procedure is the extention of the pre-selection. The selected and weighted obstacles are analysed based on impact criteria for the company. Here, each obstacle is evaluated by the criteria for an increased output quality including the pre-defined weighting factor. Attention: Section B requires advanced knowledge concerning the criteria evaluation of the obstacles.

4.1) Scoring of the evaluation criteria

Introducing 4.1:
In step 4.1 criteria are defined for the evaluation of the obstacles. Each criterion needs to be rated from 1 to 5 (low to high impact of the obstacle on the given criteria).

4.2) Weighting of the scores

Introducing 4.2:
Step 4.2 adds weighting to the evaluation. This enables the comparison of the obstacles regarding the intensity concerning the focus area and -activity.

Obstacle No: 1 of 3 **Obstacle:** Poor data quality

Scoring multiplied with weighting factor

Evaluation criteria:	Scoring	Weighting factor:	Weighted scores:
1. Awareness of significant causes	3	x 0,35 (35%)	1,05
2. Impairment of networking	3		1,05
3. Impairment of advancement & digitization	4		1,40
4. Impairment of external- /internal relationships	4		1,40
5. Required resource effort for data processing	4		1,40
6. Impairment of valid information derivation	5		1,75
7. Impairment of achievement of corporate goals	3		1,05
8. Impairment of operations	5		1,75

Final weighted score: 10,85 Total

Obstacle No: 2 of 3 **Obstacle:** Unstructured data

Scoring multiplied with weighting factor

Evaluation criteria:	Scoring	Weighting factor:	Weighted scores:
1. Awareness of significant causes	2	x 0,20 (20%)	0,40
2. Impairment of networking	3		0,60
3. Impairment of advancement & digitization	3		0,60
4. Impairment of external- /internal relationships	3		0,60
5. Required resource effort for data processing	4		0,80
6. Impairment of valid information derivation	3		0,60
7. Impairment of achievement of corporate goals	2		0,40
8. Impairment of operations	3		0,60

Final weighted score: 4,60 Total

Obstacle No: 3 of 3 **Obstacle:** Lack of acceptance

Scoring multiplied with weighting factor

Evaluation criteria:	Scoring	Weighting factor:	Weighted scores:
1. Awareness of significant causes	2	x 0,45 (45%)	0,90
2. Impairment of networking	3		1,35
3. Impairment of advancement & digitization	4		1,80
4. Impairment of external- /internal relationships	2		0,90
5. Required resource effort for data processing	4		1,80
6. Impairment of valid information derivation	2		0,90
7. Impairment of achievement of corporate goals	2		0,90
8. Impairment of operations	3		1,35

Final weighted score: 9,89 Total

Closing 4.1 & 4.2:
4.1 and 4.2 support the evaluation of the single obstacles by scoring impact criteria. Further, the weighting factors concerning the specific focus area and data processing activity are included. By multiplying the scores with the weighting and sum up the results final weighted score are calculated. The prioritization in section C are based on these scores.

Figure 7: Prioritization procedure: 4.1 criteria scoring / 4.2 score weighting

The last sheet contains section C and D. Section C deals with the ranking of the evaluated data processing obstacles. All obstacles with their weighted score are listed in the table starting with the obstacle with the highest score. This obstacle presents the highest need for action regarding data processing and needs to be handled first. Section C is the final part of the prioritization procedure.

The following section D can be taken as an outlook on how to work with the results. First the obstacles should be reduced. This means, picking the obstacles with the highest impact on data processing and address their causes. After causes are eliminated in the best way, a reduction of the remaining effect can be done. The reduction of the obstacles and it´s effects, both have influence on the impact of the obstacle. After first obstacle was processed, the second one can be tackled and so on. It is important that the prioritization procedure is repeated on a regular basis like once a yearly. This allows the comparison between different evaluations and shows changes of obstacles impacts over time. Figure 8 presents sheet 4 including section C and D.

C) Ranking of the evaluated data processing obstacles — sheet 4 of 4

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Introducion C:
Section C concerns the ranking of the evaluated data processing obstacles. All obstacles evaluated in section B need to be ranked based on the final weighted score and inserted in the ranking list. The obstacle with the highest score needs to be inserted first followed by the second highest score and so on. The list presents the obstacles with the highest need for action based on the pre-defined evaluation criteria.

Ranking N	Obstacle:	Final weighted score:
1.	Poor data quality	10,85
2.	Lack of acceptance	9,89
3.	Unstructured Data	4,60
4.		
5.		

Closing C:
The execution of section C is the final pre-determined step for this procedure. This list is an overview about the impacting obstacles and can be taken as a guideline for dealing with the obstacles in the future.

D) Outlook: Working with the results

Introducion D:
Section D is an extention for the procedure. Here, no execution steps are presented for the procedure but an outlook is given for potential actions. In general, no concrete advise can be given on how to handle the specific obstacles, since the impact of the obstacle and the individual situation of the company require individual solutions. However, a main direction can be recommended in order to improve the current situation. This is shortly described in section D.

Reducing the obstacles

Chosing the obstacle with the highest impact and working on the causes.This can also reduce the effects of the obstacles. When the reduction of the causes is done, a further reduction of the effects should achieved. Both influence the impact of the obstacle. After doing so, chose the next obstacle and repeat the optimization.

Continuous evaluation

Repeat the evaluation and weighting of the data processing obstacles on a yearly basis to visualize the changes of the impact by external influences and by internal influences based ob working on the causes and effects of an obstacle. This supports the continuous optimization and increasing the data processing.

Closing D:
Section D needs to be executed individual for each obstacle and for each individual situation of a company. To do so, the company needs to find ist own way to reduce the causes and effects of the impacting obstacle. The specific way can not be given by a general procedure. The continuous evaluation on a yearly bases helps to track the ob stacles and increas the data processing in long term.

Figure 8:

Prioritization procedure: C) Ranking / D) Outlook

Theoretical and managerial contributions

For this research a SLR was executed. The SLR offers detailed insights on the used literature as well as on the procedure gathering the literature. This procedure enables a recreation of the research steps and supports a potential extension for future research. The SLR presents summarized information on data processing obstacles including 15 different obstacles. An comparable extended review is not present in literature so far, which is a theoretical contribution of this research. Further, the results of the SLR as well as the procedure based on it can be used in practice. This saves time for not doing separate research in companies. Once the obstacles are known, these are further analysed regarding the relation to supply chain- or company context. This division is not present in literature yet and creates value for theory as well as it supports management regarding the identification of own obstacles in these fields of action. Management can review the given obstacles and execute an adaptation to the individual company situation. Based on the obstacles evaluation criteria were derived. These criteria create value for management and theory. Criteria can be used to develop further evaluations and prioritization procedures in theory and it can be taken as part of procedures inside a company. The criteria are derived based on impacts originated from obstacles with a focus on practice, what increases the contribution for management. After the development of the procedure an execution was done in a company to improve the procedure and increase the practicability; contribution for management increases.

Summarized, the executed SLR offers effort- and time saving results which can be used by management and for future research. Further, the developed prioritization procedure, which includes 15 identified obstacles, impact criteria and a procedure to evaluate weight and rank the obstacles, presents high contribution to management and theory. The procedure supports the degree of data processing i.e., companies as well as it provides research results valuable for theory.

Further, increased data processing can enable the implementation of technology like blockchain as well as it increases the usability of blockchain. If more valid data is available, this data can be protected from manipulation and presented in a transparent way along the supply chain. Also, the implementation of a blockchain solutions can further support the mitigation of existing obstacles like the lack in data security. The procedure can be taken as a supporting preparation before the implementation of blockchain technology is executed

Limitations and further research

For the executed research some limitations as well as advice for future research can be given. The presented obstacles are identified by the conducted SLR. However, an additional survey could be executed to gain further obstacles from industry. Nevertheless, building the prioritization procedure based on the SLR results is sufficient to start dealing with data processing and its obstacles The used groups of technology, organization, data and process are used to structure the obstacles and to include a knowledge level during the procedure. These groups are derived from literature. Future research could find other suitable groups to adjust the procedure. Further, the evaluation criteria are determined, based on possible impacts the obstacles have on the companies. These impacts, based on low or missing data processing, can be faced by companies. Future research can focus on deriving further suitable evaluation criteria to optimize the procedure and thereby increase the value of the procedure results. The criteria were evaluated by a five-pint Likert scale. This scale can be extended if needed.

Since giving advice for action after receiving the procedure results is highly depending on the individual situation the company is dealing with, concrete advice is not given in this research paper since a general advice is not supporting However, future research can define some specific common situations and present advice for these situation groups.

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