STUDY REPORT

DIGITIZATION IN PLANNING, BUDGETING AND FORECASTING

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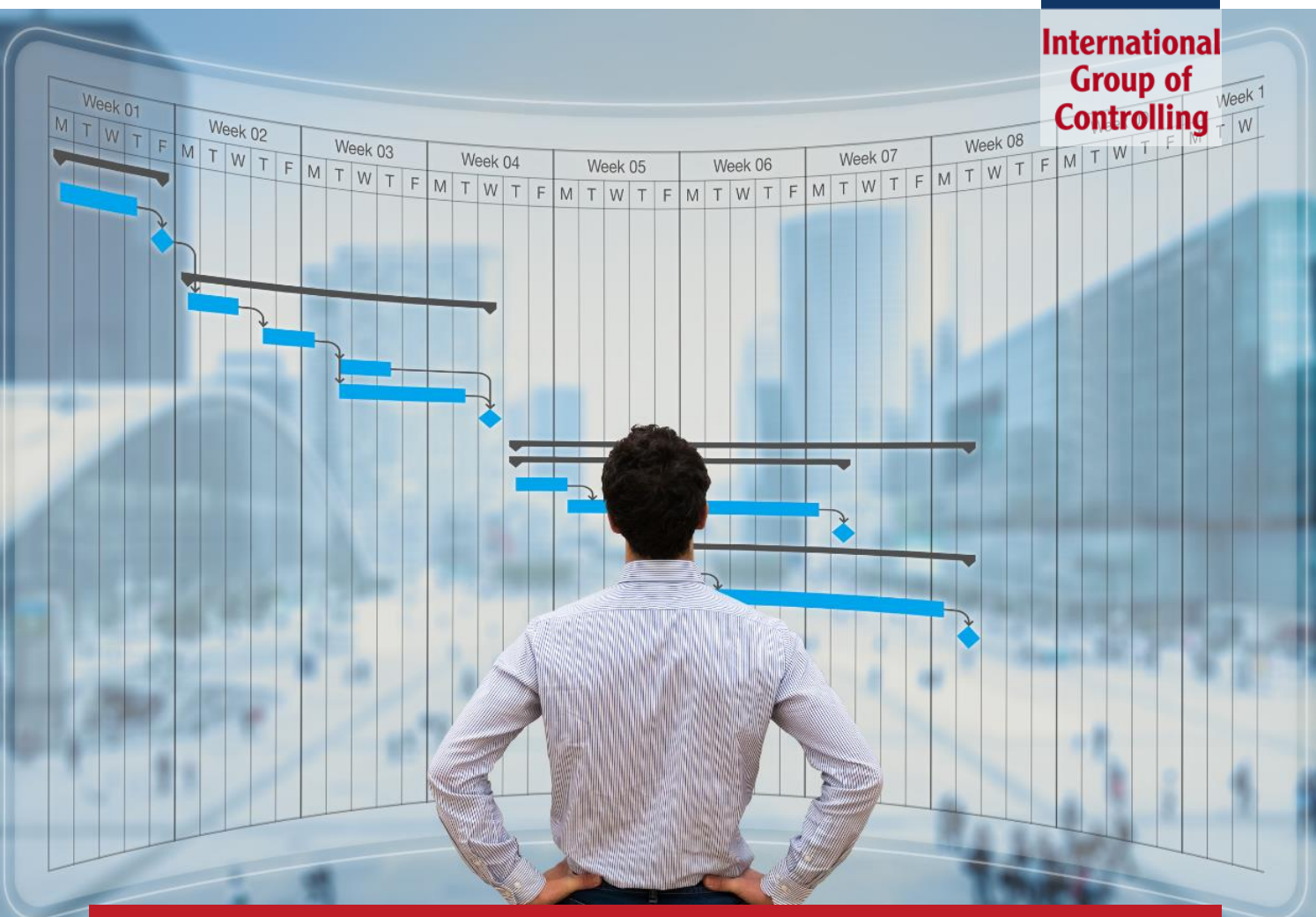
International Group of Controlling

MANAGEMENT SUMMARY

This study sets out to explore the application of digital instruments and digitalized processes in corporate planning, budgeting and forecasting. Digital instruments encompass statistical methods, business analytics and the like while digitalized processes are either fully automated and done by a software or bots perform previous manual tasks with robotic process automation. Planning, budgeting and forecasting are especially suitable for this discussion because they involve many sets of information and consume many resources in firms.

In the area of operational planning and budgeting, the following technologies for digitization are primarily mentioned in the literature: Big Data, Predictive Analytics, Business Analytics. In addition, the possibility of using artificial intelligence (AI for short) is discussed, especially in forecasting.

Use cases in practice range from the introduction of specific tools for digitization to the implementation of a company-wide integrated planning, budgeting and forecasting solution with AI and analytics components, which can be used for simulation purposes, for example.

Companies pursue a variety of goals with the introduction of technologies in planning, budgeting and forecasting. Besides reducing variances and improving the quality of planning and forecasting, there is also a push to increase automation and the associated reduction in costs.

It is apparent that the current state of digitization in planning, budgeting and forecasting is low and the adoption of technologies is still limited. Only a small proportion of the companies surveyed reported that they already had experience with the technologies mentioned above. This holds except for the use of driver models and scenario planning which are more widespread.

Proven methods are primarily used for planning and budgeting (traditional planning, classic budgeting). However, rolling planning and, in some cases, better budgeting are gaining in relevance.

The study hints to several roadblocks for digitization. The main obstacles are the lack of knowledge and insufficient capacities. Problems of acceptance and an insufficient information base are also a challenge. The case for introducing digital technologies is also hard to make, especially in regard to financial outcomes.

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1 INTRODUCTION

Digitization in planning, budgeting and forecasting has become increasingly relevant in recent years. Previous studies have already shown the enormous potential offered by digitization in this main process of the IGC Controlling Process Model 2.0. However, the consistent use of digitization in this area is not yet to be found in practice. Often, only first steps towards digitization can be identified. In order to increase digitization in planning, budgeting and forecasting in the future, it is relevant to understand technologies and create awareness of possible barriers. In addition to looking at the potentials and implementation status of the subprocesses of planning, budgeting and forecasting, the desired benefits of digitization and the existing competencies in controlling are presented in this study. Special attention is paid to the roadblocks in order to understand and overcome them in management digital change. The results of this study document the potential of digitization, provide support for increasing digitization in planning, budgeting and forecasting and creating long term potential for success.

2 STUDY BACKGROUND

2.1 STUDY OBJECTIVES

The study at hand focuses on digitization in planning, budgeting and forecasting. Based on the processes of the IGC Controlling Process Model 2.0, the status quo and potentials of digitization are examined. This is done through a systematic literature analysis (SLA) and an empirical survey with a standardized questionnaire, as well as expert interviews.

The following research questions are examined:

1. Are the processes of the IGC Controlling Process Model 2.0 reflected in practice?

2. What is the level of implementation of digital technologies in Controlling in general?

3. What advantages and potential for success do companies hope to gain from digital technologies in planning, budgeting and forecasting?

4. What are the roadblocks in firms that hinder using digital technologies in planning, budgeting and forecasting?

5. What skills are required for the digital transformation in planning, budgeting and forecasting?

2.2 METHODOLOGY

The study combines three approaches: Systematic literature analysis (SLA), questionnaires and expert interviews. All three approaches are then triangulated to form the final study.

Systematic literature analysis (SLA)

The systematic literature analysis (SLA) is conducted by a structured filtering process to identify relevant literature. Initially, all literature in EBSCO-, ECONBIZ- and JSTOR-databases containing specific search terms were listed. Subsequently, this list is filtered in a multi-stage-process in order to sort out duplicate or irrelevant literature. Finally, the systematic literature analysis results in the relevant literature which is included into this study.

The following table shows a summary of the filtering process (table 1).

Primary Keyword 1	+	Primary Keyword 2	Sum of all literature in EBSCO-, ECONBIZ- and JSTOR-databases	Potentially relevant literature	Relevant literature
digit*; IT*; technol*		plan*	277; 1768; 1268	63	7
digit*; IT*; technol*		budget*	19; 424; 107		
digit*; IT*; technol*		forecast*	21; 392; 385	33	1
digit*; IT*; technol*		Prognose*	2; 3; 1		

Table 1. Process of strategic literature analysis (SLA)

Questionnaires

In order to light up the topicality and trends of digitization in planning, budgeting and forecasting, we conducted an empirical survey on current issues in this context between August and September 2021. The high interest of corporate practice in this topic can be seen in the response of 381 usable online questionnaires, although not all respondents completed the questionnaire completely. The questionnaire contained 33 questions, which were divided into eight sections. First, information about the company and the respondents were requested. Then, the embedding of the controlling function in the company organization was asked. Following that, the focus was placed on the controlling processes in planning, budgeting and forecasting in order to query their digitization potential, implementation status and reference projects in the subsequent steps. The next step examines the competencies. The last section asked for information on the success of controlling.

Among the companies surveyed, 43% report sales of less than 100 million Euro. 44% are active in the manufacturing sector and 25% in the service sector. Also, 95% of the questionnaires were completed by employees at various hierarchical levels in the finance department.

Expert interviews

Besides that, we complemented the survey with in-depth expert interviews. A total of four experts were recruited and all interviews were transcribed. At the end, more than 40 pages of transcribed interviews were jointly analysed in an iterative process. The statements are

integrated into the study through concrete application examples and personal quotes. The following experts were interviewed as part of the study:

- Mr. Alpha, Partner at a consulting firm

- Mr. Beta, Senior Manager Controlling with a large industrial enterprise

- Mr. Gamma, Director Group Controlling at a large industrial corporation

- Mr. Delta, Partner at a consulting firm

2.3 CONTROLLING PROCESS MODEL 2.0

The Controlling Process Model 2.0 (figure 1) was developed in 2017 by the International Group of Controlling (IGC) based on the Controlling Process Model 1.0 (2011). The following changes in version 2.0 were made:

- Combining planning, budgeting and forecasting

- Separation of project controlling and investment controlling

- New subprocess Data Management

- Function Controlling as second dimension

- Management control process now includes all subprocesses
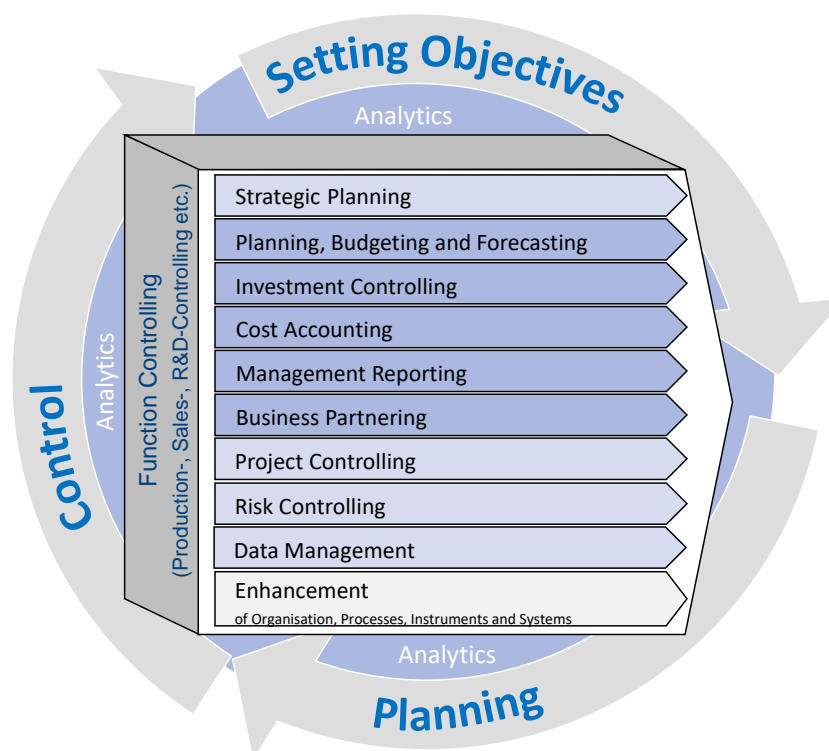
Figure 1. Controlling Process Model 2.0 (based on International Group of Controlling 2017, p. 20)

The Controlling Process Model is based on the IGC Controlling Definition and the IGC Controller Mission Statement. It is also based on the quality standards of the IGC and ICV for controlling (DIN SPEC 1086).

This study focuses on the main process "Planning, Budgeting and Forecasting". This includes planning, controlling, coordination, forecasting and exploration functions. Planning and budgeting should promote the systematic discussion of goals,

measures and budgets within the organization. This supports management in achieving the short- and medium-term goals derived from the strategic objectives. It also includes the profit- and liquidity-oriented management of the business units. Forecasting is intended to provide early information on deviations from the plan so that measures can be taken. In addition to the consideration of financial and non-financial information, this also includes, for example, simulation and scenario considerations.

The main process "Planning, Budgeting and Forecasting" comprises the following subprocesses:

- Set-up of the process

- Establish and communicate planning premises and top-down goals

- Create, summarize and consolidate individual plans and budgets

- Review results of planning, adjust plans as needed and adopt plan

- Create/update forecast, compare with last forecast/plan/budget and analyse variances

- Develop countermeasures

(International Group of Controlling 2017, p. 29 ff.)

3 RESULTS OF THE LITERATURE ANALYSIS

3.1 DIGITIZATION IN OPERATIVE PLANNING AND BUDGETING

Systematic literature analysis "Planning and Budgeting"

The systematic literature analysis regarding operative planning and budgeting, which was conducted by searching the EBSCO, ECONBIZ and JSTOR databases, resulted in a total of 3,863 hits. An initial screening of the literature found, led to the identification of 63 potentially relevant titles. To further narrow down the search and eliminate any non-relevant literature left, the titles were examined in detail by reading the abstract and, where necessary, by inspecting the entire article. The majority of the literature had to be labelled as non-relevant, as it dealt with the planning of the digitalization, strategic planning or was not thematically appropriate in general, as it was discussing e.g. IT planning. In the end, 7 relevant titles were identified and the key findings of each one is summarized in the following.

1. According to Baumöl and Perscheid, Business Analytics tools can enable management accountants to evaluate and interpret large amounts of data. In the authors' article in "Controlling", they further identified four maturity stages of Business Analytics in enterprises. The earliest stage is Descriptive Analytics, followed by Diagnostic Analytics and Realtime Analytics. The latest, most promising stage is Predictive Analytics, which generates forecasts, outperforming traditional methods in that area (Baumöl and Perscheid 2019, pp. 34-38).

2. In 2020, the digitization of budgeting was examined as part of an empirical study. The study is based on responses from 115 German companies with at least 100 employees and a minimum turnover of 30 million euros. It was determined that the use of business analytics in the budgeting process makes sense, as it is often, highly data driven. The use of business analytics can simplify the previously very cumbersome budgeting process. Likewise, the use of business analytics in the budgeting process is very positively associated (Bergmann et al. 2020, pp. 34-49).

3. In a study conducted in 2018, 30 financial management representatives from German companies were interviewed to examine planning in the digital age. In regard to planning challenges posed by the digitalization it was found, that the respondents consider quicker changes, digital business models, the incorporation of external data sources and an effective data management as the main hurdles to overcome. Besides that, the respondents attributed Advanced Analytics and RPA a high disruptive potential in planning and budgeting processes (Dillerup et al. 2019, pp. 46-52).

4. In a study conducted in 2002 among 296 Taiwanese enterprises, the relationship between a firm's strategy, the use of IT applications in planning and control functions and company performance as well as a number of impeding factors was examined. In a first step, the authors proved that a company's strategy has an influence on the use of IT applications. In a second step, the results indicated a strong positive relationship between the use of IT tools for planning and control

functions and performance. Furthermore, it was demonstrated, that IT impediments like inadequate education, staff resistance and poor leadership harm the effectiveness of such IT tools (Duh et al. 2006).

5. Another article in the journal "Controlling" (2018) addressed the influence of digitalization tools on corporate planning. In practice, a shift from traditional and modern planning to digital planning is imminent. By using tools such as cloud planning platforms, companies can perform their planning in a more detailed and automated way. Furthermore, by providing many different scenarios, companies can better weigh their decisions against each other and better adapt to the new circumstances when changes occur (Kappes and Leyk 2018, pp. 4-11).

6. In an article published in "Controlling" in 2020, the impact of digitalization on the budgeting process was evaluated and supported with results of an empirical study. This empirical study consisted of 130 respondents who were surveyed using an online questionnaire at the beginning of 2019. It was found that 74% of respondents see added value in using Big Data in budgeting. Likewise, it showed that 81% agreed with the hypothesis that more accurate planning can be achieved with the use of Advanced Analytics (Koch et al. 2020, pp. 54-60).

7. In an article in the "Controlling & Management Review", the authors have identified the ability to adapt to new, digital business models and value drivers as a key challenge for planning and management accounting. Therefore, they propose a renewal of the used methods: Besides updating existing, lagging KPIs to leading KPIs, an agile controlling and the implementation of tools can make the planning process more flexible (Thaler and Pierer von Esch 2020, pp. 8-15).

Summary of key findings:

Using Business Analytics will allow companies to use larger amounts of data thanks to a high degree of automation and a faster processing.

This is especially beneficial for planning and budgeting as these processes are heavily data driven. According to one of the studies, respondents considered as main challenges: speed of changes, digital business models, the incorporation of external data and an effective data management. Another study found that a company's strategy influences the usage of IT tools. The presented results also indicated a positive correlation between using IT tools for planning and control functions and performance. This reasoning is supported as companies are able to perform a more detailed planning and budgeting process due to higher automation and the possibility to create more scenarios and therefore improving the decision as there are more options to choose from. Also, the increased number of scenarios allows a faster response to circumstantial changes in the company's environment.

Supplement to systematic literature analysis

Books/Journals

1. In the book Management and Controlling by Petzold and Westerkamp published in 2020, the task areas of IT controlling were explained and their impact on corporate processes described. Today, IT controlling covers a much wider range of tasks than it was the case a few years ago. One of the main tasks of IT controlling is operational and strategic planning. The task there is to support management in terms of content, coordination, documentation and communication from all those affected (Amann et al. 2020, pp. 227-236).

2. Digitalization can bring great advantages to the budgeting and planning process.

This is the conclusion reached by authors Binder and Dillerup in their article in "Controller Magazin" from 2021. Modern technologies such as big data, advanced analytics, Industry 4.0, in memory computing and blockchain technologies can make planning more flexible and, above all, increase efficiency and effectiveness. In practice, Big Data technologies are especially in demand as companies use big data to run plausibility analyses (Binder and Dillerup 2021, pp. 73-79).

3. In 2019, Ronald Gleich, Michael Kappes and Jörg Leyk published a book on planning, budgeting, and forecasting, where they discussed, among other things, the impact of digitization on these processes. They found that by using modern tools in the budgeting process, it was possible to increase all four principles of modern budgeting (simplicity, flexibility, integration and participation, and addressee orientation). For example, by implementing modern tools, it was possible to link other business processes more easily with budgeting or to output data in greater detail (Gleich et al. 2019a, pp. 30-32).

4. Modern planning tools are still not widespread in practice, although they can be of great importance to the company for the planning and budgeting process. This problem was addressed in the book "Unternehmensplanung im Zeitalter der Digitalisierung"(2020). Although companies have been aware of technologies such as cloud computing, artificial intelligence, or Big Data for years, they are not really applied comprehensively in practice. This is, for example, due to a lack of capacity in implementation or a lack of knowledge. It is therefore particularly important to integrate the affected departments in the changes (Grund et al. 2020, pp. 11-21).

5. In the fourth issue of "Controller Magazin" from 2011, IT solutions in budgeting were presented in the first part of a two-part report. It was noted that efficient planning is hardly conceivable without the help of IT. A modern example of this is planning with the help of data warehouse technologies, which make it possible to store a large amount of data. This has advantages for large companies, as they then have a much larger volume of data available for planning (Koschitzki et al. 2011, pp. 28-34).

6. A study published in "Controlling" in 2018 examined how the digital transformation is affecting the concept of "modern budgeting" in companies. The study included 109 participants and it showed that most respondents see their budgeting process as at least affected by the digital transformation. Moreover, with 69 points out of 100 points, the respondents also agree with the statement that the use of digital tools can simplify budgeting. (Nasca et al. 2018, pp. 37-45).

7. In an empirical study conducted in "Controlling" in 2015, the importance of big data in controlling was determined. Of the 154 participants, more than a quarter already use big data in controlling. Especially in the areas of operational planning and forecasting, 59% of the respondents see at least a rather large benefit. This is because Big Data can make the lengthy and time-consuming planning process easier for employees. Big Data makes it possible to calculate many different scenarios quickly and provide data in real time. As a result, controlling receives better planning results to further process (Willmes et al. 2015, pp. 256-261).

Summary of key findings:

The task of IT controlling has steadily increased in the last few years. The planning and budgeting process can profit from new technologies as the process can be made more flexible and efficiency and effectiveness can be

increased. Also, the increased usage of IT tools allows an easier integration and interaction with other business processes, benefiting with a higher quality output. One of the references above stresses the fact that modern planning tools are not very widespread in practice, which is due to the lack of capacity for implementation or a lack of knowledge. An offered solution is that all relevant departments should be integrated in the implementation process. Especially larger companies can draw a greater benefit from using modern planning tools as they can take advantage of the fact that they have a larger amount of data available to include in their system. Several studies also have shown that the use of modern planning tools can simplify the planning and budgeting processes as well as help employees with lengthy and time-consuming processes, allowing them to focus on other tasks.

Additionally, real time updates can be provided with ease and Big Data can be used to calculate different scenarios quickly, resulting in an improved planning and budgeting process with better results.

Presentations at congresses

1. As part of the "29th Stuttgarter Controlling-Forum", Prof. Péter Horváth talked about the controlling in the digital age, where he laid an emphasis on the developments within the planning process. For instance, planning in the future will be part of an integrated IT-process, where Big Data will give traditional instruments a new dimension. One result of this development is the possibility to steer with live data in real-time, which will make the planning process more dynamic. The speaker also mentions that for enterprises to profit from the technological advancements, the controller himself is ought to develop from an accounting professional to a data professional (Horvath 2015).

Consultant Studies

1. In September 2018, Deloitte published an article on how modern technologies affect the controller. The activities of planning and budgeting are affected by many technologies. As an example, the use of Robotic Process Automation was mentioned, through which repetitive controlling processes can be easily automated. This leads to a broad data collection, which can be very helpful for planning or budgeting (Deloitte 2018, pp. 1-3).

2. Digital transformation in controlling was discussed in another study by the Lucerne University of Applied Sciences and Arts. In this empirical study from 2016, 223 Swiss companies were surveyed in various ways. The participants indicated that they see potential for improvement in planning, but also in budgeting and forecasting. An improvement in the speed of information processing in this area is seen by 85% of the respondents as at least rather strong. This improvement would probably lead, above all, to companies being able to plan better in order to adapt quicker to environmental changes (Egle and Keimer 2021, pp. 25-26).

3. Deloitte published a study in cooperation with the Lucerne University of Applied Sciences and Arts that looked at the digitalization of Swiss controlling. A total of 210 Swiss controllers were surveyed for the study. It was found that only 32% of the respondents estimate automation in operational planning and budgeting to be between 50-100%. According to their self-assessment, 42% of the respondents had a degree of automation of 25% or less (Keimer et al. 2018, pp. 5-39).

4. In an empirical study conducted in 2015, ACCA together with the auditing firm KPMG assesses the performance management of companies and the provision of its gathered information to the CFO to support the budgeting, planning

and forecasting process. More than 900 professionals in finance from over 50 countries took part in the study. It was found that 41% of the respondents stated that their company has not yet made any further investments in planning tools, outside of Microsoft Excel. This is the case even though these tools can easily capture and process data (O'Mahony and Lyon 2015, pp. 4-17).

5. In 2015, PwC conducted an empirical study on digital transformation in controlling, in which 36 large medium-sized companies participated between October 2014 and December 2014. With 35 questions, the study also looked at operational planning and budgeting, among other things. It is true that the use of IT tools is intended to relieve controllers of the burden of data collection and evaluation in order to have more time for the functional analysis of the data. However, according to the survey results, this has not yet been achieved. With 2.3 points on a scale of one to four, many still do not have enough time for this. It was also noted that optimizing the budgeting process is a key challenge (Rasch and Koß 2015, pp. 9-24).

6. In an empirical study conducted in 2014, the auditing firm KPMG examined the use of big data in controlling. A total of 154 companies from German-speaking countries took part in the study. The study showed that more than half of the participating companies (59%) see a rather large benefit of big data for operational planning and forecasting. 20% are neutral, while the remaining 21% see no benefit from big data for operational planning and forecasting (Willmes and Hess 2014, pp. 7-13).

7. Deloitte conducted a study together with Heilbronn University in which 115 respondents participated who either work in science or in practice. They addressed the fact that current planning processes are very resource intensive. With the latest technologies, Industry 4.0 makes it possible to include a much wider range of data in planning. Technologies such as big data or advanced analytics in particular can be very helpful here but are still used too little in practice (Witzeman and Epstein 2019, pp. 1-2).

Summary of key findings:

RPA can help automate repetitive controlling processes, increase the data collected and support the planning and budgeting process. Respondents of one study see as one of the strongest points for using digital technologies that the speed of information processing will increase and that will allow the company more flexibility and faster reaction to environmental changes. In another study it was found that only 32% estimate their own degree of automation for their planning and budgeting process being between 50 - 100%. 42% of the respondents even estimated it at 25% or less. This result is supported by another study where 41% of the respondents said that their company has not yet made any effort investing in modern tools although they are aware of the possible benefits. Additionally, the evaluated sources also supported the key finding that processes can be simplified, and employees freed for other task as modern tools would take over time-consuming tasks.

Intermediate Conclusion

A total of 21 suitable publications were found in the literature search for the topic of digitization in operational planning and budgeting. Seven of them belong to the category of empirical papers, seven publications to the category of books/journals, and the remaining seven to the category of consultant studies (figure 2). The topic of technologies was found in all three categories and describes potential technologies that can be used for digitization in operational planning and budgeting. Here, the technologies Big Data, Advanced Analytics and Business Analytics were particularly frequent (figure 3).

Empirical papers

Consultant studies

Technologies

Challenges

Opportunities

Current State

Changing role of the Controller
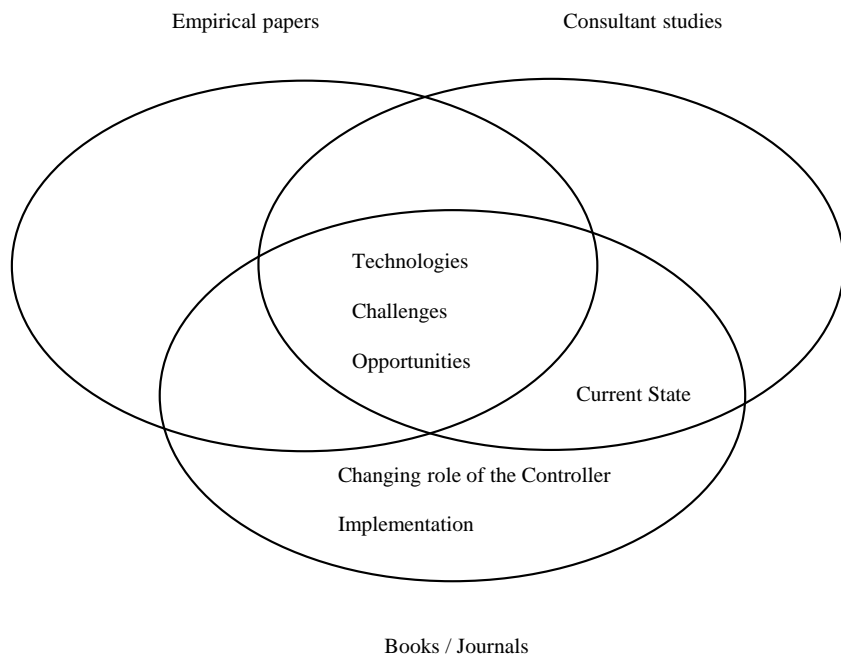
Implementation

Books / Journals

Figure 2. Intermediate conclusion Planning and Budgeting

The possible challenges, but also the opportunities, were also discussed in all three categories. It became clear that companies can optimize the planning and budgeting process through the use of technologies. Possible

challenges arise primarily due to a lack of knowledge or insufficient capacities.

The current application status of technologies in operational planning and budgeting was addressed in the consultant studies and books
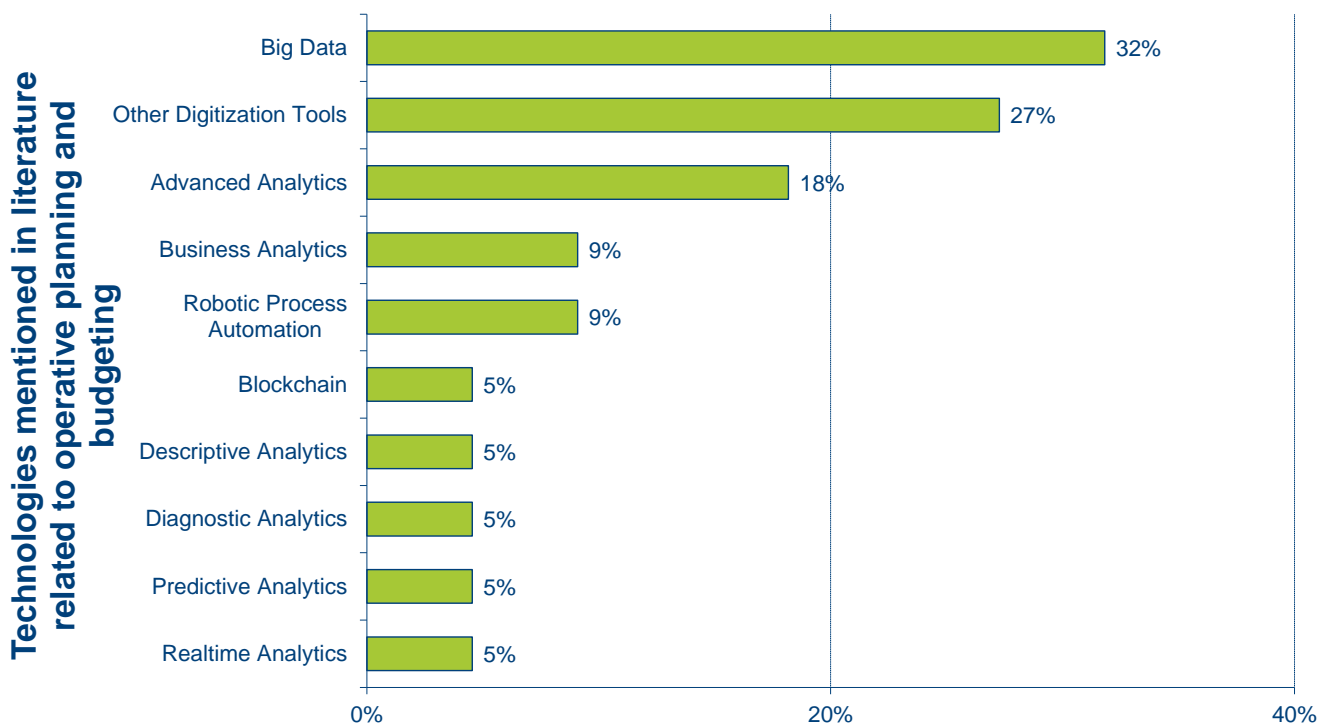

Figure 3. Technologies mentioned in literature related to operative planning and budgeting

/ journals. It was found that despite the great possibilities, the application rate is relatively low.

The changing role of the controller has only been addressed in books and journals. It describes how the controller should act in the future, should technologies be used in companies. Likewise, the implementation of technologies was only addressed in this category.

The following chart (figure 4) shows the frequency of individual technologies mentioned in the literature.

This figure illustrates the individual subject areas once again. They have been supplemented by the category of presentations at congresses. The topics of technologies and opportunities were addressed in all four, which is why the circle in the fifth column is completely filled. The challenges were not mentioned in the presentations, which is why the circle is only three-quarters full. The topics current state and the role of the controller were worked out in two categories, so that half of the circle is filled. The implementation of the technologies was

only discussed in the category books / journals, which is why only a quarter of the circle is filled in.

3.2 DIGITIZATION IN FORECASTING

Systematic literature analysis "Forecasting"

The systematic literature analysis in regard to forecasting, which was conducted by searching the EBSCO, ECONBIZ and JSTOR database, resulted in a total of 804 hits. An initial screening of the literature found, led to the identification of 33 potentially relevant titles. To further narrow down the search and eliminate any non-relevant literature left, the titles were examined in detail by reading the abstract and, where necessary, by inspecting the entire article. The majority of the literature had to be labelled as non-relevant, as it was not thematically appropriate, since it was

	Empirical papers	Books/ Journals	Presentations at congresses	Consultant studies	SUM
Technologies	●	●	●	●	●
Challenges	●	●	○	●	◔
Opportunities	●	●	●	●	●
Current state	○	●	○	●	◐
Role of Controller	○	●	●	○	◐
Implementation	○	●	○	○	◕

Figure 4. The frequency of individual technologies mentioned in the literature

discussing e.g., weather forecasting or the approximate life cycle of a specific technology. In the end, one relevant title was identified, and the key findings are summarized in the following.

1. Smith & Mentzer conducted a study among 216 forecasting professionals in manufacturing or distribution, where they collected responses via an email survey. The aim of the study was to examine the Forecasting Task-Technology Fit. Results indicated that forecasting support systems can increase the perceived quality of forecasts as well as their performance. On this basis, the authors concluded, that the beneficial potentials of accurate forecasts depend on forecast support systems, which in turn depend on the user's assessment of those systems. Thus, highlighting the importance of the user, the available data and the access to appropriate data (Smith and Mentzer 2010).

Supplement to systematic literature analysis

1. The implementation and use of predictive analytics are the subject of an article by Holthoff & Decher from "Controlling" in 2020, in which it was described that predictive analytics is being used more and more frequently in forecasting. This is mainly explained by the higher availability of data, new technologies and more employees. The advantages lie primarily in greater accuracy and forecasting efficiency. However, interviews also revealed that a lack of know-how, but also missing data quantity and quality are seen as challenges for implementation. (Holthoff and Decher 2020, pp. 53-59)

2. In their scientific work from 2011, Lisa de Leon, Patricia D. Rafferty and Richard Herschel address the replacement of the annual budgeting process with the rolling forecast approach and the connection to business intelligence. The problem with the annual budget is that it is set once at the

beginning of the year and therefore cannot be flexible to changes. The concept of rolling forecasting enables the provision of many new forecasts, which consequently provide important information for decision making. Through the additional use of new technologies such as Big Data, it is possible to include and consider a large amount of data in these processes (Leon et al. 2012, pp. 6-12).

Books/Journals

1. The automation of forecasting was discussed by Matthias Emler and Can Tunco in the IDL Dialog. It was noted that the forecasting process in many companies is still based on conventional and rather costly methods, even though increasing efficiency and effectiveness in this area is a fundamental goal of companies. By implementing certain IT levers, companies can automate their forecasting to a large extent and thus expand existing data and make more accurate forecasts, for example in the case of sales forecasts (Emler and Tunco 2017, pp. 10-16).

2. The forecasting process at Infineon Technologies AG was reviewed in an article published in "Controlling" in 2020. The company switched to a driver-based forecasting process so that decisions can now be made more quickly. For driver-based forecasting, software tools are required that have a wider range of functions than the classic spreadsheet. In the concrete case of Infineon AG, the tool "Dynaplan Smia" is used; in addition, the cooperation with "SAP BW" enables the provision of large amounts of data (Federmann et al. 2020, pp. 28-35).

3. The use of artificial intelligence can also boost forecasting, as described in a 2019 issue of "Controlling". According to studies, artificial intelligence can already make far more accurate forecasts than humans as of today. However, such forecasts are

largely based on existing data, which is why integrating human intelligence can also make a lot of sense. This is particularly the case when essential forecasts are calculated, and incalculable changes occur that the AI cannot consider due to a lack of data (Friedl 2019, pp. 35-38).

4. In the digitized forecasting process, the traditional forecasting process is enhanced with the use of Big Data and predictive analytics. As a result, the effort required is significantly reduced, forecasts are made available more quickly, and they are determined on an objective basis, thus disregarding political influencing factors (Gleich et al. 2019a, pp. 49-124).

5. As part of the 2020 publication "The digitalization of the controlling function", the new financial forecast was examined during the automation at SAP SE. It was noted that by using modern technologies, it was possible to make the forecast process significantly more efficient. Through predictive analytics, SAP can forecast annual results more accurately and provide data in real time. However, this digital transformation in the forecasting process will require an increase in competence in controlling and long-term management involvement in the future (Keimer and Egle 2020, pp. 26-38).

6. The transformation of controlling and the associated control processes was covered in the journal "Controlling" in 2016. With the use of Big Data and predictive analytics, companies can obtain data that is more precise than what conventional forecasts can provide. This more accurate data enables companies to consequently take more adequate measures to counter changes more efficiently (Kieninger et al. 2016, pp. 241-247).

7. Christian Langmann examines digitization in controlling in his 2020 publication. While the impact varies across controlling processes, both operational planning and forecasting are among the most affected. The use of Big Data and Predictive Analytics will lead to more accurate and

faster data, as illustrated by a practical example from RapidMiner in Forecast. There, incoming orders in the high double-digit percentage range could be predicted correctly (Langmann 2019, pp. 9-25).

8. The use of big data in forecasting was also discussed in the first issue of the journal "Controlling" in 2021. Due to the large amount of data produced in the context of Industry 4.0, it makes a lot of sense to include this data in forecasting. The large volumes of data generated by Big Data can be processed with predictive analytics so that forecasts can be generated from them. These can then be applied as a basis for decision-making. Likewise, the use of technologies can increase accuracy and reduce discrepancies (Lingnau and Mayer 2021, pp. 37-41).

9. The application fields of business analytics were addressed in an article in the "Controlling" magazine from 2016. With the implementation of business analytics in the application fields of analysis, forecasting, optimization, simulation and radar, major improvements can be achieved. For example, the use of Big Data can generate high volumes of data. With the use of predictive analytics, these large amounts of data can be processed and thus generate information for the forecast. (Mehanna et al. 2016, pp. 502-507).

10. In 2016, an article appeared in the magazine "Controlling" focused on short-term sales forecasting with the help of predictive analytics, using Infineon Technologies AG as an example. It was noted that predictive analytics is becoming increasingly relevant as companies in today's world have to consider a greater number of influencing factors. Using Infineon Technologies AG as a concrete example, the crawl charts were initially evaluated qualitatively with the help of interpretations from the various specialist departments. This was followed by quantitative modelling, which resulted in the company having more precise data for

short-term sales forecasting (Möller et al. 2016, pp. 509-517).

11. In the 2018 book "Planung und Reporting im BI-gestützten Controlling" by Dietmar Schön, among other things, technologies were presented that can be used to support the forecasting process. It was noted that companies will not only focus on Big Data technologies in terms of data evaluation, as this technology tends to evaluate data poorly. Business intelligence technologies will be used much more (Schön 2018, pp. 429-435).

Summary of key findings:

Although increasing the degree of automation in the forecasting process would improve the forecast accuracy due to the inclusion of more data, many companies still base their forecasts on conventional methods. Which is quite contradicting to companies' actual goals as companies have a big interest in being able to create forecasts with the highest possibly accuracy and avoid any kind of unexpected events. This rather slow change is also surprising as several studies have proven that forecasts from AI supported systems are more accurate than those done only by humans. But the best results, especially for essential forecasts, can be reached when AI and human intelligence work together as the AI can only work with data that is provided while the human could bring other scenarios into the equation for which there is no data available. Another positive effect of having a forecast created by AI is that it will be on a very objective basis, plus forecasts can be created faster and in real time changed through adjustment of the input data.

Presentations at congresses

1. During the "Controller Congress 2019" Christoph Knebel, Senior Business Analyst at bofrost talked about digitalized forecasting at bofrost, where a Machine Learning-based algorithm is used to predict future revenue streams. An emphasis laid on the changing role of controllers: besides methodological understanding, controller are partially required, and to some point poised, to become Data Scientists, according to the speaker. This enables the controlling department to pull relevant data, build ML-models, evaluate and interpret the results themselves (Knebel 2019).

2. As part of the "29th Stuttgarter Controlling Forum" Dr. Uwe Michel proposed some theses for the future of digitalized controlling. For one, the speaker claimed that forecasting will evolve from reactive analytics to proactive prognostics, making past-based analysis obsolete and increasing the importance for real-time predictions detached from fixed control cycles and over months condensed data. Furthermore, the speaker sees automatization in forecasting progressing from automizing only data pro-vision and pre-processing to the automatization of the entire forecasting process trough predictive models and algorithms (Michel 2015).

3. Stephanie Noeth-Zahn's presentation within the "34th Stuttgarter Controlling & Management Forum" discussed unlikely events with a significant economical impact ("black swans") and its implications for advanced analytics in forecasting. The so-called black swans are so relevant for forecasting because they tend to send just little signals indicating their arrival, however the impacts on a company or entire economy have the potential to be devastating. Therefore, the speaker presents an approach, where AI is used to pick up small signal to help improve the reliability of forecasts. The speaker further indicates that enterprises need to take more external data sources into account for the forecasting process (Noeth-Zahn 2020).

4. The "Congress der Controller 2015" featured a presentation by Erik Roßmeißl, Commercial Director at Wittenstein AG, about the challenges for forecasting posed

by Industry 4.0. According to Roßmeißl, the digitalization of the industry will have a significant impact on planning and forecasting practices, such that planning will be much more reliant on forecasts, than on traditional planning. Furthermore, proven methods, like the Balanced Scorecard might need to be developed to more dynamic approaches. In this context, the concept of planning and forecasting for business/ financial years will also become obsolete (Roßmeißl 2015).

Summary of key findings:

The role of controllers is changing as controllers are required to develop a basic understanding how the digital technologies work. Therefore, it is necessary for them to take a step in the direction of Data Scientists. Another speaker claims that there will be a change for forecasting from reactive analytics to proactive prognostics, putting more emphasis on real-time predictions and less on past data-driven analysis. Enabling forecasts to be a task that can be done at any time and not following a fixed schedule cycle. According to one speaker AI can help to detect "black swans" (unlikely events with a significant economic impact) as there are usually small indicators/precursors available that announce their arrival, which could be picked up by AI and then be reflected in the forecasts. Additionally, one speaker thinks that in the future planning will be much more reliant on forecasts than on traditional planning and thinks that the current methods-in-use will need to be updated to a more dynamic approach.

Consultant Studies

1. In PwC's paper "Reimagine forecasting" released in 2016 the auditing and consulting firm names three steps which are significant for CFOs to create a value added to their companies. In the first step, PwC states that organizations require to make a more

efficient use of their data sources and gives a model based on five factors to so. In the second step, it is essential to better integrate predictive analyses of leading industry and macro-economic trends combined with micro indicators regarding the behaviour of the customer. In the last step, PwC instructs to bring this changed forecast to practice and to utilize the value, which it provides for the company (Blase and Mannella 2016, p. 1).

2. Another finding from the 2015 study by KPMG and ACCA is that 69% either agree or strongly agree with the thesis that the process of traditional budgeting will change into a rolling forecasting within the next five years. Moreover, 66% believe that highly automated forecasting with only little manual interference will be used by companies in the future (Budnik et al. 2017, pp. 4-18).

3. The study by Deloitte and the Lucerne University of Applied Sciences and Arts regarding digitalization in Swiss controlling, which was mentioned earlier, revealed a further finding. The survey revealed that automation in the forecasting process was even lower than in operational planning and budgeting. Here, 72% of the respondents stated that the automation in their forecasting process was up to 50% (Keimer et al. 2018, p. 39).

4. KPMG published another study on digitization in accounting in 2020. The study is based on an online survey in which 311 people took part. It was then supplemented with 11 expert interviews. One of the questions asked was where companies are using artificial intelligence in accounting. Regarding forecasting, it was found that only 5% of respondents said, they used AI in forecasting. 24% said, it was being trialed while for a majority (52%) it was still not currently an issue (Kreher et al. 2020, pp. 8-24).

5. Capgemini Consulting published a survey in 2015 in which the model "Digital Journey" is developed to support CFOs in assessing their status combined with the progress regarding the digitalization in their

departments. Information from over 100 CFOs or financial principals of European countries have been gathered.

One important finding of this survey is that it is a key challenge for CFOs in the coming years to manage rising volumes of unstructured and structured data to be capable of giving better predictions and forecasts regarding the future and its business trends (Labbé et al. 2015, pp. 2-8).

6. A paper released by A Controlling consulting firm in 2017 shows the methology and use of digitalized forecasts. First it deals with the three main components of a digitalized forecast: data, algorithms and user interface. Next, it gives a procedure model to develop a digitalized forecast and last it shows two different examples of use for digital forecasts. The key finding of this paper is that these ways of using different components in order to create digitalized forecasts outperform the conventional and manual forecasts regarding their quality by far (Lips and Mayer 2017, pp. 3-7).

7. Deloitte addressed the topic of forecasting in a digital world in its 2018 magazine "Crunch time 6", describing how the use of algorithms in forecasting makes more and more accurate data available to companies. Likewise, forecasts can be made more accurately and in real time, and decisions are made on an objective basis. Companies also have many options available to them, so impacts from the market can be factored in more quickly (Merrill et al. 2018, pp. 12-13).

8. In cooperation with Daimler Mobility a paper by BCG has been released in 2019 in which both parties are exchanging views on the idea of forward-looking steering of financial topics. Main findings were that there are multiple ways of how to apply the concept of forward-looking steering although there are five elements, which are essential to it and that dashboards are great for visualizing Forecasts and other analyses. It is also said that statistical Forecasts based on machine learning are at least equal to expert's

judgement in 70% of the cases (Unger and Rodt 2019, pp. 4-9).

9. In 2018, the consulting firm Protiviti published the paper "Seeing the Future more clearly" in which the challenges and opportunities of Financial Forecasting based on Machine Learning are discussed. According to this paper the use of Machine Learning within Financial Forecasting leads to a faster and more accurate development of Forecasts as well as the capability of using far more data to create them. In addition, it enables analysts to work on value-adding tasks instead of mundane assignments (Seasongood et al. 2018, pp. 1-3).

10. The auditing and consulting firm PwC released their "Predictive Excellence Study" together with experts from the Justus-Liebig-Universität in 2020, in which the influence of poor Forecasting is quantified and analysed. 7743 ad-hoc notifications between 2000 and 2018 have been gathered and analysed with the help of artificial intelligence and machine learning resulting in a company value destruction of €228 million, on average, due to a poorly managed financial Forecasting. Furthermore, total net savings of €70-85 million over five years would be generated for an average company listed on the stock market if introducing a forecasting tool driven by data (Werner et al. 2020, pp. 4-12).

Summary of key findings:

An efficient handling of the available data and well-integrated analytics are the foundation for a good forecast, which can create additional value for the company. In one study 69% of the respondent agreed that the process of traditional budgeting will evolve into a rolling forecasting in the next five years. In the same study also 66% of the respondents believe that forecasting will be highly automated.
The current degree of automation for forecasting is even lower than that of operational planning and budgeting. Only 5% of

respondents in a study said, that they are using AI in forecasting, 24% said it was in a trial period and more than 50% said that is currently not an issue at all. Another study identified that one of the biggest challenges will be how companies will handle the increasing amount of data that is available to them in a structured or unstructured way and how they can be used for better forecasts. Similar to the planning and budgeting process, the usage of AI can allow employees to focus on other tasks while mundane assignments will be handled by AI. Another study revealed that a poorly managed financial Forecasting can destroy the value of a company by 228 million euros on average and an average listed company could make a total net savings of 70-85 million euros over five years if they would introduce a forecasting tool driven by data.

Intermediate conclusion

A total of 24 suitable publications were found in the literature search for the topic of digitization in forecasting. Three of them are empirical

papers, eleven publications are books/journals, and the remaining ten are consultant studies (figure 5). The topics of technologies (figure 6), which are/ will be in use, opportunities and challenges of digitalization in forecasting were found in all three categories. To sum up, it can be stated that with technologies like predictive analytics (AI) amounts of data can be analysed to increase the accuracy and robustness of forecasts. Possible challenges arise primarily due to a lack of knowledge or insufficient capacities.

Discussions about future developments and changes of the forecasting induced by an ongoing digitalization were found in empirical papers and consultant studies. A prominent finding was that companies have to move on from annual forecasting periods to a rolling forecast.

The current status of using technologies in forecasting was addressed in consultant studies and books / journals. It was found that despite the great possibilities, the current level of usage is relatively low.

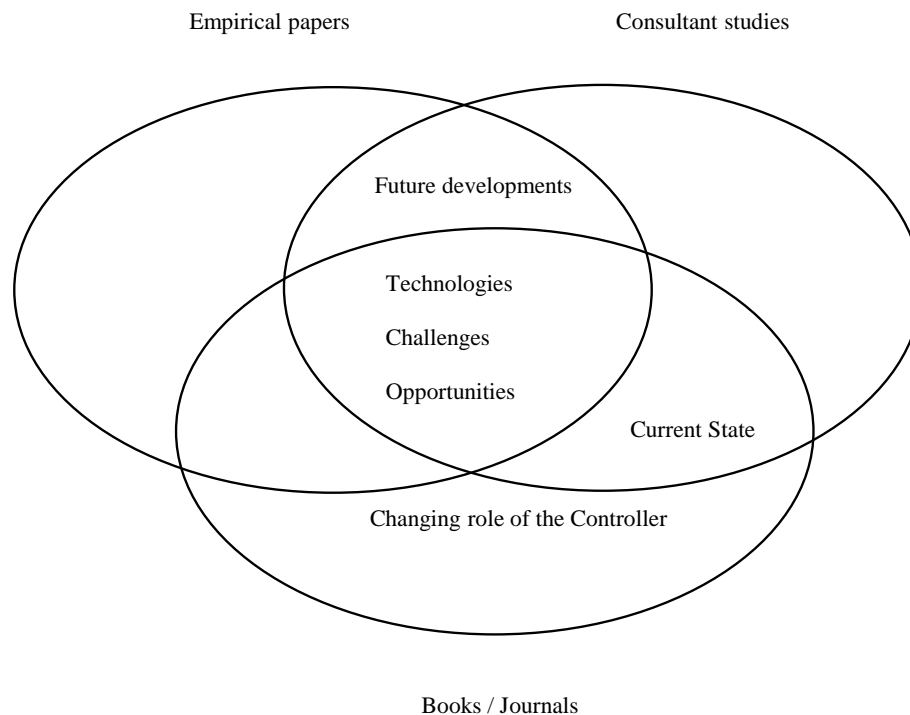The changing role of the controller has only been addressed in books and journals. It was

Empirical papers   Consultant studies

Figure 5. Intermediate conclusion Forecasting

Technologies mentioned in literature related to forecasting

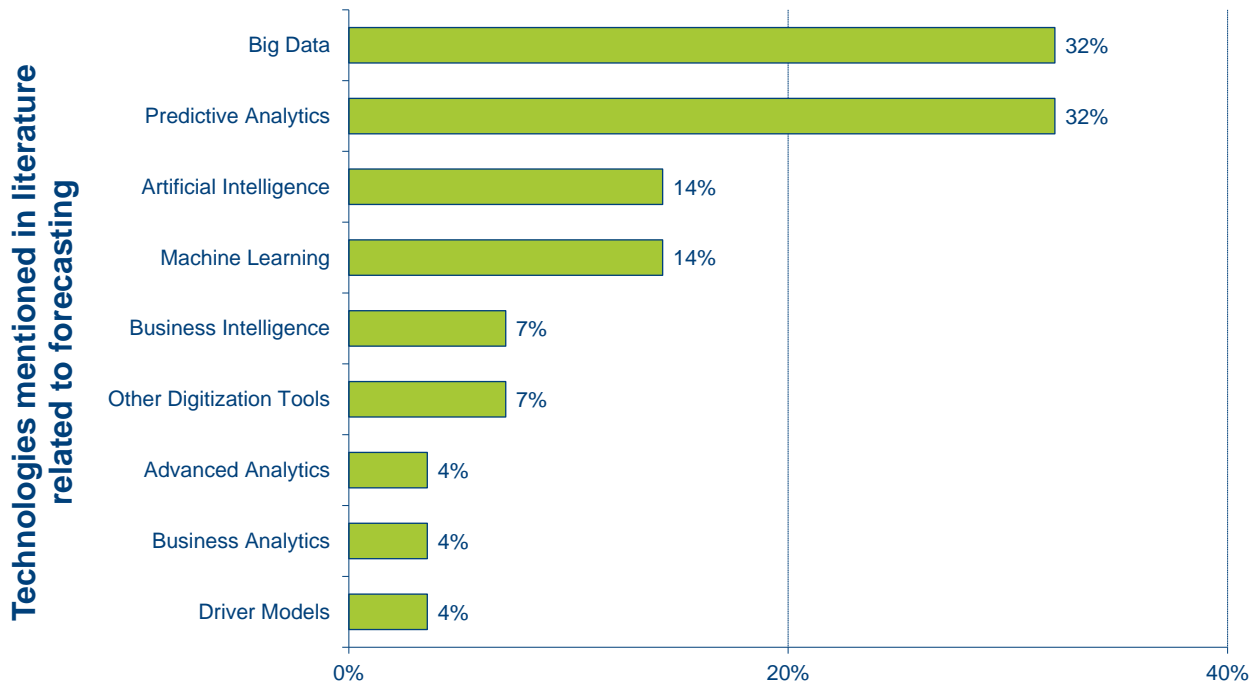| Technology	Percentage
Big Data	32%
Predictive Analytics	32%
Artificial Intelligence	14%
Machine Learning	14%
Business Intelligence	7%
Other Digitization Tools	7%
Advanced Analytics	4%
Business Analytics	4%
Driver Models	4%

Figure 6. Technologies mentioned in literature related to forecasting

argued that with new technologies and a more data-reliant forecasting process, the controller of the future has to expand his capabilities to also become a data scientist.

The chart presented in figure 7 shows the frequency of individual technologies mentioned in the literature.

This graphic illustrates the individual subject areas. They have been supplemented by the category of presentations at congresses.

The topics of technologies, opportunities and challenges were addressed in all four, which is why the circle in the fifth column is completely filled. The future developments were only

	Empirical papers	Books/ Journals	Presentations at congresses	Consultant studies	SUM
Role of Controller	◔	●	●	◔	◑
Technologies	●	●	●	●	●
Current state	◔	●	◔	●	◑
Opportunities	●	●	●	●	●
Challenges	●	●	●	●	●
Future developments	●	◔	●	●	◕

Figure 7. The frequency of individual technologies mentioned in the literature.

mentioned in three of the four categories, which is why the circle is only three-quarters full. The topics current state and the role of the controller were worked out in two categories, so that half of the circle is filled.

3.3 INTERMEDIATE CONCLUSION PART A AND B

The literature research of the topic digitalization in operative planning and budgeting as well as in forecasting has yielded a total of 22 and 28 sources, respectively (figure 8). Besides a systematic literature analysis, three source types were searched particularly: publications in books/ journals, presentations at congresses and consultant studies. It is apparent, that operational planning and budgeting shared many similar topics when compared to

forecasting. The relevant technologies, opportunities, challenges and the current state of the digitalization of the particular process as well as the changing role of the controller were addressed in both fields.

However, there were also topics, that were only addressed in the literature of one of the researched fields. For one thing, the implementation process of the relevant technologies was only examined in regard to the digitalization of operative planning and budgeting. On the other hand, future developments and implications of a more digitalized proves were only discussed in sources about forecasting.

Operational Planning and Budgeting   Forecasting

Technologies

Challenges

Implementation   Opportunities   Future developments

Current State
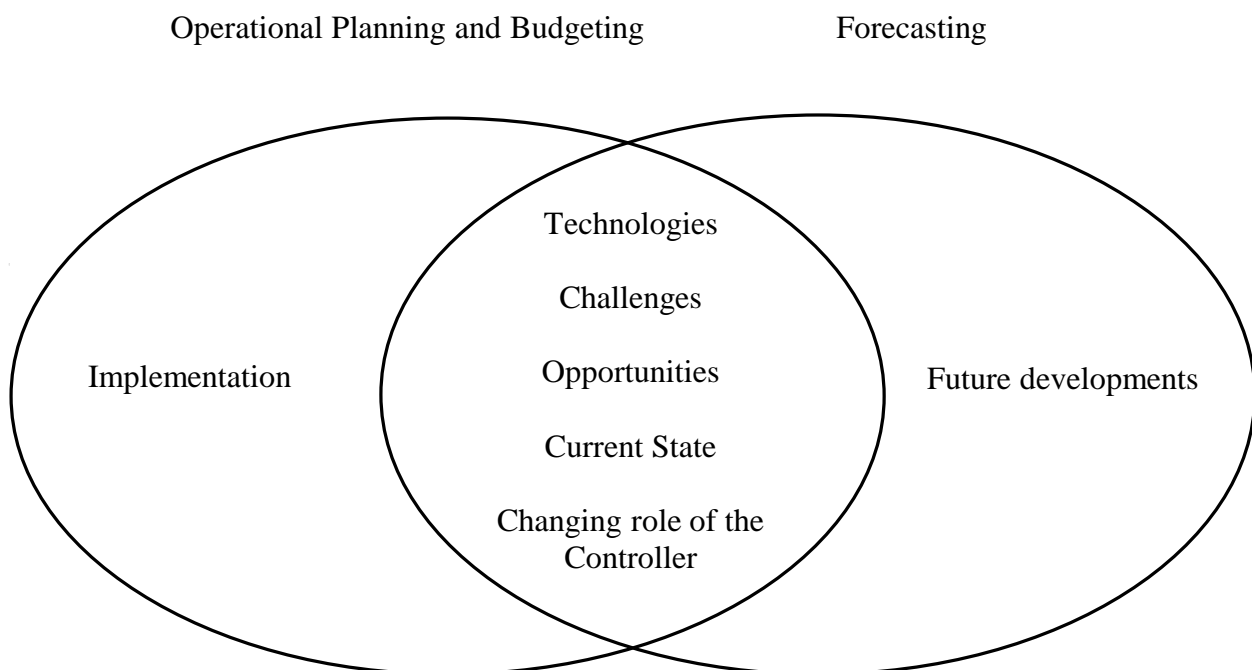
Changing role of the Controller

Figure 8. Combined intermediate conclusion

4 FINDINGS FROM AN EMPIRICAL STUDY

The second approach in this study is
a standardized questionnaire. Selected results
of the questionnaire are presented below.
At the beginning, the tasks performed by the
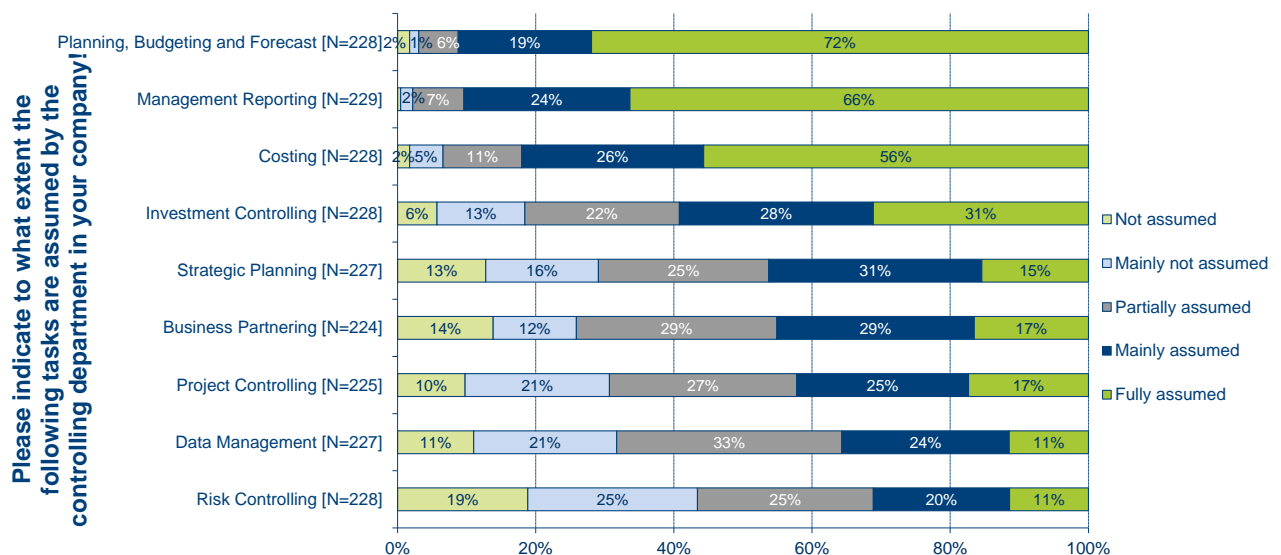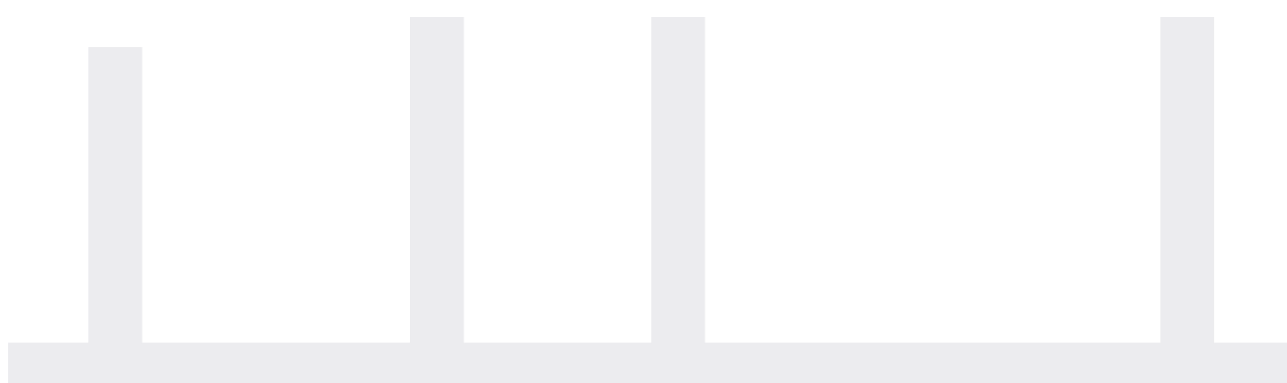controlling department are presented (figure 9).

Figure 9. Tasks of the controlling department

Most controlling departments perform the tasks
of planning, budgeting, and forecasting, as well
as management reporting and costing.
Data management and risk controlling play
a minor role.

The following figures (10 and 11) are dedicated to the intensity of use of digital technologies.

The study results indicate that generally few technologies are used in forecasting at the moment (figure 10). Driver models and scenario planning are partly used in company's forecasting, while other digital technologies are used with low intensity. The category "other" includes ERPs, Excel and other Business Intelligence Suites. After focusing on forecasting in this figure, next one shows the intensity of use of digital technologies in planning and budgeting (figure 11).
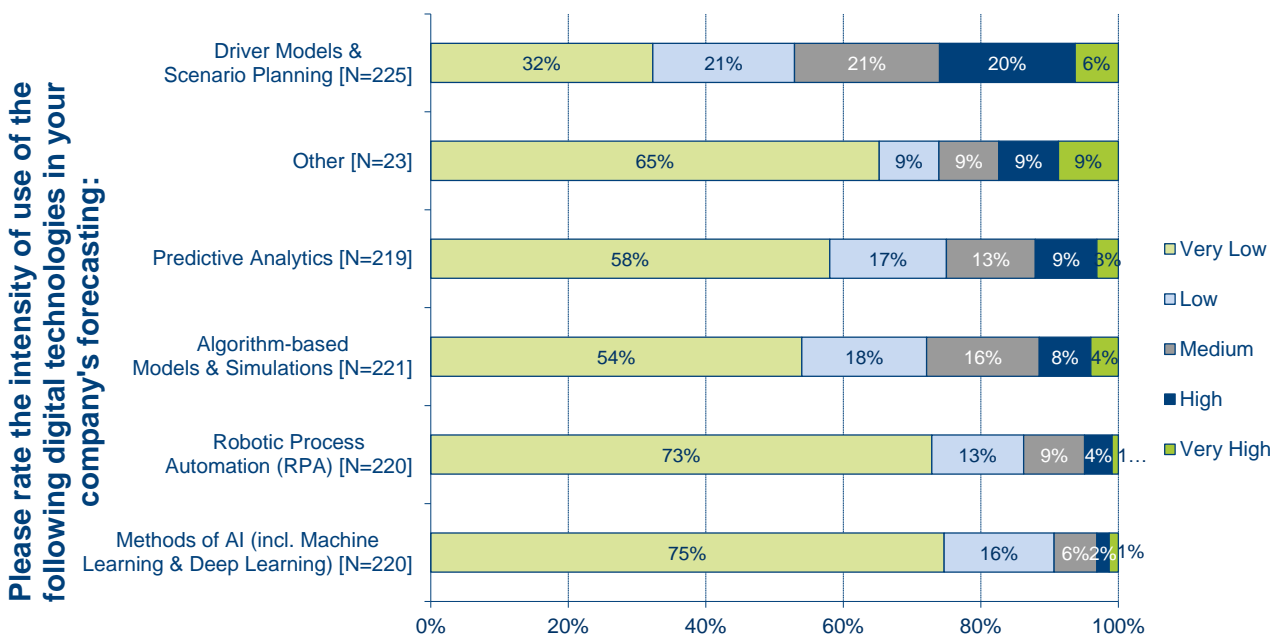

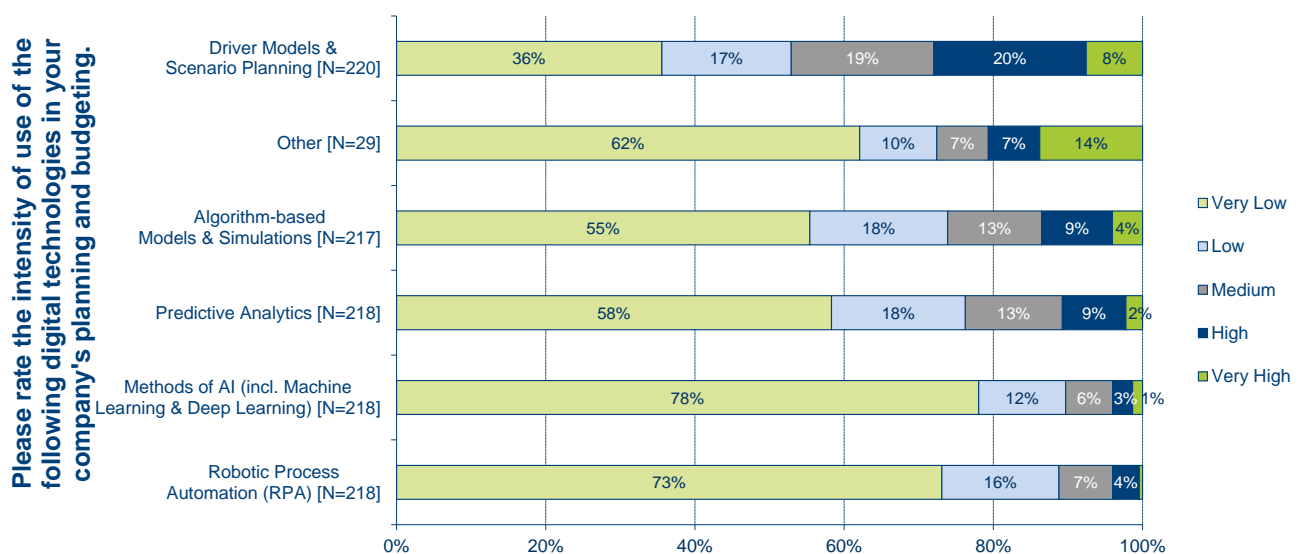Figure 10. Intensity of use of digital technologies in forecasting

Figure 11. Intensity of use of digital technologies in planning and budgeting

Digital technologies in planning and budgeting show similar result as in the forecasting. The most used digital technology for planning and budgeting are driver models and scenario planning. Other digital technologies are only used (very) low usage intensity.

It is evident that only a small number of digital technologies is currently being used in both forecasting and planning/budgeting.

The application of different planning methods is presented in figure 12. The highest application rate by a considerable margin can be seen with traditional planning methods with over 51% participants stating a high application rate and 33% a rather high application rate. Rolling planning comes second in the study with a high application rate of 16% and a rather high application rate of 23%. Other methods such
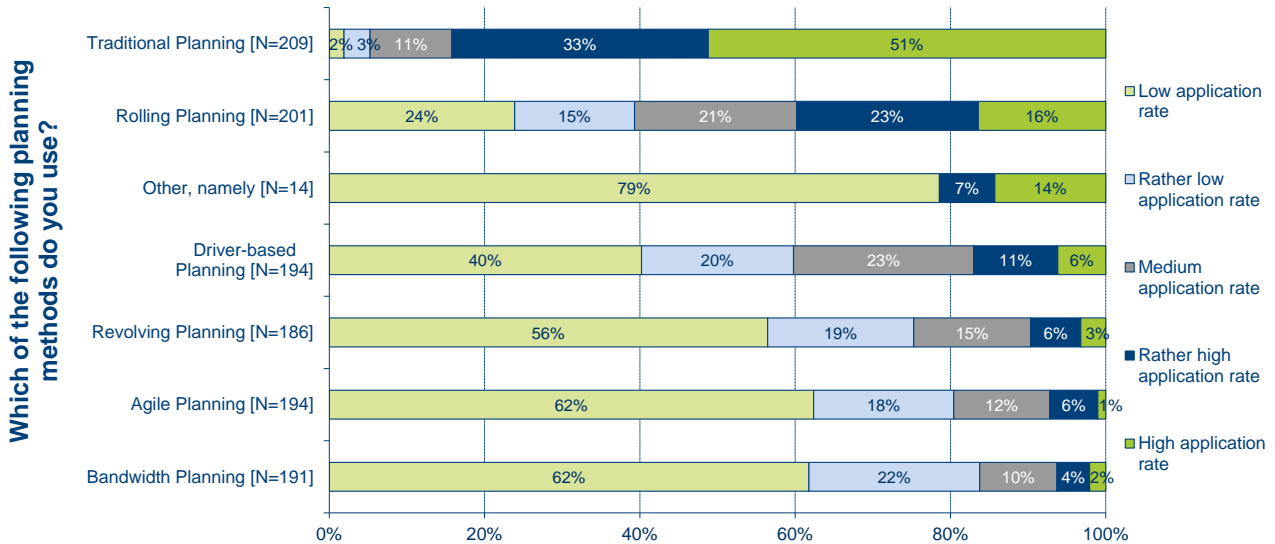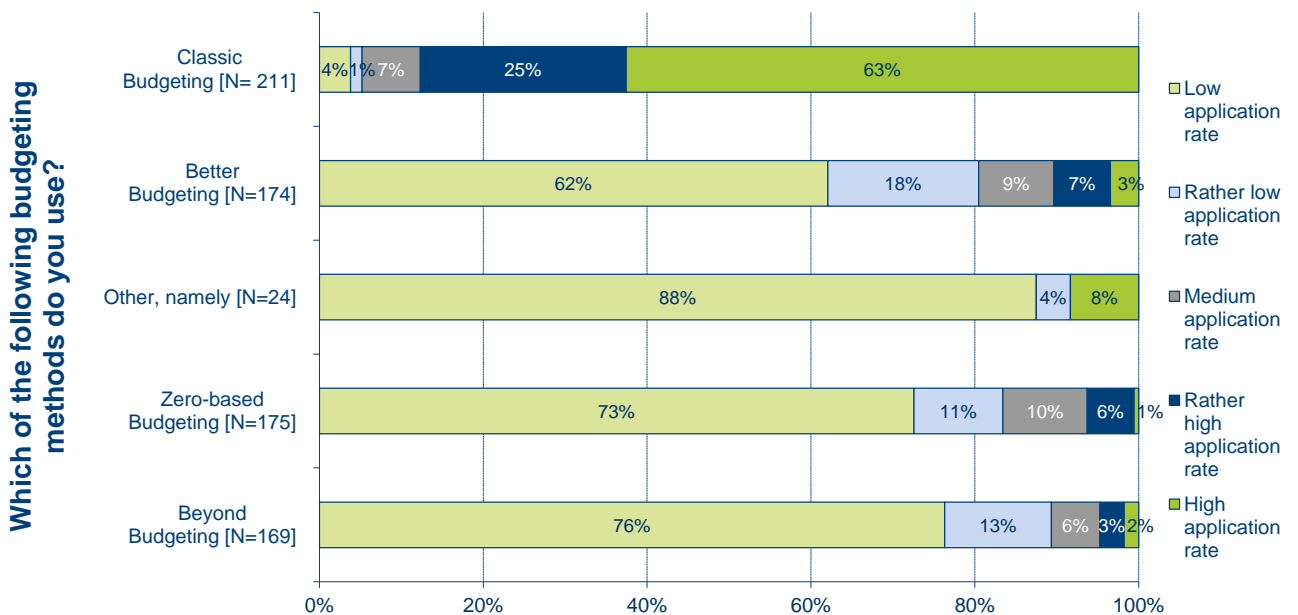

Figure 12. Planning methods

Figure 13. Budgeting methods

as rolling planning, driver-based planning or revolving planning were found to have far less application in the sample of the study.

Similar to the planning process is in the budgeting process the Classic Budgeting the method that has the highest application rate with 63% stating a high and 25% a rather high application rate (figure 13). Other budgeting methods see a considerable drop off as the second most used method is the Better Budgeting with 3% stating a high and 7% a rather high application rate. Zero-based budgeting and beyond budgeting play a minor role.

Number of forecasts

In the study, participants were asked how many forecasts are done yearly. 26% stated that they have 4 or more forecasts yearly. 15% of participants are forecasting 4 times, 28% 3 times, 18% have 2 forecasts and 9% state that they have only one per year. Only 1% have no

forecasts at all and 2% do not know how many forecasts are done on a yearly basis.

The figure 14 shows the current level of digitization of subprocesses in planning, budgeting and forecasting. The highest degree of digitization can be seen in the creation and updating of forecasts or to compare newly generated data for forecasts, plans or budgets to past data and analyse the corresponding deviations. The next highest degree of digitization is the subprocess of creating individual plans and budgets and to summarize and consolidate them.
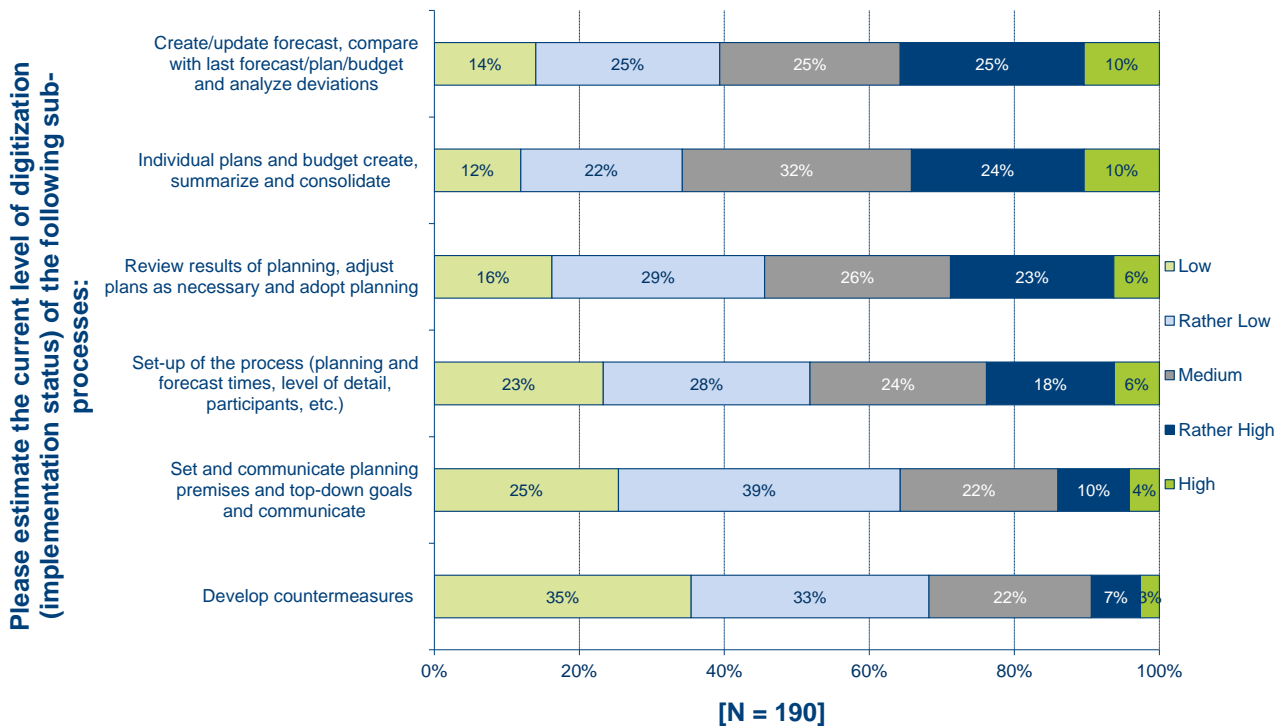

Figure 14. Current level of digitization

The previous figures have shown the status quo with regard to digitization in planning, budgeting and forecasting. In the following, expected benefits, barriers and competence levels will be presented (figure 15).

The participants of the study state that the biggest barrier for using modern technologies in forecasting is the lack of competencies of the employees which 50% of the respondents see as the main reason. 47% see a problem in the culture and the acceptance in the company.
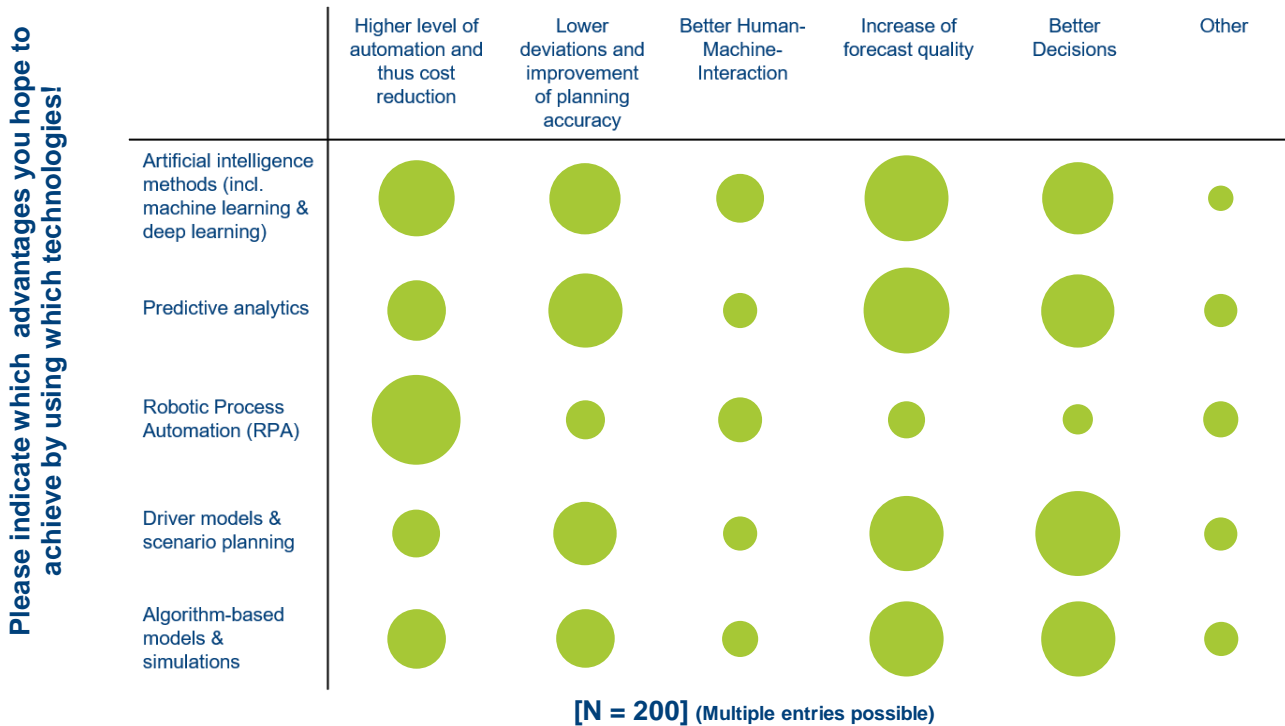
Figure 15. Expected benefits from the use of digital technologies

Figure 14 shows the current level of digitization of subprocesses in planning, budgeting and forecasting. The highest degree of digitization can be seen in the creation and updating of forecasts or to compare newly generated data for forecasts, plans or budgets to past data and analyse the corresponding deviations. The next highest degree of digitization is the subprocess of creating individual plans and budgets and to summarize and consolidate them.

The previous figures have shown the status quo with regard to digitization in planning, budgeting and forecasting. In the following, expected benefits, barriers and competence levels will be presented (figures 16 and 17).

An insufficient internal database is seen by 45% as a barrier to the usage of modern technologies. Further barriers in forecasting are for example organizational barriers, lack of business cases for the use of the technologies and missing reference projects and examples (figure 16).
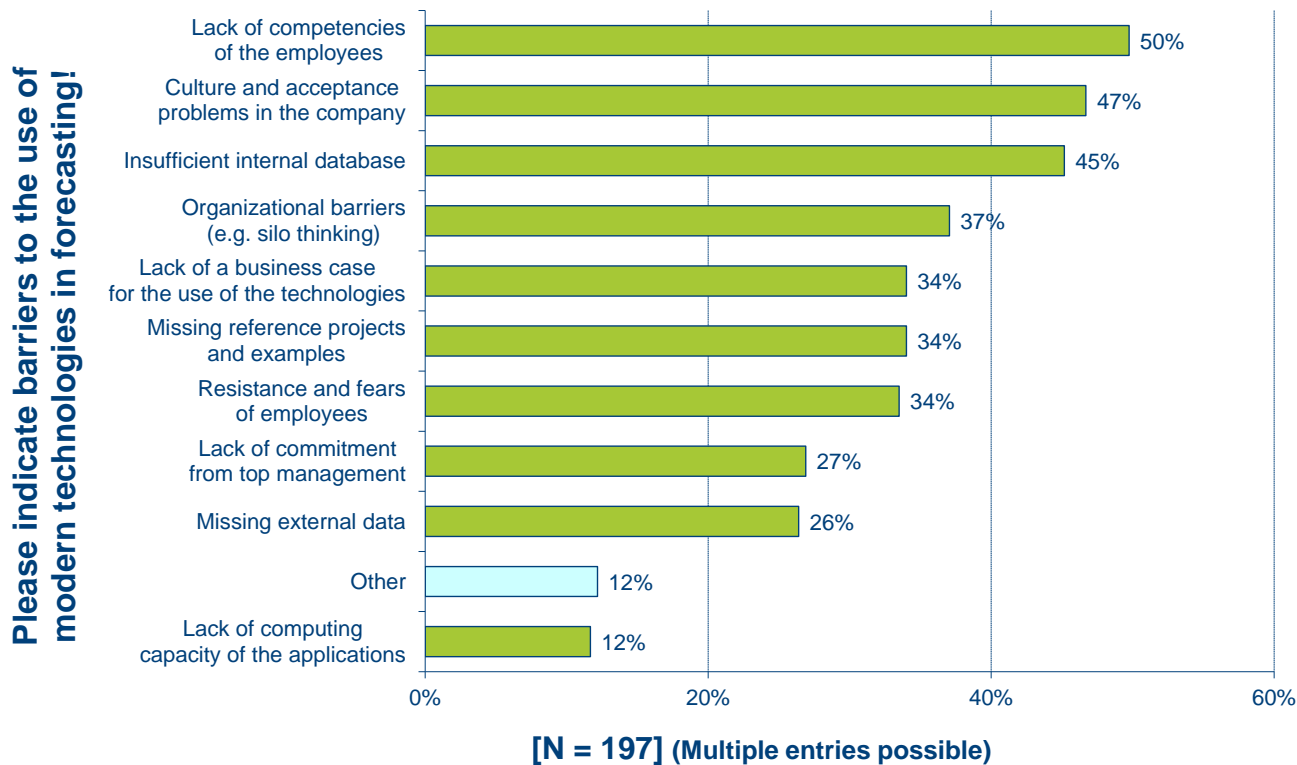
Figure 17. Barriers to the use of modern technologies in forecasting

The result for barriers in planning and budgeting (figure 17) is similar to the barriers in forecasting. The biggest barriers for the planning and budgeting are according to the study the lack of competencies (48%), cultural and acceptance problems in the company (42%) and insufficient internal databases (39%).
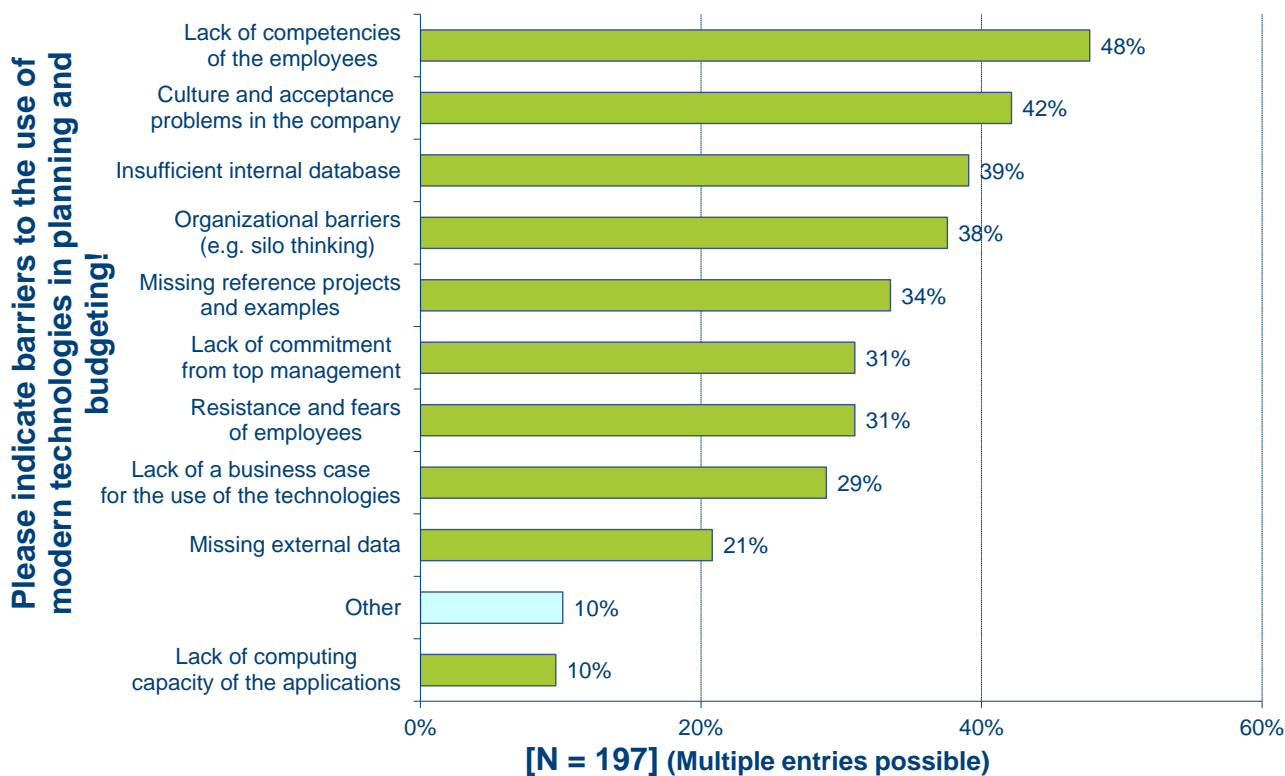
Figure 16. Barriers to the use of modern technologies in planning and budgeting

After considering the barriers, the following two figures (18 and 19) show the current level of competency in planning, budgeting and forecasting.

good. Impulse giving is considered as the competence with the biggest backlog demand. Only 8% see themselves as very good lined up, 30% as good, but 42% state a low, 19% a high and 2% even a very high backlog demand.
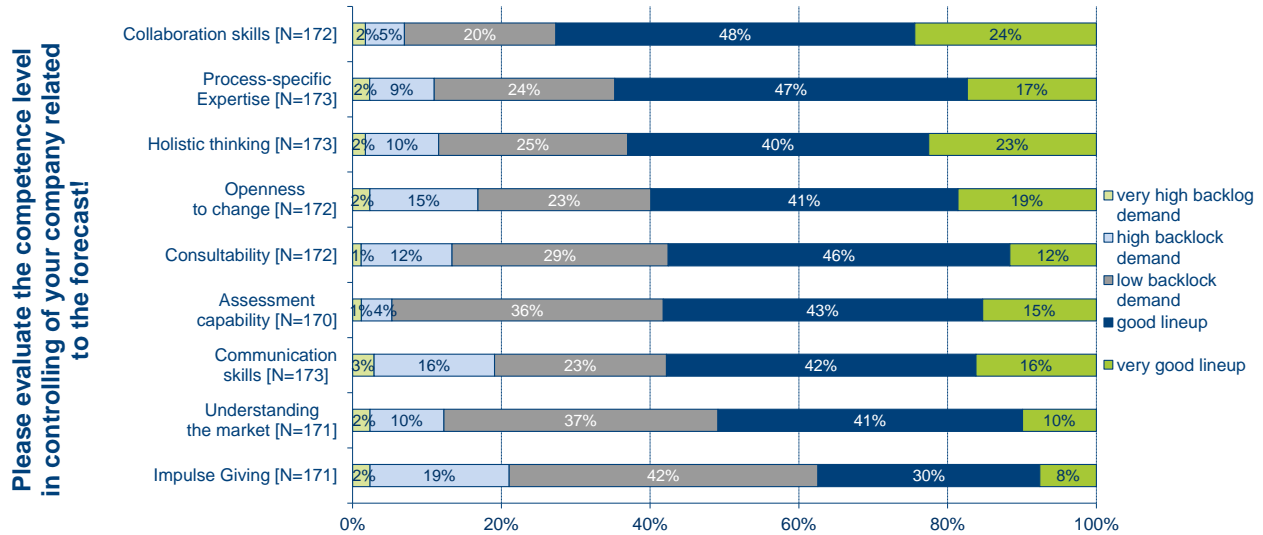
Figure 18. Competence level in forecasting

The survey respondents evaluate their collaboration skills as the skill where they have the best lineup (fig. 18). 24% see themselves with a very good lineup,48% state a good lineup. The process-specific expertise is evaluated by 17% as very good and 47% as

Organizational skills are stated as the strongest asset in the study for the planning and budgeting processes (figure 19). 45% state a good lineup and 18% even a very good lineup. Creative will is seen as the second strongest point of the respondents as 42% see a good
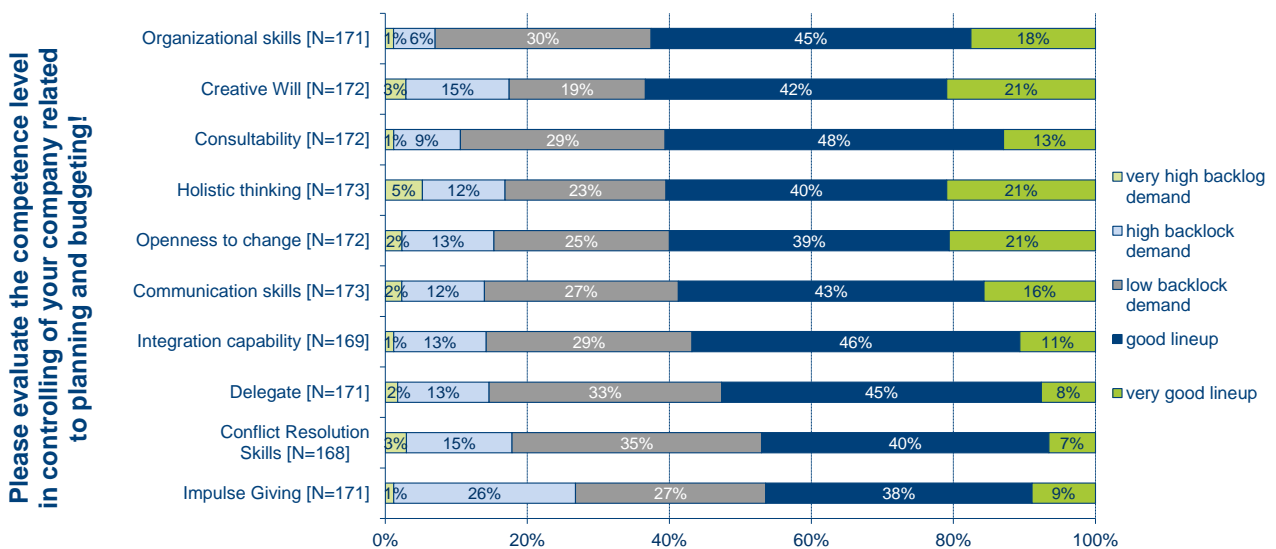
Figure 19. Competence level in planning and budgeting

lineup and 21% a very good lineup. As in the forecasting process impulse giving is seen as the competence with the biggest backlog as 27% state a low, 26% a high and 1% a very high backlog demand with only 38% seeing themselves with a good lineup and 9% specify a very good lineup.

involved managers. Furthermore, 31% agree with this statement and 35% of participants neither agree nor disagree while 19% disagree and 9% do not agree with this statement at all.

Please assess the methodological competence level in your company's controlling with regard to planning, budgeting and forecasting!

	very high backlog demand	high backlock demand	low backlock demand	good lineup	very good lineup
Accounting and Reporting [N=169]	2%	9%	27%	44%	19%
Current business development [N=168]	1%	7%	33%	47%	12%
Planning tools (e.g. top-down vs. bottom-up) [N=167]	4%	14%	27%	43%	12%
Process Design [N=167]	2%	19%	32%	38%	10%
Forecast instruments (e.g. projections, relevance tree) [N=165]	7%	26%	30%	30%	7%
IT-Tools [N=169]	8%	28%	36%	20%	8%
Integrated Performance-Management [N=166]	9%	28%	36%	19%	8%

Figure 20. Methodological competences in planning, budgeting and forecasting

The highest methodological competence level respondents see in the accounting and reporting of their controlling department as 44% state a good lineup and 19% even a very good lineup (figure 20). For current business development 12% of participants specify a very good lineup and 47% a good lineup. The lowest methodological competence level can be seen in the integrated performance management where only 8% state a very good and 19% a good lineup, while 36% see a low, 28% a high and 9% a very high backlog demand.

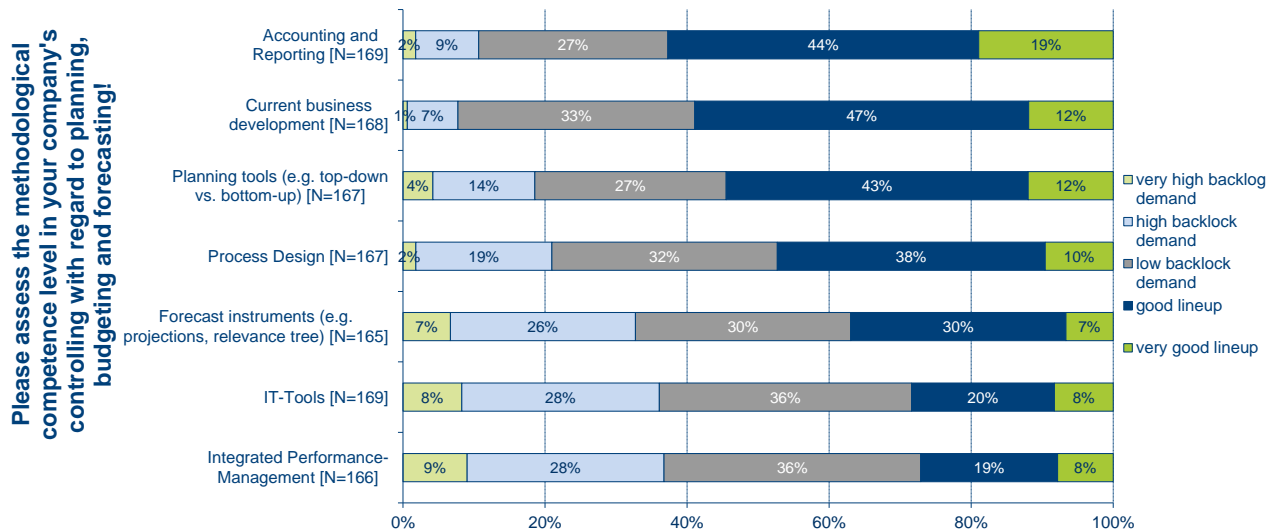At the end of the standardized questionnaire, participants were asked to comment on various statements (figure 21).

Planning is seen to be an important resource for information with 25% completely agreeing and 46% agreeing with this statement. Undesirable events can be identified early thanks to comparisons is a statement which is agreed upon by 68% with 20 even agreeing completely. Only 6% of respondents completely agree with the statement that preformulated goals in the planning process motivate the

Satisfaction with company's success

When asked how satisfied the respondents are with their company success in comparison to their strongest competitor, 13% specify themselves as very satisfied. 39% are rather satisfied, 37% are partly satisfied, while only 9% are rather unsatisfied and 1% very unsatisfied with their own company success.

Corporate uncertainty

To conclude, the survey the respondents were asked how they evaluate the uncertainty surrounding their company environment. 9% rate their company environment with a very high level of uncertainty, 28% see a high uncertainty. The most respondents evaluate their uncertainty on a medium level (40%). 20% see

a low and 4% a very low level of uncertainty
surrounding their company.

To what extent do the following statements apply to your company/business unit?

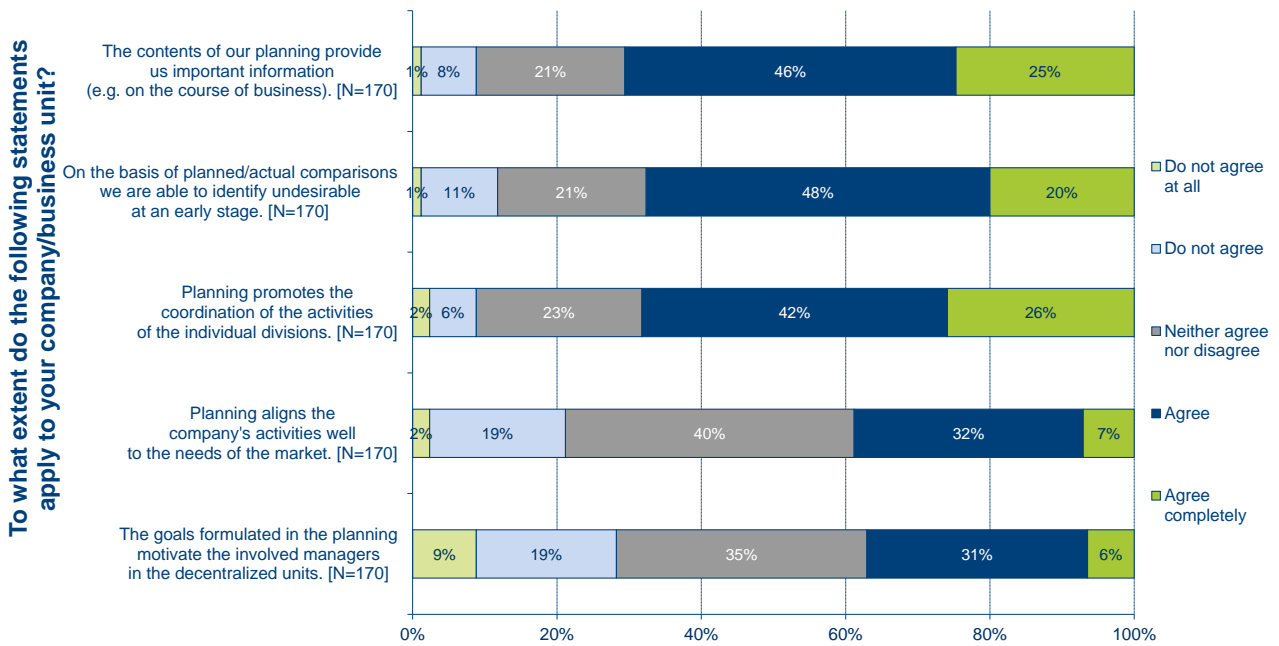| Statement	Do not agree at all	Do not agree	Neither agree nor disagree	Agree	Agree completely
The contents of our planning provide us important information (e.g. on the course of business). [N=170]	1%	8%	21%	46%	25%
On the basis of planned/actual comparisons we are able to identify undesirable at an early stage. [N=170]	1%	11%	21%	48%	20%
Planning promotes the coordination of the activities of the individual divisions. [N=170]	2%	6%	23%	42%	26%
Planning aligns the company's activities well to the needs of the market. [N=170]	2%	19%	40%	32%	7%
The goals formulated in the planning motivate the involved managers in the decentralized units. [N=170]	9%	19%	35%	31%	6%

Figure 21. Statements in context of planning, budgeting and forecasting

5 EXPERT INTERVIEWS

Controlling in general

As described in the introduction, the following interview partners were interviewed on the topic of digitization in planning, budgeting and forecasting:

- Mr. Alpha, Partner at a consulting firm (Firm A)

- Mr. Beta, Senior Manager Controlling with a large industrial enterprise (Firm B)

- Mr. Gamma, Director Group Controlling at a large industrial corporation (Firm C)

- Mr. Delta, Partner at a consulting firm (Firm D)

There are two consulting firms in the sample. Firm A mainly advises corporate groups and large medium-sized companies. Firm B, on the other hand, advises the entire range of company sizes. Mr. Alpha explains that the IGC process model is often found in their client companies. Mr. Delta shares this opinion and lists the current degree of digitalization of the main processes at the clients on the basis of the process steps of the IGC process model: Strategic planning is largely done manually with a low level of digitization. There are isolated approaches, for example through a digital balanced scorecard. Mr. Alpha adds that in some companies, however, there is no strategic planning at all. Planning, budgeting and forecasting, which is the focus of this study, has a higher degree of digitization in some cases, but process support is weak and end-to-end digitization is lacking. Cost accounting is usually implemented in the ERP system but is often very rigid. End-to-end digitization is also lacking in management reporting, even if BI solutions are already being used. In project controlling and risk controlling, the degree of digitization is low.

Data management is the basic prerequisite for digitization in the previous main process steps.

The two industrial firms (firms B and C) use the IGC process model in their controlling processes. Although this is not always done explicitly, the processes are largely congruent. In addition, both companies are increasingly focusing on the business partner as the main role for controllers. The importance of controlling is generally rated highly at Firm C and Firm B. Firm C underlines this with the fact that the CFO is always part of the top management team.

Controlling process "Planning, Budgeting and Forecasting"

As presented in the previous topic, all companies agree with the application of the IGC process model in practice. Within the Firm C divisions, however, there are also individual process characteristics for which there is not yet a groupwide formalization. Firm A also uses the process model in consulting projects, but existing processes of the clients are also considered and further developed on the basis of the process model. Increasingly, a top-down approach for planning can be observed, but there are also bottom-up procedures (countercurrent procedures). Mr. Gamma explains that the integrated planning process (integration of strategic planning and financial planning) is specified top-down. Mr. Beta states that a segment-specific differentiation of planning at Firm B would be useful in the future. In fact, the focus in the inpatient business (e.g., with hospitals) is on sales targets and in the outpatient business with end customers on market share targets. Mr. Gamma added that, in addition to the processes of the IGC process model, there is a "Firm C Digital Unit" which

coordinates data management across the entire Group and is located at a very high level.

A controversial topic in practice is the tension between planning accuracy and simplification of planning. Mr. Gamma recommends delineating and clearly defining the purposes of planning so as not to run the risk of distorting planning and forecasting through stakeholder expectations. It would not be possible to satisfy all stakeholders in the process. In this context, Mr. Alpha notes a bandwidth planning makes little sense, since planning defines where the company wants to go in the long term. However, he recommends thinking in different scenarios (realistic scenario, worst case, best case) when planning. Mr. Beta explained that the Board of Management expected a high level of detail in the planning. However, the acceptance of a lower level of detail in the planning was currently being examined. In the meantime, planning at Firm B has been shortened from a 3-year plan to a 1-year plan. However, Mr. Beta thinks that the 3-year planning was more compatible with the corporate strategy and that smaller fluctuations were not so significant. In principle, however, he prefers to go into greater detail in case of doubt in order to obtain a more accurate result. Firm C prepares a medium-term plan with a three-year planning horizon and also prepares three forecasts annually (two of them bottom-up).

Another challenge is that planning and forecasting often diverge widely. Mr. Delta confirms that this is also due to the fact that planning tends to have a goalsetting character or is important in external communication. On the other hand, the forecast should be used as a separate instrument with the goal of high accuracy. By optimizing rigid planning cycles and incentive models, planning and forecasting could be harmonized. Mr. Alpha states that (semi-) automated simulation models could significantly increase the degree of target achievement in planning. Here, all levers (e.g., market-driven events such as commodity price developments) would be considered and integrated into various scenarios. Mr. Gamma explained that deviations from the plan are currently less critical at Firm C because the plan

tends to be exceeded. Therefore, there is also an understanding in the management that planning is rarely accurate. Nevertheless, Firm C wants to optimize the planning accuracy.

Mr. Delta raised concerns regarding the new version of the IGC process model insofar as the previous process model with the separation of planning, budgeting and forecasting had been more targeted. Mr. Alpha (Firm A) also emphasizes that the planning/reporting and forecasting processes should be considered separately. With regard to the digitization potential presented below, planning is more strategy-driven and forecasting is more machine-driven.

Digitization potential of the subprocesses

The subprocesses are as follows:

- Set-up of the process
- Establish and communicate planning premises and top-down goals
- Create, summarize and consolidate individual plans and budgets
- Review results of planning, adjust plans as needed and adopt plan
- Create/update forecast, compare with last forecast/plan/budget and analyse variances
- Develop countermeasures

In general, the interview partners see a low to medium level of digitization in practice. Digitization is often limited to the use of an ERP system.

Especially in the set-up of the process and the planning premises, the interview partners see a low potential for digitization. Mr. Delta explains that there is a particularly great need for optimization in this sub-process. The topic of planning coordination is enormously important, as many departments are involved here. Special tools (e.g., Confluence) could be used to digitize communication here. Existing data models are an obstacle, because many

systems are still too limited for multidimensional evaluation. The identification of relevant drivers is essential for the development of planning models. Mr. Gamma explained further digitization potentials of the subprocesses at Firm C: In Create, summarize and consolidate individual plans and budgets, Firm C has made progress in digitization by introducing an online management information system. In this tool, all planning data would be brought together centrally and automatically. A budget tool has also been introduced in which there are direct consolidation options. In the subprocess Create/update forecast, compare with last forecast/plan/budget and analyse variances, the digitization of the forecast would have a high priority. However, a limited or area-specific data basis is often an obstacle here.

The interviewees share the opinion that humans remain relevant despite the high potential for digitization. Although operational processes can be partially automated, the final control of the results remains with the human being. Mr. Alpha believes that 50% of the controller positions in southern Germany could be reduced through process improvements and digital tools. Mr. Gamma also notes that RPA in accounting could result in an overcapacity of employees, but he explains that Firm C is in a growth process and that competencies of existing employees would only have to be transformed more with regard to digitalization. Mr. Beta explains that intensive human resources would be needed for the time being to maintain the data. He is confident that with sufficient data maintenance, automated values could be generated via machine learning in the future. He sees human intervention still occurring at Firm B in the future. Nevertheless, he notes that in certain areas, a purely machine calculation might make more sense, as operational political issues would not have any influence here and the calculation would be much more objective. In summary, every expert sees an automation of 100% as very unrealistic, since humans should always be included in the process with a right of veto.

Implementation status of the digitization of subprocesses

All interviewees share the opinion that predictive analytics, machine learning and robotic process automation (RPA) are currently hardly used in planning, budgeting and forecasting. RPA is seen more as a bridging technology. Mr. Alpha estimates the use of predictive analytics at 15% of companies. At Firm C, there are initial machine learning approaches for forecasting. Predictive analytics also plays a role here. However, Mr. Delta notes that his clients have so far only had isolated use cases for identifying machine learning potential. Mr. Beta also explains that this is not yet being used at Firm B. Mr. Gamma says that these technologies in controlling are still at an early stage of development at Firm C. In the area of forecasting, there are initial machine learning approaches with the help of a pilot. Driver models, simulations and scenario planning are partly represented in practice, but Mr. Alpha notes that studies on the spread of these approaches may not represent the actual spread. In a 2009 study, for example, 75% of the companies surveyed responded that they use simulation models. He observes here, even today, a lower spread. In planning, however, some companies are well on the way to developing functioning simulation models.

In order to be active in the area of predictive-, prescriptive analytics or machine learning, the use of an ERP system is a prerequisite. Mr. Alpha, however, does not call the mere implementation of an ERP system digitalization, but rather automation, i.e., a first stage to digitalization. Nevertheless, an enormous leap in efficiency can already be observed through the introduction of a functioning SAP S/4 HANA system alone. The use of the analytics tool "SAP Analytics Cloud" is increasingly being observed, but the intelligence behind it is sometimes perceived as very trivial. Mr. Beta also says that the SAP Analytics Cloud would be used at Firm B. The availability of tools in this area is generally high, but it should be noted that a seamless implementation of tools, which may come from different companies, should be

integrated in the overall company and breaks should be avoided.

Possible advantages of digital technologies in controlling are that predictive or prescriptive analytics could be used to calculate scenarios and find correlations that humans do not discover. According to Mr. Alpha, this is particularly helpful for medium-term forecast calculations in the form of scenario models. He estimates that predictive analytics is used in 15% of companies and prescriptive analytics in 1%. A database with historical data of at least 5 years is required for use. The challenge at this point is often that organizational structures have changed in the five-year history (e.g., due to M&A activities), which means that the data history must be adjusted retroactively. The need for external data is given, but often not necessary.

The introduction of digital technologies requires a high expenditure of resources. According to Mr. Alpha, including the tool and the introduction, the costs are often in the seven-digit range. As a result, companies often postpone this investment to the future. Especially due to the Corona pandemic and the accompanying uncertain economic situation, investments were often postponed. The trade-off between cost and added value is often difficult to make with digital technologies. For example, he said, it is difficult to justify why an investment should be made to introduce SAP HANA when a functioning ERP system already exists. One possible argumentation aid here is that all existing processes would be rethought through the introduction of HANA. Also, alternative lower-cost ERP systems are coming to the fore more often (e.g., Workday). At this point, Mr. Beta relates that the introduction of Sales Force was also difficult to justify financially, but standards were set as a result, which the company did not want to miss. In addition, there are hurdles in the implementation of data mining projects, for example, with regard to data protection and legal coordination. Apart from that, companies are often stuck with existing legacy systems and have to invest a lot of effort in change management. Although tools are easy to use nowadays, employees are often afraid of new

technologies and acceptance is difficult to build. On the positive side, Mr. Alpha mentioned that young people entering the workforce already have skills in digital tools through their training/studies. In practice, according to Mr. Delta, there is usually no hard cut with the blocking of legacy systems, but rather a soft cut with a gentle introduction to the new systems. This is particularly necessary in the case of teams that have grown over a long period of time and include employees with a high level of experience. The fear of replaceability is clearly noticeable. Mr. Gamma states that it is probably difficult to subordinate analyses created inhouse (e.g., via a CRM system) to a "black box" in the form of prescriptive analytics and to accept this.

Reference projects

Mr. Delta (Firm D) explains their inhouse trainee program "Digital Finance", where participants get a broad overview of diverse areas and tools in the digitalization of finance, for example in process mining, R, Python, ETL solutions (e.g., Alteryx) as an interface between legacy systems to automate manual handover processes through small pieces of code. In practice, corporations, such as Siemens, have already used Ateryx.

Mr. Alpha (Firm A) lists some successful examples in the implementation of digital technologies. For example, a professional simulation model was introduced in the Bayer Group. At SwissRe, a groupwide platform with extensive simulation capabilities was implemented. Advanced analytics components were introduced at Lanxess.

Mr. Beta (Firm B) cites the "SAP Analytics Cloud", which is currently being introduced, as a reference project. There is also a "Controlling Systems" team at Firm B, which has resources to try out new things in addition to its daily tasks. With regard to the introduction of SAP HANA, Mr. Beta pointed out that Firm B is pursuing a two-part project plan here, divided into a process-related and methodological part, whereby he would like to work on the process-

related part first in order to avoid duplication of work.

Mr. Gamma (Firm C) explained that the first machine learning approaches were implemented in forecasting at Firm C. Here, forecasts of different business models were presented by special pilots. There are also initiatives in the area of RPA in certain areas through pilots in India and Germany.

6 DIGITALIZATION IN PRACTICE

What practitioners concern most

Part of the questionnaire was an open question that asked for reference projects in the area of digitization in planning, budgeting and forecasting. Based on the answers, some practical examples are presented below:

Introduction and use of software/ERP solutions

In the area of software/ERP, the introduction of SAP S/4 HANA was increasingly mentioned. However, other tools were also mentioned, such as the introduction of Corporate Planner, SAS Visual Forecasting incl. Plato (planning tool for operational planning), CCH Tagetik and Sharepoint. In addition to the introduction of specific tools, the integration or linking of certain tools was also listed, such as the introduction of an interface between SAP and the management information system.

Introduction of business intelligence systems

The introduction of business intelligence systems is increasingly being mentioned, especially for the analysis of the company's own data. These are intended specifically for the analysis and visualization of data and can be displayed via dashboards, for example. The systems are often cloud-based.
The introduction of SAP's own analytics tool "SAP Analytics Cloud" was also mentioned several times. The introduction of SAP Business Warehouse and volume planning in this tool was also stated.

Tool-based process improvement

In the case of process improvement through digital tools, for example, contract digitization or the introduction of a digital workflow in accounting were listed. The switch to digital files or digital document management was also mentioned.

Automation/integration

When it comes to automation or integration, a variety of automation options were mentioned. For example, an automated supplier bonus control was introduced or management reporting was automated. The introduction of fully integrated budgeting processes was also mentioned. Another aspect is the integration of operational laboratory control (extension S&OP) into financial planning/forecasting.

Digital technologies and artificial intelligence (AI)

Predictive analytics, driver-based, data-driven planning and simulation models were increasingly listed in this item. Machine learning is already playing a role at some companies. Time series analysis for revenue forecasting was also brought up. In addition, rolling planning and forecasting were mentioned. Another tool mentioned is Robotic Process Automation (RPA). In principle, the use of cloud solutions is playing an increasingly important role in order to be able to access data regardless of location.

Case studies

1. Kappes and Klehr were looking at the implementation process of a simulation model and how it could be done. The authors are saying that the Covid19 pandemic showed that even the most advanced systems using Predictive Analytics will fail due to the enormous disruption caused by the pandemic. To prepare for events with an extreme uncertainty there is a need for companies to outline several scenarios for a company's future including the respective measures. With scenarios a company will always have options at hand allowing a shorter reaction time and according to the authors gaining a competitive advantage as well as reducing the risk for the company. A first successful implementation can be found with Bayer AG who implemented their "integrated financial models" to support their decision-making. The Siemens group implemented a driver-based model with some automated aspects and the Zurich Insurance Group was able to implement a system that next to its scenario-modelling also supports their mandatory stress testing for their risk management.

   The authors suggest that the simulations are implemented in the form of scenario modelling separated into three steps. The first step is the introduction of the basic scenario (Base Case) which then will be further developed with the help of a driver model and the necessary measures to be taken into a scenario. Varying the driver model and the planned measures will create a new scenario every time. The next step is the introduction of automation to the simulation. With the help of Predictive Analytics, a forecast based on internal (historic) data and external factors is generated and serves as the Base Case. Therefore, the simulations can always be based on the latest data and the focus can be shifted to the actual modelling process with driver models and measures.

Additionally, a risk simulation can be added in this step where specific risks are included in each scenario. The risks can then be aggregated with a Monte Carlo Simulation and used for risk management purposes. The last step is the optimization step where Prescriptive Analytics will be introduced to support the decision-making process and help identify the optimal scenario. But according to the author there is no widespread employment of this method as of yet although they see it as the next logical step of the previous developments. (Kappes and Klehr 2020, pp. 50-55, 2021, pp. 64-69)

2. Schertzinger et al. review in their case study the introduction of a new planning process at Swiss Re. According to the authors there were three big challenges to solve. One was the applications in use who had insufficient integration and with a high level of complexity due to additional adjustments and extensions in the past. The second challenge was that the planning process was evaluated as tedious, complex and bureaucratic. Additionally, the greater focus was on meeting the reporting standards and deadlines instead of the reported content as a result the planning process was seen as inefficient with only limited benefit. The last challenge was that the market environment for Swiss Re changed. Reinsurers are faced with a market with a higher dynamic and increased volatility requiring shorter reaction times. Therefore, a system was needed which could assess new developments and indicate the potential effects in a shorter time while maintaining a close level of detail. This made the introduction of scenarios a necessity.

   The targets for the new planning process were integration, standardization, digitization and flexibilization and already prepare the expansion to other control mechanisms. The project was divided into four steps. The first step was the implementation of a coherent planning platform where all the individual segments

and their plans are portrayed as modules and can then be combined to a complete plan. For the new platform a new harmonious data model had to be introduced which has a high complexity due to the nature of the business, but greatly improving the reporting due to the new standardized format used in all segments. The planning tool chosen to achieve the desired solution was the IBM Cognos TM1. The second implementation step was the introduction of a driver-based planning process with a high level of detail where drivers are adjusted according to internal or external factors to change a standardized base case. The third step was the integration of several valuation standards to the system as national legislation can dictate a certain valuation and the system should be able to work with all the needed standards while being consistent and reliable as well as the (automated) integration of different statements like the income statement, balance sheet or cash flow statement. The final step was the introduction of simulation, which can be used to create ad hoc scenarios to support the set target goals as well as support the risk management like in the identification of ORSA scenarios as it is mandated in Solvency II directive of the EU. According to the authors the simulation models will not only shorten the process and improve the trust internally, but also externally with regulating authorities. (Schertzinger et al. 2017, pp. 293-308)

3. Gleich et al. studied how a pharmaceutical company was able to successfully integrate their finance forecast with their operative forecasts. The target of the project was to improve the effectivity of management control as well as to increase the efficiency of planning and forecasting. A big challenge unique to the pharma industry was a very country-specific sales organization combined with a centralized service center. The issue was that the finance and the operative organization were not integrated, and the data was often not accessible for the other organization. But the goal was to integrate both sides so that a new planning process can be created where both financial and operative forecasts can be used to exchange data and therefore improve the time needed to create a forecast as well as increase the accuracy of the forecasts due to more data being available.

The integration of the financial forecasts and the operative forecasts has certain challenges. Partly company-specific based on the structure of the company, different views on the market in different departments, different person in charge of the forecasts as well as IT-specific challenges as certain data is only accessible for certain departments, but there were also industry-specific challenges like the very complex value chain. For example, the planning horizon for a pharmaceutical company is 18 months on average which is severely more prospective in comparison to the generic industry. Additionally, the production of drugs is mostly standardized, but the already mentioned very country-specific sales organization are in a strong contrast as the national legislations can differ and force the company to tailor its approach to the given legislations.

The company decided to go with a best practice approach consisting of four steps. The first step was the introduction of a driver-based model, which will eliminate the challenge of different views as it will bring a consistent view to all internal organizations. In this project the driver-based model was created with the financial organization before then creating specific models for the operative organizations. The inclusion of the team members not only guaranteed a technical integrity, but also improved the acceptance of the new process within the workforce. The second step was the implementation of an end-to-end process which includes all the individual planning processes of the financial and operative organizations and combining it under a centralized

responsibility and creating a integrated coordination step where the partaking departments in the process come together and harmonize their respective forecast resulting in forecasts that can be used for operative management as well as for the top management. The third step was the building of an integrated planning platform which will allow the forwarding of necessary data to other organizations due to the introduction of coherent interfaces.

In this case the pharmaceutical company already had introduced a digital platform, which meant that less effort was needed to create the desired integrated planning platform. The last step was the application of Predictive Analytics to specific forecasts where additional value could be gained by the capabilities of Predictive Analytics as it has the potential to be more objective and faster as traditional forecasts. (Gleich et al. 2019b, pp. 116-126)

7 RECOMMENDATIONS FOR TRAINING IN CONTROLLING

Specific conclusions can be drawn from the study regarding the training and education requirements for practically active controllers.

Overall, 49 percent of the survey participants see a lack of competence among employees as the greatest obstacle to the digitization of planning, budgeting and forecasting.

In the area of planning, budgeting and forecasting, the findings of the competence analysis show that employees in accounting and reporting are comparatively well positioned. They also have knowledge of market and business development.

It is interesting to note that around 20% of companies also see a need to catch up in planning tools. Greater deficits are identified in process design (21%), forecasting tools (33%), IT tools (36%) and, above all, integrated performance management (37%). The focus of training and continuing education should then also be on the latter two categories.

In terms of personal skills, there is a greater need to catch up in the soft skills of giving impetus (27%), communication skills (19%) and openness to change (17%).

In concrete terms, this means for controller training and continuing education:

Digital technologies and their application are important. However, the analysis shows that, on the one hand, the methodological fundamentals of planning, budgeting and forecasting and, above all, their integrated application need to be trained even more intensively. A second topic area here is the active communication of market knowledge and the animation of active change. This can be generated in particular in change management workshops and presentation training courses, such as those already fundamentally provided for in level 5 of the Controller Academy training.

8 FURTHER IMPLICATIONS

Distinguish between planning, budgeting and forecasting

The results of the study showed that digital technologies are not applied equally in planning, budgeting and forecasting. For the IGC controlling process model, this means the following: For planning and budgeting, opportunities for improvement are seen via AI and scenario analysis, and automation of bottom-up planning is also seen via RPA. In forecasting, it is currently hoped that RPA will make it possible to automate the evaluation of closed data, which will also make it possible to achieve greater data accuracy and more precise sensitivity analyses.

Create awareness for opportunities and risks of digitization in planning, budgeting and forecasting

Digitization in planning, budgeting and forecasting is in an area of tension in practice. The awareness of existing potential for success is undisputed. However, companies are hesitant to tackle the topic of digitization due to (probably unnecessary) fears. Companies should implement a change management process that considers employees' fears of digital transformation. Mature training concepts are also needed to train employees' skills for the digital transformation.

Understand the strategic perspective of digitization

Digitization should be highly placed in companies to note the relevance of the topic. It belongs on the agenda of shareholders, executive boards and supervisory boards/advisory boards. Digitization should be understood as a strategically significant step for future success potential. Only if this is done centrally at a high level will a company-wide integration of digital processes and tools succeed.

Identify backlogs and eliminate them in a targeted manner

Digital technologies in planning, budgeting and forecasting are currently only used to a small percentage in practice. There is no fixed recipe for success for a successful digitization strategy. Rather, it requires digitization concepts adapted to the corporate context. It can be helpful to look at the digitization project in two parts: In the first step, process and methodological adjustments are developed through digitization, and in the second step, these are transferred into systems and tools.

9 CONCLUSION

In summary, the study has yielded several important implications for theory and practice. Companies have recognized that digital technologies for the controlling subprocess of planning, budgeting and forecasting each offer different potentials in terms of increasing efficiency and effectiveness.

With regard to digitization, it even seems necessary to consider the topics of planning and budgeting on the one hand and forecasting on the other hand somewhat separately.

In planning and budgeting, the companies recognize that digital technologies can on the one hand make the process faster and also increase the accuracy of planning (and thus the information content). Here it is again important to address the difference between planning and budgeting compared to forecasting. In the future, too, good planning should contain an action-steering element in the sense of "what do I want to do" and not just consist of extrapolating "where will we get to". In this respect, there are at least certain limits to automation here. Not yet applied by the companies in the study, but already hinted at both in theory and in the current CIMA paper on corporate planning, is the possibility of largely automating bottom-up planning in the companies and only providing for a "manual override" from the management's point of view. This could free up valuable controller capacities for other topics. Also of interest for risk-oriented corporate management is the scenario-based evaluation of existing data. Machine learning and driver-based planning can provide support here. In terms of controller competencies, companies need to sharpen their skills in the supposed core areas of planning tools, but also in performance management and IT knowledge. Even if artificial intelligence is seen as the core technology of the future - which is correct - limits and restrictions should become clear here: In controlling in particular,

aspirations and reality too often contradict each other. The current IT landscape in most companies, even larger ones, does not yet allow for information at the push of a button. SAP HANA and connection to the Analytics Cloud will make even more possible in the future, but machine-based decisions are neither possible nor desirable from a controller's perspective. On the other hand, the study shows that many companies do not implement the existing and quite inexpensive "low hanging fruits" through RPA, for example, because the necessary competencies are not available internally. AI should therefore be demystified and provided with realistic expectations.

In terms of efficiency and effectiveness, there is probably more potential to be tapped in forecasting than in planning and budgeting. Machine learning can help to extrapolate even large amounts of data and increase the accuracy of forecasts. In this respect, faster and more agile countermeasures can also be taken in companies. Here, it is not so much the supposed lack of data or inadequate tools that fail, but on the one hand the partial lack of business understanding and on the other hand the communication skills.

For the future, a reference model with the digitization steps for planning, budgeting and forecasting should be developed. The following checklist shows a few more important points here:

- Planning and budgeting: check the set-up of the planning process; check data sources for consistency; identify time-lags in the planning process and determine any automation potential in bottom-up planning; use AI primarily in the area of bottom-up planning, but maintain the ultimate primacy of humans.

- Forecasting: Aggregate and standardize data sources for current forecasts;

create a uniform IT data basis; identify
automation potential and exploit it
through machine learning; establish
more agile and faster feedback cycles.

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11 THE AUTHORS

Prof. Dr. habil. Patrick Ulrich

Prof. Dr. habil. Patrick Ulrich is a full professor for corporate management and control at Aalen University and spokesman of the board of directors of the Aalen Institute for Corporate Management (AAUF). He is also a private lecturer at the Otto-Friedrich-University of Bamberg and a lecturer at several other universities and colleges. In his doctoral and post-doctoral studies, he dealt with the management and controlling of family businesses. His current work focuses on digital transformation, governance, risk and compliance (GRC), management accounting, strategic management and sustainability with an emphasis on SMEs, midsized companies and family businesses.

Prof. Dr. Robert Rieg

Prof. Dr. Robert Rieg is full professor of management accounting and control at Aalen University in Germany. He serves as vice dean for research in the faculty of business and is head of the master program Financial Management (M.Sc.). After graduating from Hohenheim University he worked as a consultant. His current research covers changing roles of management accountants and digitalization in management accounting and control.