Validation of a scale to evaluate Digital Dependence of Employees

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BACKGROUND: The evolution of technologies and mobility, new digital resources have emerged transforming human behavior. These include the abusive use of digital devices, leading to various dependences regarding the way people use technology. Collective environments also begin to exhibit symptoms of such dependences.

OBJECTIVE: Validate a Digital Dependence of Employees Scale (DDES), applied to personnel not holding leadership positions in organizations.

METHOD: Data were collected via Internet. The sample totaled 301 volunteers from a state-owned company, of which 294 were statistically validated. Participants were asked to answer 20 questions prepared by experts. After the collection procedure, a database was created for statistical analysis.

RESULTS: Statistical analysis procedure including factorial analysis was conducted, which confirmed data adequacy. Three statistical criteria were used: Bartlett Sphericity test, Kaiser-Meyer-Olkin Criterion and Factorial analysis, including Screeplot; the latter determined adequate commonalities, indicating the cancellation of only 1 out of the 20 original scale questions. The internal consistency of the scale measured through the Cronbach Alpha Coefficient showed a positive result of 0.764. Thus, scale validation objectives were achieved.

CONCLUSION: The DDES scale was considered validated to be applied to employees in organizational environments. The limitations found to apply the scale did not compromise its results.

KEYWORDS: digital dependence; digital dependence of employees; scale; DDES.

■ INTRODUCTION

Digital dependence[1] is defined as a lack of autonomy or independence to perform tasks without the use of digital communication devices, such as the Internet, handsets, tablets, social networks and the like.[1] Lack of these resources, even if temporary, can generate anxiety, fear and insecurity, preventing the individual from carrying out his normal activities. Nomofobia[3] is the irrational fear of being without your mobile phone or being unable to use it for some reason, such as the absence of a signal or running out of minutes or battery power. Together with digital amnesia, attention deficit, digital dementia, abusive use of social networks, compromised vision, among other dysfunctions, nomophobia is one of the examples that fit into the context of digital dependence.[1]

In the mid-1990s, the first study on human internet dependence[4] emerged. From then on, this theme began to surface at an ever increasing rate: at the time of writing, with the evolution of technology and especially with the mobility factor, new technological digital resources continuously crop up, transforming human behavior in decisive ways. This transformation obviously includes abusive use[5,6] which may cause harmful effects on health. Care is needed to minimize physical, psychological and behavioral damages.[7,8]

Apart from internet dependence as previously studied, the dependence on social networks and communication devices has also been researched.[9] Behavioral and psychological changes, related to abusive and uncontrolled use, create severe impacts on users' lives.[10]

The expansion of the Digital Age[1] extrapolated dependence at an individual level and is now, typically, a social phenomenon, given its collective and broad characteristic, capable of influencing organizational environments, hitherto not contemplated.[1]

Employee abusive, indiscriminate and prolonged use in the workplace may be detrimental to individual performance as well as to the collective organizational results. In addition, and because a large part of collective human behavior interferes with, and is modified by organizational culture, individual digital habits in organizations may feedback as an influence the culture and destination of organizations. Culture is as influential in human behavior and consequently in organizations as it is invisible; discussing it is more difficult than mapping it or than subsequently analyzing its profile. Because of its invisibility and apparent ethereal state, however paradoxical this may sound, it is solid enough to re-forge organizational profiles.[11] Consequently, we consider it vital to investigate, the occurrence of such phenomena in the collective environment of organizations, using a validated instrument.

The purpose of this paper was thus to validate a digital dependence evaluation scale, built specifically for application to employees who do not hold leadership positions in organizations.

■ MATERIALS AND METHOD

We performed a search for scales on digital dependence within organizational environments that might have subsidized the construction and validation of what we required. The keywords used in the search were: digital dependence in organizations; digital dependence in companies and digital dependence of employees. To the best of our knowledge, the topic had no precedent and thus the prospect of success with findings at the organizational level tended to zero. Unsurprisingly, the search found nothing possessing any minimally useful properties. Consequently, in developing our scale, no data restrictions were placed on including any possible valid content. Also, and for these same reasons, the nationalities of participating content authors was left open.

According to Hair et al[12] no questionnaire should be administered before the researcher has evaluated the expected accuracy and consistency of the answers.

Such a pilot test allows us to previously evaluate the questionnaire and then submit it to specialists who are knowledgeable about the theme.[1] Thus, a first version (with 20 questions) was built collectively by 6 specialists and subjected to a new evaluation, as described below.

In this new evaluation, carried out by 6 different specialists, the clarity, objectivity and focus of the 20 questions were examined. A final version of the scale was obtained and applied to 301 volunteers, men and women, aged 18 - 65 years; seven answered questionnaires were discarded, on account of faulty completion, resulting in an effective sample of 294 participants. The data collection procedure was performed electronically, through a computational resource often used in academic circles for investigations of this nature.

The scale was applied online, being made available for 30 days to a target audience made up of employees, who did not hold leadership positions of a Brazilian state-owned company included in the segment of Information Technology and Communication.

The 20 DDES questions offered the responder the following options: Never/Rarely (0 points), Frequently (1 point) and Always (2 points). Consequently, total points obtained from each responder ranged from 0 to 40. After data collection, a database was set up to permit the performance of statistical analysis leading to scale validation, as well as to identify the profile of the sample from the demographic point of view. Statistical validation was made up of descriptive statistics, factorial analysis, factorial loads and internal consistency, using the R computer program, version 3.4.2.[13]

The resulting sum obtained classified the volunteers in the following categories: 0 to 8 (without disturbances); 9 to 18 (mild disorders); 19 to 28 (moderate); 29 to 38 (severe).

Demographic data were only used for demographic identification of participants and recorded age group; educational level and gender.

The construction of the DDES scale was specifically aimed to make it as short as possible in terms of the number of items within the scope of the theme, without unusual words, without embarrassing assertions, without implication of subordination. None of these precaution impacted the objectives of the collection instrument. Once validated by specialists, DDES was applied to employees.

Inclusion criteria. All employees of the company (analysts and technicians) were invited to voluntarily participate in the research and were instructed about its objectives. All of those who accepted the invitation were of age and active in their functions.

Exclusion Criteria. Research participants could not be holding managerial positions. Outsourced employees were not invited.

■ RESULTS

Primary inspection of data. Mistakes, such as errors in the sum of the totals of the questions caused seven participants to be excluded, reducing the data set to 294 entries.

Descriptive Statistics

In this section, we present the descriptive tables of the sample.

Table 1 displays demographic information gleaned from the database. As noted in "Methods", this information was collected merely for information purposes and did not interfere with the project's objectives. In terms of educational level, there is no perceptible difference between the groups, except for the four volunteers with a doctoral degree, which makes it not significant for mean tests.

Factorial Analysis.[14] The first test was the Bartlett Sphericity test,[15] to verify if the questions correlated with each other, which would ensure the consistency of the set of items. In this test, the null hypothesis is that a correlation matrix is equal to the identity matrix. Factor analysis is feasible because the value found produced $p < 0.001$, indicating a strong correlation between the questions.

The next criterion was the Kaiser-Meyer-Olkin Criterion or KMO,[15] to verify the adequacy of the factor analysis A value 0.754. was found, Previous reports diverge, some regarding 0.7 as good[15], while others claim that values above 0.8 is more appropriate[16].

Table 2 shows the Measure Sampling Adequacy indices for each of the questions, where five questions obtained values greater than 0.8, ten between 0.7 - 0.8, two with values bordering 0.7 and one in the vicinity of 0.5.

Results found for Bartlett and KMO showed it to be appropriate to perform the factorial analysis for the questionnaire.

Factorial loads. The next step was to verify the factor loads to determine the number of relevant factors, using 3 criteria: Factorial Load, Screeplot and Parallel Analysis.

Factorial Load Criterion. It is advisable [15] to use factorial loads whose sums result in a value above 0.9, and, worst scenario, above 0.8. However, for this data set, we would need at least 14 factors, which would not solve our data reduction data (Table 3).

We then proceeded to the Screeplot criterion of the correlation matrix, where factors related to Eigenvalues > 1 were eliminated.

Screeplot Criterion. By this criterion, 7 factors must be used, and in this case, the commonalities of the variables are presented in table 4:

Analyzing the commonalities, we found that only question #7 (highlighted in bold type) has a value below 0.5, which is considered low16; this led to the exclusion of the question. The deleted question read:

Table 1. Demographic data: participants by gender, educational levels and age.

Gender					
Female			Male		
94 (32%)			200 (68%)		
Education					
Undergraduate	Postgraduate	Master	Doctoral	Not informed	
92 (31.3%)	159 (54.1%)	38 (12.9%)	4 (1.4%)	1 (0.3%)	
age					
20 - 30	31 - 40	41 - 50	51 - 60	> 60	Not informed
10 (3.4%)	114 (38.8%)	73 (24.8%)	81 (27.6%)	15 (5.1%)	1 (0.3%)

Table 2. Measure Sampling Adequacy of the DDES questions.

DDES 1	DDES 2	DDES 3	DDES 4	DDES 5
0.773	0.718	0.697	0.806	0.803
DDES 6	DDES 7	DDES 8	DDES 9	DDES 10
0.695	0.770	0.812	0.751	0.761
DDES 11	DDES 12	DDES 13	DDES 14	DDES 15
0.709	0.841	0.698	0.617	0.705
DDES 16	DDES 17	DDES 18	DDES 19	DDES 20
0.783	0.804	0.744	0.502	0.787

Table 3. Factorial loads of Principal Components.

	DDES 1	DDES 2	DDES 3	DDES 4	DDES 5
Standard deviation	1.970	1.309	1.188	1.119	1.073
Proportion of variance	0.190	0.086	0.071	0.063	0.058
Cumulative proportion	0.190	0.279	0.350	0.413	0.470
	DDES 6	DDES 7	DDES 8	DDES 9	DDES 10
Standard deviation	1.036	1.024	0.951	0.938	0.921
Proportion of variance	0.054	0.052	0.045	0.044	0.042
Cumulative proportion	0.524	0.576	0.622	0.666	0.708
	DDES 11	DDES 12	DDES 13	DDES 14	DDES 15
Standard deviation	0.906	0.853	0.831	0.801	0.780
Proportion of variance	0.041	0.036	0.035	0.032	0.03
Cumulative proportion	0.749	0.785	0.820	0.852	0.880
	DDES 16	DDES 17	DDES 18	DDES 19	DDES 20
Standard deviation	0.780	0.726	0.672	0.644	0.594
Proportion of variance	0.03	0.026	0.023	0.021	0.018
Cumulative proportion	0.910	0.939	0.962	0.982	1.000

Table 4. Commonalities through the Screeplot.

DDES 1	DDES 2	DDES 3	DDES 4	DDES 5
0.644	0.602	0.640	0.529	0.540
DDES 6	**DDES 7**	DDES 8	DDES 9	DDES 10
0.561	**0.431**	0.567	0.581	0.508
DDES 11	DDES 12	DDES 13	DDES 14	DDES 15
0.573	0.542	0.740	0.655	0.671
DDES 16	DDES 17	DDES 18	DDES 19	DDES 20
0.572	0.512	0.508	0.548	0.602

" How often you ignore labor aspects concerning the use of personal communications devices of your co-workers or other employees of the company, for professional activities?"

Parallel Analysis Criterion.[16] By this criterion, 3 factors were found, according to the commonalities displayed in Table 5.

The problem encountered when using Parallel Analysis was that most of the commonalities were very low, with only questions 13 and 15 reaching the minimum value of 0.5. We therefore adopted the Commonalities through Screeplot which allowed the confirmation of all but question #7.

Table 5. Commonalities by Parallel Analysis.

DDES 1	DDES 2	DDES 3	DDES 4	DDES 5
0.543	0.324	0.360	0.398	0.469
DDES 6	DDES 7	DDES 8	DDES 9	DDES 10
0.310	0.221	0.441	0.448	0.162
DDES 11	DDES 12	**DDES 13**	DDES 14	**DDES 15**
0.196	0.296	**0.660**	0.339	**0.577**
DDES 16	DDES 17	DDES 18	DDES 19	DDES 20
0.272	0.389	0.252	0.061	0.282

Internal Consistency through the Cronbach Alpha Coefficient. The last step was to calculate the Cronbach Alpha Coefficient [17,18] in order to measure the internal consistency of the questionnaire. The value found was 0.764, which is considered acceptable[12] and shows consistency between the items of the questionnaire.

■ DISCUSSION

Digital dependence has grown within organizations, usually undetected by its leaders, who were caught unprepared to identify and understand the effects of this phenomenon; unfortunately, it interferes with human behavior, organizational environment and consequently with culture, performance and expected results.[1]

King et al[19] reported that personal, social, academic and professional life is compromised because of abusive use and/or dependence on digital technologies in daily life.

Research on this phenomenon must be expanded within the collective environments of organizations to make data more consistent. In addition, such research may guide and direct the actions of its leaders toward a better coexistence with their teams. Team members with digital dependence can present variable characteristics, according to the various organizational profiles.

Digital dependence has a global collective dimension encompassing communities, organizations, cities and nations. Thus, dependence becomes a social fact, because of the universality of its amplitude; in plain English, digital dependence transforms entire communities and their cultures. It is thus totally justifiable to construct an instrument, such as the herein described Digital Dependence of Employees Scale, that may become the objective basis of research on digital employee dependence within organizations. We are convinced that DDES collected a satisfactory data set considering the number of questions created in the initial scale.

Completed questionnaires showed a high concentration of low scores. Strictly speaking this may mean that our volunteers see themselves in a condition of light digital dependence. This perception is not surprising because, in general, digital addicts do not think themselves to be addicts and tend to answer questions at lower (instead of true) degrees of dependence. It should also be understood that our volunteers are employed in a digital technology company, where all things digital are perceived as natural, making it even more difficult to see oneself as a digital dependent person.

Demographic data showed a well distributed frequency, revealing consistent degrees of comprehension for the items in the scale, as well as a good frequency distribution by age group of participants, especially in the 31-40, 41-50 and 51-60 bands. No single age band predominates, avoiding an embarrassing research bias.

With more of these surveys using DDES it may become possible to observe behaviors correlated with age band concentration, revealing new contributions of the scale.

Factor analysis could be performed due to the low p-value in Bartlett's sphericity test, indicating that there is a correlation between the questions. In addition, the KMO criterion ratified the adequacy of the factorial analysis, because 15 of the 20 items of the scale had values > 0.7, which is satisfactory. Four items ranged slightly below 0.7, while one was at the level of 0.5; taken together, this a very good result for a 20-item questionnaire.

Three criteria were used to choose the number of factors: Factorial Load, Screeplot and Parallel Analysis, with the number of factors being respectively 14, 7 and 3. The number of factors chosen was 7 of the Screeplot, because with 14 there would be too many factors to be worked out and with 3, too many questions would have to be eliminated because of lower commonalities. With the adopted factoring, only one variable or question was withdrawn from the scale because it was the only one with a commonality < 0.5. Thus, the final scale has 19 questions, as shown Annex 1.

The internal consistency extracted by Cronbach's Alpha[17,18] presented a value of 0.764; this ratifies the alignment between the scale questions, since values above 0.7 are considered valid.

This study has minor limitations. The theme is a total novelty, and this means that authorization of application within in their organization came from managers/directors who knew next to nothing about the theme. Then, when it comes to application in an organizational environment, the volunteers must have had a measure of mistrust about what would be done with their answers, even though they had been told that the data would be treated collectively. This was aggravated by the fact that the application was performed online, which prevents the researcher observing the volunteers' actions/reactions while completing the form. In spite of all this, it was possible to manage effectively the coordination of the organization that served as a research field, with efficient and attentive monitoring of these aspects. Another limitation of the study was the lack of other instruments similar to the objectives of this research that could subsidize the construction of the present scale.

■ CONCLUSION

The validation of the DDES scale was completed, resulting in a scale that meets the objective of evaluating digital dependence of employees in an organizational environment. We consider it important to construct an unprecedented and specific instrument such as this to support future scientific research in the field of digital dependence of employees in the collective milieu of organizations. The growth of this theme and its possible interference with organizational culture, human behavior and operation of the organizations justifies this work.

New research will reinforce the validity of this scale and may allow comparisons between results produced by employees of companies of different natures through the dynamics of digital technology usage.

AUTHOR CONTRIBUTION

LL Gonçalves: reviewed the literature, applied the scales and wrote the present article.

AE Nardi: co-oriented and wrote this article.

MSKL Pádua: wrote this article.

E Guedes: wrote this article

HK Santos: analyzed statistically and wrote this article.

FL Guimarães: wrote this article.

D Rodrigues: analyzed statistically and wrote this article.

ALS King: oriented and wrote this article.

■ CONFLICT OF INTEREST

All authors declare no conflict of interest.

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ANNEX 1 _ VALID VERSION OF THE DDES

Scale to evaluate the digital dependence of employees (DDES).

Date: ____ / ____ / _____ Age: _____
* Name Voluntary: _____

Volunteer initials: _____ (Required for insertion into the database)
Gender: F ( ) M ( )
Company: ( ) Public ( ) Private
Level of Education: ( ) Middle ( ) Upper ( ) Postgraduate ( ) Master
( ) Doctorate degree
* Signature of the Volunteer: _____
*Email:_____ _____
* Phone number:_____
* Optional observations

Interviewer: _____ _____

The acronym CCPT&O refers to the Digital Dependence, that is, dependence on technologies such as computer, cell phone, tablet, among others.
The test is a scale of 19 questions that measure the employee's digital dependence at a mild, moderate, and severe CCPT&O level.

Please enter the number corresponding to the answer next to the question:
Never / Rarely (0); Often (1); Always (2)

Questions:

1. How often do you feel destabilized when CCPT&O access restrictions are imposed on your organization?
2. How often do you prioritize your personal communication (Facebook, Whats App, E-mail, etc.) to the detriment of work, occupying more time with CCPT&O than with work?
3. How often have your performance in work or productivity been affected by the overuse of CCPT&O information and communication technologies in your organization?
4. How often do you care about restrictions on the use of CCPT&O individual communication technology devices
5. How often do you feel uneasy because there are actions to minimize the CCPT&O Digital Dependency in your organization?
6. How often do you see, unconcerned, with the Digital Dependence CCPT&O in your organization?
7. How often do you have your work income improved by the indiscriminate personal use of CCPT&O communication technologies?
8. How often do you in your organization disregard the limit between the use considered "normal" or acceptable and the abusive use of information and communication technologies CCPT&O?
9. How often do you take breaks in the workout so that you can use exercise equipment or do stretching, breathing and relaxation exercises to relieve the intensive use of CCPT&O?
10. How often do you avoid taking breaks in the use of exercise equipment? Information technology and communication CCPT&O in your company
11. How often do you use your particular CCPT&O information and communication technology devices for the services of the organization where you work?
12. How often do you feel motivated to have greater digital freedom of the CCPT&O granted by the organization?
13. How often do you minimize your relationships with co-workers due to the use of CCPT&O information and communication technologies?
14. How often do you feel more comfortable with your organization's permission to use your own CCPT&O digital devices, at work?
15. How often do you disregard the negative effects of abusive use of CCPT&O information and communication technologies?

16. How often do you get better acquainted with colleagues in your organization due to the use of CCPT&O information and communication technologies?
17. How often do you hide from your organization your relationship with colleagues through the use of information and communication technologies (CCPT&O)?
18. How often do you wait for messages of professional recognition or praise from the company or your boss that come through CCPT&O?
19. How often would you use CCPT&O for personal communication if it were banned from your company?

Results: After answering all the questions, add the numbers you selected for each answer to get a final score. The higher the score, the higher the employee's digital dependence level in the company and the related problems. Below the values for the points obtained in your score:

0 - 8 points: No signs of digital dependence of the employee with total control over the their use of CCPT&O technologies.

9 - 18 points: Light signs of possible digital dependence of employees in the company at a light level. The company may begin to have occasional problems due to the onset of digital dependence on CCPT&O employees. It may present future impacts in the business context because employees use CCPT&O more often than necessary. Be aware that digital dependence on employees does not harm the company.

19 - 28 points: Moderate signs of possible digital dependence on employees at a moderate level. It begins to have problems due to digital dependence CCPT&O being more frequent of the employee. You should consider the impacts on business life because employees use technologies (CCPT&O) with greater intensity than recommended. Employees must learn to deal with CCPT&O technologies more consciously.

29 - 38 points: Severe signs, the use of CCPT&O technologies by employees is causing significant problems in the company at a serious level. The company should evaluate the consequences of these impacts. It should observe at this moment, losses in the income of employees in the personal, social, family and professional areas, significantly compromising their quality of work and performance. The company must refer the employees with this framework for professional evaluation (doctor and psychologist) to receive guidance in specialized centers and if necessary treatment. The company must use institutions that promote the conscious use of technologies to establish partnerships that promote a good working environment.