The Development and Validation of the "Attitudes Towards Digitalization" (Att-Dig) Questionnaire

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Abstract: Attitudes towards digitalization play a major role in almost all areas of human interaction including the health care system. Unfortunately, existing assessments and respective instruments on attitudes towards digitalization are often negatively framed, while balanced and broader approaches exist only marginally. The aim of this work was therefore to develop an assessment instrument from a self-generated item pool capturing a broad range of aspects of attitudes towards digitalization. Items were answered in an online survey by a total of 214 participants (mean age: 30.8±14.4 years 56,1% female). A principal component analysis was performed and 5 subscales "Digitalisation and Social Life" (5 items, Cronbach's alpha=0.789)," Digitalisation and Loss of Control" (4 items, Cronbach's alpha=0.817), " Digitalisation, Knowledge and Education" (4 items, Cronbach's alpha=0.791), " Digitalisation and Gain of freedom" (3 items, Cronbach's alpha=0.749), and " Digitalisation, Equity and Prosperity" (3 items, Cronbach's alpha=0.699) were extracted covering 63.5% of the item variance, showing a sufficient internal consistency of the subscales. There were significant differences for some of the subscales with regard to gender, age, and education. Only weak and non-significant correlations were found with respect to the subscales "self-efficacy", "optimism", and "pessimism" of the SWOP-K9 questionnaire. Thus, in sum, although there is a need for further research, the Att-Dig is a sound survey instrument to economically assess the attitude towards digitalisation. It can be used in different areas of public life and health care and is easy and quick to answer.

1 INTRODUCTION

Digitalization is one of the most important and powerful trends affecting people's lives as well as the development of organizations and societies in the 21st century (Parviainen et al., 2017). With the growing possibilities offered by digital technologies an increasing number of digital services has emerged and is being offered in all areas of life creating transformations, new realities and opportunities for a better life (Annoni et al. 2023). At the same time, people experience digitalization as an enormous challenge that requires extensive adaptation processes that often lead to excessive demands, self-doubt and anxiety (Hassani et al., 2021; Dabić et al., 2023; Teepe et al., 2023).

In the field of healthcare, digitalization very early was seen as a potential element of a utopia of a fair and patient-oriented healthcare system. And even if the first attempts at a digital apparatus for finding medicines failed in the 19th century (Ostermann, 2019), there was great euphoria a hundred years later when the first computers seemed to revolutionize the doctor-patient relationship (Ostermann, 2023). Pitkienen & Kenzelmann (1966) wrote about computers used by physicians: "Technology does not stultify the doctor, but increases his knowledge by forcing him to deal with a greater number of diagnostic options". Or almost at the same time on a more abstract level: "If physicians are to interact with computers, the consequences of this behavior must be reinforicing" (Slack et al., 1970).

However, it is not only the expected benefits but also the general attitude towards the corresponding technologies and their inherent transformations that influence their acceptance by actors in the health care system (Rivera Romero et al., 2024), which also includes the patient's views and experiences of this topic (Kulzer et al., 2022; Gybel et al., 2024). So far,

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according to (Cresswell et al., 2023) this might also include “unmeasurable” dimensions.

Thus, attitudes towards digital technologies play an important role and should be explored in more detail. Unfortunately, existing assessments on attitudes towards digitalization are often negatively framed and focus on fears or dystopian elements, while balanced and broader approaches exist only marginally. The picture is similar at the level of assessment instruments: the only validated scale, the Digitalisation Anxiety Scale (DAS), focuses on fear of digitalization (Pfaffinger et al., 2021).

The aim of this work is therefore to develop an assessment instrument from a self-generated item pool that should be able to capture a broad range of aspects of attitudes towards digitalization.

2 MATERIAL AND METHODS

In order to capture a broad range of aspects of attitudes towards digitalisation, items were generated in a psychological assessment class on test construction with 38 students of psychology at the University of Witten/Herdecke, which then were handed over to an in-house expert panel consisting of two health care experts, two psychologists and one computer scientist, who finally selected 19 items, which could be answered on a 6-point Likert scale from 1 = absolutely disagree to 6 = absolutely agree.

From June to September 2018, participants aged at least 18 years were recruited for the survey through direct contact as well as through distribution on social media groups. For data collection, the online survey tool SoSciSurvey was used. Participants who were not able to use the online survey, were allowed to answer in a paper-pencil questionnaire version. Ethical approval was obtained from the Ethical Committee of Witten/Herdecke University (ID: S-318/2023; approved on 19 December 2023).

Principal components analysis (PCA) was used to analyse relations between the items and to detect potential factors. Beforehand, Kaiser-Meyer-Olkin criterion: (KMO≥ 0.50) and Bartlett test of sphericity were calculated to determine whether the items were appropriate for PCA. To determine the number of reliable items, Item communalities were calculated. A communality value of 0.5 was chosen as cutoff value above which items were included in an exploratory factor analysis (Schreiber, 2021).

To obtain a solution with independent factors Varimax rotation was applied to arrive at a solution explaining the maximum amount of variance. Kaiser-Gutman criterion (Eigenvalue > 1) and Scree-Plot investigation was used to categorize a factor as meaningful. Internal consistency was examined by calculating Cronbach’s alpha for the single factors. Internal reliability was assessed by means of item-factor correlations.

Sub-scale means were calculated for the total sample and the groups based on the socio-demographic parameters gender, age, education and income. For that purpose one-factorial Analysis of Variance (ANOVA) was calculated to detect significant differences based on a level of significance of 5%.

Finally correlations with the subscales of the SWOP-K9 questionnaire (Scholler et al., 1999) were performed. This short questionnaire consists of 9 items measuring “self-efficacy” (5 items), “optimism”, and “pessimism” (2 items each). Due to the fact that optimism and self-efficacy is positively associated with an "affinity for technology" (Edison et al., 2003) this questionnaire was used for external validation.

3 RESULTS

3.1 Sample

A total of N=214 participants aged between 18 and 92 years (Mean age: 30.8± 14.4 years) of whom 120 (56.1%) were female completed the survey and were included in the evaluation.

Table 1: Sociodemographic data of the total sample.

Gender	
Male	94 (43.9%)
Female	120 (56.1%)
Age (years)	
Mean ± SD	30.8 ± 14.4
Median	24.0
Relationship status	
In a relationship/married	129 (60.3%)
Single and other relationship	87 (39.7%)
School Education	
High-school	173 (80.8%)
Other schools	41 (19.2%)
Monthly income	
<2,000 €	119 (55.6%)
> 2,000 €	87 (36.0%)
No answer	18 (8.4%)
Raised in (inhabitants)	
<100,000	146 (68.2%)
>100,000	68 (31.8%)
Job area	
Health & Social Sector	106 (49.5%)
Others (Education, Finance, R&D, …)	108 (50.5%)

Almost half of them (n=106; 49.5%) stated to work in the health or social sector. More than half of the participants were married or in a relationship (n=129; 60.3%), while 81 participants (37.9%) stated to be single. 4 out of 5 participants (n=173; 80.8%) had a high school exam and almost one third of the sample (n=75; 35.0%) had a monthly income below 1,000 €, while the second third of the sample had a monthly income between 1,000€ and 3,000€ (n=73; 34.2%). One hundred forty-six participants (68.2%) grew up in a small or middle town (< 100,000 inhabitants) (Table 2). A more detailed description of the sample is given in Niewrzol and Ostermann (2024).

3.2 Principal Component Analysis

A KMO of .850 and a significant Bartlett's test of sphericity ($\chi 2(171) = 1493.5$ $p < .001$), confirmed that the items were suitable for an exploratory factor analysis. This was also confirmed by the communality values which were located between 0.565 and 0.753 (Figure 1).

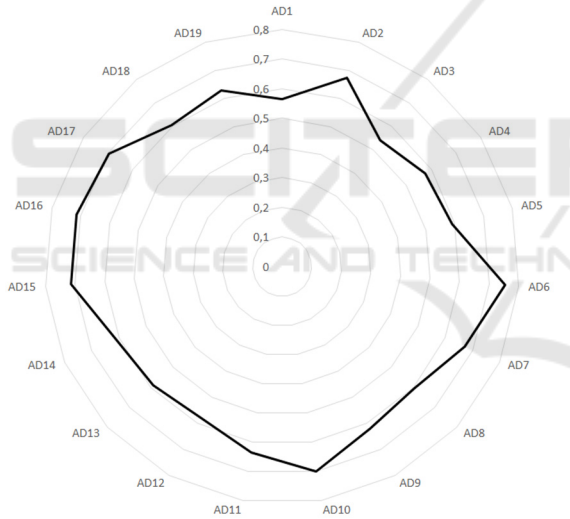

Figure 1: Communalities of the items in order of their appearance in tables 2-6.

After six iterations of Varimax rotation, PCA found five main components with Eigenvalues > 1 explaining 63.5% of the variance. Visual inspection of the screeplot suggested at least 4 dimensions as sufficiently meaningful, as after the fourth factor the amount of the slope in the scree plot changes significantly downwards (Figure 2).

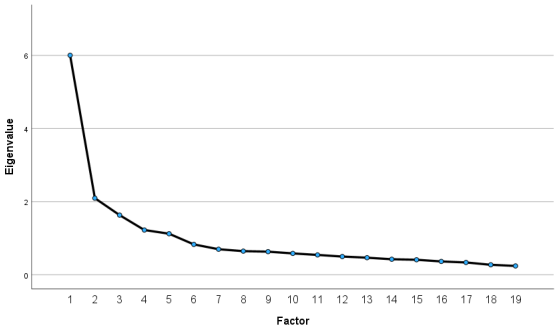

Figure 2: Screeplot of the factors.

The first factor explained 31.6% of the variance and included 5 items dealing with the improvement of social life through digitalisation, i.e. "Digitalisation improves my relationship with people" or "Digitalisation creates connectedness". Factor loadings of the items ranged between 0.656 and 0.728 with only one side loadings >0.3 for the fitht factor for the item "Digitalisation can make relationships much more intense". With Cronbach's α of 0.789 the internal consistency of this factor can be considered as very good. Correlation of the items with the factor ranged between 0.498 and 0.636. The scale was named "Digitalisation and Social Life" (DSL).

Table 2: Factor 1 (DSL): Results of the PCA, reliability and Items parameters (M= mean; SD = standard deviation; FL = Factor loading; r(I-F) = Correlation of the items with the factor). Scale range from 1= completely disagree to 6= completely agree).

Items AD01 to AD05 Digitalization…	M ± SD	FL	r(I-F)
…enables me to better commu-nicate what is important to me	3.03 ± 1.27	.728	.636
…improves my relationship with people.	2.91 ± 1.37	.718	.556
… creates connectedness.	3.46 ± 1.16	.696	.498
…enables me to get more socially involved.	3.02 ± 1.37	.663	.566
…can make relationships much more intense.	2.74 ± 1.36	.656	.586

The second factor explained 11.0% of the variance and included 4 items dealing with the loss of control through digitalisation, i.e. "Digitalization means a loss of self-determination".

Table 3: Factor 2 (DLC): Results of the PCA, reliability and Items parameters (M= mean; SD = standard deviation; FL = Factor loading; r(I-F) = Correlation of the items with the factor). Scale range from 1= completely disagree to 6= completely agree).

Items AD06 to AD09 Digitalization…	M ± SD	FL	r(I-F)
… leaves me at its mercy	2.96 ± 1.28	.817	.637
… means a loss of control	3.17 ± 1.50	.787	.716
… makes me helpless	2.35 ± 1.14	.750	.587
… means a loss of self-determination	3.34 ± 1.34	.745	.628

Factor loadings of the items ranged between 0.745 and 0.817. With Cronbach's α of 0.817 the internal consistency of this factor can be considered as excellent. Correlation of the items with the factor ranged between 0.587 and 0.716. The scale was named "Digitalisation and Loss of Control" (DLC).

The third factor explained 8.6% of the variance also including 4 items dealing with the loss of control through digitalisation, i.e. "Digitalization increases the collective knowledge". Factor loadings of the items ranged between 0.656 and 0.821. With Cronbach's α of 0.791 the internal consistency of this factor can be considered as very good. Correlation of the items with the factor ranged between 0.578 and 0.627. The scale was named "Digitalisation, Knowledge and Education" (DKE).

Table 4: Factor 3 (DKE): Results of the PCA, reliability and Items parameters (M= mean; SD = standard deviation; FL = Factor loading; r(I-F) = Correlation of the items with the factor). Scale range from 1= completely disagree to 6= completely agree).

Items AD10 to AD13 Digitalization…	M ± SD	FL	r(I-F)
…increases the collective knowledge	4.45 ± 1.209	.821	.617
… expands the collective memory	3.99 ± 1.372	.756	.578
… creates education for all	3.91 ± 1.283	.695	.585
… promotes freedom of expression.	3.93 ± 1.284	.656	.627

The fourth factor explained 6.4% of the variance and includes 3 items dealing with the gain of freedom through digitalisation, i.e. "Digitalisation takes work out of my hands". Factor loadings of the items ranged between 0.623 and 0.831. With Cronbach's α of 0.749 the internal consistency of this factor can be considered as very good.

Table 5: Factor 4 (DGF): Results of the PCA, reliability and Items parameters (M= mean; SD = standard deviation; FL = Factor loading; r(I-F) = Correlation of the items with the factor). Scale range from 1= completely disagree to 6= completely agree).

Items AD14 to AD16 Digitalization…	M ± SD	FL	r(I-F)
…takes work out of my hands	4.12 ± 1.20	.831	.537
… improves my daily life	4.19 ± 1.07	.731	.654
… means freedom.	3.55 ± 1.30	.623	.554

Correlation of the items with the factor ranged between 0.537 and 0.654. The scale was named "Digitalisation and Gain of freedom" (DGF).

The fifth and last factor explained 6.4% of the variance and includes 3 items dealing with equity and prosperity through digitalisation, i.e. "Digitalisation will create prosperity for everyone".

Table 6: Factor 5 (DEP): Results of the PCA, reliability and Items parameters (M= mean; SD = standard deviation; FL = Factor loading; r(I-F) = Correlation of the items with the factor). Scale range from 1= completely disagree to 6= completely agree).

Items AD17 to AD17 Digitalization…	M ± SD	FL	r(I-F)
… solves our environmental problems	2.34 ± 1.21	.791	.514
… creates equity and justice	2.15 ± 1.11	.698	.531
… will create prosperity for everyone	2.52 ± 1.17	.687	.503

Factor loadings of the items ranged between 0.687 and 0.791. With Cronbach's α of 0.699 the internal consistency of this factor can be considered as good. Correlation of the items with the factor ranged between 0.503 and 0.531. The scale was named "Digitalisation, Equity and Prosperity" (DEP).

Based on the results of the PCA, the corresponding scale means were calculated and examined for differences in relation to socio-demographic aspects and for correlations with the SWOP-K9 subscales.

Figures 3-8 show the values of the Att-Dig subscales with respect to the sociodemographic subgroups.

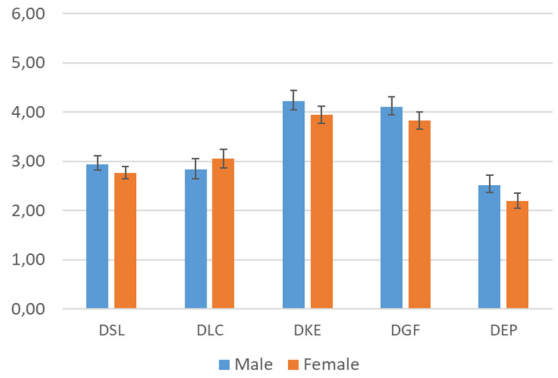

Figure 3: Mean values of the Att-Dig subscales with respect to gender (Error bars show the 95% confidence interval).

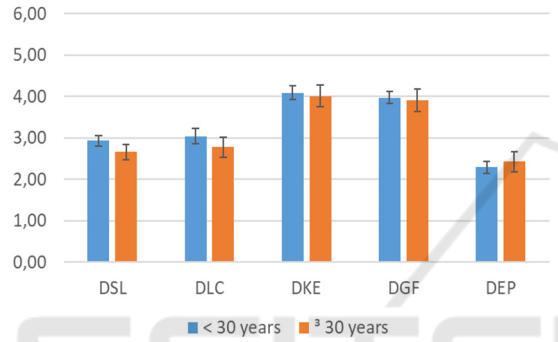

Figure 4: Mean values of the Att-Dig subscales with respect to age (Error bars show the 95% confidence interval).

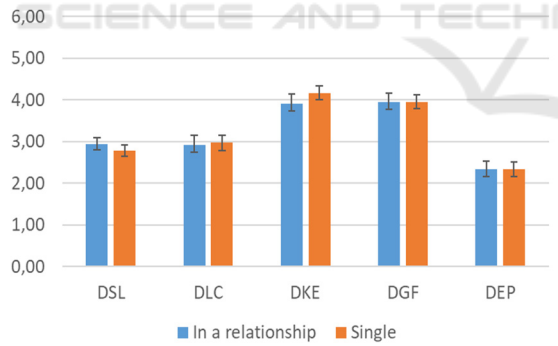

Figure 5: Mean values of the Att-Dig subscales with respect to relationship status (Error bars show the 95% confidence interval).

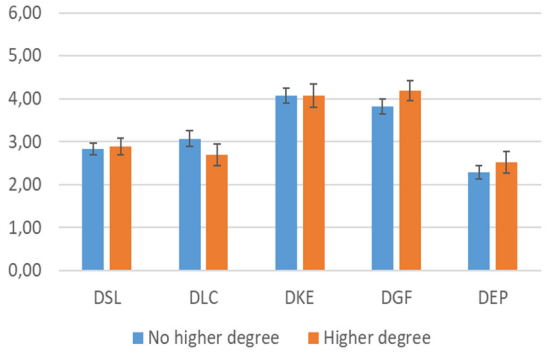

Figure 6: Mean values of the Att-Dig subscales with respect to educational degree (Error bars show the 95% confidence interval).

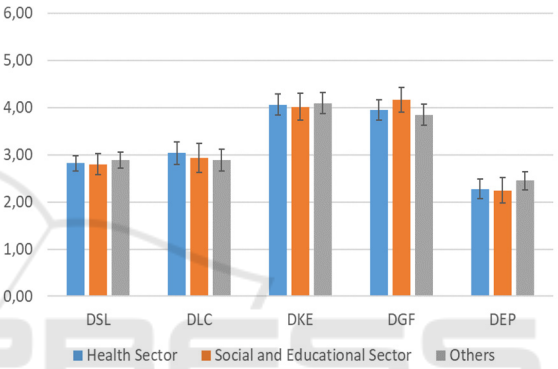

Figure 7: Mean values of the Att-Dig subscales with respect to job sector (Error bars show the 95% confidence interval).

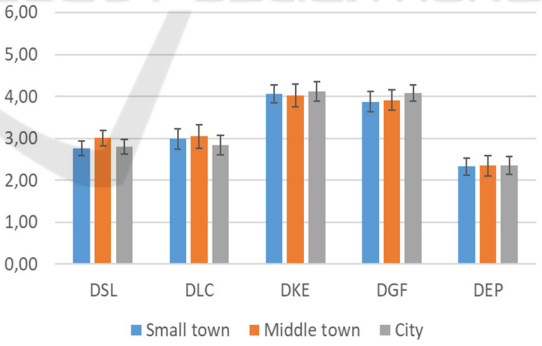

Figure 8: Mean values of the Att-Dig subscales with respect to socialisation (Error bars show the 95% confidence interval).

In particular significant differences were found in the subscale DSL with respect to age ($F=6.052$; $p=0.015$), DLC ($F= 6.104$; $p= 0.014$) and DGF ($F=6.252$; $p= 0.013$) with respect to educational degree, and DKE ($F= 4.128$; $p= 0.043$), DGF ($F= 4.506$; $p=0.0035$) and DEP ($F= 6.283$; $p= 0.013$) with respect to gender.

Table 8 shows the correlation with the SWOP-K9 subscales “self-efficacy”, “optimism”, and “pessimism”.

Table 8: Correlations with the SWOP-K9 subscales “self-efficacy” (SE), “optimism” (OP), and “pessimism” (PM).

Att-DIG/SWOP subscales	SE	OP	PM
DSL	0.012	-0.047	-0.011
DLC	-0.152	-0.041	-0.016
DKE	0.06	0.125	-0.093
DGF	0.086	0.13	-0.034
DEP	0.08	0.024	-0.022

All correlations were weak and only the correlation of “Digitalisation and Loss of Control” (DLC) with “Self efficacy” (SE) was significant ($p=0.026$) and negative ($r=-0.152$) which due to the nature of the scales and their meaning is rather evident.

4 DISCUSSION

Digitalization is becoming increasingly important in every society and in every area of society and is increasingly determining people's everyday lives. This applies in particular to the healthcare system, where digitalization is playing an increasingly important role in patient care such as in projects like “Open notes” (O’Neill et al, 2021) or when introducing the “Electronic Health Card” in the German health care system (Jorzig et al., 2020)

Thus there is an urgent need for research on scales and questionnaires quantifying attitudes towards digitalisation. This article aims at contributing to this field of research and summarizes first results of the development and validation of the Attitudes towards Digitalisation Questionnaire (Att-Dig). Our analysis yielded a stable and convergent five-factor solution that exhibited convincing validity with values of Cronbach's alpha between 0.699 and 0.817).

Correlations with the SWOP-K9 were neglectable, while differences especially with respect to gender and education need further investigations.

Our study has some limitations. Firstly, the item selection did not rely on conceptual theoretical models as already been discussed in (Niewrzol & Ostermann, 2024). This however does not directly imply that the questionnaire is invalid, but futher inspection of the results is recommended in particular due to the fact that digitalisation has advanced in the last 5 years. However, as with other constructs, it can be assumed that the factorial structure remains the same even after six years even if attitudes towards digitalization may have changed. Thus this work cleary focusses mainly on the validity of the scales rather than discussing the outcomes of the survey. In particular critical items, e.g. "Digitization increases the collective knowledge" or "Digitization does/does not create equity and justice" have not be discussed based on this data set but may be subject to future studies.

In addition, technical readiness and socio-organizational factors should also be taken into account in further studies when measuring the attitudes towards digitization in a given context and should be surveyed in studies using the Att-Dig. This in particular is relevant in the health context, in which previous surveys have shown very high approval ratings for digitization (Veikkolainen et al., 2023)

Secondly the sample size in the present study is borderline. Although communality values as given in this study according to (Schreiber, 2021) justify a sample size of around 200, Costello & Osborne (2009) argue that the required sample size of a factor analytical approach should at least have a subject to item ratio of 10:1 but preferable a ratio of 20:1 to avoid an unstable factor structure. Thus 214 participants can be regarded as adequate just at the border of a sufficient sample size.

From a methodological point of view, the use of an exploratory factor analysis can be criticized and in the construction of psychological constructs it is often suggested to do a confirmatory factor analysis instead (Schreiber, 2019). Moreover, the use of a PCA instead of e.g. a principal axis factoring (PAF) approach is also still a matter of discussion (Niewrzol & Ostermann, 2024). Here, a simulation study found that PCA loadings might be better approximations of the true factor loadings than the loadings produced by PAF (de Winter et al. 2016). Thus, although this discussion is still ongoing, we believe that our approach has produced sufficiently reliable scales, which was confirmed not least by Horn's parallel analysis.

Nevertheless, not only for methodological reason i.e. sample size, have we suggested replicating the survey on other samples such as schoolchildren or older people or in other health related contexts in order to analyse measurement invariances which was not possible in the present study.

5 CONCLUSION

In sum, although there is a need for further research, the Att-Dig is a sound survey instrument to economically assess the attitude towards

digitalisation. It can be used in different areas of public life and health care and is easy and quick to answer.

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