Conceptualizing IT Resilience: An Explorative Approach

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Abstract. Modern technologies such as mobile phones and wearables are increasingly embedded in our daily life which makes detachment almost impossible. Therefore, understanding personal characteristics that allow individuals to buffer negative effects is an important tool to reduce negative consequences of technology use. Extant literature on technostress provides initial insights into how individuals are able to handle stressors. However, important constructs have not yet been investigated. We contribute to existing literature on technostress by proposing IT resilience as a new construct that can be considered a coping mechanism for technostress. We present the results of an explorative factor analysis (n=80), which suggest that IT resilience is a multi-dimensional construct with three sub dimensions: bounce back, self-efficacy, and coping. We conclude with a discussion on how to include IT resilience in theory development and human centric design.

Keywords: IT Resilience, Technostress, Explorative Factor Analysis

1 Introduction

Information Technology (IT) is a fundamental part of our daily life and is integrated into our daily routine. Mobile technologies such as mobile phones or tablets in particular are widely used and are, thus, object to a great number of research [1]. Emerging technologies including affective technologies [2], wearables [3], or smart textiles [4] are further contributing to the omnipresence of IT.

As a consequence of this development, Information Systems (IS) research has not only recognized positive aspects of IT but also revealed potential pitfalls. In this vein, the 'dark side of technology' [5] has emerged as an important research area within the (IS) discipline. Within this movement, technology-induced stress (i.e. technostress) has been introduced and analyzed from various perspectives [6–8] in order to investigate causes and consequences of technology-related stress and its outcome.

Despite the increasing efforts to understand technostress both research and practice see a high number of individuals that are affected by technology-induced stress. The impact of technostress becomes visible with regard to mobile phone use [9, 10]. The prevalence of technostress is unfortunate because it has a negative influence on productivity [11], job satisfaction [8], and job performance [8]. Therefore, both organizations and individuals can benefit from avoiding technostress.

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Since technology is a growing aspect of our daily life, individuals rely on effective strategies in order to reduce negative influences such as technostress. Therefore, it is imperative to investigate individual characteristics that are effective tools to counteract technostress and can later be used to design technology. However, current literature only provides initial insights into individual characteristics in the context of technostress [12]. Without investigating potential characteristics, it is difficult to reduce technology-induced negative consequences.

In this context, the purpose of this study is to expand the current body of knowledge by conceptualizing a new individual characteristic, namely IT resilience. Resilience has gained a lot of attention in stress-related domains (see for instance [13]). Unfortunately, it has not yet been adapted for the IS domain. In this paper, we present the results of an Exploratory Factor Analysis (EFA), which provides evidence that IT resilience reflects three dimensions: bounce back, self-efficacy, and coping. Taking all of these into account, this paper seeks to adopt resilience for the IT domain.

This paper is structured as follows. First, we review existing literature on resilience and provide an overview of its central characteristics and demonstrate the relationship between resilience and the IT domain (section 2). Next, we summarize our scale development procedure (section 3). In section 4, we present our research methodology and the results of an EFA. This paper concludes with a discussion of the results, its implications on theory and technology design, and provides fruitful avenues for future research by taking into account current limitations.

2 Related Work

The term resilience originates from material sciences to describe the property of an object [14]. It is especially used to describe how an object behaves under pressure and whether it is able to "bounce back" into its original state. The concept of resilience can easily be observed in mattresses. Putting a mattress under pressure deforms its shape (usually into a U-form). Due to its design, however, a mattress is able to "bounce back" into its original form.

This example can be applied to how an individual perceives stress. In other words, a high degree of resilience enables an individual to return to an initial state (i.e. a balanced state). Since being resilient is an important aspect of modern life, psychology and sociology have already adopted this notion and defined it as the ability or the measure of coping with stress to support resistance or bounce back in stressful situations [15, 16]. Note that resilience as a concept is not about being invulnerable to negative effects but the ability to overcome and manage stress (perception).

Despite numerous attempts to conceptualize resilience (in psychology and sociology) a common definition does not yet exist. Therefore, we refer to a widely adopted notion (e.g. [17]) that can be adopted for IS literature [18] and which summarizes core aspects used in other studies (e.g. [15]). Accordingly, resilience can be defined as "an individual's positive psychological state of development that is characterized by the following (a) having confidence (self-efficacy) to take on and put in the necessary effort

to succeed at challenging tasks; (b) having a positive attitude (optimism) towards succeeding now and in future; (c) keeping track of goals and when necessary, readjusting paths to achieve goals (hope) in order to succeed; and (d) when faced with problems and adversity, sustaining and bouncing back (resiliency) to attain success." [18]. In the following, we refer to this notion acknowledging that resilience is related to self-efficacy, a positive attribution, focus on goals and the ability to bounce back.

As described above, resilience refers to a set of individual features that are relevant when dealing with environmental stress-related effects. For the IS discipline, the most important environmental aspects are technology-related. Therefore, technology use as well as technological characteristics can trigger stress perception. Based on this notion, we define IT resilience as follows: IT resilience is a set of individual features that allows an individual to absorb negatively perceived external influence factors that are induced by information technology and allows returning to an initial state. We refer to Luthans, Youssef and Avolios (2007) definition [18], to juxtapose resilience with IT resilience.

Table 1. Resilience and IT Resilience

Themes	*Resilience [18]*	*IT Resilience*
Self-Efficacy	"having confidence (self-efficacy) to take on and put in the necessary effort to succeed at challenging tasks" [18]	confidence (self-efficacy) in working with **(mobile) technologies** regardless of the situation (stress, challenging tasks, errors), respectively the ability to adapt to these situations-
Positive attribution	"making a positive attribution (optimism) about succeeding now and in future" [18]	being optimistic about finding solutions for problems as well as being adaptable towards **technology-induced** stress, problems or tight deadlines
Preserving towards goals	"preserving towards goals and when necessary, redirecting paths to goals (hope) in order to succeed" [18]	Keeping track of **technology-related goals (e.g. use behavior)** and if necessary readjusting paths to achieve goals by having structured plans
Bounce back	"when beset by problems and adversity, sustaining and bouncing back and even beyond (resiliency) to attain success."	when faced with **technology-related problems (e.g. technostress)** and adversity, sustaining and bouncing back to succeed as well as cultivating social contacts and keeping a work-life-balance.

3 Scale Development Procedure

3.1 Review of existing scales

Previous literature has provided numerous measurement scales for resilience that have been established for specific targets (c.f. Table 2). Resilience has its root in (clinical)

psychology to understand how individuals and groups are dealing with diseases. Therefore, it is not surprising that a great number of scales are focusing on clinical aspects (e.g. [16, 19]). Existing scales are also diverse with regard to its target group. For example, measurement scales have been specifically developed for adults (e.g. [15, 20]), children (e.g. [21, 22]) or the elderly (e.g. [19]). Similarly, the scales are targeting different domains including workplaces (e.g. [23]) or clinical applications (e.g. [16]). There are also different scales with regard to the underlying unit of analysis. Some scales have been developed to assess the individual (e.g. [15, 24]), others for group evaluations (e.g. [20, 25]) and organizations (e.g. [23]).

Table 2. Overview (adopted and extended from [17] and [26])

	Name		*(number of) dimensions*
Individual	CD-RISC [15]	(5)	personal competence, trust / tolerance /strengthening effects of stress, acceptance of change and secure relationships, control, spiritual influence
	Dispositional resilience scale [27]	(3)	commitment, control and challenge
	RSA [24]	(5)	personal competence, social competence, family coherence, social support, personal structure
	RS [28]	(2)	personal competence, acceptance of life and self
	Brief Resilience [16]	(1)	ability to bounce back or recover from stress
	Ego Resilience [29]	(4)	confident optimism, productive activity, insight and warmth, skilled expressiveness
	READ [30]	(5)	personal competence, social competence, structured style, family cohesion, social resources
Group	FRAS [20]	(6)	family communication and problem solving, utilizing social and economic resources, maintaining a positive outlook, family connectedness, family spirituality, ability to make meaning of adversity
	CCRAM [25]	(5)	leadership, collective efficacy, preparedness, place attachment, social trust
Organizational	BRT-53 [31]	(2)	planning, adaptive capacity
	BRT-13B [32]	(2)	planning, adaptive capacity
	RAW [23]	(7)	living authentically, finding your calling, maintaining perspective, managing stress, interacting cooperatively, staying healthy, building networks
	Team Resilience Scale [17]	(4)	group structure/enabling structure, mastery approaches, social capital, collective efficacy

Although various scales have been developed for resilience, none of them acknowledges the role of IT. Against this background, we develop a new scale for IT resilience in the following.

3.2 Preliminary measurement instrument for IT resilience

Since resilience has already been established in other domains, our scale development procedure does not start with a blank slate. In other words, we adopt items from existing instruments. For this preliminary study, we identified 30 items from existing scales to cover all dimensions of resilience as proposed earlier. More specifically, we included existing items for self-efficacy. Since previous literature considers self-efficacy to be a core aspect (e.g. [18]), there is no available scale on the individual level. In order to maintain content validity, we therefore adopt an IS-specific scale [33] to capture this aspect. In the context of resilience, being able to rely on one's instinct is related to self-efficacy. Therefore, we included another five items from an existing scale to capture this specific aspect as well [15]. Next, we adopted nine items from the brief resilience scale [16] and from the RAW scale [23] in order to cover the ability to "bounce back". Then, we included three items from the resilience work scale [23] to include coping. Since literature in this context often refers to hardiness (e.g. [19, 34]), we also included four items to include this aspect of coping. To include the ability to focus on goals, we included items proposed by Friborg et al. [24]. After identifying the relevant constructs and items, the sentences were adapted for the IT context by introducing sentences as well as slightly adopting the measurement items. We particularly paid attention to simplifying the questions to avoid misunderstandings. To ensure that the participants understand the context, we ask them to imagine situations from work where IS use has caused problems. An overview of all measurement items used in this study can be found in the following table (Table 3).

Table 3. Measurement Instrument

ID	*Adapted item*	*Reference*
In situations where stress is caused by technology in general or technology use, …		
RES1	… I tend to bounce back quickly.	[16]
RES2	… I have a hard time making it through those situations.	
RES3	… It does not take me long to recover.	
RES4	… It is hard for me to snap back.	
RES5	… I usually come through those times with little trouble.	
RES6	… I tend to take a long time to get over it.	
When using my technologies, …		
CP2	...I make sure I take breaks to maintain my strength and energy.	[23]
CP3	...I am careful that they do does not dominate my personal life.	
HD1	...I am able to adapt to changes.	[15]
SE1	...I am confident in working with them.	[33]
SE2	…I feel comfortable with them.	
SE3	…I am sure I can work with them.	
SE4	…I can work with them even if no one tells me how to do it.	
SE5	…I can handle them better than most.	
When things go wrong or I have problems in using technologies, …		
BB1	...they usually overshadows the other parts of my life.	[23]
BB2	...they don't ever "faze me" for long.	

BB3	...they drag me down.	
CP1	...I have developed some reliable ways to relax.	[23]
HD2	...I can deal with whatever comes.	
HD3	...past success gives me confidence for them.	[15]
HD4	...I have close and secure relationships.	
INST1	…I can make unpopular or difficult decisions.	
INST2	…I prefer to take the lead in problem solving.	
INST3	…I see the humorous side of things.	[15]
INST4	…coping with this stress strengthens me.	
INST5	…under this pressure, I focus and think clearly.	
SST1	…I prefer to have structured plans.	
SST2	…I maintain daily rules even in difficult situations.	[24]
SST3	…and I have a goal, I do my best to attain it.	
SST4	…regular rules make my daily life easier.	

4 Research Methodology

4.1 Data collection and descriptive statistics

The data was obtained via an online questionnaire shared on different social media platforms like WhatsApp and Facebook. The survey was accessible for two weeks and a total of 177 people participated. Since technology induced stress is not limited to defined working hours, we excluded participants that are not using their mobile technologies outside their regular working hours for work-related purposes (45 participants). After removing incomplete observations as well as outliers, the final sample yielded 80 observations. Hence, the sample size exceeds the suggested requirements for an EFA [35]. An overview of the descriptive statistics is provided in Table 4.

Table 4. Descriptive Statistics

Age	*n*	*%*	*Working Hours*	*n*	*%*	*Gender*	*n*	*%*
18-30	58	74,3	<30	33	42,8	male	38	48,1
31-40	10	12,8	31-40	24	31,2	female	41	51,9
41-50	8	10,3	>41	20	26,0			
> 50	2	2,6						

4.2 Data analysis

We used an EFA in order to address our research objective. Both the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (.693) as well as the Barlett test of sphericity ($\chi^2 = 760{,}49$, $p < .000$) support the use of an EFA. Since the objective of this research is the development of an IT resilience scale with few meaningful components, we used a principal component analysis (PCA) for this purpose [36].

We analyzed the item correlations in order to reveal non-correlated (< .3) or too highly correlated (>.9) items. As a result, we dropped items with correlations that are

too low (SST3, INST2). No items were excluded due correlations that are too high. Next, we analyzed the anti-image matrix and excluded all items that are below .5. To that end, we further dropped ADP4 (.467), SST1 (.421), SST4 (.398), and CP1 (.487). Therefore, 24 items remained for further analysis.

The results of the EFA (24 items, KMO = .780, Barlett test of sphericity (χ^2 = 816,323, $p < .000$), Eigenvalue ≥ 1) indicate that out of seven factors, only four factors explain more than ten percent of variance. Therefore, we decided to continue our analysis with four factors.

Next, the EFA was conducted with a pre-defined number of four factors. Again, we analyzed the anti-image matrix and excluded items with loadings below .6. As a consequence, we dropped CP3 (.561). Furthermore, we dropped HD2 due to cross loadings on two factors. As a consequence, only three factors remained explaining more than ten percent of variance. This step is also supported by the results of the scree plot. Finally, we dropped INST1, INST5, ERS1, and CP2 due to too low factor loadings (<.5). Our final scale includes three factors with 17 items. The construct correlations of the identified constructs are shown in Table 6. All constructs have a significant correlation between .3 and .5.

Table 5. Measurement Instrument

ID	*Factor 1*	*Factor 2*	*Factor 3*	*Cronbach's α*	*IT Resilience*
RES2	,752				
RES3	,708				
RES4	,653				
RES5	,776			.846	
RES6	,633				
BB1	,590				
BB2	,554				
BB3	,644				
HD1		,586			.859
ADP1		,804			
ADP2		,698		.808	
ADP3		,854			
ADP5		,661			
HD3			,709		
HD4			,609	.676	
INST3			,728		
INST4			,698		

Table 6. Correlations between the Constructs

	(1) Factor 1	*(2) Factor 2*	*(3) Factor 3*
(1) Factor 1	1	,316**	,437**
(2) Factor 2	,316**	1	,344**
(3) Factor 3	,437**	,344**	1

4.3 Interpretation of the identified factors

Factor 1 describes the ability to bounce back when technostress occurs. Consequently, we label this factor "bounce back". This dimension of resilience is in line with previous literature (e.g. [16, 23]) describing one of the most discussed aspects of resilience: the ability to recover from technology induced stress [16, 17, 19]. At the heart of this construct is the ability to survive this adversity and return to the previous level of functioning. The bounce back factor has a reliability of α=.846 and consists of eight items. These eight items make the most extensive factor of the IT-resilience measurement scale proposed here.

Factor 2 describes the ability to believe in one's own skills and to work with (mobile) technology in every situation. In line with related IS literature, this factor is labeled as "self-efficacy". The second factor has an α = .808 and includes five measurement items. Most items used here are adopted from the self-efficacy scale [33] and the CD-RISC scale [15], which is in line with other operationalizations of resilience.

The last factor (factor 3) describes the ability to handle negative aspects and problems of technology use by seeing things in a humorous way and having social support. Therefore, we label this factor as "coping". The factor has an internal consistency of α=.676 and uses four measurement items. Since this is an explorative study, the value of α is sufficient (e.g. [37]) and allows for further interpretation. Note that the number of items is imbalanced. Since each item loading is above .4, the distribution of items is not an issue (e.g. [38]).

The results of our factor analysis suggest that IT resilience has three dimensions: *bounce back, self-efficacy* and *coping***.** The results highlight the fact that a positive attitude and social support have a positive influence on resilience. Furthermore, the results in table 7 emphasize that this attitude can support the ability to bounce back. This is in line with previous (non IS) literature that has conceptualized resilience in a similar way [16, 17, 19].

5 Discussion

The research objective of this paper is the conceptualization of resilience for IS research. The results of the survey data indicate that IT resilience can be conceptualized with three dimensions: bounce back, self-efficacy, and coping.

The dark side of technology is increasingly acknowledged in IS research [5, 39]. This paper contributes to that research stream by providing a new construct – IT Resilience – that can be used to explore negative consequences of technology use. Existing literature has already investigated the role of coping mechanisms [12, 40]. IT resilience is able to extend these insights and expand on previous literature.

With the individualization of IS [41, 42] technology use is becoming omnipresent. This development has caused a movement towards the conceptualization of new constructs. For example, IT identity has been proposed [43, 44] to capture the omnipresent, inseparable interaction with IT. Similarly, psychological ownership of technology has been proposed [45–47] to explore what happens when technology is used beyond specific boundaries. With this development, negative consequences are inevitable. In this

light, new constructs are needed that allow the analysis of contemporary use behavior. Promising constructs that have the potential to do so have been proposed (see for instance mindfulness [48, 49]). IT resilience expands existing efforts by offering a new lens to analyze use behavior in light of negative consequences. Therefore, it is can be used in combination with related constructs such as IT identity [43, 44] or psychological ownership [45–47].

Note that IT resilience as introduced here is multi-dimensional. Therefore, it shares the common characteristic of multi-dimensional constructs, including the ability to explain phenomena of interest more comprehensively. Against this background, IT resilience a promising candidate for a multi-dimensional construct that can be adopted for existing as well as future research areas. For example, studies that have already looked at coping mechanisms [40] can refer to IT resilience to gain deeper insights.

Although IT resilience is a primarily psychological construct, it is an appropriate perspective to enhance human centric design. Existing literature points out that psychological and biological aspects are important aspects when it comes to technostress [50]. On a conceptual level, extant literature proposes the notion of an Explanatory Design Theory (EDT) [51, 52] to investigate such relationships, i.e. the relationship between design features and effect variables such as technostress. Acknowledging that technology design is a potential cause for negative consequences [53], IT resilience as proposed here is an important aspect that can be included in design theories (on the effect side). IT resilience can also inform a designer on how to design an IT artifact. For example, *bounce back* mechanisms can be included in technology design to enhance the overall IT resilience of a user. We can find related examples in e-mail systems that employ automatic answer mechanisms. In summary, design theories can draw from IT resilience to either build design features or to include the construct on the effect side, which makes this construct relevant for design science.

6 Outlook and Limitations

Just like every piece of research, this study has limitations that pave the way for future research. Because IT resilience has not yet been adopted for the IS domain, this research is exploratory in nature. Therefore, future research can draw from these insights to go one step further by means of confirmatory investigations such as confirmatory factor analysis or embedding IT resilience in IS theories. Moreover, future research may further investigate IT resilience by analyzing the concept of coping from an emotional and problem-focused point of view. In the same vein, future research needs to investigate IT resilience within different groups. This research builds upon a sample with a high number of young people. However, previous literature has shown that IS-related phenomena such as IT resilience can differ between groups. With regard to IT resilience, this heterogeneity might also become relevant for different age groups for example.

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