Impact of the Pandemic on the Barriers to the Digital Transformation in Higher Education - Comparing Pre- and Intra-Covid-19 Perceptions of Management Students

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Abstract. The rise of digital technologies is a macro trend, forcing organizations to transform digitally. This so-called digital transformation (DT) is affecting the field of higher education, too. Higher education institutions (HEI) digitalize internal processes and offer digitally-enabled education services. Different types of barriers are challenging a successful DT and need to be mastered. Our study follows a longitudinal research design by surveying different student cohorts in the same courses. Before the pandemic, we identified the barriers to DT and transferred them into a research model. Pre-pandemic, we surveyed the influence of barriers perceived by management students on the DT process of their HEI. Taking the pandemic as a solid external driver on DT, we examined students' intra-pandemic perception in the same courses as the pre-pandemic analysis. With pre-pandemic data, the projection explains over 50% of the adjustment problems of the DT process. Based on intra-pandemic data, the explanation decreases to 45%. Hypothetically, we expected a better explanation degree as an impact of the pandemic. Interestingly, results indicate that intra-pandemic perceptions got more complex and, therefore, less significant.

Keywords: Digital transformation · Barriers · Student perception · Covid-19 · Higher education

1 Introduction

The concept of digital transformation (DT) aims at using new digital technologies to enable significant improvements in organizations at different levels, such as processes, business models, and connections with different stakeholders [1]. All areas of society are impacted by DT, such as teaching and learning in higher education (HE) [2]. DT in HE brings a shift to digital teaching and learning methods as well as digital administrative processes. Digital technologies allow for constructivist learning and learner assessment. They are transforming access to learning materials, dialogue with, and collaboration

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between involved groups. The potential is promising, but higher education institutions (HEIs) face obstacles in making sense of these technologies and integrating them into an overall package. Although digital content has been used in virtual learning environments for years, its use was still spotty before the Covid-19 pandemic. Obstacles exist to the full integration and alignment of digital content into degree programs [3]. Legal and organizational procedures, as well as personal biases, slow down DT. We call these obstacles barriers to DT and define them as "those things that hinder, slow down, or stop the DT process" [4].

Due to the Covid-19 pandemic, this transformation process has received a tremendous push forward [5] and forced HEIs to evolve [6]. Existing courses had to be adapted to online-only. Departments had to find new ways to maintain their services under contact restrictions in a short period of time. This sudden change was also accompanied by new ways of working, such as virtual communication [6]. However, the forced DT is not free of barriers [8].

Even before the pandemic, we developed a barrier model using mixed methods [9]. This model contains an applicable scale to measure existing barriers among different stakeholders and follows a socio-technical perspective [10]. In this study, we use the model along with the scale to examine barriers perceived to exist by users in HE before and during the pandemic. Identifying and evaluating these barriers enables improvement of the ongoing DT process. Thus, instructors and administrators at universities can derive suggestions for improvement and work around barriers.

As a sample for our study, we chose to survey management students. They encounter a DT environment as users. In general, students represent the user group in HEIs. Especially management students are particularly critical and aware of their future employability. Even if management students are at another stage of their careers compared to working managers, they share a similar attitude and are trained in certain models such as the Deming circle. Also, these students have grown up as digital natives. Thus, they encounter DT in their daily lives and their education. Also, they will face DT's impact in their professional lives later on [11]. Therefore, DT is thought to be a central topic in the curriculum of management studies [12]. Therefore, our research question is: What differences in the barriers to DT of their HEIs do management students perceive between a pre- and an intra-pandemic educational setting?

We use an existing quantitative instrument to answer this question and survey students at a pre- and intra-pandemic time point when courses were switched from a blended to a complete online design. With this externally forced change, also the DT is enforced. Our hypothesis is that the pandemic will have an effect on the HEIs to overcome barriers. Therefore, we examine the influence of individual, organizational, technical, and environmental barriers on the perception of the DT process by using two different types of digitally organized teaching.

2 Theoretical Development

Increasing technology use and the availability of information assets based on ubiquitous connectivity are currently shaping HE [13]. Digital resources are supporting the conduction of lectures as they enrich learning content. Furthermore, they help with the implementation of strategies and evaluations within learning and teaching [14].

According to the overall concept of DT, it is more than the mere use of technologies for teaching in HEIs. Also, DT implies that data, such as student results, become less private and more traceable. Potentially, lecturers and administrators can easily share data on students. An essential aim for universities under increasing competition is the introduction of digitalized processes, as these are supposed to be more efficient. The usage of digital technologies varies. It ranges from digitally-enabled 1:1 communication between students and teachers to 1:many massive open online courses [15]. In general, DT enhances the possibilities for learning. It adds channels and new forms of content. Thus, blended learning environments have established themselves as further developments of traditional lectures. Whereas even more advanced e-learning offers follow a complete digital design. New approaches promise more positive learning habits as well as attitudes towards learning [16]. However, barriers to the implementation and usage of blended and e-learning designs exist [3, 17]. Initial costs and set-up times for setting up e-learning offers, especially for high-quality content of lecturers, are high. Other problems are organizational interfaces within study programs as well as the access to and the usage of digital technologies [3].

Research on DT in HE mostly addresses certain learning settings. Three groups of HE research exists, which focus on the challenges and gains of DT. The first group is focusing on analyzing student's technology acceptance [18] and DT's effects on students' learning outcomes [19]. The second group contains research on DT-related instructional design and its acceptance [20]. The third group focuses on organizational obstacles within HEIs [21, 22] as these often provoke resistance to change within institutions [23], such as additional workload [24], lack of institutional support [22, 23], and resources such as time and technical equipment. As DT is also impacting the curricula, faculty is often critical to accept these changes [25]. Also, external barriers hinder the DT of HE. Globalization and a more competitive environment are putting pressure on HEIs. However, they are often slow in keeping up with the speed of the change [25].

Recent research on the impact of the pandemic on HE is spreading out in the above-mentioned groups. Marinoni et al. [8] report problems in communication, lack of resources, and problems in pursuing educational and research tasks. Other studies compare data from different time points and find more continuous studying habits among students, leading to higher study efficiency [26].

In conclusion, research on HE is often focusing on specific teaching scenarios. Due to this limited generalizability, we broaden the perspective and take further dimensions of barriers into account to measure the students' view on DT in HE [9].

3 Longitudinal Trend Research Design

In this study, we use a quantitative instrument that was developed according to an exploratory sequential mixed methods approach [27]. Mixed methods are advantageous when complex issues such as policies, interventions, and transformations are researched. They allow for more robust analysis and add details to complex phenomena [28]. For the explorative step, we collected data from 46 interviewees involved in the DT of companies. This data was coded and clustered in different steps to identify the specific dimensions of barriers that might affect the DT process. By using results from the

literature, the dimensions were specified into items adopted to a HE setting to survey students and their perceptions. The result is an instrument modeling the causes of DT barriers in HEIs. On a generic level, barriers in HE are not that different from those faced for DT in business settings [29]. We assume that students in HE are getting a taste of how DT will shape future work environments. Especially management education is thought to connect to theoretical models and practical assignments [30]. The transition from management interviews [4] to students' perception is a valid approach as the role of students will evolve over time. Currently, they are using their university. Thus, they are a stakeholder group grown up as digital natives. In the future, they will be digitally involved in their workplaces. Their current perception will influence their attitude toward DT in the long term as future decision-makers. Therefore, we use different dimensions of barriers to DT stemming from business research and apply them in our research on management students.

We use the quantitative instrument to survey two cohorts of management students in the same courses at a time point just before the pandemic and at a time point during the pandemic. The curricula of the programs did not change. Thus, we conduct a comparative longitudinal trend study [31]. The pre-pandemic measurement was taken after the spring term 2019 in the courses Business Process Management and Digital Transformation. Additionally, data from students of previous semesters in the course Project Management were surveyed. All the courses were electives in Business Studies programs and related to the field of information systems in terms of content. Before the pandemic, the courses were instructed with a blended-learning approach of digital components and a supplementary attendance part. Also, students experienced digitalized administrative procedures such as course subscriptions, exam registrations, and communication. One hundred four respondents completed the first round of the questionnaire, with 58.5% male and 41.5% female participants. None indicated a third gender. 80% have already gained initial work experience. The pre-pandemic measurement was taken to answer how students perceive the DT of their HEI. During the pandemic, the hypothesis evolved that it has a positive influence on the perception of DT, as enforced digitally-transformed courses are becoming the new normal. In other areas of HE, positive effects were found [32]. Therefore, we surveyed the next cohort of students in the same three courses at an intra-pandemic time point during the autumn term 2020/2021. One hundred thirteen respondents completed the second round of the questionnaire. The distribution of gender is 66% male and 34% female. None indicated a third gender. Around 66% possess initial work experience.

To compare the two data sets, we examine them statistically by using multiple linear regression analysis. We analyze the effect barriers have on the perceived DT process in both samples.

4 Data Collection Instrument

As described, we conducted a survey at two different time points using the same questionnaire [9]. The questionnaire is displayed in Table 1 and consists of six dimensions measuring the DT Process and its barriers by using a total of 30 items.

Considering that barrier models in literature often formulate the adoption of technology as the target variable [33], we defined the DT process of HEIs as the first and

dependent variable in our study. HEIs are becoming digitally-enabled organizations with the need to digitize internal processes on the one hand and develop a broad portfolio of digital services and smart teaching on the other hand [34]. The offering and implementation of smart products and services can be operationalized, observed, and understood as the progression in DT maturity. These different aspects are represented in six items to measure the DT process. We assume that the dependent variable is negatively affected by barriers, the independent variables in our model.

Following the socio-technical perspective, barriers can have an impact on different levels and presumably with different intensities. Based on qualitative interviews, statements about barriers were aggregated into five barrier dimensions. The dimensions allow the individual effect on DT to be examined.

Individual barriers are one of the dimensions. They reflect an individual's difficulties accepting the DT process [4]. Such personal fears create situations in which users refuse to cooperate with the socio-technical system. Especially, as these fears are diffuse, they are difficult to resolve. Six items measure the individual barriers. We take up the fear of losing control over data [35] by measuring the students' perception of the data stored in the background of the digital learning platforms (dlp). Having no influence on the amount and type of data storage can be intimidating [36]. With more data storage, new data analysis methods come along, and users become more traceable and might fear a lack of control [37]. Hence, students might doubt secure data handling. HEIs might potentially be able to draw conclusions on the students' individual behavior [38]. Generally, potential disruptions in the job market due to DT is a fear, not only for students. [39]. DT affects the learning environment and thus influences course delivery, learning outcomes, and job perspectives [40]. Also, DT could negatively influence instructors' job perspectives and decrease the student-to-teacher ratio.

Organizational barriers are another dimension, which are measured by using seven items. We base their construction on existing scales for change management and inertia [17]. Different HEI stakeholders might resist cultural change from traditional teaching roles or processes to new ones, even if they are the better alternatives [41]. An absence of support from the university management and a lack of strategy are often related to each other [42]. A form of management support is to solve the provision of missing resources needed to set up new structures, implement online learning concepts, or support digitally-enhanced administration as part of the DT process [22, 23].

Three items measure the impact of the dimension of technical barriers, which might hinder the DT process. These items orient towards measuring the technical interplay and integration, such as security concerns, dependence on technologies, and performance of the current infrastructure [15]. In order to partake in an online learning environment, students need suitable infrastructure in the form of continuous data connection, devices to utilize service structures, and software on their side [23]. As this is students' responsibility, it might hinder some students who don't have sufficient financial resources nor technical knowledge. We orient towards existing scales to measure the perception of the current infrastructure and security settings [42].

Four items measure the external barriers to DT. Digital learning environments combine different types of content and data. Thus, standards are needed for connection and seamless data exchange [43]. If such a standard is lacking, students might perceive it

Table 1. Questionnaire

Dimension	Items
DT Process (DT)	My university offers digital services, which support me in my studies
	My university continues to use existing methods for teaching and services
	My university is moving forward in terms of DT
	I have the impression that the university's internal processes have been digitalized
Individual Barriers (Ind.)	I am aware of the kind of (apparent) data about me that is stored when using the dlp
	I have the impression that I control the data that is stored about me
	I trust the university in handling the data I generate when using the platform
	The traceability of the data (which the lecturer can access) does not affect my use of the dlp
	I think that through the use of IT, teaching of the same quality can be done with fewer staff
	The changed form of the course harms my learning success
Organizational Barriers (Orga.)	University management supports the DT at the university
	The university has created specific jobs/projects for the DT
	At my university, we have a clear vision or DT strategy
	The learning culture at the university has not changed due to DT
	The university strives to constantly learn about and improve in how to transform digitally
	In my university, there is openness to new ideas in teaching
	I have the impression that there are not enough resources (time, money, IT staff) for the dlp
Technical Barriers (Tec.)	I have had problems with my internet connection while working with the dlp
	I have no security concerns when using the dlp
	I possess all the necessary technical means to use the dlp
External Barriers (Ext.)	I can easily integrate additional data and information into the content of the dlp
	I cannot read and edit the contents of the dlp with my standard programs
	I consider laws regulating the handling of digital products and services to be missing
	I think there are enough data protection laws that protect me in dealing with the dlp

(*continued*)

Table 1. (*continued*)

Dimension	Items
Missing Skills (Skills)	All in all, my IT knowledge is adequate to keep up with the changes in the course
	I have the impression that the teacher has sufficient IT skills to operate the dlp
	I don't see any advantages to the technical support provided by the dlp in the course
	I think that in the dlp, all available technical possibilities have been used
	I was integrated into the decision process about the use and scope of the dlp
	I was sufficiently trained in the use of the dlp

as a hinder. Also, standards secure access to teaching content on different devices [44]. As a lot of HEIs are public organizations, they need to have distinct security standards for data access in place, e.g., when it comes to online examinations or the electronic distribution of certificates and grades [16]. Regarding their status as a public organization, HEIs have less freedom to choose the software they use. For the formulation of the items, inspiration was taken from research on regulations [45].

Six items measure the dimension missing skills, which require special abilities to personally succeed in the DT process. Students, instructors, and administrative staff might lack sufficient IT knowledge. Thus, we survey for the perceived IT knowledge of students and teachers [46]. As internal stakeholders, students need to understand and be able to use digital concepts [47]. The understanding is essential to use available digital services and to know the right background in a digital process. Thus, items measure the perception of received training [48].

All items of the dimensions were measured on a 5-point Likert scale ranging from "I strongly agree" to "I do not agree at all". In total, participants had to indicate their perceived barriers and the DT process in 30 items. To avoid response bias, we formulated a part of the questions positively. Items on barriers could otherwise have led to a negative framing of the respondents.

5 Results

After the data collection, we analyzed and compared the data sets. To do so, we poled all items in one direction, whereby a high value corresponds to a perception of a weaker DT process or more distinctive barriers.

In the first step of the analysis, we examined the descriptive statistics. Table 2 shows that there are both similarities and differences between the pre-pandemic and intra-pandemic groups. When looking at the DT process, it is noticeable that the intra-covid group assesses the DT process worse on a mean basis. Only smaller changes, ranging

Table 2. Descriptive statistic

Dimension	Pre-pandemic						Intra-pandemic					
	N	Minimum	Maximum	Mean	Deviation	Variance	N	Minimum	Maximum	Mean	Deviation	Variance
DT	104	1.00	5.00	3.20	.86	.74	113	1.00	5.00	3.77	.90	.81
Ind.	104	1.40	5.00	3.37	.72	.52	113	1.00	4.20	3.10	.55	.31
Orga.	104	1.40	4.83	3.05	.65	.42	113	1.60	5.00	3.63	.59	.35
Tec.	104	1.00	5.00	4.02	.80	.65	113	1.00	5.00	3.53	.97	.93
Ext.	104	1.33	5.00	3.38	.80	.63	113	1.67	5.00	3.19	.67	.44
Skills	104	1.33	5.00	3.13	.77	.60	113	1.33	5.00	3.38	.77	.60

from 0.19 to 0.27, can be observed when looking at the mean values for individual and external barriers as well as missing skills. Greater differences can be seen in organizational and technical barriers, although the direction of change is different. While organizational barriers are perceived as more salient on average in the intra-covid group, technical barriers are perceived as lower.

In the next step, we examined whether the changes in student response behavior described above have an impact on the linear correlation between barriers and the DT process. The Pearson correlation coefficients in Table 3 are showing significant relationships between several barrier dimensions and the DT process in both samples. When looking at both groups in detail, however, differences become apparent. While the magnitude of the linear relationship is often comparable, differences are particularly visible in the significance and direction of effect. While no significant correlation between individual barriers and the DT process was observed in the pre-pandemic group, these dimensions show a significant weak linear correlation [52] in the intra-pandemic group. Thus, a lower degree of DT is also accompanied by more distinct individual barriers. Similarities between the two samples can be observed at the organizational barriers. Organizational barriers and the DT process show a moderate linear relationship with significant values of 0.67 in the pre-pandemic setting and 0.66 in the intra-pandemic setting. Similar to the individual barriers in the intra-pandemic setting, the Pearson correlation coefficient implies that a lower degree of DT is accompanied by more distinct organizational barriers in both samples. When comparing the samples, differences in the direction of the linear relationship can be seen for the technical barriers. The intra-covid sample shows a significant linear correlation between the two dimensions, which was expected due to the presumed effect of barriers in general. Higher levels of technical barriers are associated with lower levels of DT. Before the pandemic, however, an opposite significant correlation was observed: Higher levels of technical barriers were accompanied by higher levels of DT. A similar pattern can be observed in the case of external barriers. While a contrasting linear relationship was observed in the pre-pandemic sample, a previously suspected relationship could be observed in the intra-pandemic sample. However, a significant correlation was only found in the pre-covid sample. No significant linear relationship can be found between the external barriers and the DT process in the intra-pandemic sample. Last but not least, the missing skills show comparable results in both samples regarding the linear correlation with the DT. Both samples show a significant linear relationship, which, however, was weaker in the intra-covid sample. Pearson's correlation shows no evidence of multicollinearity among the barrier dimensions, which is important for the following regression analysis.

The Pearson correlation coefficient does not indicate the cause-effect direction. It rather shows the linear relationship between two variables. Thus, the two data sets were analyzed with a multiple regression analysis in the next step to gain a deeper understanding. To increase the comparability of the results, we chose the inclusion method for the regression analysis. Through this, we were able to investigate which barriers have a significant impact on the DT process and how the impact changed over time. As we compare the different samples with an identical model, we focus on the unstandardized regression coefficients. In addition, the different variables are measured

Table 3. Pearson correlation matrix

Dimension	Pre-pandemic						Intra-pandemic					
	DT	Ind.	Orga.	Tec.	Ext.	Skills	DT	Ind.	Orga.	Tec.	Ext.	Skills
DT	1.00						1.00					
Ind.	.15	1.00					.26**	1.00				
Orga.	.67**	.12*	1.00				.66**	.28**	1.00			
Tec.	−.19*	.35**	−.10	1.00			.21*	.24**	.36**	1.00	,	
Ext.	−.17*	.18*	0.00	.38**	1.00		.04	.082	.20*	.20*	1.00	
Skills	.48**	.28**	.44**	.07	.18*	1.00	.26**	.37**	.14	.062	−.017	1.00

*p < 0.05 significant, **p < 0.01 significant

on identical scales of measure, eliminating the need to consider standardized regression coefficients. Table 4 shows the results of the regression.

Table 4. Regression

Variable	Pre-pandemic		Intra-pandemic	
	Coefficient	Sig.	Coefficient	Sig.
Intercept	1.027	.039	-.267	.637
Ind.	.047	.612	.065	.652
Orga.	.703	.000	1.006	.000
Tec.	−.103	.226	−.028	.704
Ext.	−.205	.013	−.111	.263
Skills	.308	.001	.186	.040
N	104		113	
R^2	.545		.475	
Adjusted R^2	.521		.450	

The pre-covid model shows three significant barrier dimensions, while the intra-covid model shows only two dimensions significant at the 0.05 level. In addition, the adjusted R^2 of the pre-pandemic model shows a higher explanatory power of 0.521 compared to 0.440 in the intra-pandemic model. In both cases, the models explain the variance of the dependent variable to a satisfactory level. The models show the strongest significant influence on the DT process for the organizational barriers, with the coefficient being even higher for the intra-covid sample. The second strongest dimension is the lack of skills. Here it is apparent that the missing skills in the pre-covid model have a higher impact on the DT process than in the intra-pandemic model. For external barriers, however, only a significant influence was found in the pre-pandemic sample. Nevertheless, the effect manifests itself differently than intended. The DT process is perceived as more intensive with an increase in external barriers. This anomaly is addressed in the later

discussion. Moreover, in both regressions, no significant influence of individual and technical barriers could be proven.

All in all, both similarities and differences emerge in the results of our longitudinal trend research design. In the pandemic, the DT process was perceived to be lower by the students. A stronger perception of organizational barriers was observable.

6 Discussion

In our study, the adjusted R^2 decreased over time. Thus, there are factors that are not considered in the questionnaire. The questionnaire is based on qualitative interviews conducted before the pandemic and might not have covered specific pandemic-related issues. Also, stress-related issues might overlap with the respondent's answers.

In addition, it is likely that the pandemic does not affect all students equally. Aucejo et al. [49] highlighted in a study that low-income students were more affected by the impact. Perceptions of barriers and DT may be influenced to a greater extent by students' individual circumstances.

During the pandemic, students perceive the DT process to be weaker. The perception is the result of higher digital awareness, as digitalization is often the solution to pandemic-related problems of social distancing. Regarding the correlation with other dimensions, nearly all of them decreased. In general, it seems that the weaknesses of the DT got more visible to students as a stressed DT might not deliver better results.

As for the individual barriers, the mean decreased by 0.27 only, which indicates the students perceive them to be about the same at the two different time points. The correlation with the organizational barriers and skills increased. At the same time, the correlation with technical and external barriers decreased. This indicates a closer connection between individual barriers, organizational barriers, and skills. This group of barriers could be perceived as internal factors, as students are the internal users of the HEIs' teaching offers. One important factor in this dimension is the role of trust, in which HE should serve as a role model [35]. Other authors have highlighted factors, such as individual resistance and technophobia [21], which could partly be true in this study. Although, the standard deviation is rather low in the intra-pandemic sample, indicating a rather homogenous point of view. As the surveyed students are technology-interested management students, our sample could be biased when it comes to technophobia.

Organizational barriers seem to be the key barrier in our research. The difference of the pre- and intra-pandemic mean is leaning more towards the negative side of the scale. At the same time, the standard deviation decreased a bit, which means the perception of students got more homogenous. The correlation with technical barriers and skills changed to some extent, even with a change in direction (from negative to positive). The coefficients are in both cases significant, with a huge increase in the coefficient. These results approve the results of other studies, in which the organizational factors are the major key to success or to hinder [3]. It shows that in the students' perception, this barrier got worse. Of course, HEIs had to quickly shift to online teaching, which might indicate that not all organizational processes were in place.

The mean of the technical barriers decreased rather substantially by 0.5. Important shifts in the correlation with external barriers, organizational barriers, and the DT

process are visible. For the DT process and the organizational barriers, the correlation even changes from negative to positive. Even in the correlation analysis, the coefficient decreased without being significant. This could be interpreted in a way that technical barriers are not perceived as barriers anymore. Instead, the functioning of the technical side, such as the dlp, is perceived as less disturbing. By being forced to use these technologies, students probably had positive experiences. As other studies show, students are more satisfied with digitally transformed courses [50], which might also interplay with other barriers and the overall DT process.

The means of the external barriers are rather stable. The intra-covid sample shows a small decrease in the mean and the standard deviation. The correlation with skills shifts to negative, whereas the correlation with the DT process shifts to positive. In general, the values are relatively low. It might be a weak signal that skills are negatively affected by new external requirements, e.g., when new standards evolve. The influence on the DT process in the regression analysis and its significance decreased, showing less impact on the DT process. In general, students might not be involved enough in external developments or judge this barrier as less important as it is a factor that simply must be accepted, such as the General Data Protection Regulation settings.

The last dimension of missing skills is also rather stable in terms of its means and standard deviations. Thus, the general perception of this barrier is not substantially influenced by the pandemic. In correlation to other barriers, there is a decrease in relation to the DT process, the organizational barriers, and the external barriers. The coefficient in the regression analysis is decreasing and is non-significant in the intra-pandemic sample. It seems students value their skills as relatively stable but perceive them as less connected to other barriers. An increased correlation exists with individual barriers. Both dimensions could be interpreted as a personal perspective and thus perceived as rather stable.

In our study, we surveyed management students taking elective courses with an IS focus. Other studies compared the online activity level of students from different faculties. [51] In general, students are less active during the pandemic. Still, technology-related programs show a higher degree of engagement than management-related programs. Thus, we expect our respondents to be more positive towards the enforced change in the course delivery.

7 Conclusion and Limitations

Our longitudinal trend study examines the impact of the pandemic on the perceived barriers of HEIs' DT process from the perspective of management students. We aimed to determine commonalities and differences between a pre-pandemic and intra-pandemic sample based on individual, organizational, technical, and external barriers, as well as missing skills. By considering different dimensions, a socio-technical perspective was obtained.

From an overall perspective, the pre- and intra-pandemic data show many similarities. Nevertheless, they differ in the details. The lower R^2 of the regression model indicates that the DT process is influenced by additional factors than the barriers included in the questionnaire. Due to the pandemic, HEIs were forced to take steps towards DT. Thus,

shortcomings in the process were highlighted. Consequently, the students in our study rate DT worse and primarily perceive organizational factors as the cause for this. For the future, however, it is unclear whether barriers have been overcome sustainably or whether they have been reinforced. A post-pandemic study could provide evidence on this.

The study and its findings should be interpreted with limitations. We surveyed students before and during the pandemic. Cohorts with different management students in the same courses with the same curricula were involved in this study. Higher reliability of results would have been expected if the same cohort of students had been captured over time. Given the high turnover of students combined with an anonymous instrument, such a research approach was unfortunately not possible. In addition, it should be considered that the courses are electives that belong to the field of information systems. This leads us to expect that we surveyed a certain kind of student audience with a basic affinity for technology regardless of the cohort. Thus, it will influence the reliability of the results in a positive way.

Also, our study shows a limited perspective on the digitalization of HEIs. As described, students are one stakeholder group. Academic faculty, administrative personnel, the general public, and the local community around HEIs have to be included in future studies, too.

To sum up, our results should still be validated by a more diversified group of students. Also, further need to pay attention to different stakeholder perspectives, e.g., by using case study approaches. Follow-up studies could pay particular attention to technology affinity but also include more in-depth sociodemographic data of students. Since the underlying model and questionnaire were developed prior to the pandemic, further qualitative research could provide additional insights that were not addressed in this questionnaire. The impact of a pandemic is complex. Its intensity can be influenced by factors such as income and living situation. These varying experiences can lead to different perceptions of the same barriers.

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