
Big data in SMEs – findings of an empirical study

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Abstract: The aim of this study is to provide an analysis of the relevance, challenges and potentials of big data analytics for small and medium-sized enterprises (SMEs) in Germany. Big data is a comparatively young topic and the literature indicates that little research has addressed big data in SMEs in a German context. Given the lack of knowledge in this field, this paper follows a rather explorative approach. Based on literature review there is a research gap for SMEs in terms of relevance of big data analytics, of affiliated challenges and risks as well as opportunities and potentials and responsibility issues. Following a multi-perspective approach, twelve experts with various backgrounds were interviewed in order to get a holistic view of the topic. Half of them are employed in SMEs, whereas the other six experts come from external consultancies and academic institutions.

Keywords: big data analytics; small and medium-sized enterprises; SMEs; relevance; challenges; potentials; Germany.

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1 Introduction

This paper shows the results of a qualitative study, which analyses the relevance, challenges and potentials of big data analytics for small and medium-sized enterprises (SMEs) in Germany. The term 'big data' is a relatively recent construct and was first used in 1997 by researchers Michael Cox and David Ellsworth at NASA (Bundesrechenzentrum, 2015), who addressed the rapid and unstoppable increase in data volumes (Press, 2013). Due to the increasing digitalisation (Roßmeißl and Gleich, 2014; Seufert, 2014; Feindt and Grüssing, 2014) and an increased storage of pictures and videos, there is an ever-increasing data expansion (Vierkorn et al., 2014; Stockinger and Stadelmann, 2014). Additionally, the 'internet of things' had made it possible to connect the digital world to the physical one for several years now (Roßmeißl and Gleich, 2014). Meanwhile, machine-generating data such as log files or sensor data are also being obtained (Stockinger and Stadelmann, 2014). Big data is significant to a various fields such as national development, industry, scientific research and many others (Jin et al., 2015). The rapid growth in data volumes and availability is considered the main initiator of big data. Despite the potentials there are also risks, according to Jagadish (2014) "... we are only beginning to scratch the surface today in our characterisation of data privacy. ... Mistakes and overreach ... can quickly lead to backlash that could close many things down." As the meta-study of Frizzo-Barker et al. (2016) shows scholars across many disciplines have turned their attention to big data.

Due to its novelty, big data was until recently a buzzword, which was not clearly defined. However, this has changed and most companies of all sizes now seem to be fully aware of the topic. Internationally there are a variety of different studies on the dissemination of big data analytics in companies (e.g., Sen et al., 2016; Oxford Economics Survey, 2013; Thompson et al., 2013). Some studies have been published focussing solely on German companies (e.g., BARC, 2014; Deloitte, 2014; PWC, 2014). But up to now there is a research gap for a holistic view on big data analytics in SMEs, which this paper tries to bridge. The main research questions in our study are:

- “What challenges and risks do medium-sized companies face when confronted with big data?”
- “What opportunities and potentials can big data generate for medium-sized companies?”
- “Who can take over responsibility for big data activities in medium-sized companies?”

2 Big data

2.1 Definition of big data

There have been several independent attempts to define big data. The global management consulting firm McKinsey (2011) determines the term as follows and deals mainly with the increasing volume of data: “big data refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze.” Davenport (2014) agrees to that in his view of big data as “the broad range of new and massive data types that have appeared over the last decade (...)” and adds the feature data variety. Another important feature of big data is the non-negligible data velocity. On the one hand, this is the accelerating transfer rate, in which data is currently being generated in highly diverse fields of applications. On the other hand, these huge amounts of data must be analysed within a small time frame or even in (almost) real-time for the fastest possible response (BITKOM, 2014a). Dumbill (2012) refers to this third characteristic in his interpretation of big data: “big data is data that exceeds the processing capacity of conventional database systems. The data (...) moves too fast, or doesn’t fit the strictures of your database architectures.”

For data management, Laney (2001) was the first one to define volume, velocity and variety as integrative and interdependent. His understanding of the so-called ‘3 V’s’ is nowadays used by many specialists and organisations (Berman, 2013; BITKOM, 2014a; Miele and Shockley, 2013; Schroeck et al., 2012). But some experts and institutions expand the 3V model by a fourth dimension, veracity, which was initiated by IBM (Schroeck et al., 2012; Grönke et al., 2014; Baumöl and Berlitz, 2014). Hence the four dimensions are (Baumöl and Berlitz, 2014; Bendler et al., 2014; Britzelmaier, 2017; BITKOM, 2014b; Dorschel, 2015; Fasel, 2014; Fraunhofer, 2012; Kaufmann, 2014; King, 2014; Mayer-Schönberger, 2015; McAfee and Brynjolfsson, 2012):

- ‘Volume’, the exponential growth of the datasets.
- ‘Variety’ reflects numerous different types of data such as ‘structured’, ‘semi-structured’ and ‘unstructured’ data. Dealing with data variety is, according to Burow et al. (2014), the greatest challenge for many companies.
- ‘Velocity’ describes the increasing speed with which new data are generated, today often almost ‘real-time’.

- ‘*Veracity*’ refers to the quality of the data in particular for its authenticity, completeness and ambiguity (Baumöl and Berlitz, 2014). Many data, such as web videos or data from social networks, do not have high trustworthiness and represent a great risk because of the high manipulability (Burow et al., 2014).

All four elements solely describe the characteristics of big data. Grönke et al. (2014) and King (2014) point out that a single consideration of volume, variety, velocity and veracity of the data is not sufficient if big data is to *create value* within companies. The real additional value of big data is the creation of new insights based on an analysis and evaluation of the data (big data analytics).

This results in following definition which shall be used for this study: big data analytics describes the processing and evaluation of constantly growing datasets with a diverse data structure in the highest possible data quality at a high speed, whose goal it is to generate economic value.

2.2 *Big data responsibility in companies*

The general responsibility for big data in companies is not entirely clear. Big data can impact many business areas, resulting in the need to coordinate new findings. Not only in business practice but also in literature, it is agreed that the departments management control and IT play an important role in the coordination process (Burow et al., 2014). Although according to Weber (2014), there is a lack of suitable persons who have an adequate overview of the company, management accountants are most likely to see and implement big data’s interdisciplinary opportunities due to their interaction with all management levels and functions. Burow et al. (2014) also underlines the necessary cooperation with the IT department, which is the enabler that provides the IT systems for the data handling. The processing (analytics) of big data is carried out by the management control department, which provides decision-makers with evaluated analysis results (Burow et al., 2014). However, because of this close interlinking between IT and management control makes it necessary, that management accountants deal with new, changed requirements (Horváth and Aschenbrücker, 2014; Becker et al., 2015; Grönke and Heimel, 2015; Michel et al., 2015).

2.3 *Context of the study*

Big data analytics is a very young field of research in both, the theoretical scientific view and the practical implementation in companies (Schroeck et al., 2012). Also the literature research shows that first relevant professional literature or research-specific studies have been published no earlier than 2011.

There are more general papers dealing with the company-internal use of big data to improve knowledge management (Tian, 2017; Khan and Vorley, 2017). Ferraris et al. (2016) developed an innovative framework to promote social innovation within an ecosystem and emphasise the relevance of ICT (Ferraris et al., 2016). Ferraris et al. (2017) analyse the role of external and internal knowledge for open innovation in multinational companies’ subsidiaries.

Besides a number of papers dealing with very specific or more general aspects a small number of studies has been published focussing on the dissemination of big data in companies:

Table 1 Previous studies

<i>Study</i>	<i>Year</i>	<i>Title of the study</i>	<i>Sample size</i>	<i>Language</i>
BARC	2014	Big data analytics 2014	370	German
BITKOM	2014b	Potenziale und Einsatz von big data – Ergebnisse einer repräsentativen Umfrage in Deutschland	507	German
Commerzbank	2015	Management im Wandel: Digitaler, effizienter, flexibler.	4,000	German
Deloitte	2014	Data analytics im Mittelstand	70	German
EIU	2012	Big data – lessons from the leaders	752	English
Experton Group	2012	Datenexplosion in der Unternehmens-IT – Wie big data das business und die IT verändert	100	German
IBM (Miele and Shockley)	2013	Analytics: the real-world use of big data	1,144	English
IBM (Schroeck et al.)	2012	Analytics: big data in der Praxis	1,144	English
IDC	2012	Big business dank big data?	254	German
KPMG	2014	Ein Meer an Daten – Ein Mehr an Wissen	154	German
PwC	2014	Revolution big data	213	German
MIT Sloan Management Review (LaValle et al.)	2011	Big data, analytics and the path from insights to value	3,000	English

A study conducted by the Experton Group (2012) reveals, that almost 50% of the respondents have not yet started any concrete big data activities. 38% plan activities in the future, while only 13% have already implemented and executed big data projects. Consequently, only about 50% of German companies are actively engaged with the issue, while internationally 75% of the companies already deal with big data. This rather conservative and waiting attitude towards big data in German companies is confirmed by a study conducted by the auditing firm KPMG (2014). The study shows that 47% have neither planned the use of big data solutions at present nor in the future and only 11% carry out pilot projects. The study also reveals that the younger the participants, the higher the potential and importance of big data are weighted. After all, the more advanced a company deals with big data, explores possible potentials and is actively involved with big data solutions, the higher the potential is also assessed.

Studies also confirm, that the responsibility of big data is often not clearly defined in companies. Due to the novelty as well as the lack of experience, interdisciplinary project teams are responsible. According to the BARC (2014) study, the departments IT (44%), finance and management control (39%) as well as those of the BI organisation (36%) are particularly important. The same can also be observed in the actual application fields of big data. According to BITKOM's (2014b) study report, big data solutions are particularly used in finance and management control (44%) as well as in IT (33%). Big data activities also take place in the areas of logistics (33%) and HR (26%). By far the biggest use is, however, in the fields of marketing and sales (74%).

2.4 *Small and medium-sized enterprises*

SMEs economically play a very important role in Germany (Mac an Bhaird, 2010). There are qualitative and quantitative characteristics of such. The IFM Bonn (German SME research institute) defines firms with at maximum 50 million Euro revenue and less than 500 employees as SMEs, whereas the EU sets the threshold at 250 employees. Furthermore, these are usually owner-led and have a flat hierarchy; often low standards in information processing can be found (Pfohl, 2006). The enormous importance of SME is expressed through the following figures: in 2014 were 3.7 million SME in Germany, which accounts 99.6% of all German companies. Those employed 58.5% of the German labour (IFM, 2016). Hence, they have a structural, environmental, political as well as social significance and represent the regional and economic German backbone. In addition, SMEs have the comparatively highest importance in Germany compared to other European countries (BMW, 2014; Statistisches Bundesamt, 2012; European Commission, 2014).

However, there is no legal and generally valid definition for the concept of SMEs in Germany. That makes a comparability of studies on SMEs complicated (Curran and Blackburn, 2001).

Due to the novelty and complexity of big data, which leads to a lack of familiarity also with larger medium-sized companies, an own defined definition shall be used for this research. Hence, the thresholds of up to 3,000 employees and annual sales of up to EUR 600 million are set as quantitative indicators. These are subjectively determined, but are based on the analysis of various studies and the knowledge gained from them. In addition, the listed qualitative aspects are considered, but are rated as complementary and do not always have to be fully applicable to the companies under investigation. There is no application of corporate or group interlinking in this research. Accordingly, SMEs that are dependent on a group are not included in the definition of SMEs.

2.5 *Previous studies*

In a study conducted by the professional services firm Deloitte (2014), the growing importance of big data is also apparent for SMEs. 87% of surveyed SMEs reported that there was a sharp rise in data volumes in the recent past, which made a more intensive debate indispensable. Furthermore, 77% of respondents strongly support the need for ever-faster decision-making due to the increasing complexity of the environment. Hence, despite the high significance of big data for SMEs, it comes as a surprise that according to BARC (2014), only 7% use big data solutions as an integral part of business processes or 13% have at least a pilot project. The remaining 80% have no active discussion of the topic. Similar results are evident in the survey of BITKOM (2014b). Only 7% of SMEs up to 499 employees already use big data solutions, whereas 64% did not plan a concrete use of it. For comparison, 27% of the companies with more than 500 employees already use big data solutions.

A study of the auditing company PWC (2014) takes a closer look at the surprising and paradoxical attitude of SMEs towards big data, whose importance they are aware of. It compares the familiarity with big data on the basis of different company sizes and the already mentioned lack of knowledge becomes clear. There is a correlation between company size and familiarity with the topic. With increasing company size, the familiarity with big data also increases.

The topic ‘SME and big data’ is not only relevant in Germany. Sen et al. (2016) name a number of studies and papers, which deal with the issue as well.

Oxford Economics Survey (2013) name technology and innovation as strategic priorities for SME growth and big data is considered as one of the key drivers of it. Being able to analyse and predict market and customer behaviour with big data is a new paradigm shift for SMEs. When it is implemented correctly, it can yield increased flexibility, productivity, responsiveness, anticipation and ability to meet customer need through capturing blind spots and making better decisions.

Thompson et al. (2013) propose that the common belief is that tighter innovation will lead to growth of SMEs. The new technologies might enable companies to generate knowledge from the new technology that could lead to competitive advantage. Hence, SMEs should take business-related risks and should not be afraid of the failure for advancements towards the future (Abebe, 2014).

Sen et al. (2016) summarise different opinions about the role big data might play in SME: “although former data editor of ‘the economist’ Cukier (2014) suggested that big data is better data, Campbell Williams – marketing director of six degrees group – dismisses the necessity of big data for SMEs. However, not everybody agrees with this view. Big data and analytics leaders including Lauren Walker from IBM UK and Ireland are vigorous that SMEs ought to be looking at big data to gain competitive advantage and growth. This can be done by analysing their past performance and combining it to external data to understand the market behaviour before market does and uncover new insights” (MacInnes, 2013; Simons, 2013; Preez, 2014).

3 Research questions

As shown above, most studies do not follow a specific size of companies like SMEs. They also do only differentiate very limited or not at all between qualitative features. Nevertheless, a number of studies show the strong reluctance of SMEs to deal with big data activities compared to large corporations. The main reason is their lack of familiarity with the topic. Although there are some new insights regarding big data in general, the research on SMEs is yet to mature. Their statements are often limited and very superficial. Given this background, the study aims at answering following research questions:

- RQ 1: how relevant is big data analytics for SMEs?
- RQ 2: what are the challenges and risks, but also opportunities and potentials concerning big data?
- RQ 3: who can take over the responsibility for big data activities in SMEs?

In this respect, the study shall contribute to important questions concerning big data in the context of SMEs, whose outstanding importance for the German economy is undisputed.

The necessary confrontation of SMEs with big data analytics is obvious. Big data is generally a very young and complex research area, which is why in practice there are often more uncertainties regarding the handling, the concrete use as well as the potentials. Although it became clear that SMEs increasingly have problems with the subject of big

data analytics (PWC, 2014), only very limited research and studies in the context of SMEs are available. This is why this research needs to be deliberately wide-ranging in order to gain the most comprehensive insights possible. The overall objective is therefore to create a holistic picture of big data analytics in SMEs.

4 Research methodology

Researchers can use methods of empirical data collection to describe the reality and investigate a special topic (Bortz and Döring, 2016). It is generally differentiated between two types of measurement and evaluation; quantitative and qualitative research methods (Brosius et al., 2012; Bryman and Bell, 2015). Qualitative research interpretatively processes verbal or non-numerical data and often describes a complex phenomenon in its entire breadth. In contrast, the analysis of measured values in the quantitative approach is carried out statistically and numerically (Bortz and Döring, 2016; Brosius et al., 2012). Due to the uncertainty concerning big data in SMEs, quantitative research would be unrewarding since general knowledge needs to be explored first. Therefore, the acquisition of expert knowledge seems to be the best choice as the big data issue is discussed across all companies, but there is inadequate knowledge for SMEs and the research needs are therefore very extensive. For this reason, the expertise of experts will be the focus in order to identify and analyse the limited knowledge of big data in SMEs. This justifies the use of expert interviews, although authors like Fischer (2006) and Sedlmeier and Renkewitz (2013) consider them as problematic because of the lack of the sample's representative status.

Expert interviews are part of the category of qualitative interviews (Bryman and Bell, 2015). Brosius et al. (2012), Alvesson and Ashrafi (2012) as well as Flick (2014) make clear that open questions are to be preferred in qualitative methods, because they lead to answers with larger amounts of text and thus to new knowledge. Due to the novelty of big data, it is advisable and necessary to interview experts from various areas. Thus the intention to obtain a holistic picture of the research object can be taken into account. A multi-perspective approach is selected for this purpose and company internal and external interviewees were chosen.

Within companies, the two departments management control and IT are most likely responsible for big data. Therefore, experts from both departments were interviewed in order to obtain a comprehensive picture of big data regarding the company's internal situation. The internal interviewees are, in their entirety, employed in companies, which apply to the defined subject of this study and meet the criteria. On the company external side, experts from consultancies were interviewed. While those experts are not employed in the research subject of SMEs, they do have an extensive experience in business practice due to their advisory activities and thereby contribute a more practical approach. However, since these three areas are all derived from the corporate practice, experts from the theory-led field of science were also interviewed to obtain a holistic picture. In order to provide the same weighting to all four individual areas, *three experts were interviewed per area*. Table 1 provides an overview of the functions of the *selected twelve experts*. The expert interviews took place in the period from 29 June 2015 to 4 August 2015. At the beginning, an additional test interview was carried out.

Table 2 Overview of selected experts

<i>Company internal perspective</i>		<i>Company external perspective</i>	
Management control department	Commercial director and authorised signatory	Consultancies	Senior manager, authorised signatory and head of big data and advanced analytics
	Team leader management control		Founder, owner and CEO
	Team leader finance and administrations, responsible for big data		Founder and CEO, leads expert sessions on the topic of big data
IT department	Head of IT	Academics	Chairman of a standard committee, founder and CEO
	Head of IT and organisation		Professor at a university, active member in various interest representatives
	Head of IT		Founder and owner of an institute for data analysis, lecturer at a university, leads various expert and discussion sessions

After conducting and transcribing the interviews, the information obtained will be evaluated. For an analysis of such large amounts of data obtained by expert interviews, the literature pleads for the method of qualitative content analysis (Mayring, 2016; Meuser and Nagel, 2005; Bryman and Bell, 2015; White and Marsh, 2006), which was also used.

5 Findings

5.1 Relevance of big data

All experts clearly expressed that big data is very relevant to SMEs. Anyone who does not consider this will have big problems with the doubling of the data volume every two years and will not be able to master them anymore. Moreover, the common opinion of the experts is that SMEs are still very reluctant with regard to this topic and that there is a high potential for catching up.

SMEs have become aware of the rapid development of data after all. This was also very urgent, since big data can have a strong impact on the competitiveness of SMEs. Competitive advantages can be gained by making use of big data.

The respondents further indicate that big data is relevant to all kinds of industries. But big data shows a higher relevance for such industries, which generate relatively large amounts of data. Because of data protection, big data might be somewhat less relevant to companies who work with very sensitive personal data.

In addition, pioneering sectors have been mentioned, where big data is already very much addressed and applied in an advanced way. Driven by the external pressure of government and media with regard to 'Industry 4.0' (high-tech strategy of German government), companies in manufacturing and other industries in particular are described as pioneering sectors. Experts also consider the sectors of trade, especially online trade,

as extremely relevant, since a large number of electronic data, like the purchasing behaviour of customers, are being generated.

Similar to the industry view, the interviewees also agreed that the impact of big data is going to be noticeable in all areas of the company, as there is a higher degree of interest in different analyses. Big data will have a particularly high impact on the areas of production and sales. For example, big data can lead to an improvement in the predictions about the quality of products. In addition, the areas of marketing and management control were frequently mentioned. According to the experts, it will also have a strong influence on the IT department, as it is responsible for providing the respective tools and has to discuss them with the relevant departments.

5.2 Challenges and risks

The experts consider big data to be very sophisticated; therefore a correspondingly highly qualified work force is required to effectively deal with the topic. All experts, however, agree that a lack of professional staff is one of the main reasons for the lack of debate. Various aspects can be considered in the differentiation of this finding. On the one hand, there is a lack of expertise within the company to deal with the new kind of data analysis. In the opinion of the experts, highly qualified people in the field of big data need both, very specific technical IT knowledge and a well-developed business management understanding. This combination of specialists is currently very rare on the market and especially for SMEs very difficult to get. The experts also complain that the subject matter is so new that young academics and graduates have too few points of contact with big data analytics. Consequently, there is a lack of suitable specialists for data analysis in the high-end environment. Thus, many companies only have the opportunity to engage external consultants.

This leads to a further main problem in the opinion of the experts, high costs. Some of the interviewees said that in many SMEs the information and data analysis, as well as the IT infrastructure are compared to the average of all companies of all sizes are below average, and do not have the necessary basic prerequisites for the successful engagement with big data. One expert described this metaphorically as an ‘investment backlog’ of the past. Due to the increasing and especially abrupt new meaning of big data, this new awareness makes it clear to many companies that they need to invest a great deal of money in the near future. These high investment costs amount to external consultants, corresponding big data tools and software, but also the time of the engagement and thus the bound personnel costs. In this context, new staff is often unavoidable; some experts even advocate the creation of new departments.

Moreover, SMEs place great importance on data protection and, according to experts, are particularly sensitive to data handling. German companies seem to be very sceptical towards big data technology innovations, especially cloud systems in the USA.

As a further not negligible aspect, some experts mention the prevailing demographic structures in SMEs. Many of the management positions are occupied by people of the so-called ‘baby boomer generation’. An expert described a large part of these persons metaphorically as ‘technological Neanderthals’. This seems to be in line with Angela Merkel’s remark during Obama’s visit in Germany in 2013: ‘Das Internet ist für uns alle Neuland’. That can be translated into ‘the internet is new territory for us all’. Those

people not seem to be accustomed to ever-changing technological changes and often find it difficult to adapt to the fast moving and constantly changing technological innovations and to select the innovations relevant to their company. They are constantly confronted with new technologies – as is big data – and often do not deal with such modern topics because of the lack of knowledge and mental overload. Furthermore, some experts also referred to family enterprises, which are often run by comparatively very old owners, with a markedly lacking interest in the company management. The conservative mind-set ‘everything as usual’ is very strong and it is often difficult to convince elderly owners of the cost-benefit ratio of big data.

If SMEs do not deal with big data intensively in the near future, the experts presume a number of risks. The interviewees assume a strong to very strong competitive disadvantage, which varies depending on the industry. If SMEs ignore big data’s possibilities, they cannot uncover weak spots in the company or possible cost advantages. Many experts also argued that a not confronting might have a negative impact on the market strength, or even lead to a possible insolvency, if the corresponding trends are not or too late taken into account due to the lack of information. Many SMEs often postpone dealing with big data due to the problems mentioned so far and choose a ‘follower strategy’. Considering the rapid data development, many experts see this as very dangerous. As there are already many first movers in different sectors, they strongly urge SMEs to follow as soon as possible. There is a high backlog demand for SMEs in this context. Especially industries in which many (customer) data are generated are severely affected. It can also have a significant impact on markets where disruptive technologies and innovations often dominate the market, as it is the case with electronics consumer goods. These risks, however, cannot be generalised, since they are often sectorial and market-related and must be examined individually.

Risks can also occur after the implementation of big data applications. Almost all experts see the main risk after the introduction of big data applications in the mere collection of data that is not used since many SMEs do not know what to do. Another risk is due to the complexity of such tools and the difficult data management. Many experts see a lack of personnel, which is familiar with the complex big data tools, and that often leads to improper handling.

The experts agree without exception that the handling of the increasing amounts of data and their storage is not a big problem for SMEs anymore. Also the data velocity was only briefly mentioned as a possible problem by one of the experts.

Very often, however, data variety was mentioned as one of the biggest challenges for SMEs. Problems can arise in the processing of different data structures, i.e., the linking of unstructured, semi-structured and structured data, as well as the decision which data should be integrated into which business and decision-making processes. These must then be managed with new database technologies, which then again require corresponding knowledge and personnel. Likewise, the experts consider the veracity of data as particularly important and challenging. It has to be guaranteed and is regarded as the basic prerequisite for drawing decisive value from the information.

In order to address the challenges, the experts state the necessary requirements and prerequisites. Most of them suggested that a clear, structured big data strategy should be considered ahead of the preparation. Before SMEs are concerned with a mere, unconsidered accumulation of data, they should work through the following topics shown in Table 2, which result from the statements of the interviewed experts:

Table 3 Most important topics

1	Personnel-related questions Are there qualified employees? Do external people need to be involved in the big data strategy?
2	Development of a data governance model Due to the high sensitivity of the data topic: storage duration and usage, corresponding agreements from data protection points, protection against unauthorised data access.
3	Creation of a data map What data is currently available to the company? What data can the company have additional access to, but do not yet save it?
4	Data selection What are the most important and relevant data for the company from the potentially collectable data?
5	Concreting and consolidation What added value should and can be achieved? A purposeful use must be defined in order to make relevant statements.

The experts recommend a retrograde approach. Specific questions are derived from the big data strategy in order to look at what a company wants to achieve in concrete terms by using big data. Only a clearly structured big data strategy leads to a useful information gain.

As a further prerequisite, the experts advocate for a future closer collaboration between IT and the departments that would like to gain new insights from big data. An expert summarised this in such a way that the previous ‘corporate IT departments’ have to turn into ‘business IT departments’. In this function, they act as internal consultants and show the specialist departments which technical solutions are available for their needs.

Big data and the new methods of data analysis can lead to cross-sectorial changes. It can have strategic implications and influence processes, systems and structures. As a result, an effective change management has the task of informing employees about these innovations and preparing them accordingly. Whereas big data is a continuous process, data must always be up-to-date and, if necessary, new data needs to be integrated. In addition, the data used must always be critically interrogated and adjusted.

5.3 *Opportunities and potentials*

The experts generally see an enormous potential for big data in SMEs. Due to the immense additional information, big data can add real value in all areas.

Big data technologies can enable completely new possibilities to collect and analyse unused customer data as well as market data. In this context, the experts agree that the customer, and also the often closely connected market understanding, can be significantly improved. For example, it is possible to evaluate products and services more holistically through the new data. Thus, an earlier counter-reaction concerning poor ratings is possible (e.g., product enhancements). In addition, it is possible to better analyse customer needs. The questions “what does a consumer want?” or “what does a consumer need that he does not know yet?” are easier to answer, e.g., using unstructured and semi-structured social media monitoring data. Thus, trends in customer needs can be

better recognised. In this context, the new findings of big data also enable better-customised products that are tailored to individual customers. It is also easier to find out how to use a product at the customer's optimum level and which sales channels are the best to reach the individual customer. The mentioned aspects often result in an improvement in customer loyalty.

The interviewed experts also frequently stated that the new market forecasts also provide opportunities for SMEs to become active in new markets, as the additional data and information provide new insights of previously unused potentials. This can be based on entirely new business models, or on the possibility of entering with completely new products.

Not only on the external side, but also internally, the experts see a multitude of opportunities and potentials. Thus, a clear improvement and optimisation of business processes in all areas were often mentioned. In addition, better and often faster decisions can be made, since the decision-making bases have holistic aspects based on correct data (veracity). Frequently, unused potential savings are becoming visible, e.g., in production. This can lead to an optimisation of the production costs or an efficiency increase in the process, e.g., by early identification of waste. It would also be possible to use a 'predictive maintenance' to make faster and more accurate statements as to when a machine fails or when its optimum maintenance period is. In addition, an increase in efficiency can be achieved with the use of raw materials or energy. Such resource conservation can sometimes be reflected in the reduction of throw-outs. Some experts argued that the above stated points, if used correctly, could all lead to an increase in turnover or profitability.

The potentials presented can offer real value added to SMEs in many respects. Insofar as companies consider the topic of big data as extremely important and want to use it in many areas, this often has a wide impact in many areas of the company. The experts, who had taken this fact into account in their comments, would in this case advocate a linkage of the big data strategy to the company's objectives resp. strategies.

Due to the wide range of influence in the company, it also has a great influence on the business strategy. An enterprise-internal expert, in whose SME big data analytics already plays an important role and whose use is well advanced, called such a link as inevitable. In his experience only then the significance of the subject matter can be made clear to the employees.

SMEs have advantages over large companies in many areas, including the handling and implementation of big data. The flat hierarchies, which are often typical for SMEs, result in shorter decision-making processes. With regard to big data, this time factor makes itself noticeable with a faster release of the required budget. In addition, a first pilot project can be launched and implemented more quickly, as it is easier to bring together all project participants and project managers. This time factor plays an important role for SMEs and can bring decisive competitive advantages through the faster implementation of big data technologies.

After a big data project launch, another advantage of SMEs is their higher flexibility regarding necessary adjustments such as changes in the concept or an expansion of the budget. Furthermore, some experts mentioned that faster implementation leads to comparatively quicker and more decisive decisions, which can also bring competitive advantages.

As already stated in this study, big data is, in the opinion of the experts, relevant to all companies, but the intensity of the dispute is to be examined with regard to the meaningfulness in the individual case. In this respect, some experts have mentioned another advantage of SMEs: They examine the necessary investments for big data more precisely and question the meaningfulness significantly more than it is often the case in large companies.

5.4 Responsibility

The experts agreed without exception, that the company's management is to be actively involved in the task of stepping up and supporting the topic within the company. Big data has to be pushed ahead from the highest level, as it is a strategically important topic. The management must therefore deal with it and take responsibility for the fact that it must bear and ensure not only the political but also the corporate responsibility. Through the active participation and conscious support, it can ensure a corresponding enforcement within the company. An expert who has already been involved in many big data projects in SMEs has pointed out that there is no other chance and that big data has to be 'pressed into the company' by the management, since the issue is top priority. If the company management does not back it, the urgency and importance of the issue is not seen within the company.

When big data is specifically addressed within a company, the experts argue that the responsibility should not lie on a lower hierarchical level, but on the executive level. This seems conclusive, as they must release temporal resources, employees and other necessary means. The interviewees, however, do not agree in their statements which department can assume the overall responsibility for big data. Nevertheless, from the different statements two departments stand out: some experts do not see the general responsibility at the IT department, but it is very important for the implementation and use of big data. It must provide the necessary systems and tools and generate the various data, although many of them lack the corresponding business background for the analysis (analytics). Here, the department of management control was often put into play, which is most likely to have the overall overview and the appropriate know-how for the evaluations. A few experts also argued that the responsibility of the evaluation does not have to lie with the management control departments, but with the individual areas in which big data is used. Certainly, both views are comprehensible and must be examined individually for the implementation of big data in a company.

By contrast, the interview partners agreed without exception that a big data initiative should not immediately implement the new technologies and applications companywide; rather, they advise that the complex issue shall be addressed by means of a small project or use case. Otherwise, there is a great danger of not being able to recognise a multitude of problems and thus the risk that the actually desired added value cannot be claimed. The goal of such first small use cases is the creation of awareness within the company as well as the identification of advantages and added values by the initiative. Other departments get ideas on the areas in which big data could be applied to them in a profitable way as well. After carrying out a suitable use case, it is also desirable to monetise the demonstrated advantage.

Big data is a complex issue that can have an enterprise-wide impact. For this reason, the experts clearly advocate an interdisciplinary project team for the big data initiative in order to get a holistic view. In any case, they consider it essential to involve the IT

department, since it must act as an internal advisor for big data applications of the individual departments.

6 Conclusions and outlook

6.1 Conclusions

From the findings of this study, it can be said that SMEs have to deal with the actual core of the topic – the current data development – in all its complexity. For them there is a considerable backlog and action demand with regard to big data analytics.

In terms of RQ 1, the doubling of the worldwide data volume every two years is scientifically proven and makes a prompt discussion with the topic big data unavoidable. In this context, large companies are relatively early adopters of new data technologies. Due to the strong relevance for SMES, the quickest possible discussion is advisable in order not to lose any competitiveness in the future. If the new potentially generated data are not considered and used, the risk of a competitive disadvantage is high, as other competitors can gain clear market advantages through the information advantage. The extent to which big data has a more or less strong relevance in the individual sectors must be examined individually in advance.

Concerning RQ 2, the results show that due to the lack of professional personnel, especially SMEs are encouraged to acquire the necessary professional know-how as soon as possible either internally through appropriate continuing learning or, if necessary, (additionally) through external consultants. This is essential because the new big data technologies are far more complex than the previous applications and require corresponding knowledge. After the perception is created within a company, the advantages are pointed out and corresponding projects are regarded as worthwhile, SMEs are often faced with the increased investment costs. These should, however, not only be seen in the short but in the longer-term, since big data is a strategically important topic.

Data protection plays an important role especially in SMEs and is often treated very critically. It is therefore recommended to develop and implement a corresponding data governance model that regulates the core points of data protection and the legal and ethical handling of sensitive and personal data.

Regarding RQ 3, the inclusion of the company's management is particularly important in the case of SMEs, since big data can influence all company segments and bring corresponding values there. It is also a strategically important issue. For the first discussion of the topic, it is advisable to set up an interdisciplinary big data initiative.

Big data is a topic that also affects the IT department very much due to the new technologies. Accordingly, there must be a closer and more trusting collaboration between the relevant departments and the IT. The latter has to be more strongly understood as 'business IT', which increasingly serves as an internal consultant for the respective needs of the departments.

6.2 Limitations

The present paper has shown a holistic view of the current handling of big data in medium-sized companies. This was based on the generation of additional knowledge by experts due to the lack of research, especially in medium-sized businesses. However,

qualitative research methods and measurements are often controversially discussed due to their subjectivity and lack of representativeness. Critics see them merely as a supplement to conventional quantitative research methods. Against this background, it is therefore possible to extend the present work to include quantitative methods.

The definition of SMEs was deliberately formulated relatively broadly for the study and includes both qualitative and quantitative characteristics. A possible need for research is the further differentiation of these characteristic types. For example, an extension could be carried out on the basis of a study on how big data is handled by medium-sized companies within a group and whether this would result in advantages in comparison to companies that are independent of a group.

6.3 Outlook

The qualitative study has shown a holistic view of big data's current situation in SMEs and has thus generated a first impression. This was based – due to the lack of studies specifically on SMEs – on the generation of additional knowledge by experts. Now this impression can be refined, for example by a higher number of interviews.

It would be interesting to compare SMEs from different sectors and from different countries. Big data could be more relevant for retailing companies compared to handicraft businesses for instance. Cultural differences could lead to diverse levels of dissemination of big data in different countries.

The focus of this study was on the business background. However, the technological area or the intensive examination of specific IT technologies was less addressed. Further research needs can be undertaken here by carrying out an intensive investigation and evaluation of possible big data solutions by means of IT technologies, software or other tools.

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