Big Data

Potential for the Controller

Dream Car of the “Ideenwerkstatt” at the ICV 2014

In cooperation with

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Management summary

Over the next 10 years the global data volume is expected to undergo a fifty-fold increase. Reasons for this are, among others, the increased use of sensor technology in production and logistics, as well as the extensive distribution and use of mobile internet. This development is currently the subject of a controversial debate in theory and practice known as "**Big Data**". It is part of the controller's job to deal with the flood of information caused by Big Data, since the **supply of information to decision makers** is his core task.

If one looks at actual practice, it is evident that a few successful Big Data projects are already underway in the economic and administrative sectors. Thereby, the use of Big Data promises potentials along the entire **value chain**, from the development through to production, logistics, sales and aftersales. The opportunities Big Data presents can be identified across all industries, in particular industries with direct customer contact generate a large volume of data, which needs to be applied to company processes.

On the other hand, many companies are skeptical of "Big Data". High investment costs, the lack of skilled staff and know-how, as well as privacy risks delay its implementation in companies. Therefore, the application of Big Data must be carefully analyzed. It demands that the **controller as a business partner** identifies the realizable excess value.

The growing data volume opens up completely **new opportunities** for the controller. Due to Big Data, all kinds of monetary and non-monetary information is accessible, which enables the controller to improve his planning and controlling at different levels of corporate management. However, this limited view does not fulfill the controller's role as a business partner. His specific tasks concerning "Big Data" should include all management subsystems in accordance with the **coordination-oriented approach of controlling**. The controller should initiate the integration of Big Data in the **subfunctions of corporate management** and accompany this integration as a project manager.

Besides many opportunities, **new challenges** also arise for the controller due to the massive data growth. As a business partner to management, the controller will only be able to benefit from Big Data if he actively deals with this topic. He has to know which data and data management technologies are available. Furthermore, he needs to have expertise in regards to analysis techniques and visualization capabilities. The controller, more than ever, faces the challenge of further educating himself. He has to take up the newly developing competence areas resulting through Big Data due to the fact that two new professions have evolved. Both positions, the **business analyst** and the **data scientist**, overlap with those of the controller terms of their skills and fields of activity.

Preface

The ***"Ideenwerkstatt"*** (Dream Factory) at the ICV has the task of systemically observing the controlling-relevant environment and identifying significant trends. The Ideenwerkstatt develops the "Dream Cars" of the ICV and makes a significant contribution in enabling the ICV to be perceived as a leader in the financial and controlling community. Ideas and results are converted into concrete, practical products by ICV experts or project groups. Members of the Ideenwerkstatt are renowned controlling representatives from business practice and science.

Ideenwerkstatt's ambition is to always deal with highly-relevant and innovative topics that provide significant incentives to the controlling community. In recent years, we established the first impetus with the topics of green controlling, behavioral orientation and volatility. Continuously, our motivation is to draw the controllers' attention to new aspects through the adoption of new developments and thus, to further develop controlling.

This year we decided to select "Big Data" as the main topic due to its tremendously increasing importance during the last couple of months. Recent developments in information technology offer companies completely new opportunities for acquisition, storage and networking of previously unimaginable large amounts of information. For many experts, these developments will fundamentally change corporate governance. This will inevitably affect controlling as well. Therefore, the goal of this year's Dream Car report is to present which opportunities and risks in regards to Big Data are relevant for the controller and his daily work.

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This year again we have complemented the considerations and deliberations of the contributors with practical experience from different partners.

The following companies provided great support:

- *Deutsche Lufthansa AG*
- *Hansgrohe SE*
- *TRUMPF Werkzeugmaschinen GmbH + Co. KG*
- *IBM Deutschland GmbH*
- *SAP AG*
- *Wittenstein AG*

We would like to sincerely thank all of the companies for their willingness to support the work of the "*Ideenwerkstatt"*. A special thanks goes to *Walid Mehanna* (*Horváth & Partners Management Consult*ants, Stuttgart) for the multifaceted assistance in making expert information technology available to us.

Also, many thanks to Mr. *Andreas Aschenbrücker*, who took care of the editorial work of this report and coordinated the core team.

We wish you an interesting read and new incentives for your daily work in controlling.

Yours sincerely,

Siegfried Gänßlen

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1 Introduction: Big Data - myth and reality

> ***"Go ahead, be sceptical about big data. The author was - at first."***
> (*Thomas H. Davenport* 2014)

> ***"Big Data is just another Big Deal."***
> (*Roman Griesfelder* 2014)

> ***"Big data: The next frontier for innovation, competition and productivity."***
> (*Manyika et al.* 2011)

The essential task of *ICV's Ideenwerkstatt* is to identify developments that might be relevant for the controller's work and to analyze these constructively and critically in a timely manner. The aim is to create a "Dream Car" report that includes our assessment of the importance of Big Data, as well as concrete design recommendations. This report is intended to serve as a trigger for innovations, to uncover future potential and to substantiate this potential through examples of use respectively.

The controversy: Big Data: hype, big deal or revolution?

The topic of "Big Data" is currently under debate with lots of controversy. Some see a typical hype, whereas others are skeptically positive. Even others think Big Data revolutionizes our lives (see initial quotes). The innovative analysis options are accompanied by high investment costs and longer implementation periods for the technology.

On the one hand, the term "Big Data" initially points out the almost unimaginably growing volume of data (see Figure 1). In our days, the storage of such data volume is neither technically nor economically a problem. On the other hand, only a small percentage (5%) of this amount of data is specifically analyzed and used.

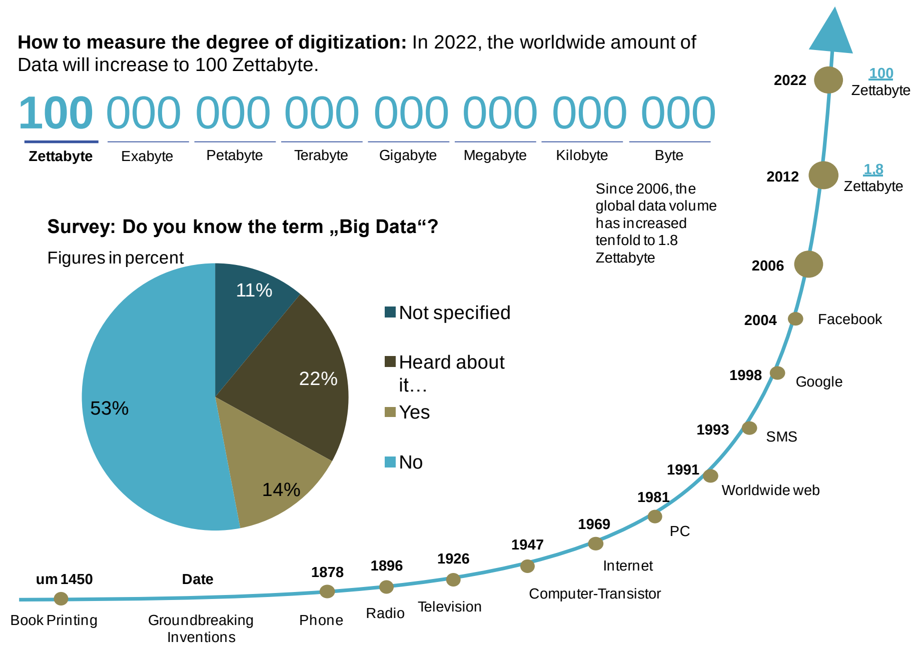

Figure 1: Development of the global volume of data (according to Geldner, 2013, p. 15 based on German Telekom, Experton Group, Aris, BITKOM)

Challenges for the controller

We want to tackle this current, highly-relevant topic from a controller's perspective:

- What is Big Data? What is the potential of Big Data in companies and organizations? What are the risks? Is this all still a long way off?
- In particular, the question: What significance does Big Data have in regard to controlling?
- How does Big Data change the controller's work? Where and how can the controller discover potentials?
- Where must the controller, in his role as the "economic conscience", critically question the costs and risks?

The following example illustrates and clarifies the topic:

Insights into current practice

The ORION system of UPS:

Big Data is nothing new to UPS, since UPS has already started to pursue a variety of package deliveries and transactions in the 1980s. Today, the company records data of 16.3 million parcels daily for 8.8 million customers, who place an average of 39.5 million parcel tracking requests per day.

A large part of the newly acquired data is generated by telematics sensors placed in more than 46,000 vehicles. The data from the UPS package truck (HGV) includes for example, speed, direction, braking and driving performance. Thereby, the data is not only used to monitor daily performance, but also to improve route planning. This initiative, called ORION ("on-road integrated optimization and navigation"), is probably the world's biggest operational research project. [...] The project has already saved more than 8.4 million gallons of fuel in 2011 due to reducing the daily routes by 85 million miles. UPS estimates that avoiding only one mile per day and per driver results in savings of 30 million U.S. dollars for the company, so that total savings are significant. […]

(*Davenport* 2014, S. 178)

Structure of the Dream Car report

In this Dream Car report, our aim is to provide answers to the questions above as follows:

- First, we explain what is to be specifically understood under the "catchall term for data" (*Davenport* 2014, p. 1) Big Data (Chapter 2).
- With the help of concrete examples, we subsequently present where and how Big Data can be used in business and administrative applications. In this context, the respective Big Data strategy is of great importance (Chapter 3).
- We ask for the potentials and risks when applying Big Data in controlling and about the controller's functions. We also clarify with whom the controller cooperates (Chapter 4).
- We give an overview of the analysis tools and the IT technology for Big Data (Chapter 5).
- Finally, we provide a set of recommendations for the controller's "Big Data readiness" (Chapter 6).

The report includes a glossary as well as recommended reading for both beginners and advanced controlling experts.

2 Definition and categorization of Big Data

Like all bold terms, "Big Data" is imprecise and used excessively by many, in particular IT vendors and consulting companies. *Davenport* (2014, p. 8) calls Big Data an "umbrella term" and prophesizes "a relatively short life span for this unfortunate term".

The term relates to the development of terminologies for evaluation and analysis of data in support of corporate management. Table 1 illustrates this development.

Table 1: Terminology development and the main areas of data analysis (according to Davenport 2014, p. 10)

Term	Period	Specific meaning
Decision-making support (DSS - Decision Support Systems)	1970-1985	Use of data analytics for decision-making support
Support of leadership (MIS - Management Information Systems; EIS - Executive Information Systems)	1980-1990	Focus on leadership support
Online Analytical Processing (OLAP)	1990-2000	Software for the analysis of multidimensional data tables
Business Intelligence (BI)	1989-2005	Reporting tools to support data-driven decisions
Analytics	2005-2010	Focus on statistical and mathematical analyses
Big Data	2010-today	Focus on large, unstructured and rapidly changing data sets

Given the diversity of the terminology in literature, it is almost impossible to differentiate the terminology levels. In particular, the term "Business Intelligence" (BI) claims to cover the entire spectrum. Kemper et al. (2010, p. 9) define BI as an *"integrated, company-specific IT-based global approach to operational decision-making support"*. Big Data is hereby only a part of BI.

In order to clarify the term further, it makes sense to mention certain conceptual features, which are constitutive for Big Data. The *BITKOM* (*Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V*.) has identified four core features (cf. Figure 2).

The intense debate about "Big Data" shows that this definition is still not sufficient from the controlling perspective. Companies can only take advantage of Big Data if they trust their data and draw measurable value from their analysis. If the quality of the underlying information is insufficient, the management loses its confidence in the data and relies more on intuition than on a solid data base when making decisions (see *Redman*, 2013, p. 86).

In addition, it requires data specialists to recognize the value of data and generate measurable economic benefits for the company. *Steve O'Neill*, CFO of U.S. hardware and software Company EMC is even considering a "return on data" as a "key performance indicator" for Big Data in companies (see *Bartram* 2013, p. 28).

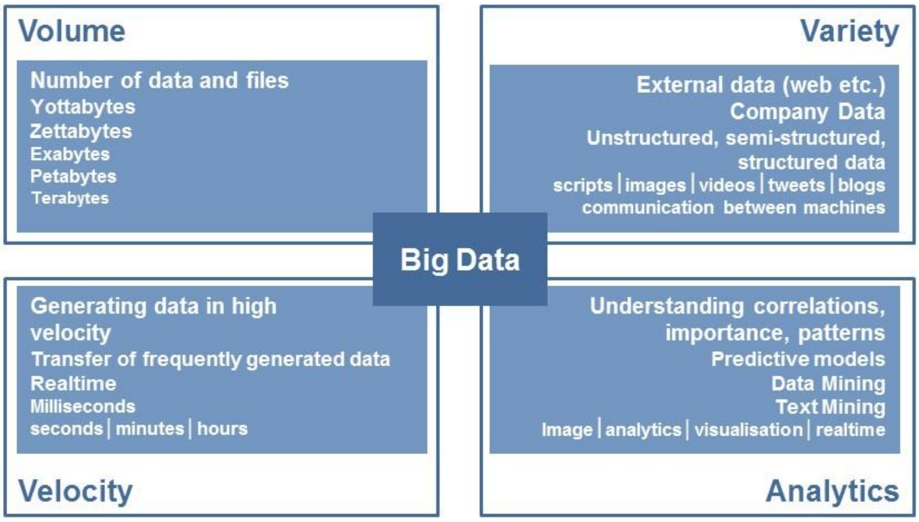

Figure 2: The characteristics of Big Data (cf. BITKOM 2012, p. 19)

Big Data are characterized by: volume, variety, velocity, veracity, data analytics and value

For this reason, we would like to expand the *Ideenwerkstatt's* basic terms by two more "V's": veracity (= credibility) and value (= value).

Thus, six essential features emerge:

1. **Volume**: As the term "Big Data" already implies, both large amounts of data from terabytes to petabytes as well as many small amounts of data, which need to be analyzed together, are covered (see *Zacher* 2012, p. 2).

2. **Variety**: Not the large amounts per se, but rather the diversity of data are simultaneously the opportunity and the challenge of Big Data. The data comes from internal and external sources as structured (relational databases etc.), semi-structured (log files) and unstructured (text on the Internet, but also streaming video and audio files etc.) (cf. *Matzer* 2013, p. 18).

3. **Velocity**: The constantly changing and only temporarily valid data requires processing in real time, or close to real time (cf. *Matzer* 2013, p. 18).

4. **Veracity**: Confidence regarding the credibility of the data must exist (cf. *Neely* 2013, *Redman* 2013).

5. **Data Analytics**: For the management, analysis and interpretation of Big Data, automated methods of recognition and use of patterns, meanings and contexts as statistical methods, optimization models, data mining, text and image analysis, etc. are necessary (*BITKOM* 2012, p. 21).

6. **Value**: The use of Big Data analytics can provide economic benefits for the company by providing deeper insight into its business. This includes, for example, the development of new products and services and reactions to business-related changes when they occur (cf. *Davenport et al*. 2012, p. 44).

Therefore, our attempt to formulate a definition is as follows:

> ***"Big Data describes the analysis and real-time processing of large, unstructured and continuously flowing amounts of data from a variety of different data sources for the creation of credible information as the basis of value-creating decisions."***

Velten and Janata (2012) summarize the main drivers for data growth and illustrate the different origins and heterogeneity of data (cf. Figure 3):

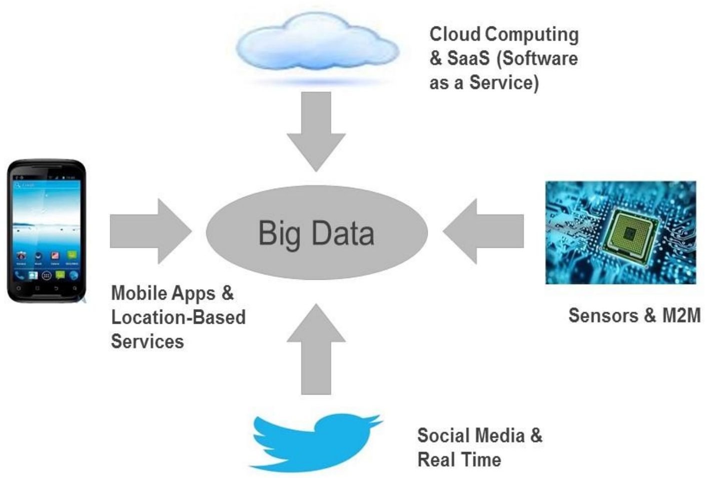

Figure 3: The main drivers of Big Data (cf. Velten & Janata 2012, p. 5)

The main drivers of data growth are of company-internal and - external nature

Due to the expansion of the internet, private users generate billions of data with each click every minute. Not only do they generate data on their stationary computers, but also by using mobile devices with a wide variety of mobile apps and location-based services. Thus, they complete each data point with further information (e.g. spatial data). For example, the news is read in the train on news apps, before being annotated and shared via social media over the network. The development of the individual user from consumer to prosumer (an individual who not only consumes, but also produces and even distributes content) additionally amplifies the company's external data growth.

Internal corporate trends also influence the increase in data volumes significantly. Companies are increasingly turning to cloud computing and software-as-a-service (SaaS) solutions in their business processes. In addition, using the latest sensor technologies and machine-to-machine solutions (M2M), production of goods, machines and devices are interconnected to allow an automated exchange of information between them. The experts are already talking about the fourth industrial revolution, the "Industry 4.0 "(cf. *Kagermann* 2012, p. 68). Their central visions are digitally interconnected, and decentrally controlled production facilities can react flexibly and autonomously (cf. *Spath* 2013).

For further analysis, we have to fill this abstract definition with concrete content and support it with examples.

3 Big Data – application in business and administration

Direct the attention to the Big Data practice

Insights into practice demonstrate a very heterogenic picture. Apart from a few companies that make headlines with Big Data projects, many organizations where this topic is not yet on the agenda can be identified. Also, certain skepticism can be observed. We want to provide transparency by asking the following questions:

- Are there any industries that are ideal for the application of Big Data?
- Which beneficial categories of Big Data applications can be distinguished?
- At which stages of the value chain can Big Data be used, and in which way?
- What are the threats and risks?
- What needs to be done?

A further differentiation is necessary in this context: What are the facts? What is the intent? What is the future scenario? These differences remain unclear in some publications.

Before we answer these questions, we will have a look at a "lighthouse project" (cf. *Prenninger* 2013) to demonstrate the potentials of Big Data: *BMW FACTS*. The aim of this project is to improve customer satisfaction by using information from the "on-and off-board diagnosis" in the automotive product lifecycle.

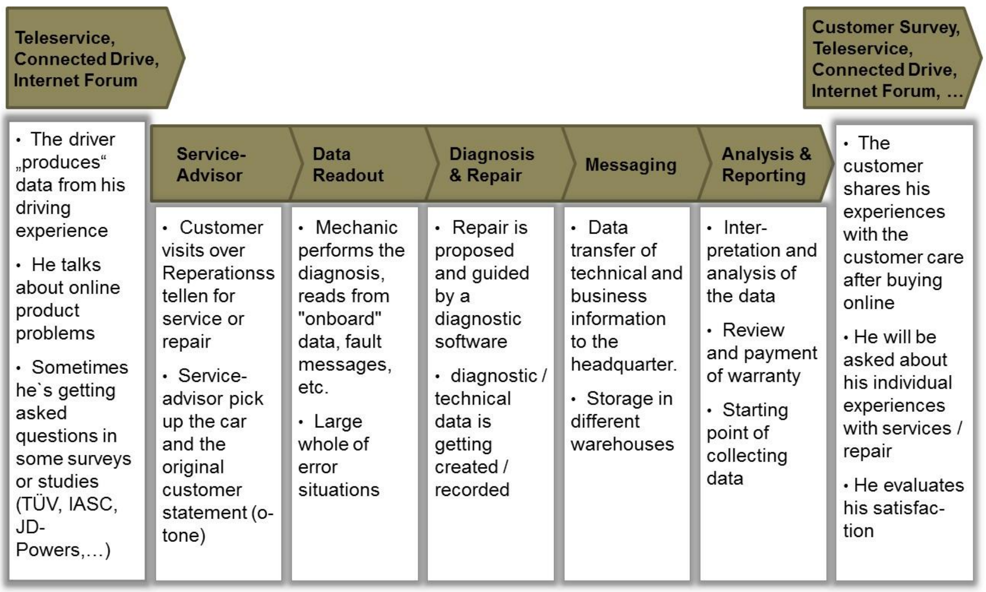

Figure 4: Sources of Diagnostic Information
(own illustration based on Prenninger, 2013, p. 5.)

The diagnosis and repairing of car defects and other car-related problems is supposed to be improved by using different data resources. Thereby, customer impressions and feedback create a significant value (see Figure 4). In order to estimate the extent of available information from the data resources shown in Figure 4, some facts are displayed in Table *2*.

Table 2: BMW FACTS - BMW developed an "on- & off - board diagnosis system (own representation based on Prenninger 2013, p. 7)

Amount	Automotive diagnostic data
~17 million	Vehicles in use
~4,000	Dealerships in 90 countries
~50,000	Customer service personnel
Up to 65	Electronic control units in a single BMW
1,000	Individual selectable options per car
>1GB	Functional software per car
15GB	On-board data per car
~2,000	Customer-relevant software functions
~12,000	Error code-related data implemented in on-board diagnostics
~3,000	Metric values in all electronic control units per car (on average)
~10,500	Test modules for all BMW series
~34,000	Schematic documents
Up to 60,000	Diagnostic sessions per day worldwide
~170	Regular feedack reports per day

BMW FACTS's goal is to make use of this vast amount of information about the entire product lifecycle of an automobile. The problems that need to be solved in that regard are shown in Figure 5.

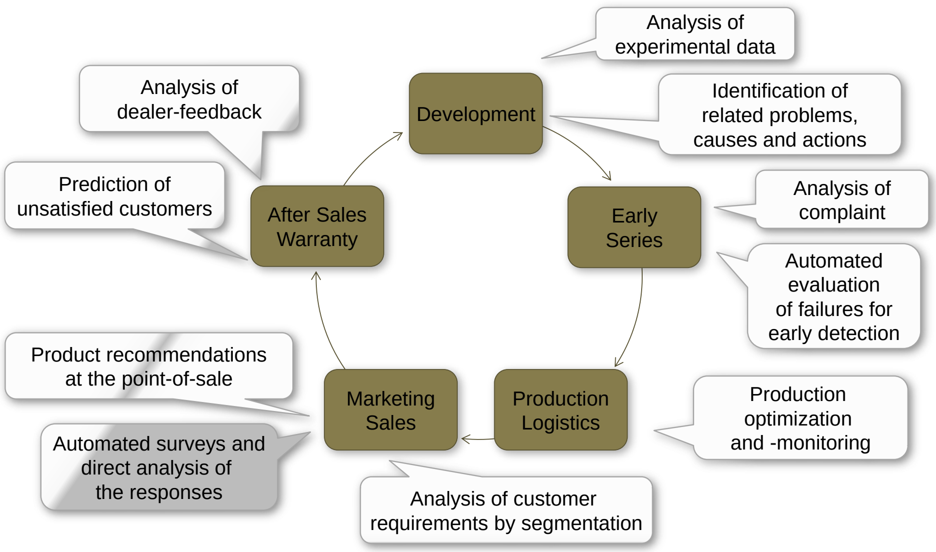

Figure 5: Analytical use of diagnostic information in the automotive product life cycle (own illustration based on Prenninger 2013, p. 9)

Using predictive analytics that entail among others, methods of data mining and sequential analysis, the available data should be used to understand causes of vehicle problems. Predictions can consequently be made about which vehicle types and classes may be affected by similar problems. Also, both ad hoc corrections and suggestions for improvements in regards to development should be derived.

3.1 Are there any industries that are ideal for the application of Big Data?

The total potential index as a benchmark for the relevance of Big Data in several different sectors

The relevance of Big Data for several different sectors can be identified through a total potential index. The total potential index consists of the following criteria: amount of data per company, performance variability, customer and vendor strength, intensity of transactions and turbulences (cf. *Manyika et al*. 2011, p. 123).

Categories	Sectors	Overall value potential index
Goods	Manufacturing	✶✶✶✶✶
	Construction	✶
	Natural resources	✶✶✶
	Computer and electronic products	✶✶✶✶
	Real estate, rental, and leasing	✶✶✶✶
	Wholesale trade	✶✶✶✶✶
	Information	✶✶✶✶✶
Services	Transportation and warehousing	✶✶✶✶
	Retail trade	✶✶✶
	Administrative, support, waste management, and remediation services	✶
	Accommodation and food services	✶✶
	Other services (except public administration)	✶
	Arts, entertainment, and recreation	✶✶
	Finance and Insurance	✶✶✶✶✶
	Professional, scientific, and technical services	✶✶✶
	Management of companies and enterprises	✶✶✶✶
Regulated and public	Government	✶✶✶✶✶
	Educational services	✶✶
	Health care and social Assistance	✶✶✶✶
	Utilities	✶✶

✶✶✶✶✶ Top quintile (highest potential) ✶✶✶ 3rd quintile (average potential) ✶ lowest quintile (very low potential)
✶✶✶✶ 2nd quintile (high potential) ✶✶ 4th quintile (low potential)

Figure 6: Evaluation of Big Data potentials per sector (own illustration based on Manyika et al 2011, p 114.).

According to *Davenport* (2014, p. 32) Big Data is valuable for industries that …

- ... move items
- ... sell something to the end user,
- ... are machine-driven,
- ... use or sell content,
- ... provide services,
- ... have physical assets,
- ... move money.

Industries with direct customer contact are especially suited for the application of Big Data

This applies especially to private and public branches that have a lot of customer contact through their customer or service orientation (travel agencies, trade etc. see Figure 6).

3.2 Which beneficial categories of Big Data applications can be distinguished?

The potentials of Big Data usage are diverse and sometimes very individual. Thus, a systematization of the benefit dimension is very difficult. *Davenport* (2014), *Wrobel* (n.d.) and *Parmar et al*. (2014) provide three possible approaches to categorize the benefits of Big Data use.

Benefit categories of Big Data by goals

1.) *Davenport* (2014, p. 73) distinguishes four different benefit categories. These benefit categories are a result of goals to be achieved through Big Data:

- cost reductions,
- quick decisions,
- “better" decisions,
- product and service innovations.

2.) On a more abstract level, *Wrobel* (n.d., p. 42) differentiates between the benefit categories according to general opportunities by the use of Big Data:

- more efficient corporate management,
- mass customization of services,
- intelligent products.

Benefit categories of Big Data by opportunities

Opportunities for a more efficient corporate management arise through the real-time query of large, current data amounts. For example, the drugstore chain *DM* plans its staff capacity based on personal preferences of employees, delivery forecasts and daily sales per drugstore (see *Wrobel* n.d., p. 45).

By collecting consumer data, mass services can be individualized. This offers new opportunities, especially in marketing. This is where new and stronger forms of customer loyalty as well as an individual and purposeful interaction with the customer develop (see *Wrobel* n.d., p. 46).

With the use of complex sensor technologies, products receive a certain "integrated intelligence". Thereby, the thermostats produced by the American manufacturer Nest, which was recently taken over by Google, are able to study the behavior of the residents and predict future usage (cf. *Wrobel* n.d., p. 49).

Questionnaire for the identification of benefit categories

3.) *Parmer et al.’s* (2014) approach focuses on basic benefit potentials. Thereby, five areas are to be considered that reveal strategic potential for the application of Big Data. To identify these potentials, a company has to ask itself the right questions regarding its data use. Figure 7 gives an overview of the potentials and questions a company needs to address.

The goal of answering these questions is to expose any possible potential and to generate ideas for the use of Big Data in the company (cf. *Parmar et al*. 2014, p. 95). Subsequently, these ideas must be prioritized and those ideas, which were deemed to be relevant, must be concretized and described in scenarios in order to conclusively evaluate their value to the company.

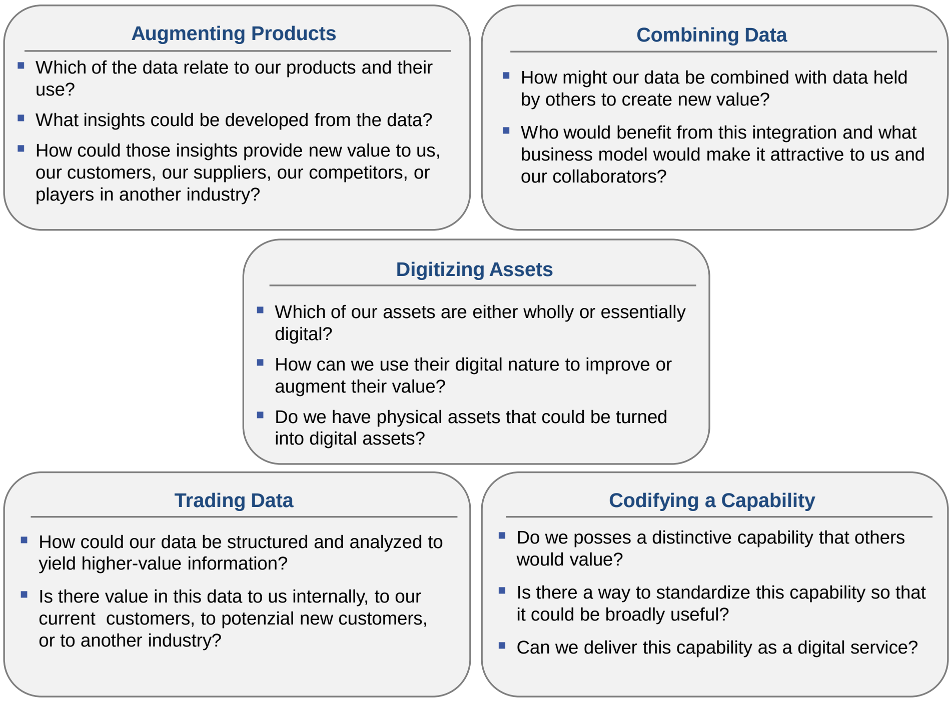

Figure 7: Potential of Big Data (own illustration based on Parmar et al 2014.)

3.3 At which stages of the value chain can Big Data be used and in which way?

"We view Big Data across the entire value chain"

The potential of Big Data becomes particularly clear when the entire value chain is analyzed. To put it in the words of *Mattias Ulbrich*, CIO *Audi AG*: "We view Big Data across the entire value chain" (cf. *Bretting/Dunker* 2013, p. 6 and Figure 8).

Development: During vehicle development, digital vehicle simulations multiply the data sets from day to day. This data is combined and analyzed together with the market data of the previous models, observations of the competition, but also social (lifestyle) trends and customer feedback. For this purpose, the Japanese motorcycle manufacturer *Yamaha* has set up the *Yamaha Design Café*. In this online portal, Yamaha offers news about their own motorcycles to their (potential) customers. At the same time, users are regularly asked to participate in surveys to get consumer insight concerning the brand, its products and for general driving behavior. The customer feedback flows directly into the product development and shapes the development, in particular the design of new vehicles and products, until shortly before their completion. Since vehicles are described digitally with all their characteristics nowadays, the period may be extended up to the so-called “design freeze” (see *Fromme*, 2013, p.13). This allows vehicle manufacturers to respond to current trends virtually in real time.

Production: Experts believe that the use of sensor technologies and machine-to-machine solutions in manufacturing and production will grow rapidly in the coming years. Thus, the vision of the "Industry 4.0" with its intelligent production systems through digital networking and de-centralized control is becoming more and more real. First application examples already illustrate the potential for production: in the foundry of a major automobile manufacturer, quality management is significantly improved through the analysis of sensor data. By linking the 600 variables of the production and quality assurance processes, sources of errors can be identified on a daily basis and corrected in a timely manner. Thus, the rejection rate could be reduced by 80 percent within twelve weeks and quality assurance costs by 50 percent (source: interviews with company representatives).

Logistics: The *Wittenstein AG*, a manufacturer of drive systems, was the first to test scenarios for the use of interconnected technologies. With the help of these insights, the control of production logistics should switch from a fixed schedule to a demand-oriented logistics control. Current requirements can be met quicker and a more flexible reaction to changes in production orders is the result. The application examples show that the production processes are much more flexible and versatile through the digital networks and can be adapted to current changes in the environment (source: interviews with company representatives).

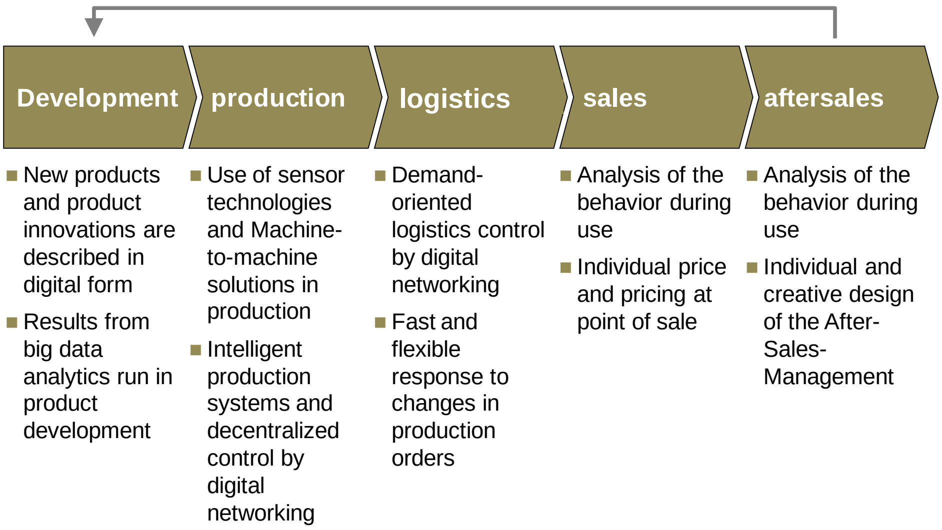

Figure 8: Big Data across the entire supply chain

Sales: The British insurer Aviva grants its customers a discount of 20 percent on their car insurance, provided that the insurance company is allowed to record the driving behavior. Thus, the first step to detailed and customized contribution rates has been implemented (Business Intelligence Magazine 2/2013, p. 15). In the future, customers will benefit even more from it. Anyone, who allows permanent monitoring of his driving behavior is assigned a risk profile and receives a customized tarif (see Müller et al., 2013, p. 67).

After sales: A detailed analysis of user behavior must contain other advantages in order to remain in the automotive industry: the maintenance intervals for vehicles can be defined more accurately, which can be of great importance especially for logistics companies. Auto shop visits can be planned according to demand and, because of existing databases between auto shops, causes and solutions for defects can be identified and resolved quickly on the basis of similar cases for each model. The automotive manufacturers and their authorized repair shops can save time and money by making their customer support proactive and personalized. Also, the customer can schedule auto shop appointments better and reduce his waiting times (see *Fromme*, 2013, p. 13).

Insights into current practice

Application of Big Data in the automotive industry

The automotive industry is cited as an example for the application of Big Data (EMC Germany GmbH, 2013):

"Since last year, ZF has had Big Data on its radar. Following the first boom in the market, we will investigate and look at serious applications pertaining to ZF in our IT innovation management in the second half of 2013. Evaluations of mass data from the production process and the products in the field in terms of continuous quality assurance and improvement are, for example, conceivable."

Peter Kraus, head of computer science ZF, Friedrichshafen

"Big Data is a buzzword with literally a huge impact. At the same time, it fits the core of our development: information management is what defines the Continental Interior Division, for example. Just as we can implement new features in the vehicle simply by linking previously separate systems today, the use of diverse data sources from transport infrastructure will lead to entirely new functions and, in the end, to a whole new quality of driving."

Helmut Matschi, Member of the Executive Board of Continental AG, Interior Division, Hanover

"The new generations of BMW vehicles contain about two gigabytes of software code and user data nowadays- in a few years it will be ten times as much. If a model needs an update, our worldwide service partners have to be able to quickly retrieve very large vehicle-specific and operation-critical data sets and load them into the cars. This is a data-logistical challenge we have to face."

Karl-Erich Probst, Head of Corporate Information Technology, BMW Group, Munich

"Eight currencies, large product lines with many subcategories, very different customers with local requirements - the conditions that affect our parts prices in the APAC region are complex. Therefore, we intend to use a Big Data solution that supports our analysts in pricing with automatically generated key figures from different data sources. We have modeled ourselves on the service offers with which the automotive industry successfully retains customers."

Raymond L. Osgood, director of the parts business at Fiat Industrial in the Asia-Pacific region

Insights into practice

WITTENSTEIN AG

Industry 4.0 in the age of Big Data at WITTENSTEIN bastian GmbH

The core idea of Industry 4.0 is to close the media break between the material and virtual production worlds via the internet of things and services and to enable the provision of value added services. The search for applications thus describes the identification of media breaks in industrial environments. Thereby, Industry 4.0 is not primarily a technologically motivated topic, whose concrete examples neither involve an exceptional technical complexity out of necessity, nor have a technologically high innovation potential. The innovation arises rather from the interconnection of several previously separated information sources and the optimization of chemical or organizational processes.

In the actual implementation, the intelligent product, the intelligent machine and the assisted operator arise as so-called technology paradigms. Physical objects in production are equipped with passive identification technologies or active sensors and computing cores, in order to provide other IT systems real-time information about themselves and their environment. Smart objects and machines thereby deliver a flood of information that forms a huge amount of data - so-called "Big Data". This flood of data needs to be processed from an economic point so that the industry user can apply the relevant information for the right purpose, at the appropriate time, and for the appropriate task.

Application examples in "urban production"

The two use cases of intra-logistics and production planning & escalation management have been implemented as part of the Federal Ministry of Education and Research funded research project Cypros - Cyber-Physical production systems. The technical realization and organizational embedding of Cyber-Physical Systems in real production and support processes takes place at the "urban production" of the WITTENSTEIN bastian GmbH in Fellbach, which serves as a showcase factory.

Use case intralogistics

A complete flow of all production and transport processes is hardly possible in the highly varied production of propulsion systems at WITTENSTEIN bastian GmbH. Supply of material, which is still based on the Kanban principle, leads to unnecessary expenses through suboptimal utilization. Through the intelligent connection of individual production resources, information transparency can be created in the production, which enables a demand-oriented control of supply. The concrete improvement potential of this use case is the need-based material supply, so that it never comes to a standstill on a machine at any time due to an off-schedule production order. For this, the media break between the allocation of delivery and pick-up areas and the expected (remaining) processing time of construction contracts must be closed.

This is carried out in several steps. First, the conventional workpiece carriers and the hourly rhythm are to be maintained. The transported production order and the delivery and pick-up areas are automatically identified by barcodes. The relevant needs are displayed to the employees on a tablet PC. Based on the information transparency in the first step, the delivery and collection needs are known. In a subsequent step, software is used to calculate the departure time. In the last step, the manual data recording can be used by intelligent workpiece carriers to automatically and independent of the process and location provide the required information transparency.

Through a step-by-step implementation of an intelligent connection of demand-oriented material supply in production, the employees are gradually introduced to the changes, so that the application of IT and technology is accepted as support mechanism for daily work.

Use case production planning and escalation management

While the WITTENSTEIN bastian Gmbh is already using modern production planning systems for the processing of production orders at the planning level, the shop floor level is still applying card-based planning board systems. The consequence is a media break between IT-based, intermediate-term and paper-based operational planning. To the detriment of all process participants, this results in a continuous deflection between the digital world and the actual order processing, and leads to avoidable organizational losses. The evaluation and resolution of escalations in the production environment of WITTENSTEIN bastian GmbH is also troubled by media breaks. These arise from the fact that information regarding the cause of escalations has thus far not been well documented. Decision makers tend to receive only partial information about the cause of the problems, and when they receive it, it’s often too late. This makes a statistical evaluation and the repatriation of knowledge difficult.

The benefit of this use case lies in the optimization of organizational procedures for order processing. In the short and intermediate-term, faster and easier escalation of issues is of primary importance. In the intermediate-term, the foundation of collected data can be used for a faster diagnosis of the cause of the problem. In the long term, this data foundation can also uncover fundamental relations regarding parameters such as materials, tools, set-up parts, manufacturing machines and suppliers.

As a first step, a digital planning board is implemented, eliminating the root cause of the media break. Employees at the planning level also have the possibility of accessing the latest information in the digital planning board system via a tablet PC. Easy access to different information views and contents is carried out either through tactile interaction or optical markers (barcode, QR Code, data matrix code) on machines and on order documents. As a second step, an application is created whereby the worker can directly document the processing of production orders and, if necessary, escalate problems. The input of job and machine master data can also be conducted by scanning optical markers on order documents or machinery. As a third, longer-term step, the collected information is transferred into a continuous improvement process.

Assessment and outlook

The conscious channeling and harnessing of the information flow that accompanies the goods movement is becoming a prerequisite for highly efficient process chains given the existing megatrends such as increasing product customization (batch size 1), increasing market volatility and production in globalized value networks. Implementing Industry 4.0 through auto ID technologies, embedded systems, IT systems of production and their interconnectedness in a factory internet presents additional challenges to manufacturing companies with regard to the increasing amount of data in the future.

Companies that are able to extract relevant information from Big Data for a realistic prediction of imminent demand and production scenarios will secure competitive advantages. Each employee is thus placed in the position of an informed decision-maker, who is able to translate information into optimized processes in a way that is targeted and appropriate to the situation. Considering, however, the implementation effort which is required for implementing the design approaches and concepts of the above described use cases, it is evident that, from a cost-benefit perspective, the introduction of consistent Big Data approaches in production is difficult to justify in today's IT landscape. Rather, Big Data applications can help bring about business models that are promising in the long run, and support services that can provide a substantial added value for both customers and companies.

Big Data features

Machines and products can generate large amounts of data in real time when equipped with identification technologies and sensors. Such data includes information on movements, maintenance requirements, material requirements, current production conditions and many other variables for each product and machine.

Controller’s lead

- Critical counterpart during the validation of data to ensure high data quality.
- Critical counterpart in the implementation of data during the reporting process.
- Business partner and process designer to optimize the processes in intra-logistics and production planning.

Lessons learned

- Bridging the gap between the virtual and material world constitutes the first step towards optimizing processes in production and logistics.
- Intra-logistics use case: The creation of information transparency enables a demand-oriented supply of material, and thereby prevents machine standstills due to production orders that are not delivered on time.
- Use case production planning and escalation management: The creation of a documentation platform for production planning allows users to react quickly and on short notice to identified problems. The documentation platform also allows users to design a long-term improvement process.

From a cost-benefit perspective, the introduction of Big Data for production planning is very difficult to justify due to high design and implementation costs.

3.4 What are the threats and risks?

Threats, risks and barriers of Big Data: Big costs, Big Brother, Big crime

Big Data encompasses three major risk areas:

- Big Data and Big Costs: Implementation is associated with high investment costs for high-performance IT systems.
- Big Data and Big Brother: Privacy is almost impossible to guarantee, leading to a 'transparent society'.
- Big Data and Big Crime: Crime and sabotage constitute substantial threats.

The analysis of social data by companies and public authorities eliminates any possibility of the desired anonymity of an individual. "The era of privacy is over," said *Facebook* founder *Mark Zuckerberg*. The revelations by the former U.S. intelligence employee *Edward Snowden* seem to confirm this statement.

An example from the Netherlands shows the diverse possibilities of data abuse:

Insights into current practice

***TomTom* for the police: The navigation device has been set against motorists.**

"The Dutch manufacturer of TomTom navigation systems had sold its data to the Dutch government. The government forwarded the material to the police, who made use of it by setting up their speed traps as profitably as possible - at locations where particularly many TomTom users had been driving too fast. TomTom's CEO publicly apologized. They had believed the government was more interested in road safety and congestion avoidance. TomTom did not expect the government to set up strategic speed traps."

(*Müller et al.* 2013, S. 74)

Only if hazards such as these can be kept under control, users' confidence in Big Data can be obtained (see *Rose et al*., 2013).

Companies are holding back on the issue of Big Data

Empirical studies on Big Data applications are still disappointing. According to a study by the *Institute for Business Intelligence* (2013), the majority of companies still do not employ Big Data (see Figure 9).

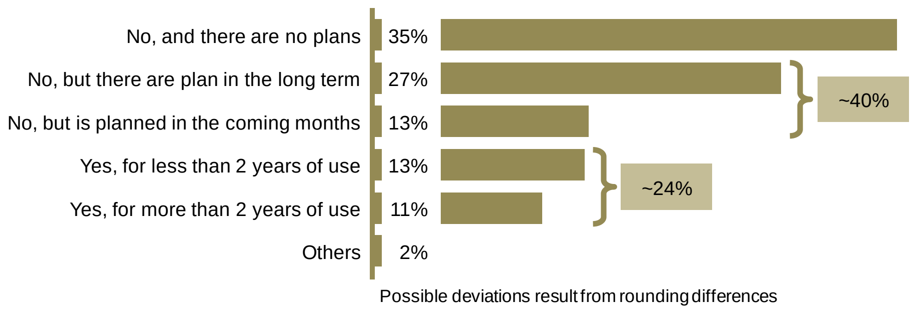

Figure 9: Use of Big Data (cf. Institute for Business Intelligence, 2013, p. 38)

Only about 24 percent of the surveyed companies already employ Big Data. Another 40 percent plan to integrate Big Data into business processes. However, more than a third of the companies do not devote any time to the issue at all.

Reasons for entrepreneurial restraint when it comes to Big Data

Barriers to Big Data use are varied, as shown by the aforementioned study (see Figure 10). A lack of qualified personnel is the biggest obstacle. This is accompanied by the estimate that a lack of know-how regarding advanced analytics (48 percent) and new data bases (44 percent) constitutes a major intricacy. Furthermore, unclear organizational responsibility, costs for the development of new data bases and advanced analytics are considered difficulties. The previously presented advantages of Big Data, however, seem to be predominantly acknowledged by companies. Accordingly, only 27 percent of companies consider the absence of advantages pertaining to Big Data to be implementation obstacles.

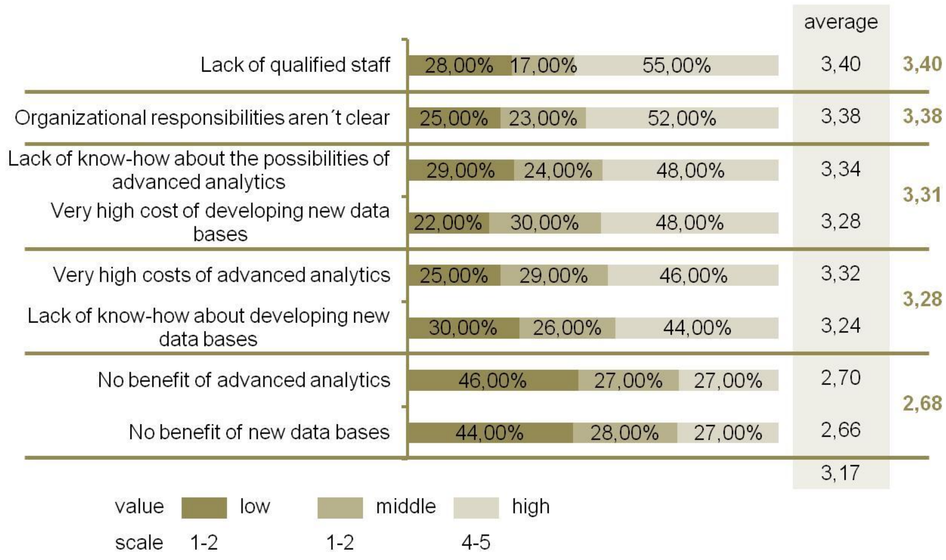

Figure 10: Barriers for the use of Big Data
(cf. Institute for Business Intelligence, 2013, p. 39)

3.5 What needs to be done?

The foregoing discussion raises the question of how a company's management should handle Big Data in their strategy.

A controller is demanded as a business partner for the topic of Big Data

Investment in high-performance IT systems for Big Data implementation needs to be soundly justified. Only a strategic cost-benefit analysis and a subsequently developed roadmap are of help in this setting. Here, a controller is required as a business partner to identify the realizable added value. Derived from the already established benefits categories, three key questions that need to be answered arise in this context:

- What cost-cutting opportunities remain to be discovered?
- How can faster and better decisions lead to an improvement of results?
- Which new performance-oriented products and services can be generated?

Davenport (2014, p. 80) gives guidelines for the "correct" adaptation of Big Data:

Guidelines for the correct adaptation of Big Data:

You should be careful if:

- Industrial changes in the past were not driven by technology.
- You do not have much data on customers or important business areas at your disposal.
- Your company is usually not a pioneer in industrial innovations.

You should be moderately aggressive if:

- Your industry is already actively dealing with Big Data or analysis.
- You want to be ahead of your competitors.
- Your company is experienced in working with technology and data.
- You employ at least a few people who can handle Big Data.

You should be very aggressive if:

- Someone in your industry is already very aggressive.
- You have previously acted as a competitor in the field of analysis.
- You have used technologies to change your industry in the past.

Insights into current practice

hansgrohe

Location planning with Big Data at Hansgrohe SE

Hansgrohe SE has been involved with this topic for the last one and a half years.

The manufacturer of faucets and showers is planning a large expansion at the logistics center in Offenburg. Prior to the final approval of the project, the investment in the expansion should be assessed and validated.

The following issues were assessed:

- Is Offenburg the right location for a logistics center?
- Is the expanded logistics center able to cover a volume increase of 35 percent?
- What cost potential arises due to the process automation?
- What costs are attributable to the European subsidiaries, and which logistics costs would result from direct shipments to those countries?

A project team, which was coordinated by the controlling department and consisted of the logistics and the corporate business development departments, collected and processed all relevant data. In addition to the master data (sites, external storage, etc.), different data containers in SAP were accessed. All (internal and external) motion data was used. In addition, data such as fuel prices, tariffs, service levels or transport times were considered.

The data was all loaded into the software. Hence, the current situation was set as ‘base scenario’. In multiple loops, this first scenario was validated by the project team. During this project phase and to ensure the correctness of the data base, the controlling department assumed the role of a critical counterpart in the project team.

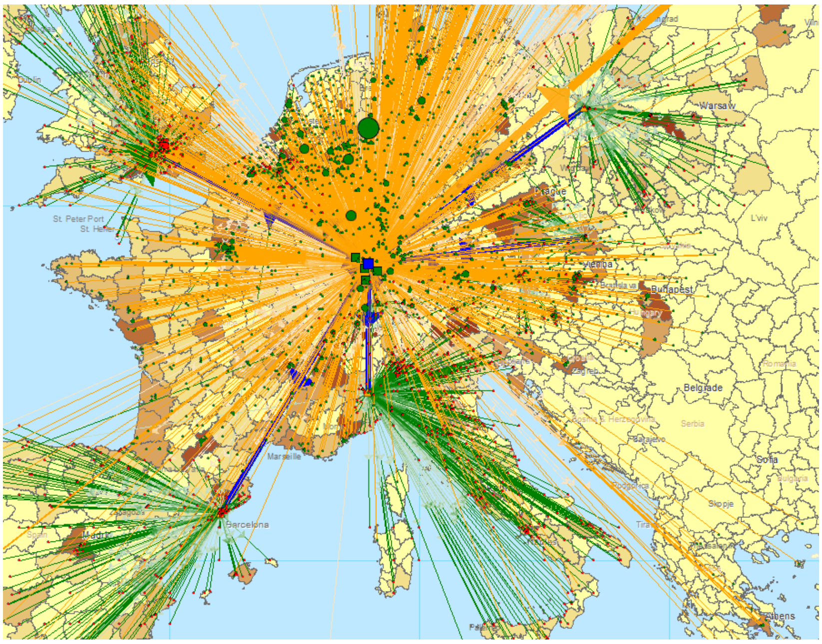

Figure 11: Product flows in Europe

Over the course of the overall project, data collection and validation were most time-consuming. The two graphs show the ‘base scenario’.

Thereby, a foundation was created for calculating a variety of pre-defined scenarios within minutes. The results were analyzed and recommendations were derived. Here, the controlling department as a business partner and process designer exerted an essential influence on the analysis and drafting of the course of actions.

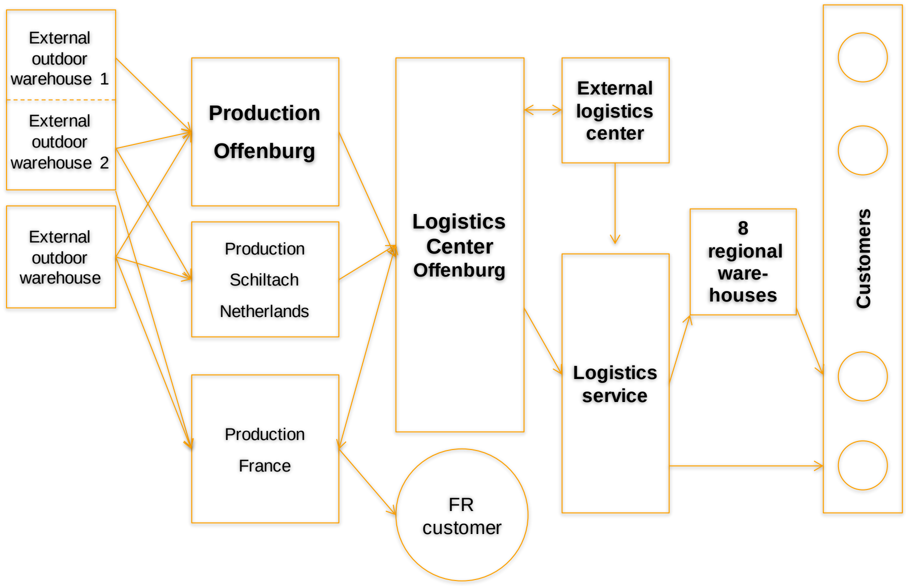

Figure 12: Base scenario logistics set-up.

From the transport cost point of view, a different position for a logistics center would have been better. With regard to total costs, Offenburg proves to be optimal for *Hansgrohe SE*. A volume increase of 35 percent can also be covered with the expanded logistics center. Optimizing these processes leads to substantial cost savings and results in an ROI in the low single digits.

The question to what extent the corporation requires other storage sites in Europe has to be raised. Some storage sites that can be closed down considering their service level, transport and other costs have been identified. Here, however, more analysis is required to clarify, for example, leases and ownership.

The validated "base scenario" can now be used as a basis for future network analyses.

Big Data features

For the simulation, 15 million data records were uploaded and evaluated. In addition to the master data (sites, external storage etc.), different data containers in SAP were accessed. All (internal and external) movement data was provided. In addition, data such as fuel prices, tariffs, service levels or transport times was considered.

Controller's lead

- Project team coordination.
- Critical counterpart during data validation to ensure high data quality.
- Business partner and process designer in the development of action recommendations.

Lessons learned

- By using appropriate software, various scenarios could be rapidly calculated and analyzed. Thus, well-founded ROI calculations for site expansions were possible.
- Over the course of the project, data collection and validation consumed the most time.
- A next step would be to include real-time data to, for example, optimize routes.

4 Controller and Big Data

4.1 Data-based decision-making

The information supply of decision makers as an interface between controller and Big Data

One of Big Data's key functions is to provide information to the company's decision making process. Moreover, as the supply of information for decision-makers is one of the core functions of the controlling department, such information provision is the link between Big Data and controlling. Analytical methodologies for data analysis can be employed to extract useful information for the decision-making process from Big Datasets. *LaValle et al*. (2011, p. 22) differentiate between three levels of development in the use of analytical methods: "aspirational", "experienced" and "transformed".

At the first "**aspirational**" level, analytical methods are used to confirm decisions that have already been made in the past. Data basically serves as a tool that documents the past. Decisions are reviewed retrospectively, possibly accompanied by an analysis of why erroneous choices were made.

The second "**experienced**" level makes use of Big Data's potential. In other words, different decision alternatives are evaluated and selected based on internal and external data. This analysis, however, is at best used for solving a specific, well-defined problem: What is the best sales strategy for a specific product? Which product configuration leads to the highest revenue? For many functions and challenges faced by a business, this level of analysis is definitely sufficient, and using data creates substantial value.

Further potential arises when different decision alternatives can be generated based on data. This level is described as "**transformed**". Analytical methods are used to increase productivity or to attain new impulses for product development. At this third level, data not only serves as a tool for correct decision making, but also helps identify fundamental causes and relationships: What influences the quality in the production process? What are the main cost drivers for production and logistics? As soon as different causes and effects are identified, decisions can be deduced in order to optimize future products, services or the organization of internal processes.

The identification of different causes and effects in a company constitutes a core potential of Big Data and can lead to better decision-making within a company.

Data quality as a key success factor for Big Data

However, successful data-based decision-making is only possible in case of veracity, i.e. if, as explained in the introductory definition of Big Data, information is correct. Apart from that, stable, well-defined and well-executed business processes are key to ensuring data quality.

Shortcomings in data quality can have substantial effects, since management decisions are based on that data. Inaccurate product specifications can increase production costs by millions (Redman 2013, p. 86). This is accompanied by damages to a company's reputation. At the same time, a manager loses trust in the reported information and might revert to relying on his own intuition.

Redman (2013) proposes three solution possibilities for this problem:

1. Create a connection between data producers and data users.
2. Do not try to correct existing data, but instead ensure the quality of new data.
3. Delegate the responsibility for data quality to the executives in the company divisions.

Despite all of the potentials of Big Data use for controlling, many CFOs still display considerable reluctance in practice. This is illustrated in the example of *Robert Bosch GmbH*.

Insights into current practice

The finance department at *Robert Bosch GmbH* and Big Data:

Interview: Big Data use in Robert Bosch GmbH's finance department

The answers to our questions were given by ***Dr. Stefan Asenkerschbaumer***, assistant CEO of *Robert Bosch GmbH* and responsible for the finance department:

1. ***In your opinion, what is the impact of Big Data on corporate management?***

From social media monitoring or the gathering of field data, we can gain insights into our customers' behavior. We are able to draw conclusions about the usage and quality of Bosch products. Thereby, forecasts about trends, future developments and customers' desires and expectations become possible. Such forecasts are the foundation for creating new business models. Hence, Big Data contributes to the strategic design of a business with regard to future customers and markets. In that sense, Big Data can provide significant impulses for corporate management.

2. ***How do you currently use Big Data opportunities in Bosch's finance department today?***

Instead of analyzing unstructured data, Bosch relies on the analysis of structured data. There is no usage of Big Data in the area of finance.

3. ***How does Bosch intend to utilize Big Data in the financial field in the future?***

The department of finance thinks that traditional methods provide sufficient management instruments. However, we could imagine using a broader scope of analysis with regard to risks and plausibility checks.

The current quality of forecasts based on unstructured data has to be regarded as uncertain, which makes a change of paradigm more difficult.

4.2 Big Data functions in controlling

A controller should encourage and support the integration of Big Data into corporate management

The functions of controlling in terms of Big Data can be systematized using the "coordination-oriented approach of controlling". This approach focuses on the constitution and coordination of different areas of leadership, especially in regard to information, planning, controlling, organization, human resources and value systems. These leadership areas are where Big Data needs to find its entry into corporate management. Controlling should provide support by starting this process and providing it with structure and consistency.

Big Data has a direct effect on **information systems**. In particular, the use of Big Data supports the consideration of non-monetary information alongside monetary information in corporate management. While the increasing importance of non-monetary influence has been an ongoing development for a some time, it is accelerated by Big Data. Non-monetary information has become far more complex and more heterogeneous with regard to origin and type. Here, a controller faces two major tasks. On the one hand, an analysis is needed with which new information can potentially be generated for better understanding a business. Further assessment is required as to if and how such information could be connected to the existing data. On the other hand, controlling has to work out what information is relevant for management, and has to provide this information to the managers. Here, a controller's disposition of displaying a certain degree of skepticism towards the promises of new solutions is helpful. As with other fields, new Big Data solutions with doubtful practical relevance, which are offered by the IT industry, should be approached critically.

Potential applications of Big Data need to be analyzed for the **planning and controlling system** as well. Issues such as forecasting, scenarios and early warning systems come to mind first. However, the scope of possible topics is broader. For instance, one could make use of data regarding image development for impairment tests or utilize new developments in the area of social media (i.e. shitstorms) for risk considerations. Again, the task requires considerable creativity and an open mind towards new possibilities.

A key question within an **organizational system** concerns controllers themselves: Are they truly the right people to establish Big Data – as described – in corporate leadership, or are contemporary IT requirements so specific that a controller's know-how is insufficient? The task of establishing Big Data could also be handed to the IT department. However, IT departments have tried to become established as business partners with limited success for a long time. Another option would be the creation of a new organizational unit ("data analysts") within a line of business. However, data analysts might possibly lack a global perspective.

Implementing Big Data within **human resources** leads to the question if and how incentives need to be designed for achieving more transparency regarding Big Data activities across company divisions, and how the use of Big Data could be promoted. Financial incentives for Big Data projects are one option, as are premiums for a successful diffusion of new solutions to other parts of the corporation.

Finally, the question emerges whether the implementation of Big Data also influences a company's fundamental values and norms (**value system**), and whether it needs to be anchored within corporate culture. This question arises not only as a consequence of the structure of partial leadership systems, instead, it has gained further visibility of late, most recently due to the NSA affair. Privacy intrusions are no longer an issue that is limited to intelligence services. Businesses also need to answer questions about ethics and legitimacy, and guarantee that information is handled responsibly.

The role of a controller in the Big Data framework depends on their self-perception

The role of controllers within this scope of tasks also depends on their self-perception. Controllers primarily regard themselves as "lords of the numbers" and who put emphasis on the creation of economic transparency, will perceive Big Data as an opportunity to grow into the role of business analysts (chapter 4.4) as well as to extend their information reporting duties beyond the scope of traditional finance systems. As previously discussed, their responsibilities are interconnected with those of IT and business line staff. Therefore, controllers need to prove that their experiences with traditional finance systems in the field of Big Data can contribute to the overall goal. It would make little sense to claim sole responsibility for Big Data.

A controller who regards himself as a navigator will mainly use Big Data for controlling purposes. Therefore, he will primarily focus on potentials for better planning and controlling at different levels of corporate management. This leads to the danger that Big Data's potential not sufficiently recognized and not adequately used. Responding to this danger requires taking a business partner's perspective. For a business partner, having an overview over all mentioned leadership systems is the norm. For example, organizational projects and incentive management have been the responsibility of controlling for a long time. Having a bird's eye perspective, and thus, an overview over all areas of leadership is immensely beneficial for adequately implementing Big Data. This is not a completely new task for a controller in the role of a business partner either: Implementing “green controlling”, for instance, required a comparable broad and comprehensive approach.

Business partners are used to fulfilling several roles at the same time. The innovator and architect are equally in demand as the critical counterpart and – if necessary – the brakeman. Acting as a business partner requires a broad spectrum of skills and knowledge, not only regarding traditionally finance-related topics, but also, and in particular, regarding business models and the business itself. Such controllers are still rare – yet, they are desperately needed for Big Data.

Insights into current practice

complexium
UNTERNEHMENSBERATUNG

Social media and #neulandkarte – from social Big Data towards social business controlling

The spread of public digital communication can nowadays be perceived as a major change in the business environment. Many potential customers, relevant talents, critical activists and other agents gather information about businesses online or write their own online contributions.

Thereby, large amounts of data with Big Data characteristics have been created. The volume is large and the data is unstructured, complex and updated on an ongoing basis. The credibility in online forums such as these is usually high. Moreover, such data provides valuable insights for businesses if it analyzed correctly.

In practice, many divisions use this new type of data source: often at first by a reduction of complexity. The variety of formats is often reduced to Facebook, which although popular, lacks high-content type discussions. The analysis is usually constrained to simple metrics, such as the number of “likes” or contributions. It is evident that often data selection is determined by the ease of measurability, and not by potential utility or analytical depth. That could be compared to simply counting invoices instead of considering their amounts.

This is illustrated by the instance of large amounts of unstructured text contributions made accessible through (computer linguistic) data analysis, and could, for example, be undertaken with the objective of rating one’s brand position, adjusting one’s communication strategy more accurately, filtering weak signals out of noise or finding potential entry points for one’s engagement.

Figure 13 shows a relevant semantic net of topics. The underlying algorithms recognize terms that occur more often than usual – i.e. are semantically significant – and draw a connection within an often common context. In this example, data sources are various online forums, in which business students discuss occupational choices.

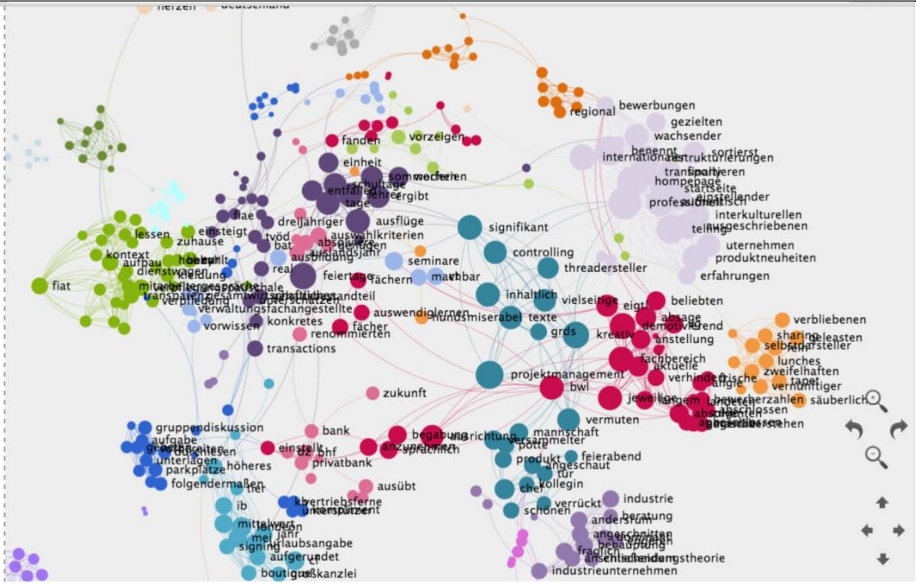

Figure 13: Semantic mapping distributed online discussion (Tool: complexium galaxy)

Colors represent different content clusters. This recruiting target group's questions, topics and assessments that are posted online become discernible almost in real time. Without presuming any preliminary hypotheses, this data analysis also provides results on the data source's "unknown unknowns". This could provide feedback on one's own position and advice regarding one's communication strategy.

By clicking on a "bubble", the underlying contributions are listed. For instance, findings for the significant – yet unsurprising – term "controlling" are listed below (see Figure 14).

Left context	Search term	Right context	Link
At the end of the year, nobody gets hired anyways. First, the annual financial statement needs to be closed,	controlling	Is mainly busy with invoicing etc. Only when all of this is completed, new job offers are made	Re: What I am doing wrong? No job.
need to be developed. Excel is a real core prerequisite for a controller, but knowledge on data bases is equally important. To be honest,	controlling	is not the most intellectually challenging field – only plus, minus, multiplication and division. Yet, controllers are	Re: Controlling - A job with a future?
I'm interested in knowing – if possible from people who've been there themselves – about exit options in	controlling	beyond the typical options (accounting,	Re: 3 years Big 4. Exit and in future nothing to do with controlling and accounting
which of these skills you guys master. I'd define mastering a skill as having been involved at all stages, starting with developing the concept, implementation and being involved in	controlling	. I'd say that depending on a company's size	Re: starting salary Junior Online Marketing Manager Berlin
Well, I don't work in	controlling	but	Re: Controlling - A job with a future?
That's an interesting topic. It's kind of evident that in	controlling	only a few employees can make it to the top and develop new structures or advise general management	Re: Controlling - A job with a future?
Hey, I'd like to know your opinion on controllers' opportunities in the future. Before, I thought that	controlling	was a rather demanding job. But now that I've read a bit more on the topic	Controlling - A job with a future?
Hey everybody, I've been working at a Big4 for 3 years but want to change jobs. I really don't want to do anything with accounting or	controlling	anymore. What do you consider the best approach? Going back to college? Consulting with a different focus? I think	3 years Big 4. Exit and in future nothing to do with controlling and accounting

Figure 14: Concordance analysis of an identified term (Tool: complexium.galaxy).

Prospective young graduates gather information about functions and companies in these online forums. For a company striving to recruit controllers, *social engagement* promises a broad coverage of the target group.

Thus, social Big Data can not only lead to valuable insights, but can also suggest direct involvement in that area. A joint and integrated assessment of corresponding KPIs (e.g. brand significance, engagement speed), as well as the respective cost data stemming from an ERP system, are the responsibility of the emerging field of social business controlling.

4.3 Big Data's potential in controlling

This section develops questions for the controlling department's main processes that arise in light of Big Data. These questions will be discussed along the lines of the core processes strategic planning (Table 3), operative planning and budgeting (Table 4), and business consulting and leadership (Table 5).

This collection of questions does not conclusively define the core functions with which a controller can and must manage Big Data. Instead, potential opportunities for Big Data usage in controlling are pointed out.

Big Data in key controlling processes: Strategic planning

Strategic planning, as the first core process in controlling, focuses upon "providing assistance to management in order to ensure and increase a business' long term profitability" (International Group of Controlling 2011, p. 23). It defines the organizational frame for core decisions and sets goals and measures.

Table 3 shows the collection of Analysis 3.0 questions for Big Data and strategic planning.

Table 3: Big Data in controlling processes – strategic planning

Controlling functions	Analytical questions	Big Data support

Strategic Analyses
• Markets
• Products
• Portfolio
• Competition
• Innovation
• Technology
• Core competencies
• Resources
	Can the assumptions of strategic planning be confirmed?
	Is there cause to change assumptions?
	Are there signals for change?
		Increase transparency in dynamics and the complexity of demand and procurement markets.
		• Long-term forecasts
		  • Segmentation and classification of demand segments
		  • Sales forecasts
		• Social media analysis
		  • Automatic observation of pre-defined topics
		  • Recognize customer needs, trends and sentiments
		  • Price comparisons
		  • Recommendations
		  • Experiences, critique
		  • Online sales

Vision, mission, values and strategic goals need to be reviewed and potentially adjusted.	Are there any consequences that can be derived from the strategic analysis?	Verify changed assumptions by adjusting analysis plans.
Review and adjust business model. Derive and update strategic line of impact.	What expectations exist regarding the business model's development?	Collect information to validate expected business development.
Definition of concrete strategic goals and measures to reach goals, as well as core metrics for valuation.	How does consistency occur? Can the key performance indicator catalog be expanded through Big Data?	Verify, if necessary, prepare readability of measured values. Define new key data.

Evaluate strategy financially – multi-year finance plan.	Do the analyses hint at financial impacts of changes?	Extend information basis of strategy evaluation.
Adjust, introduce and pass strategy with relevant stakeholders.	Can underlying assumptions be confirmed by direct communication?	Potential adjustment of Big Data applications.
Communicate strategy to various management levels	Does Big Data analysis support the understanding of strategic directions?	Adopt suggestions regarding other fields of observation, transparently present assumptions on operational level of planning.
Monitor strategy execution.	Are quick adjustments to changing signals made possible?	Prepare strategic objectives including modified or new Big Data.

Big Data in key controlling processes: Operative planning

Operative planning and budgeting's aim is to support an active and systemic analysis of goals, measures and budgets that were defined by strategic planning. It is supposed to provide an orientation framework for activities and decisions in the short and medium term (*see International Group of Controlling* 2011, p. 25). "It is about the definition of goals and measures, the assignment of resources and about financial quantifications for a company as a whole as well as for its subunits." Questions arising in the context of operative planning and budgeting are displayed in Table 4.

Table 4: Big Data in controlling processes – operative planning and budgeting

Controlling functions	Analytical questions	Big Data support
Agree upon and communicate top down goals and planning assumptions.	Does strategic planning ensure the operationalization of goals?	Ensure suitability of Big Data applications for operational control.
Single and overall budget plan creation.	Can the updating process of planning assumptions and the results of planning be improved through Big Data?	Capacity planning for new warehouse locations. Evaluation of storage strategies. Sales and turnover plan per store and product, preparation of additional offers. Preparation of feedback flow. Planning of supplier and supply mix. Planning of marketing events. Resource planning – preparation of the transition to a more flexible system.

Summarize and consolidate single plans.	Is there a structured process to analyze the possibility of target conflicts and overlaps, and possible solutions thereof?	Simulations. Preparation of updated and adjusted forecast systems.
Control results of planning and adjust if necessary.	Are last minute changes and plan iterations possible?	Realization of integrated planning calculations for rolling forecast.
Present and adopt planning.	Is there a distinction between “ongoing business” and development measures?	Combining flexible ongoing business planning with project budgeting.

Big Data in key controlling processes: Business consulting and leadership

Lastly, the core controlling process of business consulting and leadership is to be assessed in light of Big Data (Table 5).

The main objective of this process is the “inter-divisional coordination and coherence of decisions within the management process” by a controller (*International Group of Controlling* 2011, p. 45).

Controlling supports the management level with adequate instruments and relevant information as a foundation for decisions. As an “economic conscience”, a controller evaluates consequences of potential decision alternatives and creates transparency with respect to strategy, results, company finances and processes (cf. *ibid*.).

Table 5: Big Data in controlling processes – business consulting and leadership

Controlling functions	Analytical questions	Big Data support
Technical preparation of controllers.	Already acquired know-how about Big Data and business intelligence? Is continuous individual knowledge development systematically and consequently pursued?	Acquisition of knowledge concerning applications, types of analysis, mobile solutions, databases & technology, cloud solutions. Enabling a 360° perspective for observing all relevant relations (stakeholders) within a company. Knowledge acquisition regarding adequate valuation techniques.
Accompany and guide decision processes.	Is a facilitator’s role recognizable in developing information systems, including Big Data analytics and in accordance with a company’s strategic approach?	Integration of traditional transaction processes with Big Data applications/ analysis in real-time. Ensuring the collected data’s relevance

Actively initiate and accompany cost and result management measures	Were there changes to the business model? Were Big Data analyses requirements already created in the past or are they theoretically given?	Exploration of possibly attractive business segments. Development of Big Data analysis. Ensuring data quality. Results-based verification of assumptions.
Initiate and assist process analytics and process optimization	Has the relevance of online sales and procuration, automatic production, inventory and logistics management been assessed? Pathway to real-time process controlling?	Controller implement a controller's process responsibility within organizational structure Install correlation model with clear collection of input, output, outcome and outflow for a step by step evaluation of process results.
Work in projects (organization, restructuring etc.)	Do controllers have the capacity for projects and know-how in organizational development? Are Big Data application requirements ensured on a project level or set as a project goal? Are project-specific Big Data analyses already available or possible?	Big Data analytics' project goals and/or project work should be within the scope of a controller's responsibility. Ensure integration and interaction regarding a company's information system. Establishing strategic relevance, security and quality of data material.
Active fostering of business know-how.	Do controllers possess the necessary knowledge and didactical skills for knowledge dissemination? Does the choice of selected Big Data knowledge areas conform to the overall strategy? Are technologically dependent data collection and analysis processes determined?	Development of concepts for Big Data application within a business model and for business transactions. Preparation of change and transformation processes. Development of guidelines for plausibility checks of results. Set rules for working with analysis results, including a definition of corresponding decision processes.

Insights into current practice

Perspectives for integrated financial management

Big Data analytics and social business, mobile and cloud computing: Current IT developments accelerate the transformation of finance and performance management in companies. Integrated web portal solutions that use these new technologies and combine them to intuitive user interfaces are the future. This way, reporting, planning and corporate management can take place in much closer intervals and with more in-depth detail. Moreover, collaborations between different company departments and units are strengthened, work processes are personalized intelligently and mobile access from anywhere is possible.

Regardless of whether the balance of accounts occurs monthly, quarterly or annually – finance employees' stress levels rise whenever current performance indicators are needed in a corporation. The creation of reports and files is time-consuming, since the new data usually has to be updated manually from various sources, restructured, evaluated and prepared. Useful collaborative workplaces are often lacking, as are current performance indicators. These poor conditions often complicate the management of a business based on the latest indicators of financial and operative resources. Moreover, the instruments for a potentially immediate reaction to surprising internal or external developments are missing, as well as transparent and credible communication with various stakeholders.

The cutting edge for transformation

On these grounds, integrated web portal solutions are part of the future. In connection with technologies – that were also deemed critical to success by the market researcher Gartner – they provide the foundation for an up-to-date, precise and comprehensive finance management on the basis of the newest developments and insights. Important key elements of such web portal concepts are Big Data and analysis tools, applications for mobile access, as well as collaboration techniques with social media and social business components.

In the future, it will be convenient to use hybrid or company-internal cloud solutions as infrastructure, in which specific applications are hosted. They create the necessary requirements for maximum flexibility, with regard to both the composition of the correct application portfolio, for quick updates and adjustments, and for the selection and management of alternative access options. In addition, they are able to provide equally quick answers, even during peak times.

Cloud-driven web portal solutions are the best solution for intelligent, efficient and effective financial management. The special strength of web portals that work with new technologies lies in their quick and intelligent analysis of structured and unstructured data, alongside their easy integration and high flexibility, their personalization and open communication, as well as mobile data access. Portals are a great way to dissolve inflexible structures, since they can still be found in various businesses. They lead to more transparency and become the cutting edge for transformation in performance management. They offer quick access to key indicators at any time and provide information on operating workflows. IBM web-portal solutions also offer personalized task and check lists for structuring repeated and individual tasks. They list priorities, give step-by-step instructions and alert the user prior to time sensitive tasks. In addition, there are commentary and communication functions as well as interfaces that enable secure and mobile access to the applications.

Another advantage: Through this collaboration and the common perspective and evaluation of data analysis, action requirements and necessary participants are recognized quickly. On the basis of the existing information, a new scenario can be built, i.e. financial and operative consequences of decisions can be simulated ad hoc. On that basis, an informed and synchronized decision is possible without losing any time.

There are further advantages: The plausibility of these "what-if" scenarios can be increased even further with predictive and content analytics. The analysis of trends and forecasts, as well as an understanding of the situation among customers and other market participants, rounds off the decision process and serves as indicators for potential action needs.

The journey is the reward

Not everything in businesses can be implemented from one day to the next; silos cannot be opened within a brief time span either. Therefore, for the construction of such web portals, the following saying applies: The journey is the reward. That way, it is possible and sometimes even sensible to only gradually convert existing applications into a cloud-based web portal. Oftentimes a reliable and analyzable depiction of a company's current state, encompassing all business units, is an initial and partial goal. This lays the foundation for integrated planning and forecasting, which can be complemented by components such as trend and text analyses. Moreover, mobile access does not necessarily have to be the immediate standard. The same applies to the usage of social media and social business components. A step-by-step integration of these functions goes well beyond integrated data management and should also be able to flexibly cover future needs.

An example of this path to Big Data integration is given below. The charitable incorporation *AGAPLESION* displays an extraordinarily consistent approach when it comes to Big Data integration.

AGAPLESION: Integration at the highest level

This company, with around 19,000 employees, is a charitable incorporation and, with its participating Christian and social enterprises, forms a group of 100 hospitals, housing and care institutions, as well as company training centers. *AGAPLESION* was looking for an integrated solution for the planning and allocation of performance, costs and investments of its institutions, while taking account of the health insurances' particular planning demands.

The group had to deal with typical problems: The individual companies used different ERP systems, while the affiliated companies' planning was conducted in *MS Excel*. Some *AGAPLESION* companies, mainly the dependable service institutions, did not have any business planning tools at all. Integrating and consolidating a substantial amount of tables was extremely time-consuming and prone to mistakes. The planning process for the following year kept several employees busy - with several breaks in-between - for more than four months per year.

The complexity of this process, its great time intensity and inflexibility led the company to implement an "as integrated as possible solution" for the overall planning process. This solution was supposed to cover the performance planning (revenues costs, investments and maintenance). The heterogeneous data needed to be harmonized into a consistent format with consistent dimensions. Modern software solutions provided those functionalities nowadays without much effort. This constituted an enormous and decisive advantage for *AGAPLESION*´s performance management: Thereby, data and figures for all potential reports and analyses can be reported to all executives and managerial staff at any time.

Today, *AGAPLESION's* planning process lasts approximately one month instead of the previous four months. Thanks to the new group-wide performance management solution that includes planning, reporting and analysis, "scorecarding" and consolidation, current and historic data of all affiliated companies is accessible in a common data base. In addition to the huge gain of time in the planning process, the manual effort, which caused the most stress for employees, was decreased enormously: The previously necessary detection of errors, as well as the corrections and consolidations of various Excel tables have become obsolete. Apart from that, the increasing demands from the health insurance companies in terms of hospital and care home performance management and reporting can now be fulfilled without any issues.

Big Data characteristics

In order to optimize performance, cost and investment planning of the charitable institutions, *AGAPLESION* required an integration of heterogeneous data into consistent formats. This was complicated by the fact that *AGAPLESION* was spread over 100 hospitals, housing and care institutions, and training centers with varying data requirements and different software solutions.

Controller's lead

- Critical counterpart for setting consistent data standards, accounting for different data requirements and ensuring high data quality.
- Critical counterpart for the development and implementation of performance management solutions.
- Business partner and key player for the optimization of performance, cost and investment planning processes.

Lessons learned

- By collecting data in a comprehensive performance management solution, all employees have access to relevant information at any time.
- Data requests are now much more flexible, less time-intensive and data quality could be improved significantly.

By saving three months' time in performance, cost and investment planning, employees can now use the gained efficiency to handle other tasks and assignments.

4.4 Data Scientist and Business Analyst - competitors for controllers?

Big Data has requirements that go beyond a controller's prior job responsibilities. These requirements currently pertain to the job profiles of business analysts and data scientists. It remains unclear whether these profiles refer to new functions for controllers or if two completely new and distinct role profiles are created. The integration of the two functions within a company's organizational structure is yet undecided.

Business analyst & data scientist: Who are they and what are their skills?

Most companies have just begun using Big Data. Unsurprisingly, many issues are still in a developmental stage. Before examining the interaction between controller and business analyst or data scientist more closely, both job profiles/roles need to be described. Thereby, their functions within a business and the needed skills and competencies are outlined.

The **business analyst** is the central project manager for implementing Big Data solutions in business processes (e.g. IT applications, services, guidelines or the development of existing business processes (Schmidt 2013)).

A business analyst contributes to the conception of Big Data solutions and is responsible for deducing requirements from strategy, corporate goals and other corporate guidelines (e.g. legal or political circumstances).

A business analyst plans the exact proceedings for the development of a Big Data application. This comprises the specification of participating stakeholders, assigning responsibilities, selecting appropriate methods and approaches and evaluating the project's progress. Throughout the project's lifespan, the business analyst maintains the information flow regarding achieved results during single project steps.

The responsibilities of an analyst also include evaluating and validating results. This means, e.g. business case, cost-benefit analyses and different IT system assessments. Furthermore, key performance indicators for measuring successes and measures to handle implementation problems need to be developed.

Additionally, a business analyst acts as a negotiator between relevant stakeholders (customers, managers, employees, experts and others). Thereby, communicative misunderstandings between relevant agents in various internal and external functions, who often possess heterogeneous knowledge, are prevented.

In order to fulfill these functions, the business analyst needs a deep understanding of the structures, principles and processes in their own company and industry sector. Moreover, knowledge of Big Data's technological opportunities and of their use in possible business processes is needed. Furthermore, an analyst needs certain foundational abilities such as analytical thinking, problem-solving skills, and teamwork and communication skills.

The job profile of **data scientists** has arisen due to the increased importance of Big Data. While a business analyst is responsible for ensuring the accessibility of Big Data solutions for every stakeholder in a company, a data scientist's function is at the interface with IT experts (*Davenport* 2014).

A data scientist is responsible for the technological implementation of Big Data applications. This responsibility does not translate into programming tasks. Instead, the technological feasibility of Big Data solutions needs to be assessed, and possible implementation procedures need to be jointly discussed with IT experts. A data scientist should develop ideas on how data and its analysis can help solve existing business problems within the company.

This requires knowledge of common scripting and programming languages and of existing saving, scaling and implementation possibilities of common

Big Data technologies. Also, a data scientist should possess knowledge of a wide range of mathematical and statistical methods used for data analysis. For instance, a data scientist should be able to make decisions about which data analytics process is appropriate for gaining relevant insights from the existing dataset. The specific technological implementation of the application needs to be jointly undertaken with IT experts.

Once tangible results are available, a data scientist's task is to communicate, and if applicable, to visually present these results to stakeholders, who sometimes possess less technological affinity.

As is evident in the previous role descriptions, the job profiles and requirements of business analysts and data scientists overlap. In addition, both roles include functions that were previously fulfilled by a company's controller. As management's business partner, a controller naturally acts as a negotiator between different stakeholders, specifically focusing on profitability. A controller's function is analyzing business processes and interpreting results. Why shouldn't they continue these tasks with the help of Big Data and data analytics?

The controllers need to tackle the subject of Big Data and deepen their skills

The upcoming years will reveal the de facto significance of the business analyst and data scientist role profiles in real business settings. Whether and which of those functions are carried out by a controller also depends on the respective company and on the specific controller's skills. Ultimately, there are controllers in some companies at present, who are responsible for specialized fields such as production or development, while in other companies, all these functions are fulfilled by one general controller. In particular, small and medium-sized businesses will not possess the capability to employ specialized business analysts and data scientists, in particular when beginning to implement Big Data. In such a setting, investing in one's skills to develop the appropriate competencies to handle these tasks is vital for future controllers.

A controller should strive to remain the “single source of truth”, also with respect to Big Data-driven advancements of business processes.

5 Analytical methodologies and information technology

Analytical methods, IT technologies and visualization possibilities interact for the use of Big Data

You need awareness of the data sources and analytical methods that are at a controller's disposal, as well as knowledge of how to visualize the analysis results in order to use Big Data in controlling. A profound knowledge of IT technologies and their underlying concepts is also essential. Therefore, analytical methods, visualization possibilities and IT technologies are outlined below.

The following orientation framework (see Figure 15) differentiates between the analysis ('Analytics') and storage ('Management') of Big Data.

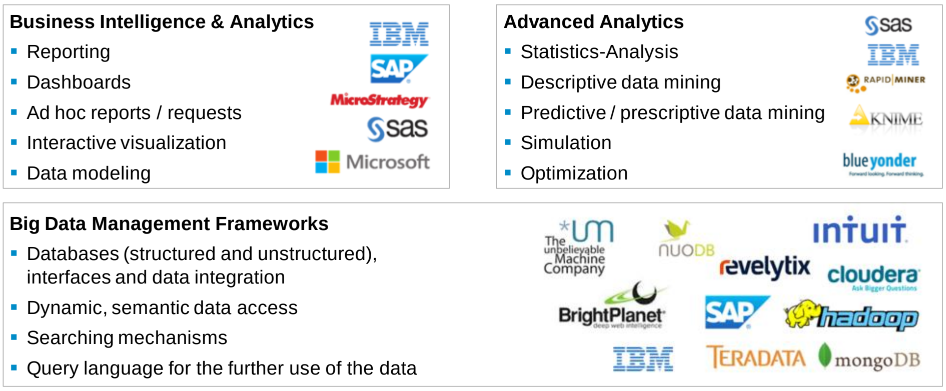

Figure 15: Technology categories, contents and exemplary provider.

5.1 Big Data Analytics

Big Data utilization is enabled by analyses which, in the simplest case, are conducted using traditional **Business Intelligence & Analytics** tools. Currently employed software tools can connect to large data pools, ensuring the data's transparency through reports, dashboards and free OLAP analyses. New products focusing on visualization – including geodata – are increasingly found in this product category. Usage of such technologies requires a clear specification of information needs as well as the transformation from semi-structured or unstructured data into a coherent structure.

Advanced analytics: Setting one's eyes on the future

Products called '**Advanced Analytics'** are being established on the market more and more. These complex analyses products complement a retrospective view with predictive analyses and simulations. Methodological foundations are derived from multivariate statistics and can be differentiated into structure uncovering and structure examining methods. Structure uncovering methods encompass cluster, factor and correspondence analyses, which can for example be employed for the analysis and optimization of product portfolios or for market segmentations. Structure examining methods, such as neural networks or variance analyses are used for auditing and fraud detection purposes. Visualization also has a particular importance for multivariate analyses, for example by making use of scatterplot matrices or network diagrams.

Multivariate analysis tools, referred to as data mining, have been discussed and made available on the market since the 1990s. Although these technologies were limited to absolute statistics experts in the past, current Big Data developments have brought forth a multitude of technology suppliers and products. With a more user-friendly handling, these new developments have made such complex methods accessible to a wider group of data analysts.

5.2 Big Data Management Frameworks – databases

Big Data Management: Data Warehouses, Data Marts, In-Memory-Computing and NoSQL-databases

The broad and fast availability of data in an accessible format is an important prerequisite for analyses. In addition to traditional data warehouses and data marts, which are usually based on relational databases, some technological changes, which occurred in recent years, have exerted a significant impact on the manageable amount and variety of data contained in databases.

In-memory computing, in which the required data is no longer saved on hard drives, but in much faster - but also significantly more expensive - central memory (RAM), is among these technological megatrends. Further trends are conceptual, for example the move from structured data storage in row-oriented and normalized data models towards column-oriented data storage, which significantly enhances the evaluation of individual performance indicators in terms of speed. The *SAP HANA* database can be highlighted as a prominent example. In the following, its usage for a specific case is outlined. Other approaches dispense the need for predetermined and structured data models, and offer new possibilities by directly generating an integrated view of heterogeneous data in a highly efficient manner at the time of a query. Examples of so-called *Not Only SQL* databases are *Google's BigTable*, *Apache Cassandra* and *MongoDB*.

5.3 Using Big Data

To give a specific example for an application, *HANA* - *SAP's* in-memory database, is outlined in the following. For the most current application scenarios, its potentials are mainly attributable to speed gain. Hence, utilization and benefits of using HANA are, to some degree, controversially discussed (see *Kurzlechner* 2014). For a controller, using SAP HANA can bring about substantial improvements in efficiency regarding operational management processes. Moreover, strategic information for management can be obtained in real time (see the following examples).

The selection and employment of Big Data technologies needs to be thoroughly taken into consideration

The following questions need to be thoroughly taken into consideration when selecting and employing Big Data technology:

- What are the most recent developments?
- How can they be integrated into the existing IT landscape and architecture?
- Which is the most fitting IT infrastructure alternative that fulfills the respective hardware requirements? In-house ('on premise') or in the cloud ('on demand')?
- What are the results of a cost-benefit analysis?

The last question in particular is crucial for a controller. In this area, increasing demands are placed on the role of controller. He needs to be capable of evaluating and assessing the substantial investments in Big Data.

Insights into current practice

Increasing the processing speed in controlling

Challenges:

The corporation in this example is a leading international chemicals group with its core business in the development and production of plastics, intermediates and specialty chemicals. Due to the product range, the corporation is heavily dependent on primary commodities, which are subject to severe pricing volatility (the share of crude oil in the products is partially at 80 percent). A corporation is required to provide largely reliable short and medium-term financial plans (balance sheet and P&L statements) that take the daily fluctuating purchase prices for commodities into consideration.

The preparation of these financial plans is complicated by the two-stage bill of material (BoM) or parts list, consisting of semi-finished and finished goods.

Value drivers and requirements:

Boosting flexibility and agility is essential for an immediate response to changes in the external market environment (e.g. rise in market price of input goods). Thus, the following corrective and countermeasures can only be implemented when price data on raw material is available in real-time:

- Adjustments to balance and P&L planning
- Adjustments to the production range

With the help of simulation capabilities or scenarios, market price fluctuations and their impact on financial key figures can be understood at an early stage:

- Simulation of P&L calculations as a whole based on variable commodity prices taking variable receptors and locations into account
- Evaluating the impact of rising or falling distribution prices on revenue

Due to the variety of products (> 60.000), different production sites (> 100), the fact that some products are manufactured in several plants (factor 3) and the requirement to plan on a monthly basis, the data volume to be processed amounts to > 216 million datasets.

Big Data/*HANA* enabler:

Due to the fact that a huge amount of data can be processed and analyzed without delay, it is possible to work with different scenarios and trend analyses, and to visualize these on different levels. Hence, the impact of commodity price fluctuations can be displayed on the product and group level. In addition, any number of scenarios (regardless of the number and depth of details) and its effects can be analyzed without causing performance problems.

Thanks to the elimination of temporal breaks between data acquisition and evaluation/analysis, the group is able to respond directly and, for instance, adjust its production range. Risks can be identified early on, and appropriate corrective measures can be initiated in a timely manner. Moreover, planning certainty is ensured with due regard to all contingencies, which would not be possible without *HANA*.

Insights into current practice

Predictive maintenance

Challenge:

The corporation in this example supplies products, services and complete systems for manufacturing and operating processes using compressed air as an energy source. For future competitiveness and the development of new business purposes, the corporation has expanded its portfolio to comprehensive services (delivery and operation of machines).

Predictive maintenance as an essential component requires processing huge volumes of data in a short time (up to 1.6 million sensor data per second) in order to:

- reduce unplanned downtime of machines for customers,
- predict malfunctions,
- provide findings (error messages, etc.) from operations as feedback to development and research to contribute to product quality,
- optimize the use and supply of resources and spare parts.

Value drivers and requirements:

With the help of the latest data provided in real-time, it is possible to plan and coordinate the demand-oriented use of resources and spare parts/components. In this manner, for instance, machines at the customer's location send requirements for maintenance directly to the machine operations center without delay in order to coordinate the needed service team members and order spare parts.

Furthermore, the development team benefits from data transfers by being able to consider this data when it comes to improving product quality and minimizing errors in product development.

The data volume to be processed is immense: All of the customer's approximate 10,000 machines are centrally connected to the machine operations center. Each machine sends 160 sensor data per second (summing to 1,600,000 sensor data per second).

This data must be available anywhere at all times in order to centrally control the appropriate processes (e.g., ordering service technicians) and to give the on-site staff the necessary information at hand.

Big Data/*HANA* enabler:

Thanks to *HANA*, time-consuming batch data load processes can be eliminated and required information can be made available instantly. Additionally, there are no temporal breaks between data acquisition and evaluation/analysis, meaning that reports are instantly available. Immediate reactions are vital in order to keep machine downtime and associated costs for the customer as low as possible and to build competitive advantages. Without *HANA*, processing huge volumes of data would be impossible.

A variety of programs and applications (e.g. customer-specific product data from CRM) have to be connected and data within such programs has to be made available.

A business model such as this can only be realized with the Big Data capabilities provided by the *HANA* solution.

Insights into current practice

Preparing detailed reports and forecasts in real-time

Challenge:

Many corporations face the same challenges regarding the preparation of financial reports and forecasts:

- Portraying actual cash flows and conducting liquidation plans is complicated by delays between incoming bookings and receipt of payments,
- Accurate forecasts of revenues and margins based on up-to-date numbers in order to identify business areas falling short of business targets,
- Identifying growth rates and results dependent on the regions, corporate divisions or suppliers early on.

The forecasting process is greatly delayed when having to deal with seasonal business or when depending on major geopolitical factors. This process could take up to many months and, due to its complexity, is conducted only once a year.

Value drivers and requirements

This includes the use of simulation capabilities to take account of the seasonal trends and historical data that help predict incoming bookings and payments receipts in order to be able to better control the cash flow. Furthermore, trends regarding, for instance, profit centers (i.e. business units) and supplier levels can be identified and the appropriate actions can be initiated in time.

As a result of having the ability to display any number of scenarios/trends with individual detail levels, substantial improvements to the quality and precision of forecasts have been made. In addition, the building process was considerably accelerated since there were no temporal breaks. Hence, forecasts can be prepared on a more frequent basis.

Big Data/*HANA* enabler:

Thanks to automated data extraction and the *HANA* in-memory technology, which accesses the central memory instead of the hard disk, the duration of preparing forecasts is significantly reduced. Thereby, the two to three-month forecast processing timeframe is reduced to three days, which makes monthly (rather than yearly) monitoring possible.

With the help of real-time data processing, cash-flow analyses and liquidity plans are portrayed accurately. All cash-relevant events and transactions from adjacent systems are considered and incorporated into liquidity assessments. Thus, future cash-out and cash-in positions, requests for proposal from the purchasing department and contracts from the sales department, are directly registered and taken into account. Beyond that, this allows insights into each position (drill-down) and keeps one informed about the most important events in real-time.

6 Proposals and recommendations

6.1 Some theses on the usage of Big Data in the task field of controlling

With Big Data, new challenges as well as new opportunities arise for a controller's daily work. The following guidelines and recommendations have been developed to help a controller tackle the topic of 'Big Data'.

1. Preparing a controller for Big Data

Recommendation 1

Acting as a primary advisor for corporate management, a controller faces challenges relating to the increasing digitalization of corporate reality. In order to adequately meet these challenges, a controller needs to have in-depth knowledge and understanding of 'Big Data'.

Therefore, the controller needs to determine whether his field of work is ready for Big Data in order to promote the development of controlling. The following approaches should help with this task:

Data management

- Is there a consensus regarding which data is relevant to effectively inform decision-makers in specific problem settings?
- Do we have access to a variety of structured and unstructured real-time data, which reflects the main influential factors of a particular issue?
- Do controllers without particular IT skills have cost-effective access to internal and external data?
- Are there clear definitions and standards for collecting, processing, storing and analyzing data that are accepted by everyone?
- Is it high quality data and is it recognized as credible by decision-makers in all corporate functions?
- Are there corporate-wide data security standards? Are the data and data structures adequately secured against unauthorized internal and external access?

Technology

- Which technologies are available at the company?
- Can the existing technologies meet the new requirements pertaining to Big Data?
- Do current technologies meet the requirements of specific applications to be undertaken using Big Data?
- Which new Big Data applications are necessary? Which applications are not yet available?
- Can these applications be developed within the company, or do they have to be outsourced?
- What is the cost-benefit ratio outsourcing and developing new technologies?

When procuring or developing novel technologies, the interoperability of the application must always be kept in mind. Pilot projects should be followed by further projects, which should be easily integrated into the existing infrastructure.

Recommendation 2

2. Accepting the emerging responsibilities of data scientists and business analysts

Parallels to controlling exist, as is evident when describing the skills and assignments of business analysts and data scientists. However, controllers must also fulfill tasks that go beyond the common skills and abilities of a controller. Controllers are prompted to analyze the newly-emerging areas of responsibility of business analysts and data scientists. They need to decide which tasks they are able to fulfill themselves, and which tasks exceed their resources and skills. Perhaps additional expert assistance is required.

- Where do the daily routines between controllers, business analysts and data scientists intersect?
- Which of the business analysts' and data scientists' tasks and skills can be taken over and fulfilled by the controller? Which tasks require special expertise that a controller may not possess?
- Is the controller able to acquire new skills to take over all required tasks, or is the support of an expert required?

Recommendation 3

3. Promoting the identification of pilot use cases

A controller has to ensure that companies are not following an IT-driven, holistic approach when introducing Big Data applications. Such an approach usually requires high initial investments and ties up significant resources. Instead, the use of Big Data should be introduced through case-oriented pilot projects for specific applications. This should lead to a clear added value and justify the efforts required; otherwise there is a risk that Big Data may be considered the IT department's playground and not find acceptance within the company.

A controller should actively support the departments responsible in identifying potential use cases. Possible questions assisting this process may be:

- Which decisions are primarily intuitive due to the lack of a satisfactory data basis? Which decisions can be significantly improved with the support of a more comprehensive data basis?
- Which operational functions generate data that can be used to improve our processes?
- What data is required to improve existing products and services? What data is required for innovations in the research and development of new products and services? Do we consider all internal and external sources of information in this search?
- What data would be required to significantly set our products and services apart from competitors?
- Do we currently use all available data for the assessment of risks in terms of likelihood and possible extent of damage?
- Are we collecting and processing data about our customers' user behavior and satisfaction and making it available to all corporate functions?

4. Building a Big Data innovation process

Recommendation 4

Successful pilot projects for the use of Big Data should be communicated as examples and best practices within a business, and their adaption should be strived for. For this, a Big Data innovation process that includes four main steps is required: piloting, measuring, communicating and adapting.

- Piloting: The willingness to undertake new Big Data-driven projects should be fostered. Thus, space for appropriate ideas and solutions should be created, for instance, in the form of an internal ideas competition.
- Measuring: The cost-benefit ratio should always be kept in mind when experimenting. KPIs should be defined within a pilot project. This promotes the acceptance of such projects amongst a company's decision makers.
- Communicating: The execution and the results of a Big Data project should be communicated in order to create acceptance for the project within the company, and to make the innovation process accessible to other departments within the company.
- Adapting: The adaption of successful pilot projects to other company departments should be considered and discussed. In addition, external projects and their incorporation should also be evaluated.

6.2 Big Data roadmap

In the following, a roadmap for the integration of Big Data into controlling is outlined (based on an internal paper by Horváth & Partners). This roadmap aims to improve controlling processes through Big Data. Since controlling is situated at the interface between controllers and managers, the structure of this roadmap is highly influenced by the fundamental impact that Big Data has on the corporate world.

In our opinion, Big Data will cause profound changes in the upcoming years, and the importance of Big Data will increase for all sorts of businesses. The procedure could development as follows:

- **2014**: Pioneers develop the first concepts for the use of Big Data and implement them in their companies. CIOs, in particular, are willing to develop instruments for the use of Big Data and to provide them to their entire company.
- **2015**: IT technologies and new analytical methods that improve the informational basis for decisions are implemented in many companies.
- **2016-2017**: The steady progress of digitalization in companies leads to comprehensive changes in operational processes.
- **2018**: Companies that are able to optimally integrate Big Data into their processes will have substantial competitive advantages as compared to their competitors.

Controlling 2018: Facing the future with Big Data

Building upon the described developments and the preceding analysis in this report, we outline a target scenario for **controlling in 2018**. In principle, this could encompass the following aspects:

- **Predictive instead of retrospective**: The informational basis for strategic and operational decisions increasingly consists of statistical forecasts, thereby complementing traditional retrospective reporting.
- **Management uses KPIs**: Retrospective product and customer-based results calculation has lost importance in controlling. KPI information has the advantage of being more up-to-date as compared to EBIT and cash flow.
- **Decisions are made quickly**: The available time period for decisions is significantly reduced. This is necessary since competition has become much more reactive. Fast decision making is enabled by the increased validity of Big Data-based forecasts.
- **Efficient models applied**: Usually, all agents on the market have access to the relevant information. Companies that are able to implement highly efficient models for operative data analysis have significant competitive advantages, obtaining profound insights into causal correlations within their company.
- **EBIT and cash are managed in an integrated way**: Due to increased volatility, it is necessary to manage potential measures of improvement in all company functions and levels by using the analysis of EBIT and cash flow effects.
- **Controlling cycle during the year**: The conventional year-to-year perspective of companies has lost its importance. Decisions are evaluated, made and executed throughout the year. Planning and profitability analysis systems, including forecasts, reporting and incentive systems, have adapted to this new cycle.

What does a roadmap illustrating the development of controlling until 2018 look like? In Figure 16, six action areas for a CFO are depicted.

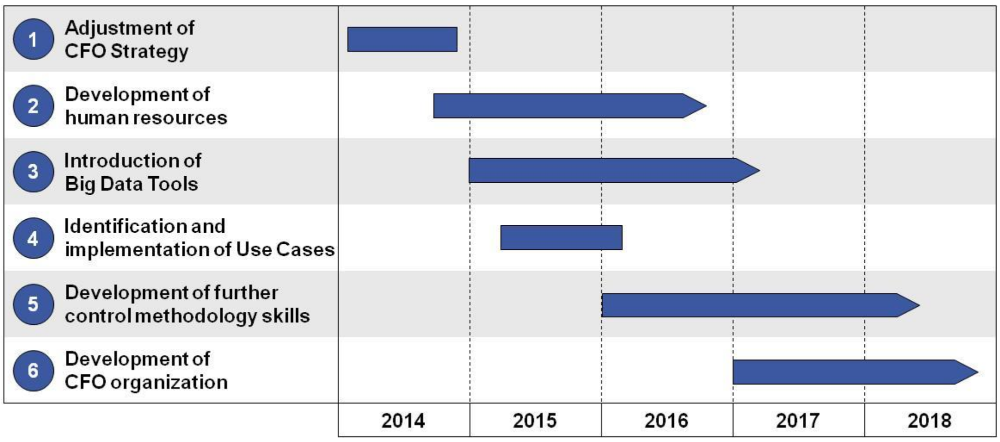

Figure 16: Big Data roadmap.

Six action areas on the way to the vision of "controlling 2018"

1. **Adjustment of CFO strategy**: The introduction of new or modified processes is facilitated by clear, comprehensive corporate governance structures. New opportunities due to data diversity and statistical methods require appropriate governance in order to use Big Data for the benefit of corporate management. The CFO department's sovereignty regarding data structures, forecasting methodologies and risk management, as well as all earnings and cash flow-related decision-making processes, needs to be accepted throughout the entire company.
2. **Development of human resources**: Statistical methods and forecasting models need to be added to the employees' set of knowledge and skills. Above all, controllers should be trained in the newly-created control methods and be made aware of faster decision cycles.
3. **Introduction of Big Data tools**: A value-generating application of Big Data necessitates the appropriate IT systems and IT tools. These tools should be selected and introduced the company based on the areas that need to be analyzed. In addition, the staff needs to be trained in handling Big Data tools.
4. **Identification and implementation of use cases**: The use of Big Data both in controlling as well as throughout the company cannot be imposed top down. Concrete use cases, which clearly highlight the benefit of Big Data, must be identified. Afterwards, their adaption into the company needs to be promoted. Thereby, acceptance for the use of Big Data among employees can be gained.
5. **Development of further control methodology skills**: The use of predictive analytics needs to be integrated in the company control framework. Value driver models need to be developed, thus creating transparency regarding the interdependencies of operational KPIs with each other, as well as between KPIs and EBIT or cash flow. Big Data can provide the controller with the long-sought opportunity of using all data available within the company and its environment. For this purpose, existing data silos in the departments need to be disposed of, while promoting the integration of internal and external data sources.
6. **Development of CFO organization**: Within the CFO organization, both a division for in-house methods and a service section, providing automated solutions for recurring tasks of other departments, should be established.

Recommended reading

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Glossary

Advanced analytics	Advanced analytics are an extension of Business Intelligence and aim, in particular, to forecast future developments.
Cloud computing	The cloud computing model allows the rapid access of a shared pool of configurable computer resources (e.g. networks, servers, data storage units, applications and services) at any time. These resources are provided with minimal management effort or with little interaction between service provider and user.
Consumer insights	The term consumer insights has its origin in marketing and describes the combination of conclusions pertaining to the true motives of consumers (needs, desires, wishes and fears, amongst others) with regard to certain products and brands.
Cyber-physical system	Cyber-physical systems (CPS) are systems with embedded software, which are equipped with sensors and so-called actors, to analyze and store collected data. Furthermore, CPSs are interconnected with communication entities and global networks, make use of worldwide accessible data and services, and provide interfaces between humans and machines.
Data mining	Data mining refers to the systematic use of methods and algorithms to identify patterns, correlations and regularities in a dataset as automatically as possible.
In-memory computing	In-memory computing refers to data management systems that store information in a computer's central random access memory (RAM). Thereby, the speed of data access is increased in comparison to traditional data management systems, which store information on hard drives.
Kanban principle	In production planning and management, the Kanban principle describes a decentralized management process in which used materials are restocked according to the "pull-principle". The provision of material using the Kanban principle only depends on the wastage of material in the production process. Kanban cards (in Japanese: Kanban = card) constitute the basic element of this management system and serve to transmit information.
Location-based services	Location-based services (LBS) are services that, based on the analysis of current geographic data, provide the users of mobile devices with selective information and other valuable services.
Logfiles	Logfiles are files in which a server records all accesses to registered systems (e.g. homepages). With the help of logfiles, it is possible to draw conclusions about the use of websites, for instance regarding access time or contents.
Machine to machine	Machine to machine (M2M) describes the automated exchange of information (communication) between any end devices, such as machines, computers, vehicles or containers, or with a central planning entity, by using networks like the internet or a mobile network.
Mobile apps	Mobile apps are software applications for mobile devices and operating systems such as smartphones, tablets, eReaders or iPods.
NoSQL databases	NoSQL databases (Not Only SQL) denote non-relational databases that focus on allocated and horizontal scalability. Due to their allocated architecture, NoSQL databases can deal with high demands and frequent changes to data, thereby alleviating the pre-

dominant problem of relational databases.

QR code
QR codes (Quick Response) are two-dimensional codes that include a variety of information and can be read by scanners.

QR codes were developed in the automotive logistics industry in order to mark or label vehicle parts. Nowadays, the codes are also used for marketing purposes on physical objects, such as posters, to provide additional information that can be accessed by using QR code applications on mobile devices.

SAP HANA
SAP HANA is a database technology offered by SAP AG, which combines hardware and software (appliance) and is based on in-memory computing.

Shitstorm
A shitstorm is an internet phenomenon in which, within a short time, a large number of critical and negative comments about a company, a product, a service or a person are published in social networks (e.g. Facebook, Twitter). Such criticism usually ranges from subjective and non-objective to threatening, aggressive or abusive.

Software-as-a-Service
The concept of Software-as-a-Service (SaaS) is based on the concept of cloud computing. Its follows the principle that software and IT infrastructure, which are offered by an external IT service provider, can be accessed by customers via the internet. The customer saves acquisition and operating costs of an in-house IT infrastructure and pays the service provider a usage-dependent fee for administration, maintenance and updates.

Terabyte, petabyte, axabyte, zettabyte, yottabyte
The abovementioned terminologies are used as a unit of measurement for data storage. The units are listed in increasing order, starting with a gigabyte.

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