RNDP

Research Notes on Data and Process Science

Article

Agile working during COVID-19 pandemic

C. Doering, M. Schmidtner, J. Maerz, V. Mueller, H. Timinger

The Institute for Data and Process Science (IDP) is a research institute of the University of applied Sciences Landshut, Germany.

The Research Notes on Data and Process Science is published digitally at least twice a year by the IDP. Responsibility for the content rests upon the authors and not upon the IDP.

All articles are peer reviewed by at least two reviewers.

Agile working during COVID-19 pandemic

Table of contents

List of abbreviations

COVID-19	Coronavirus Disease 2019
Fig.	Figure
IDP	Institute for Data and Process Science
RQ	Research Question
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
WHO	World Health Organization

Abstract

Agile working and its values have been applied by companies for several years. The values and principles of agile working aim primarily at teams that work in close proximity, for example in open-plan offices, where the teams usually work together and communicate in daily personal meetings. With the onset of the COVID-19 pandemic, many companies reduced office hours and sent their employees to home offices, in order to reduce the risk of infections. Accordingly, the way of working changes significantly, as despite all the technical advances, working from home is different from working in open-plan offices. Direct face-to-face communication has been replaced by online meetings using video conferencing, chats and cloud-based collaboration. Many employees were used to online-based tools for remote collaboration, but others were reluctant to them in the past. Due to the sudden change in the work environment a need to use these tools in order to participate in business at all arose also for the employees who would not have used them under normal conditions.

In this article, we present the results of a recent study, in which the impact of the pandemic on agile working is examined. Based on these results, we derive a scenario of the future of agile working in a post COVID-19 world. The study comprises an online survey in Germany. More than 170 people working in different job positions and from different branches and companies participated. The study reveals that the pandemic has significantly changed the way of working. However, people value the digital tools and find ways for effective and efficient collaboration in distant work environments.

1   Introduction

Agile working and management gained their popularity mostly with the publication of the agile manifesto by Beck and others in 2001 [1]. Currently the values and principles of agile management are one of the most important topics in leadership, technology and project management. Although agile working stems from software development, it is nowadays used for various new agile leadership and management techniques as well as for process models for project management. Scrum and Kanban are the most widespread models [2]. Agility allows for a rapidly and iteratively adaption to changing markets and customer requirements. It provides teams with a high degree of flexibility for the organization of their work. Agile capabilities and work culture can help companies to innovate rapidly. The benefits of agility are promising. A study found that 56% of CEOs forecast the implementation of agile management to increase their business responsiveness and their innovation ambitions [3]. Today, even large companies which used to follow traditional innovation and development processes change to agile process models in order to keep pace with societal and customer needs and come up with innovative products [4]. All the benefits from agile working are based on employees, who work self-organized in close proximity to ensure constant exchange between them and the customer. One main characteristic of agile working are therefore teams who collaborate in close vicinity in open space offices and communicating in daily face-to-face meetings.

In the end of 2019, first reports about a pneumonia of unknown cause were published [5]. It was totally unclear how this pneumonia would change the global health, society and economy. Over spring 2020 the virus spread over the whole world and in April 2020, more than 1,500,000 confirmed cases of infection with the SARS-CoV-2 virus were reported and 100,000 peopled died from this disease, called COVID-19. By end of October 2020, the numbers increased to almost 46,000,000 infections and more than 1,200,000 deaths, both are still increasing [6]. The World Health Organization (WHO) published recommendations to reduce the infection rate significantly and many countries followed these proposals. Unfortunately, a lack of medical drugs and treatment challenged the health care systems of the WHO member states. Public life had to be shut down, schools and stores were closed and most of events were prohibited. Also people were prompted to minimize social contacts and travel was significantly reduced [7]. Obviously, companies were severely affected by these propositions. Many reduced office hours and asked their employees to work from home. After all the technical possibilities the isolated work situation differs significantly from a close collaboration in open space offices. This study was initiated in order to examine the impact of this remote way of working on agility and productivity. The most important agile collaboration meetings are regular stand-ups, reviews with customers and suppliers, and internal retrospectives for process improvements. Thus, the first research question to be addressed by the study is:

RQ1: How did the measures, which were introduced due to the COVID-19 pandemic, change the way of working regarding meetings, reviews, and retrospectives?

Since current technology and services promise great collaboration also in remote working conditions, the second research question is:

RQ2: Which digital tools and services where used for remote collaboration and how well did they work?

Based on the answers to these questions, a scenario for a post-COVID-19 world was derived to examine if the current way of working will outlast the pandemic. Thus, the final research question is:

RQ3: How is the future agile collaboration affected by the experiences made with remote collaboration during the COVID-19 pandemic?

We try to answer these questions in this article. In the following Section, the research method is explained. The results are summarized in Section 3 and discussed in Section 4. A conclusion is provided in Section 5.

2 Methods and Materials

2.1 Data Collection

As the aim of the study was to identify how the way of working changed due to the COVID-19 pandemic, the objectives were integrated into 46 questions in a standardized questionnaire. First, general questions about the company and project work were asked, followed by general questions about the handling of the pandemic within the work environment. Then, questions about the way of working before and during the COVID-19 pandemic and regarding technical tools and infrastructure were integrated. As in Germany, most restrictions released to reduce the number of infections became effective March 17th, 2020, this date defines the beginning (of the effects) of the COVID-19 pandemic in this study. Before starting the main study, a limited pilot study was

conducted to check the validity of the study design. After successfully passing this check, we distributed the study via various digital channels (e.g. LinkedIn, Twitter, websites and professional online networks) in order to reach the target groups directly. The main target groups of this study were managers and project management experts in Germany. The study had a runtime of 25 days, from April 7th to May 1st, 2020. The study is realized as a standardized questionnaire with prescribed answers, free text fields and checkboxes for given topics [8].

Therefore, the collection of data differentiates into quantitative and qualitative data. Quantitative data comprises the group of participants, the size of the companies of the participants, the industrial sector and the job position. In total, 171 participants completed the study, of whom the main part of 40.4% works in companies with 1000 or more employees in the sectors of automotive supply industry (16.1%), the electronic and electrical engineering (13.2%) and in software/IT business (10.3%). In order to test how the answers reflect the real situation of the COVID-19 related measures and

to prove the representativeness of the study, a reliability test (Cronbach's alpha model) was conducted [9].

$$\alpha_{st} = \frac{N*r}{1+(N-1)*r}$$

Where:

α	Cronbach's alpha
N	171
r	average correlation between the items (Pearson correlation)

The Cronbach's alpha was found to be greater than 0,9 for all questions with a 95% confidence level and 5% margin of error, which confirms the representativeness of this study.

2.2 Quality Criteria of Data

The extent to which this study conforms to the quality attributes of a qualitative study can be described by the quality criteria of Mayring, Steinke, Döring and Bortz [8][10][11]. Together with validity and objectivity, reliability represents the three most important quality criteria. Reliability is shown by the
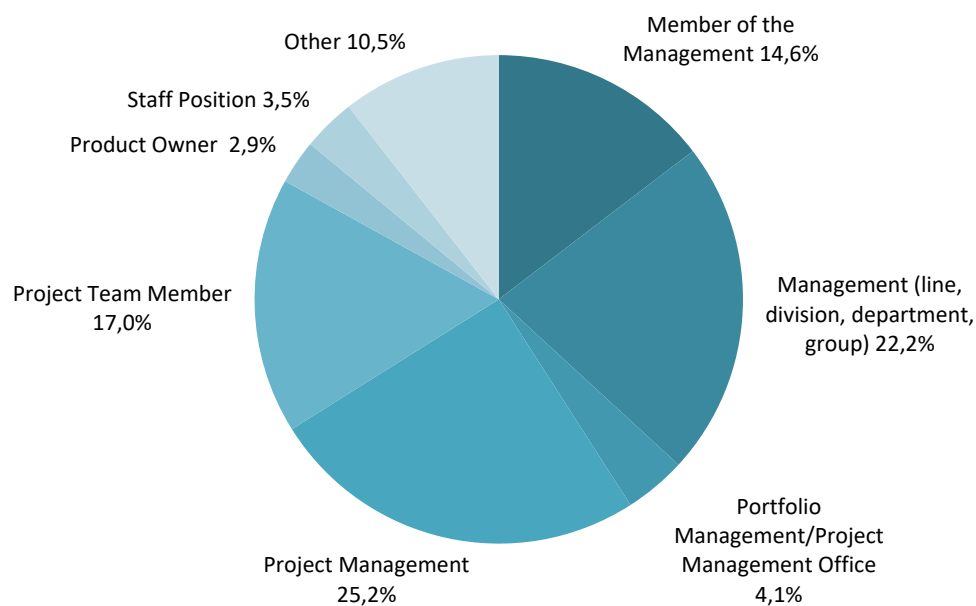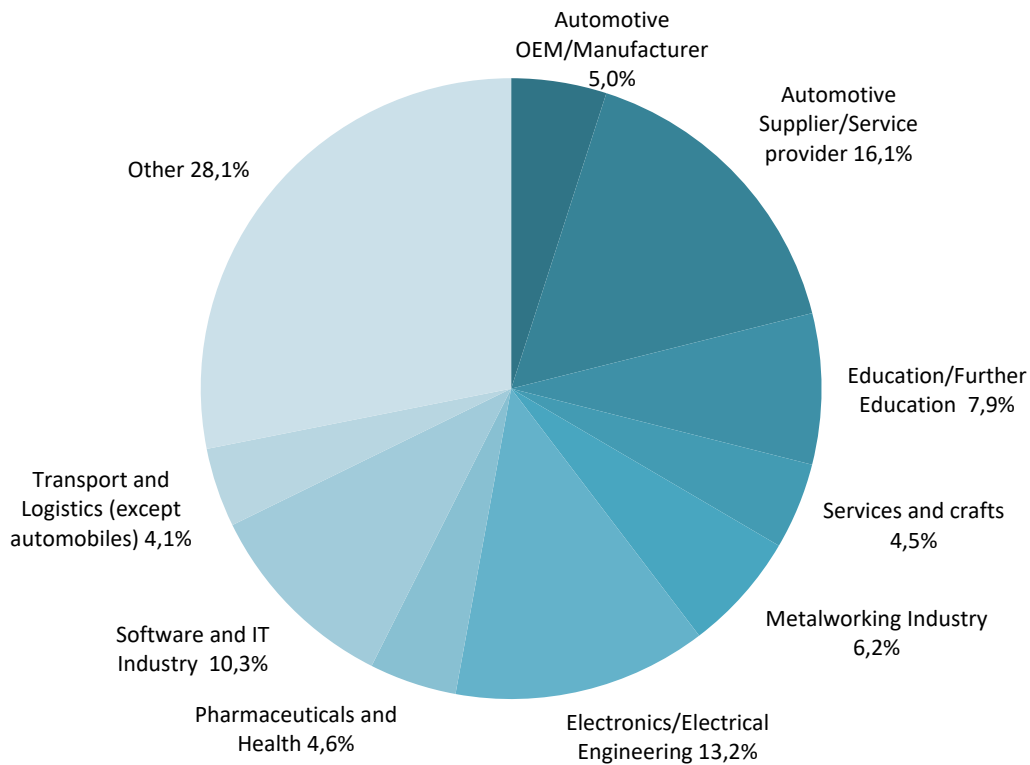

Fig. 1 Participants by job position

Fig. 2 Participants by industry

Cronbach's alpha model, whereas validity can be ensured through the conducted pilot study. Objectivity is ensured by the standardized and anonymized evaluation of the study.

3 Results

The survey reflects the expertise and experiences of different (project) managers in Germany.

3.1 General and Participant-Related Questions

The survey was completed by 171 participants. As Fig. 1 shows, 25.2% of participants stated to work as (leading) project managers and 22.2% as line manager in a department, division, or group. 17.0% work as a project team member. 14.6% are part of (other) management 10.5% of the participants have selected none of the predefined project management

roles. The free text field indicates an academic background for most of them. The remaining percentages are split between portfolio management (4.1%), staff position (3.5%) and product owner (2.9%).

Fig. 3 Participants by company size

Agile working during COVID-19 pandemic
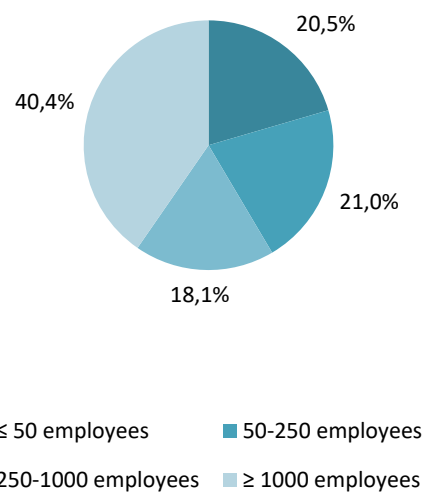
As shown in Fig. 2, the survey has participants from a wide range of different industries, automotive suppliers (16.1%), electronics/electrical engineering (13.2%) and software/IT business (10,3%) being the most common ones.

Fig. 3 shows the different sizes of companies the participants work for. 40.4% of all participants work at a company with 1.000 or more employees. 20.5% work at a company with less than 50 employees. The remaining participants either work in a company between 50 and less than 250 employees (21.0%) or between 250 and less than 1000 employees (18.1%).

3.2 Questions Regarding Company Organizations

Most of the participants (44.4%) stated that there were no company-internal emergency plans about how to address a situation like the COVID-19 pandemic before the pandemic. 22.8% of the participants were aware of such plans and 32.8% were unsure if such plans existed. As shown in Fig. 5, 51.3% of the participants who did not have emergency plans in place were unsure if such guidelines would be implemented in the future. 31.6% expect no such plans in the future while
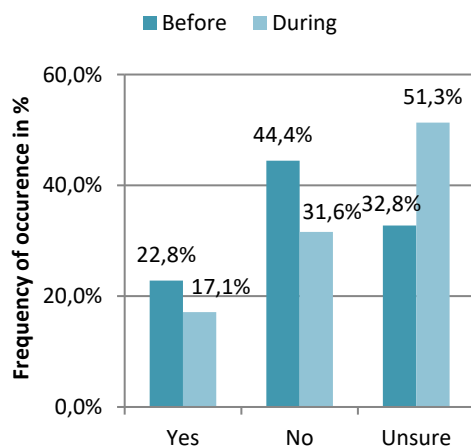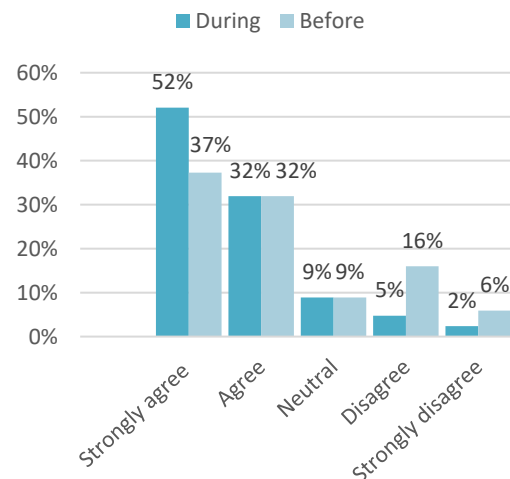

Fig. 4 How well was the organization able to adapt to the COVID-19 pandemic

17.1% expect the implementation of future emergency plans.

When asked if the organization of work in their company (flexible work time model, home-office regulations) before the pandemic was able to adapt to the COVID-19 measures, 37.0% of the participants strongly agreed with how well their current organization was able to adapt. 32.0% simply agreed and 9.0% were neutral. The remaining participants disagreed (16.0%) or disagreed strongly 6.0%. As Fig. 4 shows, most of the participants (52.0%) strongly agreed or agreed (32.0%) that the work organization was adapted quickly to the current situation, while 9.0% were neutral. Only a minority (strongly) disagreed.
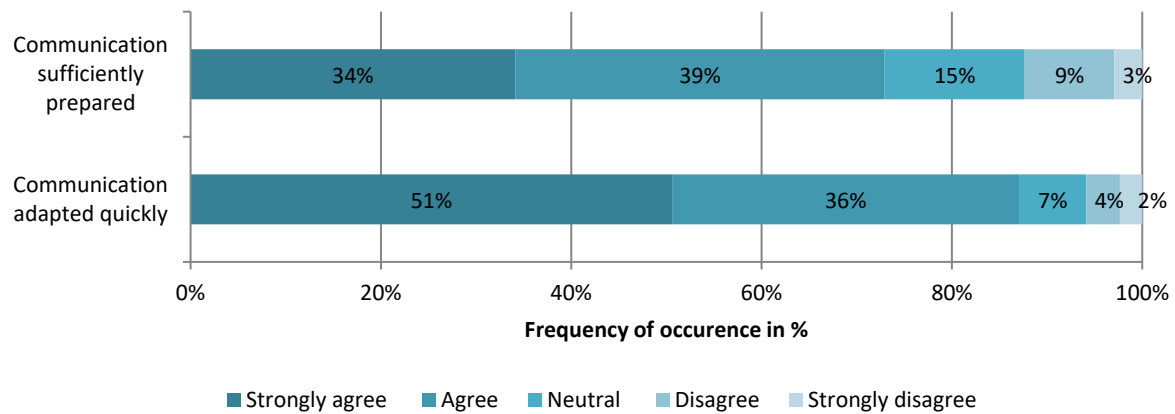

Fig. 5 Guidelines and emergency plans in case of a pandemic

Fig. 6 Adaption of internal communication before/during the pandemic

When asked if their company had digital tools (e.g. notebooks, video conference systems, cloud space) available to react appropriately to the pandemic, many participants agreed (38.0%) or agreed strongly (40.0%). 9.0% were neutral. Only few either disagreed (10.0%) or disagreed strongly (3.0%). Similar results were observed when participants were asked if their company was able to quickly provide necessary digital tools after the pandemic had begun(Fig. 7). 47.0% agreed strongly, while 30.0% simply agreed and 12.0% had a neutral opinion. Only a small part of the participants (strongly) disagreed.
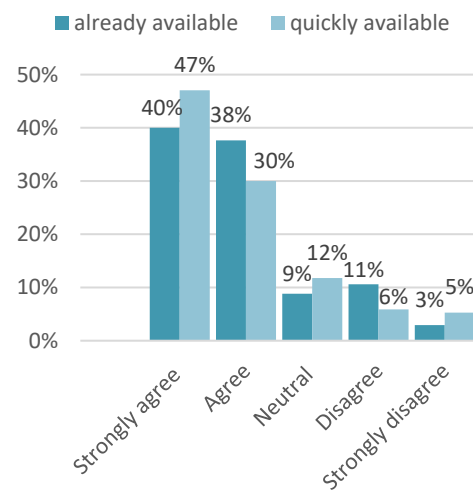
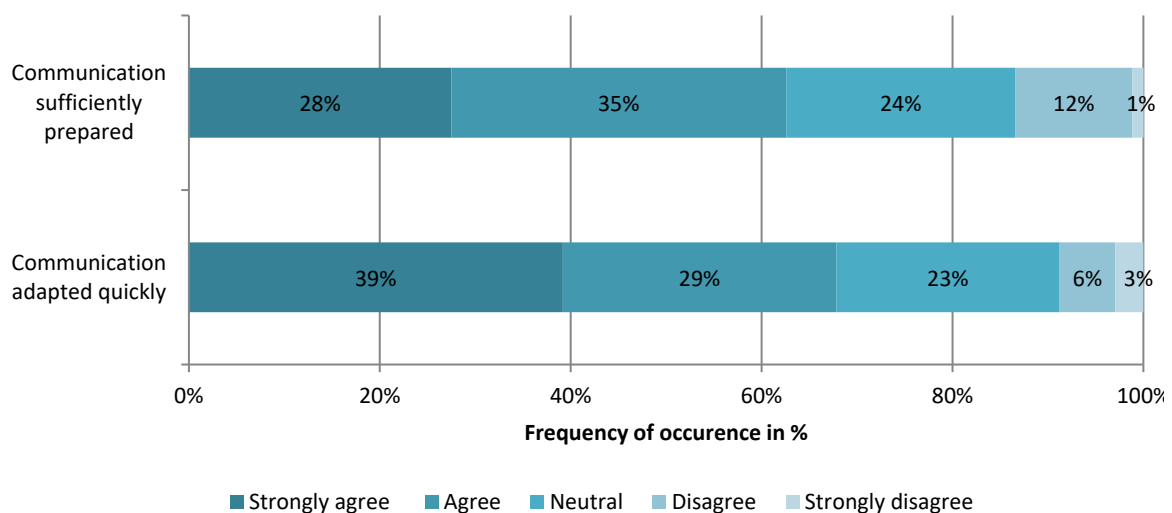**Fig. 7 Availability of digital tools before and during the pandemic**

Fig. 8 Adaption of external communication before and during COVID-19 pandemic
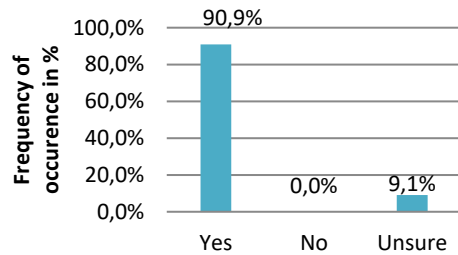
Fig. 9 New protective measures for personal meetings

The participants were asked, if their internal structure of communication before the pandemic was organized to allow for quick adaption to the new situation. Most participants agreed (39.0%) or strongly agreed (34.0%), while 15.0% had a neutral opinion. Again, only a minority disagreed (strongly) (Fig. 6). Despite these rating, 51.0% of the participants strongly agreed, that the actual adaptation to the new situation was accomplished quickly. 36.0% simply agreed and 7.0% were neutral.

A similar question was asked regarding the external communication structure (to customers, suppliers)

(Fig. 8). Most participants agreed (35.0%) or strongly agreed (28.0%) that their company had a well-organized communication structure, which was able to adapt to new situations. 24.0% had a neutral opinion. A minority disagreed (strongly). The actual adaptation after the pandemic started was rated quickly by most participants: 39% strongly agreed, 29% agreed and 23% were neutral.

Fig. 9 shows, almost all participant (90.9%) had new protective measures for personal meetings introduced in response to the pandemic. 9.1% were unsure, if additional or new protective measures were introduced. No participant answered that there were no protective measures in place.

If the participants had stated that protective measures were introduced, they were additionally asked about the nature of the protective measures. Fig. 10 shows that 90.0% were instructed to keep a minimum distance to others, while only 10.0% stated that they have specific markings for keeping distances.
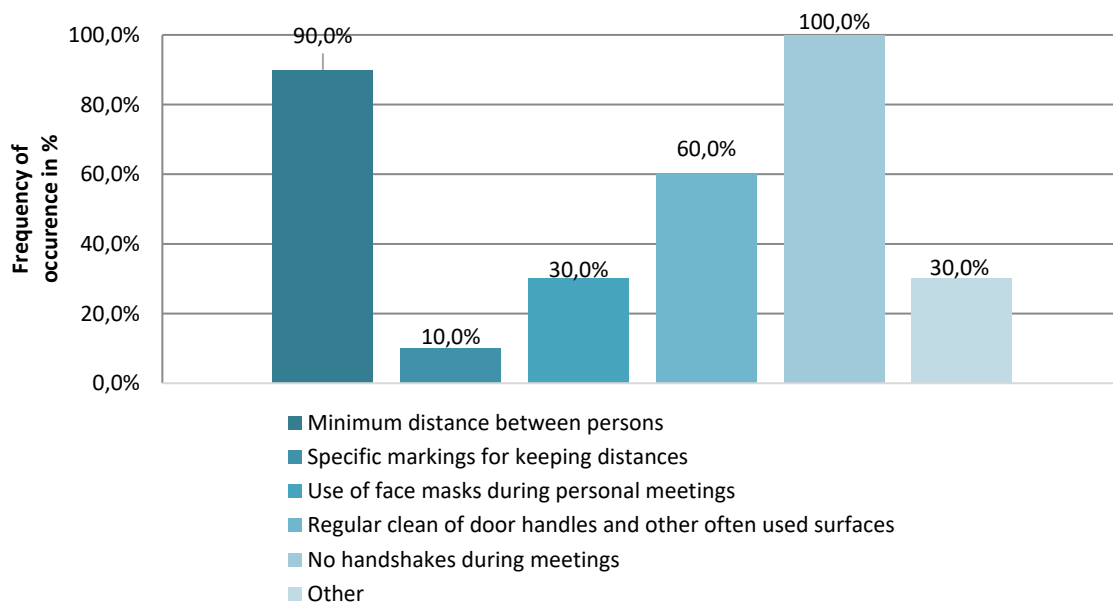

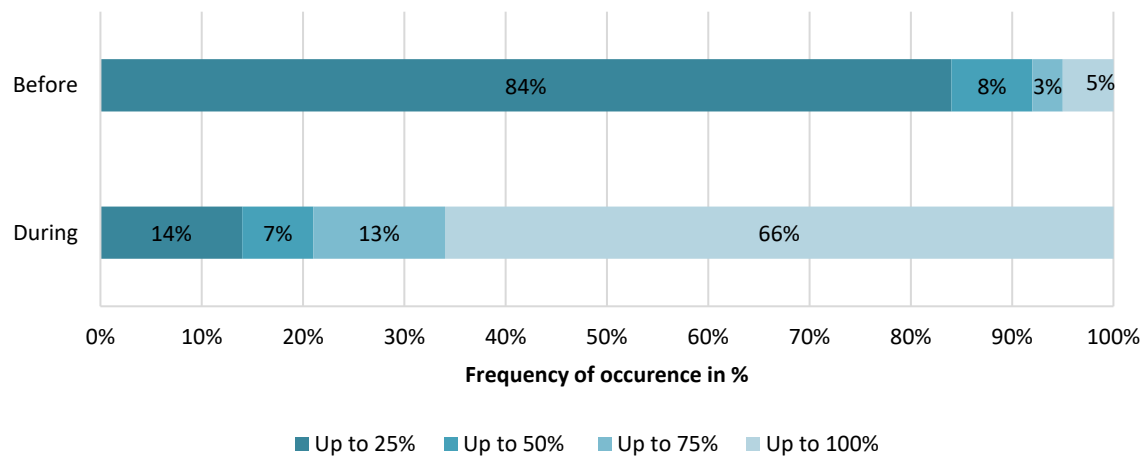**Fig. 10 Protective measures introduced for personal meetings in response to COVID-19**

Fig. 11 Percentage of home-office before and during COVID-19

100.0% of participants forgo handshakes. Participants also stated that 60.0% now regularly clean surfaces like door handles. Only 30.0% stated to use face masks during personal meetings. Also, 30.0% stated that other measures were in place, like stations for disinfectants, permanently opened doors and a reduced maximum number of persons allowed to meet simultaneously.

3.3 Questions Regarding Home-Office

As Fig. 11 shows, participants were asked what percentage of their work was usually done from home before COVID-19 pandemic. 84.0% stated that they usually did less than 25% of their work at home. 8.0% stated that between 25% and less than 50% work could be done from home. 3.0% of participants stated they usually worked between 50% but less than 75% from home. The remaining 5.0% stated that 75% or more of their work was accomplished in home-office. These figures changed drastically after the COVID-19 pandemic began. Now, 66.0% of participants accomplish 75% or more of their work from home. 13.0% stated to work between 50% and less than 75% from home. Between less than 50% and 25% of their work is

done in home-office by 7.0% of participants. Only 14.0% stated that they accomplish less than 25% from home.

Another question of this study was how participants expect the percentage of home-office to develop after the COVID-19 pandemic will be over. As shown in Fig. 12, 25.4% expect a significant increase while 40.8% expect only a slight increase compared to the time prior to the pandemic. 31.4% expect a
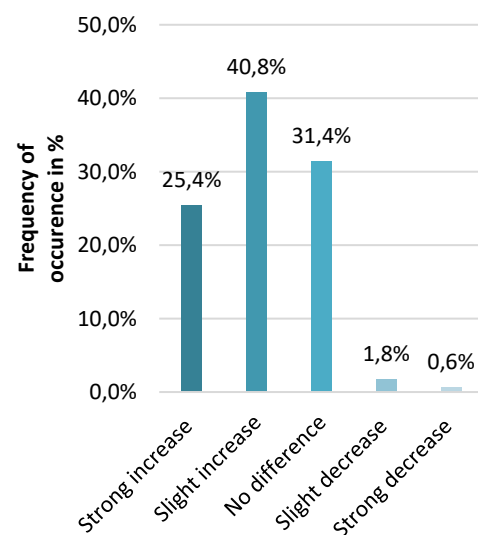

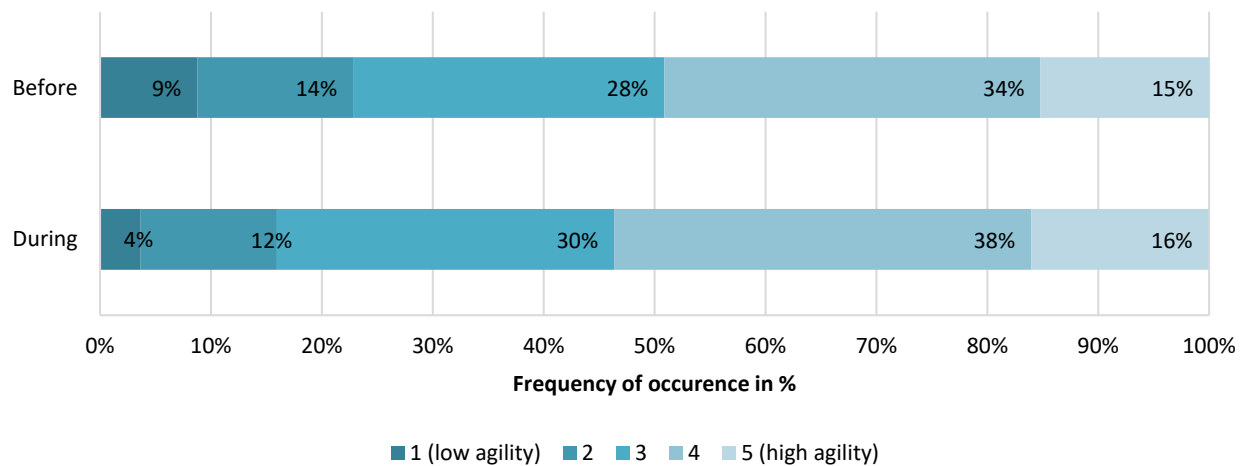**Fig. 12 Development for home-office after the pandemic ends**

Fig. 13 How participants perceived the agility of their projects before/during the pandemic

comparable level and only a minority expect some decrease.

3.4 Questions Regarding Working Methods

This section elaborates how the COVID-19 pandemic effected the working methods. The participants were asked to rate how agile they perceive their projects on a scale of 1 (low agility) to 5 (high agility), see Fig. 13. Before the start of the current pandemic, the minority of participants rated their projects with a low agility score of 1 (9.0%) or 2 (14.0%). 28.0% rated their projects with a medium score of 3. Most of the participants rated their

projects with a high agility score of 4 (34.0%) or 5 (15.0%). The average score is 3.3. In comparison to this, participants were asked to rate the agility of their projects during the COVID-19 pandemic. Now, less participants rated their agility with a score of 1 (4.0%) or 2 (12.0%). 30.0% now gave the projects a medium score of 3. The majority still rated their project agility with 4 (38.0%) or 5 (16.0%). The average score slightly increased to 3.5.

Similarly, participants were asked to rate their productivity before and during the pandemic on a scale from 1 (low productivity) to 5 (high productivity). As seen in Fig. 14, a minority of
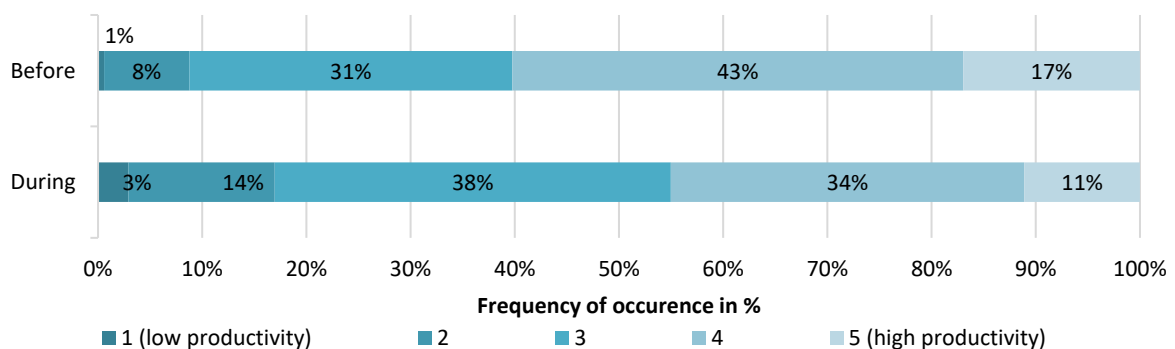

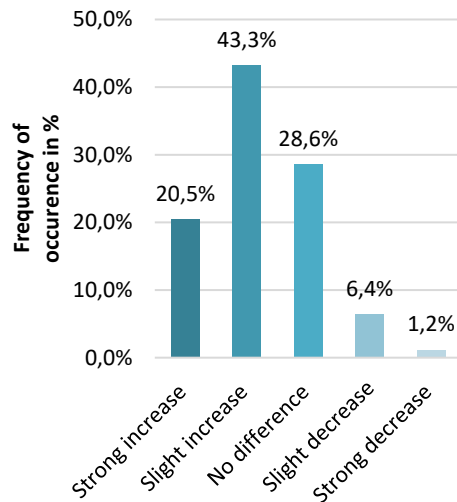**Fig. 14 How participants perceived their productivity before and during the pandemic.**

Fig. 15 Flexibilization of working methods

Fig. 16 Usage of digital tools during the COVID-19 pandemic

participants rated their productivity with a score of 1 (1.0%) or 2 (8.0%). 31.0% rated their productivity with a medium score of 3, while the majority gave a score of 4 (43.0%) or 5 (17.0%). The average score for productivity before the pandemic was 3.7. Compared to this, the participants gave slightly lower scores for productivity during the COVID-19 pandemic, see the lower row of Fig. 14. During the
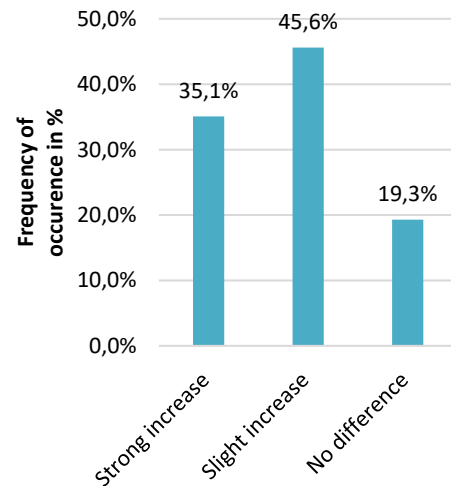
pandemic, the average score for productivity has decreased slightly to 3.4.

Additionally, the participants were requested to rate how the COVID-19 pandemic affected the flexibility of their working methods, see Fig. 15. The majority stated that they either perceive a strong (20.5%) or moderate (43.3%) increase in flexibility. 28.6% saw
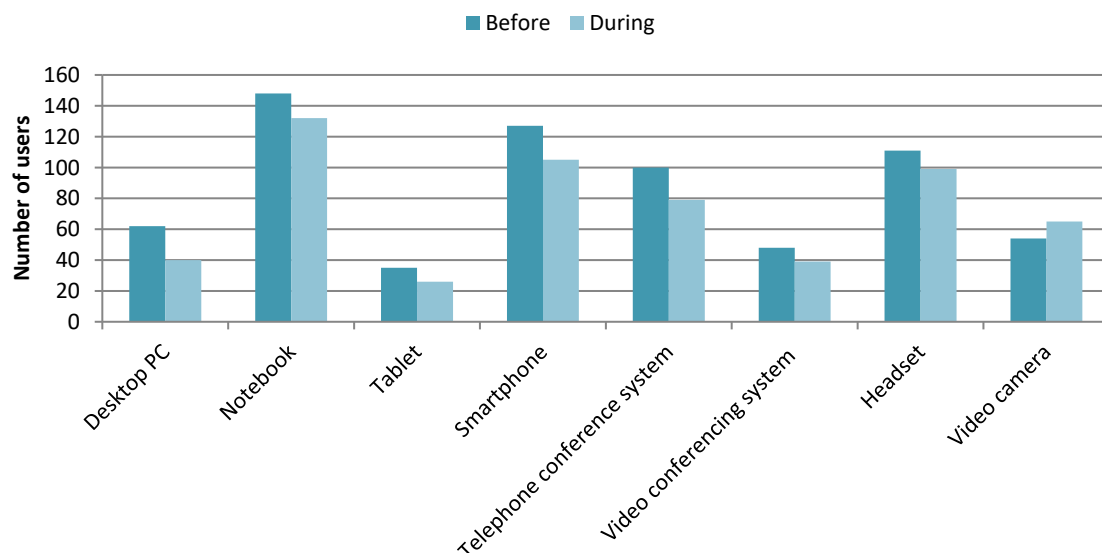

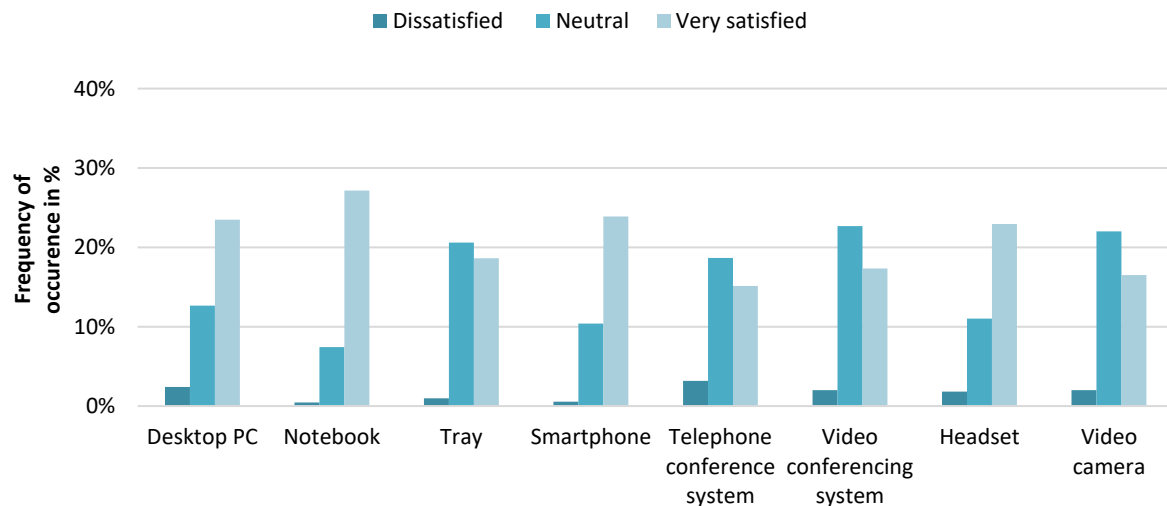**Fig. 17 Usage of hardware equipment before and during the COVID-19 pandemic**

Fig. 18 Satisfaction of the participants with their hardware equipment.

no difference in flexibility. A minority stated that their flexibility moderately (6.4%) or strongly (1.2%) decreased.

Similarly, the participants were asked about their usage of digital tools like software for video conferences or chats during the COVID-19 pandemic. As Fig. 16 outlines a vast majority stated

either a significant (35.1%) or moderate (45.6%) increase in the usage of digital tools.

In Fig. 17, the participants were requested which of the above-mentioned IT tools they used before and during the pandemic. A decline in the use of almost all media can be observed. Only headsets show a slight increase in usage.
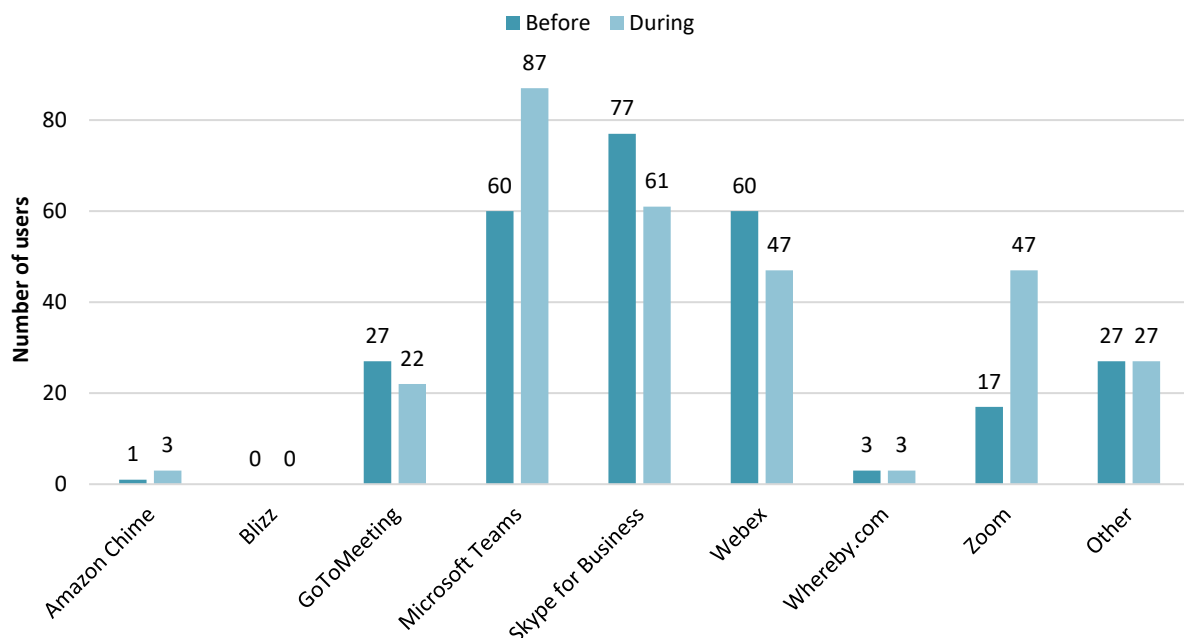

Fig. 19 Usage of video conference tools before and during the COVID-19 pandemic
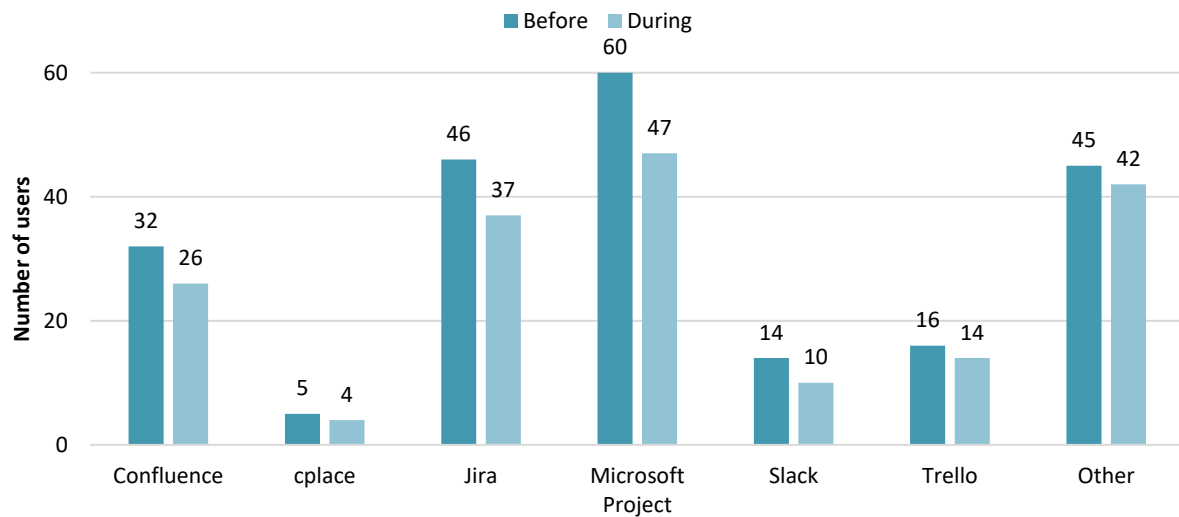
Fig. 20 Usage of specific project management tools before and during the COVID-19 pandemic.

About two thirds of the participants are very satisfied with their hardware equipment, the rest are neutral. There are hardly any dissatisfied participants (see Fig. 18).

The participants were asked, which video conferencing software was used before and during the COVID-19 pandemic (Fig. 19). A notable increase happened for the online conference tools Microsoft Teams (60 to 87 users) and Zoom (17 to 47 users). Since the participants could select multiple answers, there is no relative distribution given in percent. The participants were also asked if they like their respective tools. Most participants are pleased or neutral to the selected video conferencing software.

In Fig. 20, the usage of software for project management is illustrated. Interestingly, there is a slight decrease in all tools during the pandemic, albeit the drop is only minor.
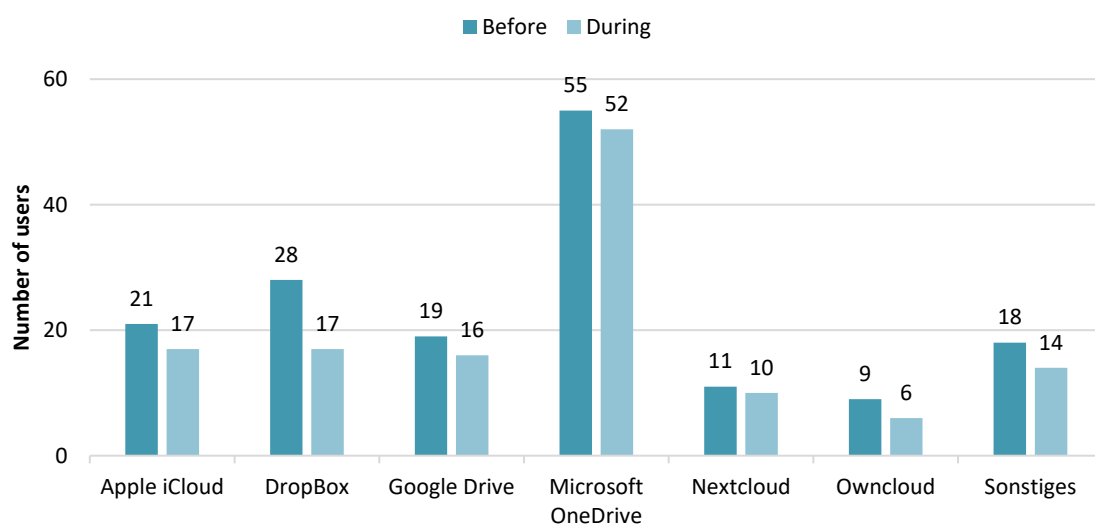

Fig. 21 Usage of specific cloud tools before and during the COVID-19-pandemic.
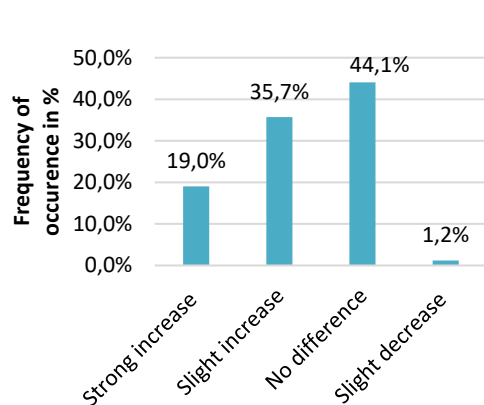
Fig. 22 Usage of mobile hardware during the COVID-19 pandemic

Fig. 23 (Stand-Up) meetings before and during the COVID-19 pandemic

The use of cloud storage is shown in Fig. 21. Most of the cloud tools are used approximately at the same level as they were before the pandemic. Again, the participants enjoy the application of the cloud storage functionality.

Additionally, the participants were asked how they perceive the usage of mobile hardware such as notebooks or tablets after the start of the pandemic(Fig. 22). Most participants stated that they either observed a significant (19.0%) or moderate (35.7%) increase in usage. 44.1% or observe a
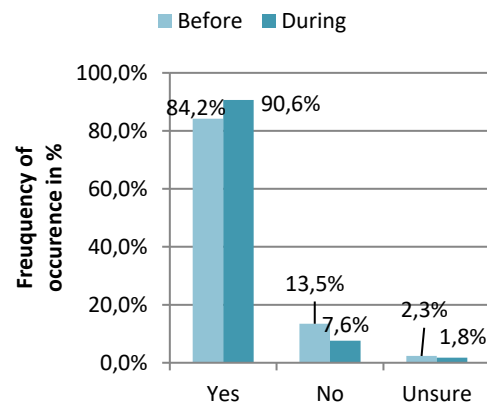
similar usage as it was before. No participant reported a significant decrease.

Fig. 23 answers the question of whether regular meetings or stand-up meetings were held in the projects after the beginning of the pandemic. 90.6% of the participants stated that this was the case after the onset of the pandemic. Before the pandemic, only 84.2% answered 'yes'. This results in a significant increase in meetings during the pandemic.

In addition, participants were asked to indicate how meetings were conducted (Fig. 24). Before COVID-19, 69.5% of respondents said they would hold their
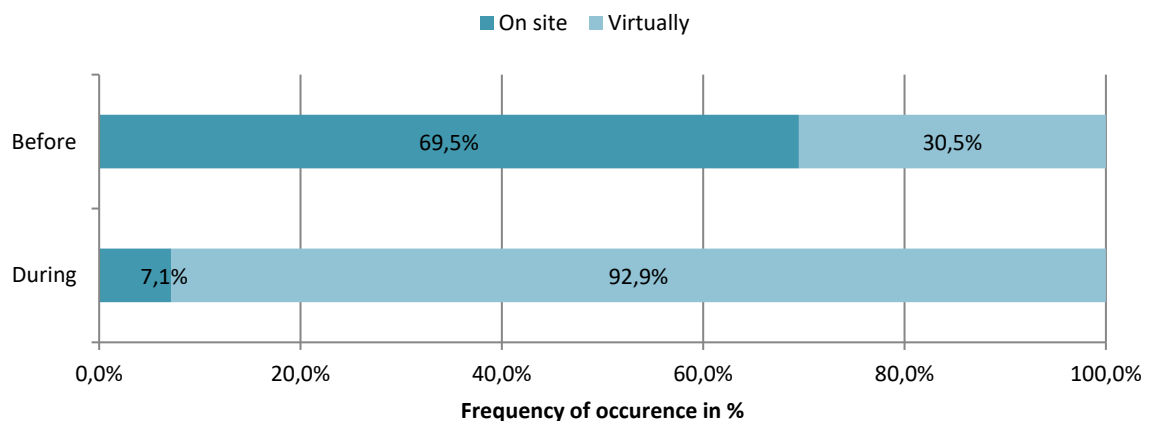

Fig. 24 Type of stand-up meetings before and during the COVID-19 pandemic.
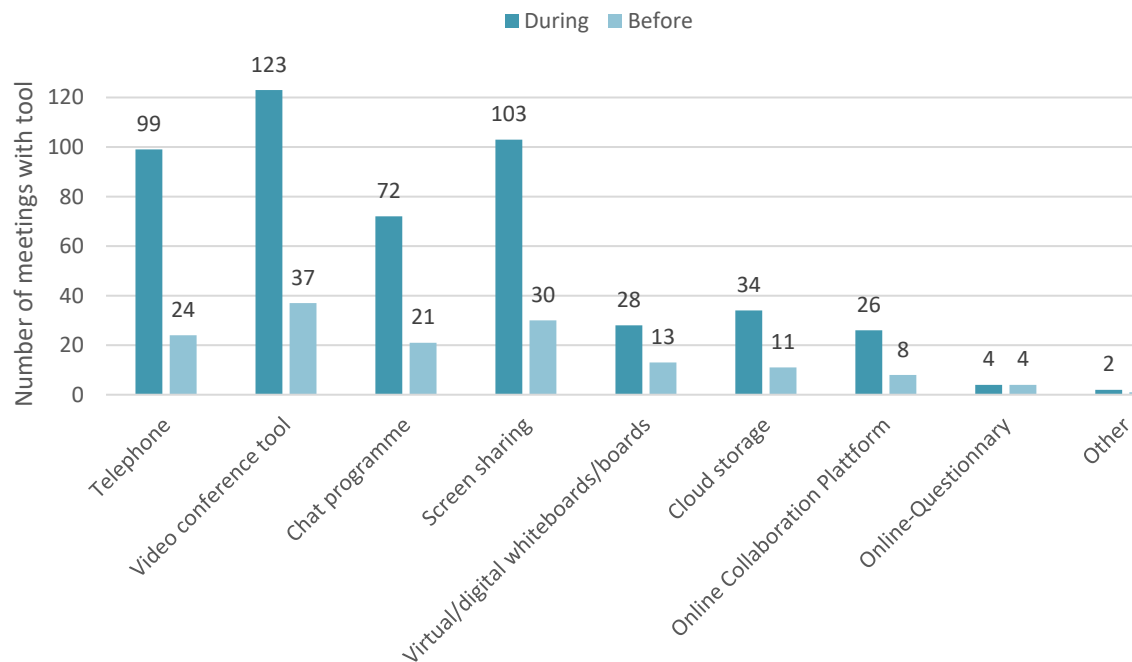
Fig. 25 Digitization of stand-up meetings before and during the COVID-19 pandemic.

regular Stand-Up meetings on site. The pandemic has reduced this share to 7.1%. This means that 92.9% of participants held meetings virtually.

With regard to the digitisation of meetings held, the numbers are very close before and after the beginning of the pandemic (Fig. 25).

In addition, the participants were asked to what extent they carry out reviews and consultations with their customers or clients. Before the pandemic,
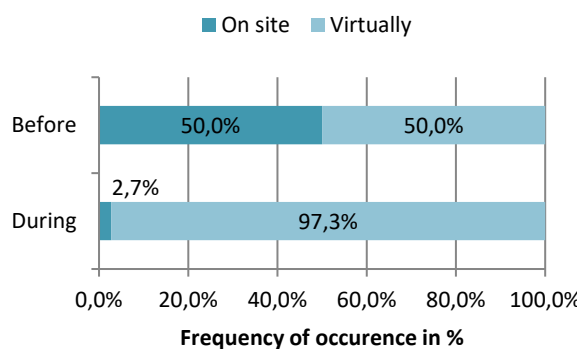
76.0% of participants said they regularly met with customers. In comparison, during the COVID-19 pandemic, it was only 64.9%(Fig. 27). This results in a sharp decline in reviews during the pandemic.

As with the meetings, the question of the form of the reviews was addressed(Fig. 26). The relationship between "on-site" and "telephone / via video / digital / online" has changed considerably in terms of before
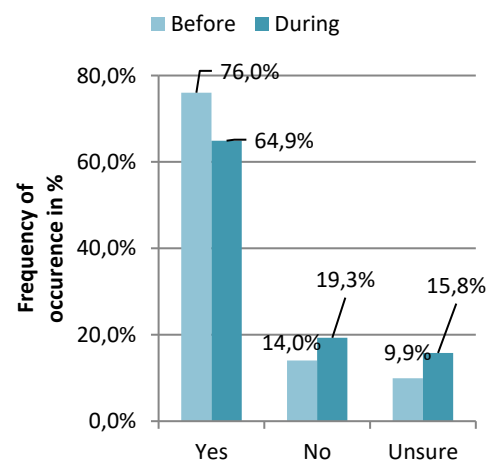

Fig. 26 Comparison of on-site and virtual review before and during the pandemic

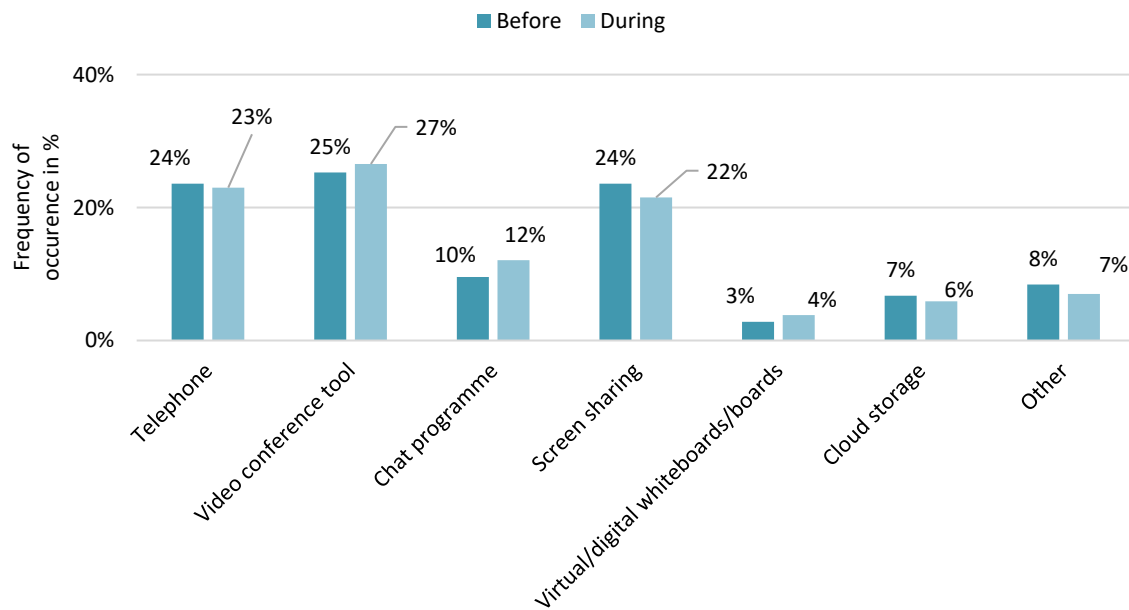**Fig. 27 Reviews with customers before and during the COVID-19 pandemic**

Fig. 28 Digitization of reviews before and during the COVID-19 pandemic

and after the beginning of the pandemic. Before the pandemic, 50.0% of participants said they did not carry out their reviews on the spot. During the pandemic, however, it is 97.3%, which means that reviews only take place online.

As Fig. 28 shows, video conferencing tools are most widely used when talking to customers, similar to internal meetings. The difference before the pandemic (25%) and during the pandemic (27%) is

low, however. Just like when using the phone with 24% and 22%. By contrast, the number of participants who use chat programs to talk to their customers rose from 10% to 12%.

Fig. 29 shows how the implementation of process improvements/reflections has changed. Prior to COVID-19, 59.1% of participants said they were optimizing their processes. After the beginning of the pandemic, the number was only about half of all respondents. Thus, a slight decrease in reflections
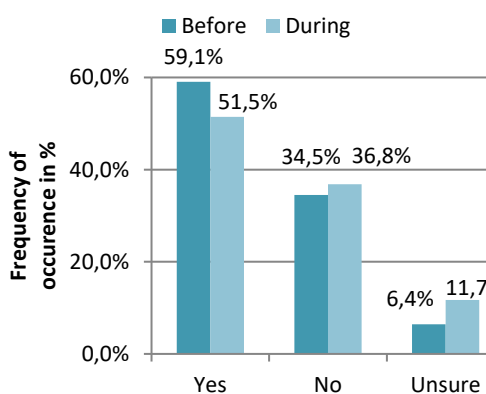

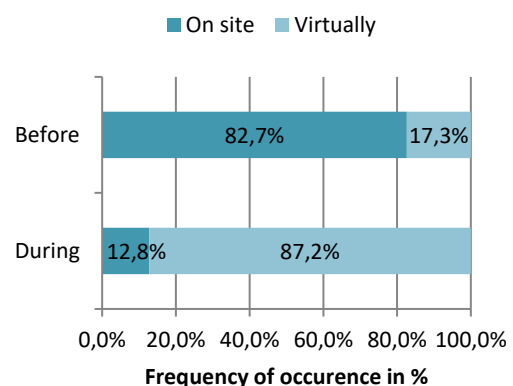**Fig. 29 Internal reflections/process improvements before and during the COVID-19 pandemic**

Fig. 30 Type of reflections/process improvements before and during the COVID-19 pandemic
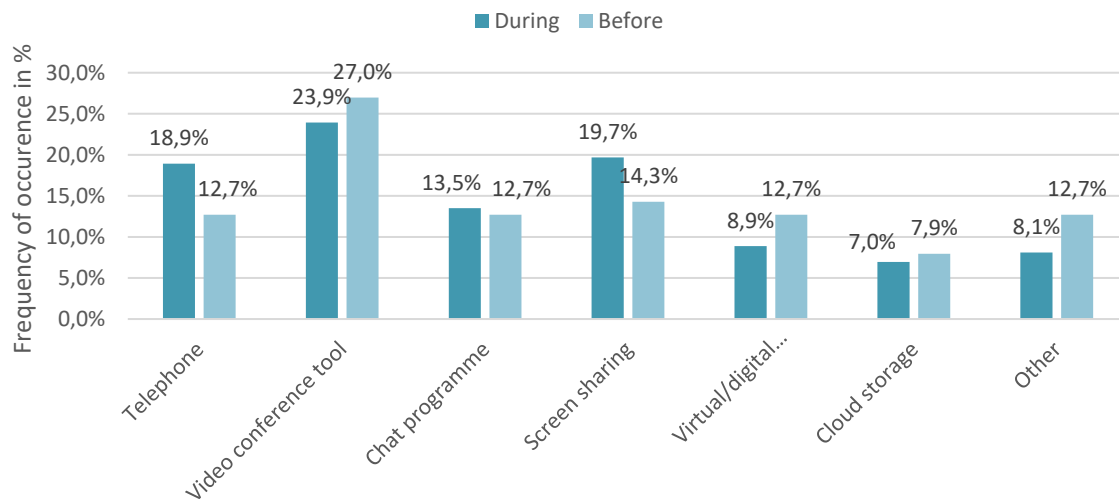
Fig. 31 Digitization of reflections before and during the pandemic.

can be concluded. Around 35% said before and during the pandemic that they would not make any process improvements.

Before the onset of COVID-19, 82.7% of the participants stated that they would improve their processes directly on site, afterwards it is only 12.8%. As a result, 87.2% of respondents plan and control the improvement of processes by telephone / video / digital or online (Fig. 30). There is therefore a reversal of the species.

When asked which tools were used for reflection/retrospectives/process improvements in their own team prior to the COVID-19 pandemic, videoconferencing tools (27%), screen sharing (14.3%), as well as telephone and chat programs (12.7%) were the most frequently mentioned tools (Fig. 31). After the onset of the pandemic, the tools remained largely unchanged.

4 Implications

This section discusses the effects found in the data that correlate with other studies.

A very surprising discovery of this study is that about 20% of the participants already had pandemic emergency plans (Fig. 5). However, this percentage is low when one considers that the German government has already recommended precautions for a corona virus pandemic in 2012. This recommendation was later even extended to a national pandemic plan [12].

While this number may seem rather small, most of the participants agreed that their company was able to adapt to the new situation relatively quickly (Fig. 4). This may be partly attributed to the participants, who mainly came from German speaking countries. While the infection rate in southern Europe increased very rapidly, it took about two weeks longer before the case numbers reached a high level in Germany.

Most companies promptly enabled their employees to work from home after the shutdown took effect. Before the pandemic, only a small number of participants was familiar with a working from home environment (Fig. 11). Since project management is generally suited for remote work, the percentage change was quite high in this area of work. Another

study which, covers a wider range of occupations, found a more balanced proportion between working from home and working on site during the pandemic [13].

As home-office has its limits and is not suited for all types of work, face-to-face meetings cannot be completely avoided even during the pandemic. Almost all participants indicated that their company has introduced additional rules for face-to-face meetings in such cases (Fig. 9). Initially, these were only very simple measures such as keeping a minimum distance and avoiding the classic handshake. Over time, other safety measures were also introduced, such as regular cleaning of surfaces and wearing face masks (Fig. 10). The reason why masks were only added later may be attributed to the ongoing discussions about their effectiveness at that time. Another reason was that masks were generally in short supply worldwide, so that they were first reserved for the medical sector. This changed drastically in the meantime, as the effectiveness of face masks in preventing the spread of SARS-CoV-2 was recognized and the use of face masks and disinfection is now even legally required in some cases.

Another interesting finding is that most participants stated that, despite the new and unfamiliar home-office environment, they were quickly able to adapt their internal and external communications, most likely due to the wide availability of digital tools and mobile devices (Fig. 6 and Fig. 8). Again, the lead time that Germany had was an important factor, as the time could be used to provide the necessary equipment and software. The switch from office to home has almost naturally increased the use of online meeting tools. What is striking here is the shift from simple communication tools such as Skype to more organization-oriented tools such as Microsoft

Teams and Zoom (Fig. 19). It can be assumed that the additional functionality in organizing teams and the increased trust in a business application were decisive criteria for this. Other reasons could be ease of use, competitive costs or the fact that they were able to quickly increase availability and provide satisfactory customer support.

Contrary to the above-mentioned development, the use of cloud storage tools and specific project management tools has declined (Fig. 20 and Fig. 21). Although the available data does not show any obvious reason for this, a possible explanation could be a lack of essential security structures at the beginning of the pandemic. For example, VPN connections were not yet in place and thus not available to employees from home. However, the participants do not expect to make greater use of specific tools in the future (Fig. 17). Since our study was conducted quite early in the pandemic, many companies were still in the process of converting to the new working environment. Another possible explanation is that the situation was new for many employees. They needed to ensure that they could stay in touch with their colleagues and balance work, childcare, home schooling and everyday life. As a result, many may have concentrated on a rather small set of tools to which they were already accustomed.

The home-office is increasingly seen as a complementary option to the traditional "onsite" work model, as around 65% of the participants recognized the advantages of working from home quite early on and expect the proportion to continue to rise after the end of the pandemic (Fig. 11 and Fig. 12).

To support this, the participants also forecast an increase in mobile hardware, such as tablets and notebooks (Fig. 17 and Fig. 18). As mobile hardware

is primarily designed to provide corporate equipment to enable home-offices, we also observe similar expectations for the use of video conferencing tools (Fig. 19).

Despite some hurdles associated with the pandemic, most participants in the study perceived an increase in flexibility and agility (Fig. 13 and Fig. 15).

The observed increase in flexibility is mainly due to more flexible working hours. Prior to the outbreak of the pandemic, most work was done during typical office hours between 8 a.m. and 5 p.m. This restriction did not apply to home-office work, so employees were able to do their work whenever they had time. For many employees with children, this flexibility was extremely helpful because the daycare centers were closed. This made it possible to shift work into the early morning or evening.

Since agile methods are better suited to support a remote work environment, the increase in agility is quite understandable (Fig. 13). Agile methods like virtual daily stand-up meetings fill the gap of the missing daily office meetings (Fig. 24). This change in work and communication behavior also affects the use of software tools for project management. The perceived increase in agility goes hand in hand with less use of traditional project management software such as Microsoft Project (Fig. 20). One possible reason for this is the difficulty of predicting and planning the future with the help of Gantt charts and milestones. However, software tools for agile project management during the pandemic were also used by fewer study participants (Fig. 20). However, the decrease is less than for traditional software. One reason for this could be that the new way of working required a lot of time, as people had to organize their home-office environment and familiarize themselves with new mobile hardware and collaboration

software. At the time of the study, these additional efforts may have led to a short-term reduction in planning and data management in software tools.

Productivity at work was estimated to be comparable to or slightly lower than before the pandemic (Fig. 14). A slight negative deviation may have resulted from the use of (extra/special) vacations, for childcare, a reduction in working time accounts or a lack of equipment in the home-office [14]. Another study came to similar results to ours but found an increase in productivity in certain areas [15].

As the number of stand-up meetings increased during the pandemic it could be argued, that this method of agile working was a suitable way for most project teams to adapt to the new environment (Fig. 23). As with regular meetings, almost all were conducted virtually. So naturally most methods of remote communication saw also an increase.

On the other hand, the number of review meetings internally and externally with customers declined during the pandemic (Fig. 27). While they were also conducted virtually (Fig. 26), the usage of digitals tools decreased here which can be attributed to the declining internal and external review numbers (Fig. 28).

5   Discussion

The study presented in this article was conducted shortly after strong measures were released in Germany, to cope with the COVID-19 pandemic.

In a time, where many companies had to re-organize their business due to the pandemic, it was not easy to encourage people to participate in a study. Thus, the questions had to be limited and written concisely. However, the number of participants and the

distribution of the industries provides valuable insights into the current situation.

The results of the study showed that the measures not only had great impact on the way of agile working, but that they also facilitated the use of digital tools and new ways of working in an extremely short period of time.

The answer to the research question RQ1 is, that agile meetings were done digitally from home. While the agility in this new setting is rated even higher, the productivity in distant working environments decreased slightly. Since the differences are rather small, it can be assumed, that people can cope with the new situation rather well.

Regarding the research question RQ2, we conclude that the use of mobile hardware, video conferencing and chat software increased and that their utilization is valued positively. Considering the short period of time which were available to adapt to these tools, this is an encouraging observation. Interestingly, the usage of project management software decreased. The study does not provide reasons for this. Potential causes might be that the time it took to get familiar with the other new tools and ways of working was taken from the maintenance of data in project management tools and that the need for video-based direct communication was greater than the communication via project management software.

For the future (RQ 3), most participants expect some changes, like increased home-office times and the use of more digital tools.

However, due to the fact, that the study was conducted at the beginning of the COVID-19 related measures, many aspects were not foreseeable at that point in time. The study, thus, provides a first glimpse of the change. It is planned, to repeat the study after a longer period to derive the long-term impact of this change.

6 Conclusion

This article presented the results of a study involving more than 170 participants regarding agile working during COVID-19 pandemic. The sudden release of strong measures, also known as "lockdown", had significant impact on the way of agile working.

The main findings of the study can be summarized as follows:

- People adapted rather smoothly this new situation and changed easily to the home-office

- The work situation become a lot more flexible while there was only a small loss in productivity

- Due to the new work situation, the usage of mobile hardware and video conference tools gained major popularity during the pandemic

- During the first months of the pandemic, the use of project management tools decreased

- Working from home is strongly connected to the usage of tools

- Home-office is expected to become part of the future work environment

In summary, the study revealed, that many companies can adapt quickly and keep up agile working and productivity. The use of mobile devices and new software. We plan a future study to examine, whether these first impressions are sustainable and if COVID-19 related measures boosted digitization of agile working.

7   Figures

Symbol directory

α	Cronbach's alpha
N	Participants
r	Average correlation between the items (Pearson correlation)

8   References

[1]   K. e. a. Beck, *Manifesto for Agile Software Development.* [Online]. Available: http://agilemanifesto.org/

[2]   A. Komus, *Abschlussbericht: Status Quo Agile 2016/2017: 3. Studie über Erfolg und Anwendungsformen von agilen Methoden.* [Online]. Available: https://www.hs-koblenz.de/index.php?id=1932

[3]   Deloitte, "Tech Trends 2020," 2020. [Online]. Available: https://www2.deloitte.com/content/dam/Deloitte/pt/Documents/tech-trends/TechTrends2020.pdf

[4]   S. Kriebel and et al., *Mastering the future: Agile model-based system design for BMW's electrified next generation platform*. 18. Internationales Stuttgarter Symposium. Wiesbaden: Springer Vieweg, 2018.

[5]   WHO, *Pneumonia of unknown cause - China.* [Online]. Available: https://www.who.int/csr/don/05-january-2020-pneumonia-of-unkown-cause-china/en//

[6]   WHO, *Coronavirus disease (COVID-19) Situation dashboard.* [Online]. Available: https://covid19.who.int/

[7]   T. Steffen, *Diese Corona-Maßnahmen gelten in den EU-Staaten.* [Online]. Available: https://www.zeit.de/zustimmung?url=https%3A%2F%2Fwww.zeit.de%2Fgesellschaft%2Fzeitgeschehen%2F2020-03%2Fcoronavirus-ueberblick-eu-grenzkontrolle-ausgangssperre-bussgelder

[8]   N. Döring and J. Bortz, *Forschungsmethoden und Evaluation in den Sozial- und Humanwissenschaften*. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg, 2016.

[9]   M. Tavakol and R. Dennick, "Making sense of Cronbach's alpha," *International journal of medical education*, vol. 2, pp. 53–55, 2011.

[10]   P. Mayring, *Qualitative content analysis: theoretical foundation, basic procedures and software solution*. Klagenfurt, 2014. [Online]. Available: https://www.ssoar.info/ssoar/bitstream/handle/document/39517/ssoar-2014-mayring-Qualitative_content_analysis_theoretical_foundation.pdf?sequence=1&isAllowed=y&lnkname=ssoar-2014-mayring-Qualitative_content_analysis_theoretical_foundation.pdf

[11]   I. Steinke, *Kriterien qualitativer Forschung: Ansätze zur Bewertung qualitativ-empirischer Sozialforschung*. Weinheim: Juventa-Verlag, 1999.

[12]   Robert Koch-Institut, *Nationaler Pandemieplan Teil I* (in ger): Robert Koch-Institut.

[13]   H.-M. von Gaudecker, R. Holler, L. Janys, B. Siflinger, and C. Zimpelmann, "Labour supply in the early stages of the CoViD-19 Pandemic: Empirical Evidence on hours, home office, and expectations," 2020.

[14]   J. Hofmann, A. Piele, and C. Piele, *Arbeiten in der Corona-Pandemie - Auf dem Weg zum New Normal*.

[15]   D. Mancl and S. D. Fraser, "COVID-19's Influence on the Future of Agile,"

Authors:

Claudia Doering was born in Freiburg, Germany, in 1991. She studied international business administration at the University of applied Sciences Landshut, Germany and the Griffith College Dublin, Ireland. She received her Master of Engineering in 2017 in systems engineering at the University of applied Sciences Landshut. Since 2018, she works as a research associate and project coordinator at the University of applied Sciences Landshut. She coordinates a public funded transfer project TRIO and works as lecturer in project management at the University of applied Sciences in Landshut. TRIO aims to improve the transfer between universities, companies and the society. Since 2018, she also conducts research in the field of knowledge transfer, information modelling and university collaborations, which is also the topic of her Ph.D. studies at the University of Regensburg, Germany. M. Eng. Claudia Doering is a certified member of the German Association for Project Management (GPM) and the VDI Association of German Engineers.

Markus Schmidtner was born in Eggenfelden, Germany, in 1986. He studied computer science (business informatics) at the University of applied Sciences Landshut, Germany. He received his Master of Science in 2019 in computer science at the University of applied Sciences Landshut. Since 2019, he works as a research associate in the research project HyValue at the University of applied Sciences Landshut. HyValue aims to improve the automotive product development process. He also works as a lecturer for project management and collaborative business process modelling. His research topics include project management and business process modelling. M. Sc. Markus Schmidtner is a certified member of the German Association for Project Management (GPM).

Johanna März was born in Landshut, Germany, in 1999. She is studying business administration at the University of applied Sciences Landshut, Germany. From March until October 2020 she was working as a student assistant at the Institute for Data and Process Science.

Vanessa Müller was born in Würzburg, Germany, in 1998. She is studying industrial engineering at the University of applied Sciences Landshut, Germany. Since July 2019 she works as a student assistant at the Institute for Data and Process Science. In October 2020 she obtained the "University Certificate Modern Project Management – Foundation".

Holger Timinger (M'20) was born in Ravensburg, Germany, in 1976. He studied electrical engineering at the University of Ulm, Germany and the University of Massachusetts in Amherst, MA, USA. In 2005, he received the Dr.-Ing. (Ph.D.) degree in electrical engineering from the University of Ulm. From 2002 to 2008, he was research assistant and research scientist with Philips Research in Hamburg, Germany. During this time, he conducted research in the field of medical imaging, algorithms, and technology. From 2008 to 2011, he was project manager for large-scale international imaging projects with Philips Healthcare. Since 2011, he is Professor for project management at the University of applied Sciences in Landshut, Germany, where he co-founded and heads the research Institute for Data and Process Science. He is author of several books related to modern project management. Prof. Dr. Holger Timinger is a certified member of the German Association for Project Management (GPM), the VDE Association for Electrical, Electronic & Information Technologies, Germany, and the Institute of Electrical and Electronics Engineers (IEEE).