Is Digital Hoarding a Mental Disorder? Development of a Construct for Digital Hoarding for Future IS Research

Completed Research Paper

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Abstract

By the time you finish reading this paper, approximately in 90 minutes, over 150,000 TB of new data will be created in the world (IBM 2017). The advent of digital devices such as smart mobile phones, wearables, the engagement in social media networks and content sharing platforms, the growth of digitized personal and business interactions and the access to free or affordable digital storage have increased the propensity of an individual to acquire and store digital content without carefully considering its repercussions. This research posits that this increasingly common behavior can lead to a condition that parallels the hoarding disorder, called digital hoarding. The study defines digital hoarding as the acquisition of and failure to discard or effectively manage digital content regardless of its use, leading to the accumulation of digital clutter. The paper conceptualizes digital hoarding as a composite construct. Using a sample of 846 individuals, the study makes valuable insights on digital hoarding and how it could lead to personal stress.

Keywords: Digital Hoarding, Hoarding Disorder, Survey, Personal stress

Introduction

The proliferation of devices such as smart mobiles, drones, lifestyle digital cameras (e.g., go-pro) has provided us with much potential to obtain and collect digital content. The availability of digital media and affordable storage options have opened new avenues for individuals to accumulate a morass of documents, music files, pictures, videos, emails and web pages (Beck 2012). Moreover, the technologies employed in digital photography, videography, editing and blending of emojis with photographs are making it more appealing for the individuals to digitize their life-events (Kalnikaitė and Whittaker 2011). Such capabilities of the technologies increase the individuals' desire to engage and share their digital contents through instant multi-media messaging, communication apps and social media platforms (Kaplan and Haenlein 2010; Sedera et al. 2016b). This leads to a recursive cycle of capturing, storing and sharing that ultimately leads to an accumulation of large amounts of digital content. The amount of digital content created by individuals on a daily basis is simply staggering. For example, Facebook alone uploads over 300 million photographs each day, 136,000 photos are uploaded each second (Zephoria 2018). Moreover, in 2017 alone, 4.7 trillion pictures were taken using smart mobile phones (Schultz 2017). With the price of data storage reaching near zero, individuals no longer foresee the storage capacity as an issue (Muchmore and Duffy 2018). For example, individuals now have access to a plethora of free storage options (e.g., Dropbox) and mobile devices with unlimited storage (e.g., Google's Pixel). As such, there is a reluctance to delete digital content, stemming from the opportunities to digitize daily events presented through the (i) advances in technologies,

(ii) abundant supply of affordable or free data storage and /or (iii) the perceived importance of retaining digital content for later use (Odom et al. 2011). Using the sample employed in this study (846 individuals), it was established that an individual has the maximum storage capacity of 47 TB, with an average of 3.7 TB of storage.

The rate at which the digital content is collected and the unstructured manner in which the digital content is stored, would eventually make it difficult for an individual to access digital content when required (Cushing 2013). The difficulty of discarding digital content, clutter created by content, and frequent excessive acquiring demonstrates signs of the hoarding disorder (Pertusa et al. 2010) – except in this case, the content is digital. We term this behavior as 'digital hoarding.' As such, digital hoarding is defined as *the acquisition of and failure to discard or effectively manage digital content regardless of its use, leading to the accumulation of digital clutter*. The definition places an added emphasis on the *effective management* of digital content, considering that digital content, unlike physical contents, does not need to be discarded. Moreover, we define digital content as intangible items either stored or accessed via technology that individuals recognize as theirs (Cushing 2013). The definition of digital hoarding, combined with digital content, draw direct links to the popular definition of Frost and Gross (1993) on traditional hoarding disorder. Hoarding disorder (traditional) has now been recognized as an independent diagnostic entity in the fifth edition of the Diagnostic Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association 2013)[1]. Recent studies on hoarding (traditional) suggest that hoarding is surprisingly much more common than previously thought (Ferrari 2018). However, unlike many other obsessive-compulsive disorders like schizophrenia, social phobia and organic mental disorder, individuals with hoarding disorder do not necessarily demonstrate early signs of it, making it nearly impossible to diagnose its presence (Grisham et al. 2006). More specifically, hoarding can have an impact on interpersonal connections, leading to strained relationships with family and friends as well as work disability and impairment (Tolin et al. 2008a; Tolin et al. 2008b). When the disorder is mature, individuals with hoarding problems often experience substantial functional impairment and diminished quality of life (Saxena et al. 2011). Moreover, hoarding results in information processing problems like attention disorder, memory recall, lack of decision making abilities and emotional issues like sadness, grief, anxiety and irritation (Wheaton 2016).

If digital hoarding has similar connotations with the traditional hoarding disorder, then it could prove to be an important health consideration that would have far reaching impacts. More importantly, if digital hoarding is found to exist, it is likely to increase with the advent of new technologies. While there is overwhelming anecdotal commentary on the existence of digital hoarding in everyday practices of most individuals, to the best of our knowledge (at the time of submission in September 2018), there has been only one academic study in information systems outlets on the notions of digital hoarding[2] (Sweeten et al. 2018).

The objective of this research is to develop the first composite construct that measures digital hoarding. We then use the developed measure to assess whether individuals possess the characteristics of hoarding of digital content (i.e. digital hoarding). In doing so, we draw from the strong stream of research from the parallel fields of psychology (e.g., Pertusa et al. 2010; Tolin et al. 2008b) and sociology (e.g., Cherrier and Ponnor 2010) to formulate an a-priori model of digital hoarding. The derivation and the establishment of a 'digital hoarding construct' will allow a cumulative tradition of research that would facilitate digital hoarding to be assessed, tracked, evaluated and find treatments, if necessary.

The paper proceeds in the following manner. First, the study provides the theoretical foundation and derives the a-priori model of the study. Next, the paper introduces the data collection and the sample employed to test the a-priori model. Subsequently, the data analysis is presented. The results of the study are described next, drawing conclusions for research and practice, finally, summarizing the limitations of the study.

[1] We acknowledge multiple definitions of hoarding (e.g., Cambridge dictionary). However, for the purpose of this study, we align with the clinical definition of the hoarding disorder that is available through DSM-5.
[2] Google patent # US5249578A being an exception.

Developing the a-priori Model

The diagnostic criteria for hoarding disorder[3] include: (i) persistent difficulty discarding or parting with contents, regardless of their value; (ii) the urge to save items and/or distress associated with discarding them; (iii) accumulation of clutter substantial enough to compromise the use of some living space; (iv) clinically significant distress or impairment of functioning due to hoarding; and (v) the symptoms are not better accounted for by another medical or psychiatric condition (Mataix-Cols et al. 2010; Pertusa et al. 2010). The most clearly articulated and thoroughly-researched model of hoarding disorder involves a cognitive behavioral approach. Early writings by Frost and Hartl (1996) outlined this conceptualization, which was refined and expanded upon by Steketee and Frost (2003). The cognitive-behavioral model includes a comprehensive and multifaceted conceptualization of factors that contribute to 'vulnerability to' and 'maintenance' of hoarding.

The aim of the present study is to raise an awareness of the potential dangers associated with possessing large quantities of digital content. As such, the objectives of the study is to provide a preliminary understanding of digital hoarding, perhaps to develop a validated measure of digital hoarding drawn through an adequate sample of the prominent literature, and reflect the symptoms of digital hoarding and its effects. As such, when deriving the a-priori model of digital hoarding, we base our measurement views on the foundational works of Frost and Hartl (1996). The a-priori model of digital hoarding is characterized using three sub-constructs of hoarding and a salient outcome, namely (1) the acquisition of and failure to discard a large number of digital content, (2) the difficulty of discarding digital content, (3) digital spaces are sufficiently cluttered, so the periodical addition of new spaces would be required, and (4) significant distress or impairment in functioning caused by digital hoarding.

Acquisition of Digital Content

The first characterization of digital hoarding is excessive acquisition of digital contents. Research shows that compulsive acquisition characterizes individuals who have the hoarding disorder (Frost et al. 1998). A contradicting highlight of digital hoarding as opposed to traditional physical hoarding relates to the methods of acquisition. While the most common method of acquiring physical entities involves purchasing, much of digital content can be either self-created, free or available on subscription based. Moreover, it has been suggested that both positive and negative emotions contribute to the excessive acquiring behaviors observed in those who hoard (Frost et al. 2002). For example, some individuals report that the act of acquiring is an enjoyable activity that brings on positive emotions and cognitions similar to positive emotion-oriented impulse control disorders such as gambling (Tolin 2011). On the other hand, some individuals report that these behaviors are motivated by negative emotions such as distress, anxiety, and guilt (Steketee et al. 2010). Given the availability, accessibility, relatively low or negligible costs of digital content, paired with the ever-changing human emotions means that the rate of acquisition of digital content would potentially be much higher than its physical counterpart.

Difficulty Discarding Digital Content

The second key characteristic of digital hoarding is the difficulty of discarding digital content. People with compulsive hoarding disorder tend to place higher values on contents and have great difficulty discarding them as a result (Frost et al. 1995). As the second defining characteristic of digital hoarding, we argue that individuals often evidence great difficulties with discarding digital contents they have formed an attachment or association with (Beck 2012). In relation to digital media, the difficulty of discarding digital contents is exacerbated from three additional facets: (i) the lack of a real need to discard digital contents due to the abundance of free or affordable digital spaces and (ii) the substantially high rate of digital content acquisition, not just by the individual, but by the entire digital network that the individual is a member of (Cushing 2013). Thirdly, (iii) the individuals place a strong value on the overall activity like the social media use, that will make it convoluted discarding of digital contents (Sedera et al. 2017b).

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[3] We use the term 'Hoarding Disorder' when referring to traditional hoarding. The term 'Digital Hoarding' is exclusively reserved for the objectives of this paper on hoarding digital content.

The difficulties endured in discarding digital content are similar to those that are specified by Frost et al. (1995). They outlined that an individual would not be able to disengage with the content and would find it difficult to flexibly think about discarding one's digital contents. As such, individuals with digital hoarding will exhibit an exaggerated emotional response towards digital contents and they will rely on such digital contents as a source of emotional comfort. A similar process may impair their ability to effectively constrain irrelevant digital contents and shift focus appropriately.

Digital Clutter

Third, the hallmark of serious compulsive hoarding problems is the clutter that prevents normal use of living spaces (Frost and Hartl 1996). Digital clutter, according to American Psychiatric Association (2013) is defined as a large number of often unrelated digital contents (various storage options such as GoogleDrive, iCloud, Dropbox) grouped together in a disordered fashion. Digital contents tend to accumulate without order in digital spaces where the individual is most active on. As such, adding new digital spaces can further increase the likelihood of digital clutter. Drawing parallels from Frost and Hartl (1996), digital clutter would prevent, inhibit or cause grievance in using *digital* storages. Moreover, unlike the physical living space, digital spaces can be added with no or minimal expense. Digital contents can be saved for a variety of reasons, but common reasons include perceived future utility, aesthetic value, and/or sentimental attachment. Saving behaviors alone however, are not considered problematic unless accompanied by significant amounts of clutter.

Figure 1 depicts the digital hoarding a-priori model which includes three sub-constructs. The three sub-constructs of the a-priori model of digital hoarding are all conceived and measured as a formative composite construct[4]. Benitez et al. (2017, p. 2), state that "*composite models/constructs are formed as linear combinations of their respective indicators*." They also argue that "*a composite construct serves as proxy for the concept under investigation (i.e., the recipe) that is composed of a mix of indicators (i.e., the ingredients)*." As such, digital hoarding is constituted from acquisition, clutter and difficulty in discarding (i.e. digital hoarding as a composite construct, where acquiring, difficulty of discarding and clutter are the entities which are combined to form the composite concept – digital hoarding). The a-priori model sub-constructs: (i) need not co-vary, (ii) are not interchangeable and (iii) cause the core-construct as opposed to being caused by it. In addition, the digital hoarding model may include different antecedents and consequences for potentially different nomological networks (Cenfetelli and Bassellier 2009; Jarvis et al. 2003; Petter et al. 2007). Moreover, the sub-constructs of digital hoarding will be measured through self-report, in a similar manner to the most commonly employed instruments such as Frost et al. (2004). It highlighted that fulfilling only one condition (e.g., clutter) is unlikely to lead to the digital hoarding disorder. Rather all three conditions must be present. Moreover, such aspects like perceived importance/ perceived use of digital content are psychological states-of-mind that are assumed to be embedded in the individual that engaged in the three actions of hoarding (Frost and Hartl 1996).

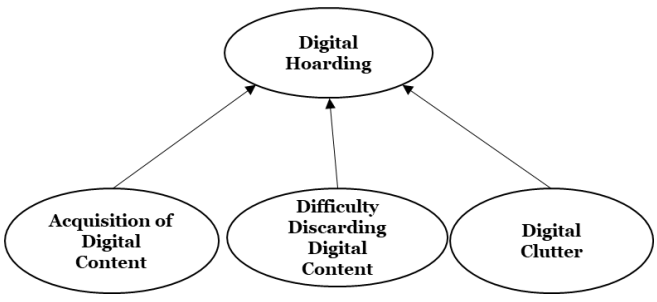

Figure 1. Digital Hoarding a-priori Model

[4] Benitez et al. (2017, p. 2) demonstrate two types of measurement models that PLS path models can contain: Factor models and composite models.

Data Collection and Sample

The survey instrument included 26 items of digital hoarding developed using the fundamental works of Frost et al. (2004). The instrument was circulated in Australia amongst a representative sample of the population, yielding responses from 846 respondents. In addition to the digital hoarding items, the survey instrument included 9 items to measure the dependent variable 'personal stress.' The items were derived through the well-established Lovibond and Lovibond (1995) scale of depression, anxiety and stress scale (DASS). Moreover, the survey gathered demographic details in relation to the respondent and their use of digital contents, including the followings: (i) types of digital spaces that the individual is using, (ii) the amount of digital storage that an individual occupies (in giga-bytes, later converted into TB) and (iii) the types of digital contents (e.g., pictures, videos, songs).

Table 1. Demographic details of the sample

Gender	**#**	**%**	**Amount of space**	**#**	**%**	**Age**	**#**	**%**
Male	440	52%	<1 TB	51	6%	Below 19	43	5%
Female	406	48%	1-3TB	135	16%	20-30	228	27%
Storage spaces	**#**	**%**	3-5TB	178	21%	31-40	245	29%
1-2	161	19%	5-7TB	144	17%	41-50	271	32%
3-4	245	29%	7-9TB	118	14%	Over 50	59	7%
5-6	228	27%	9-11TB	93	11%	**Prof. status**	**#**	**%**
6+	212	25%	11-13TB	68	8%	Employed	377	45%
Education	**#**	**%**	>13TB	59	7%	Self-employed	57	7%
HS attended	23	3%	**Storage types***	**#**	**%**	Part-time	178	21%
HS completed	294	35%	Internal storage	778	92%	Student	154	18%
Bachelors	389	46%	External storage	846	100%	Retired	46	5%
Masters	129	15%	Free cloud storage	736	87%	Unemployed	34	4%
1 + degree	11	1%	Paid cloud storage	313	37%			

HS – High school; * respondents reported more than one answer (non-mutually exclusive)

The survey designed to operationalize the sub-constructs of digital hoarding and personal stress employed a five-point Likert scale with the end values ranging from 1 to 5. The web-survey instrument included a cover page, which stipulated the code of conduct and ethics of data collection. It also included a clear description of the sub-constructs, where each digital hoarding sub-construct was described using a common, easy-to-understand definition as well as an example relating to the types of digital content that one would collect (e.g., picture, movies, documents, etc.). For example, 'Acquisition of Digital Content' included the description' *Acquisition of Digital Content referrers to the gathering of digital content, either paid or free, by means of images, photos, movies, documents.'* In addition to the items of digital hoarding and personal stress, the survey instrument included four items as global measures for digital hoarding construct that are necessary for formative construct validation and model testing. The global measures follow the suggestions of Diamantopoulos and Winklhofer (2001, p. 272), who argued that global items that "summarize the essence of the construct that the index purports to measure" must be included when testing the measurement model. In order to reduce the common method variance, the items for all three sub-constructs were not grouped under their headings (Gorla et al. 2010; Sharma et al. 2009). The sample demographics are summarized in the Table 1. Note that the respondent was not requested to select where and how they store their digital content from a pre-defined list, rather were requested to enter the amount of storage (in GB), the storage name (e.g., Google Drive) and the types of digital spaces (e.g., cloud). This information was later categorized for reporting and analyses purposes.

Data Analysis

The analysis herein employs partial least squares (PLS) structural equation modeling (SEM) method. The study analysis follows the guidelines of Benitez et al. (2017) and Benitez et al. (2018). The model and sub-construct validation in this research are reported under seven headings: (i) content validity (which was tested using the content validity ratio [CVR]), (ii) confirmatory composite analysis, (iii) construct validity (which was tested using the average variance extracted [AVE]), (iv) testing the measurement model, (v) the structural model (observing the additivity, reporting the common method biasness and nomological net test), (vi) nomological net test using the dependent variable, and (vii) a series of post-hoc analyses. The PLS-SEM is a technique that is commonly employed in the information systems field which has the capacity to evaluate complex research questions by estimating a complex research model, modelling latent variables and estimating several types of measurement errors.

PLS-SEM is therefore well-suited for highly complex predictive models, which supports the mapping of formative observed variables (Becker et al. 2012; Henseler and Sarstedt 2013; Wold 1989). To test the measurement and structural models, we employed ADANCO 2.0.1 software (Dijkstra and Henseler 2015) with the bootstrap resampling method (4999 resamples). Following guidelines of Dijkstra (2010), the three sub-constructs were estimated by using the regression weights (mode B).

Content Analysis

Since the sub-constructs and measures were derived through well-established literature from psychology (Frost et al. 2004; Lovibond and Lovibond 1995), the sub-constructs and items are accredited with substantial content validity. Yet, the departure from its traditional form to digital hoarding means that the notions must be re-established for content validity (Nunnally 1967). The current study followed the guidelines of McKenzie et al. (1999) for establishing content validity, which entailed four steps[5]: (i) using the guidelines proposed by Lynn (1986), an initial draft of the survey instrument was created by canvassing the related literature in order to derive its measures; (ii) following the guidelines of the American Educational Research Association (2002), a panel of respondents was established to review and evaluate the possible survey questions, ensuring that the panel had the necessary training, experience and qualifications; (iii) the panel critiqued the survey measures; and (iv) the panel conducted a review of the questionnaire, assessing how well each item represented each of the three sub-constructs. In the fourth step, a quantitative assessment was made, establishing the CVR for each item/question based on the formula proposed by Lawshe (1975). Based on the pilot tests, the minimum CVR value of 0.834 was observed at a statistical significance of $p<0.05$. Feedback from the pilot-test respondents resulted in minor modifications to the wording of the survey items and endorsement of the research model and its three sub-constructs and associated measures (Lawshe 1975; Lynn 1986; McKenzie et al. 1999).

Confirmatory Composite Analysis

The assessment of the measurement model commences with a confirmatory composite analysis with the objective of evaluating the overall fit of the saturated model (Henseler 2017; Henseler et al. 2016). A confirmatory composite analysis helps to understand whether it makes sense to create the proposed formative construct and detects model misspecification (Henseler et al. 2014). According to Henseler et al. (2014) and Benitez et al. (2017) the confirmatory composite analysis was conducted. This assesses the adequacy of the composite model by comparing the empirical correlation matrix with the model-implied correlation matrix by examining the standardized root mean squared residual (SRMR), unweighted least squares (ULS) discrepancy (dULS), and geodesic discrepancy (dG) (Henseler et al. 2014). These measures of goodness of fit evaluate the discrepancy between the empirical correlation matrix and the model-implied correlation matrix (Benitez-Amado and Ray 2012; Benitez et al. 2016; Dijkstra and Henseler 2015; Hu and Bentler 1999).

SRMR allows assessing the average magnitude of the discrepancies between observed and expected correlations as an absolute measure of (model) fit criterion. The SRMR of the model was 0.036 – below the recommended threshold of less than 0.080 at the 0.05 alpha level (Dijkstra and Henseler 2015; Hu and

[5] The four-step approach followed here is analogous to the Q-sort approach for attaining content validity

Bentler 1999), with d_{ULS} =0.189 and d_G = 0.026 demonstrating that we can ensure with a probability of 5% that the measurement structure of our composite constructs is correct. We can thus proceed to evaluate the specific properties of our composite constructs.

Construct Validity

We established construct validity for each sub-construct using the AVE. All the sub-constructs demonstrated satisfactory convergent and discriminant validity, with the AVE for all three sub-constructs measuring above 0.5 (Cenfetelli and Bassellier 2009; Fornell and Larcker 1981). The AVE of each construct was greater than the variance shared between the construct and the other constructs in the model, indicating strong discriminant validity. Table 2 presents the results of the AVE analysis.

Table 2: Construct correlation matrix

	1	2	3
Acquiring (1)	0.821		
Difficulty Discarding (2)	0.105	0.94	
Clutter (3)	0.229	0.103	0.947

Testing the Measurement Model

Following the established guidelines (e.g., Cenfetelli and Bassellier 2009; Diamantopoulos and Siguaw 2006; Diamantopoulos and Winklhofer 2001; Dijkstra and Henseler 2015; Henseler 2017; Sedera et al. 2017a), the items were first tested for multi-collinearity amongst the measures using variance inflation factors (VIF). The VIF from a regression of all the sub-constructs ranged between 1.23 and 2.37, indicating that multi-collinearity is not a problem in our data (Diamantopoulos and Siguaw 2006).

Figure 2 depicts the results of the measurement model test, with values significant at the level of 0.005 Alpha (Henseler et al. 2016). Supporting our study objective of deriving a construct and further validating the digital hoarding construct, the results indicated that all the three sub-constructs demonstrated strong and significant predictors of digital hoarding. Overall, the model constructs explained 85% of the variance of digital hoarding construct (the adjusted R^2 of 0.86). This percentage of explanation is adequate considering model parsimony. From Figure 2, the study establishes the convergent and discriminant validity of the model constructs. The convergent validity of the constructs conformed to the established heuristics, with all the t-values of the outer model weights exceeding the one-sided[6] cut-off of 1.645 levels[7] significant at the 0.05 (*) alpha protection level (Benitez et al. 2017; Henseler 2017; Henseler et al. 2016). Using the weights of the sub-constructs of the digital hoarding composite construct in Figure 2, the following observations are made. Observing the relative contributions of each of the sub-constructs, it appears that 'acquisition' makes the highest contribution to digital hoarding, followed by 'difficulty discarding' and 'clutter.'

Common Method Bias

Sharma et al. (2009) advise against the common practice of gathering perceptual data on both independent variable and the dependent variable from the same respondent, as it may create common method variance (CMV). Gorla et al. (2010) observed that CMV is more likely to exist in abstract constructs (e.g., digital hoarding). However, researchers demonstrate that composite models are less likely to suffer from common method bias (Rueda et al. 2017). Even so, paying attention to the need to reduce CMV, the items for hoarding were not grouped under their construct headings in the survey. We also employed Harman (1976) one-factor test, with the result that not all the measures led to a single factor solution; thus confirming that CMV was unlikely.

[6] The one-sided test was appropriate because we only hypothesized a positive contribution of the formative components of expertise. The two-sided cut-off of 1.96 was used otherwise.

[7] The t-values of the loadings are equivalent to t-values in least-squares regressions. Each measurement item is explained by the linear regression of its latent construct and its measurement error (Diamantopoulos and Winklhofer 2001).

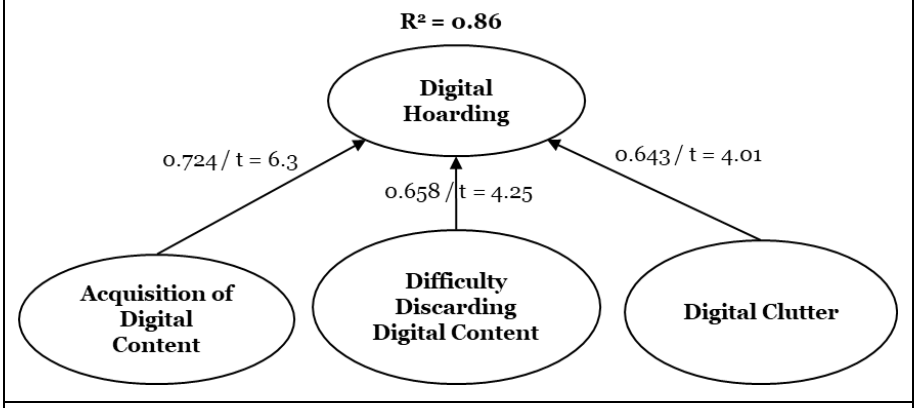

Figure 2. Results of the analysis explaining 86% of the variance

Does Digital Hoarding Lead to Personal Stress?

While the aforementioned tests demonstrate the existence of digital hoarding, one could argue that it may not lead to any negative consequences. The acid test of a newly adopted construct is the nomological network test, where the newly developed construct is tested in its nomological network (Agarwal and Lucas Jr 2005). The assessment of the nomological network test, as prescribed in Cronbach and Meehl (1955) is an essential aspect of testing the validity of the newly developed construct – in this case with personal stress[8].

Theoretically (and tautologically), literature argues that 'stress' arises through hoarding (Mataix-Cols et al. 2010; Pertusa et al. 2010; Timpano et al. 2011) and can be considered as the closest dependent variable of digital hoarding. Stress, akin to Mitchell et al. (2008), we define as the degree to which digital hoarding in one's life is appraised as unpredictable, uncontrollable, and overwhelming. While recognizing that stress can be caused by many other factors, stress has been identified as a natural outcome of the hoarding disorder. In a simple hypothesis, one might conceive that 'substantial digital hoarding leads to stress' (we note that similar notions have been presented in relation to traditional hoarding) (Grisham et al. 2005). However, it is not a foregone conclusion that a collection of *digital* content can lead to stress. Moreover, the relationship between digital hoarding and stress is tested herein for the first time. The nine reflective measures, based on the study of stress by Lovibond and Lovibond (1995), loaded into a single factor indicating their suitability as a measurement construct. The structural model analysis presented in Figure 3 shows the relationship between digital hoarding as the independent variable and personal stress as the dependent variable.
As Figure 3 depicts, the path coefficient was 0.589 and the r^2 was 0.37. Not only did the results of the nomological network testing (Figure 3) evidence the existence of a strong, positive relationship between digital hoarding and personal stress as hypothesized, they further evidenced the validity of both constructs. As such, if either construct is not valid we are unlikely to see a relationship (Diamantopoulos and Winklhofer 2001; Edwards and Bagozzi 2000). This further evidences the construct validity of digital hoarding, by 'identification through structural relations' [see for e.g. Jarvis et al. (2003, p. 214: Figure 5, Panel 4)].

The impact of digital hoarding (as opposed to traditional hoarding disorder) seems to have a similar negative effect on one's level of stress. Past studies on traditional hording disorder (e.g., Grisham et al.

[8] Cronbach and Meehl (1955) outline five steps in conducting construct validity using nomological network test: (i) at least have two constructs, (ii) theoretically or tautologically related, (iii) correspondence rule, (iv) empirical measurement of both constructs and (v) empirical linkage through hypothesis development.

2010; Henry and Crawford 2005; Shaw et al. 2015) measured using the Frost et al. (2004) instrument, indicated the effect on personal stress ranges between 0.254 and 0.371.

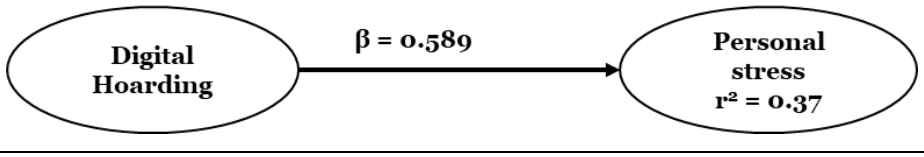

Figure 3. Nomological net of Digital Hoarding leading to Personal Stress

As such the results established in this study, where digital hoarding has a positive significant effect on personal stress, explaining 37% of its variance is a worthy of a finding. Moreover, the comparable results on the effect of digital hoarding on personal stress between traditional hoarding is deemed reasonable.

Overall, the rigorous six-stepped validation process and the results described above provide confidence in the conceptualization, measurement the effects of the newly developed construct – digital hoarding.

Post-Hoc Analyses on Digital Storage Availability

Having validated the digital hoarding construct and having demonstrated the nomological relationship between digital hoarding and personal stress, we explore the specific conditions that are perhaps unique and exclusive only to *digital* hoarding (as opposed to traditional hoarding disorder). Exploring such conditions will provide the boundaries at which the model conceptualizations are valid and true.

First, we explore the effect of seemingly unrestricted storage that individuals enjoy through affordable (or free) digital storage options. This is indicative of a possible contradiction between digital and traditional hoarding. For example, do respondents with large digital storages likely to demonstrate the symptoms of digital hoarding? (as compared to those who have low digital storage). The 'amount of storage' in the traditional hoarding disorder literature receives less attention, given that an individual cannot dynamically and easily change the extent and the nature of physical storage. However, one could argue that the ability to dynamically alter digital storage with minimal cost *could* minimize digital hoarding and its effect on the levels of stress.

To test the effect of the amount of storage, two polarized samples, based on the amount of digital storage currently used, were created using the top and the bottom 25% percentiles of the sample. Next, the two samples (n_1 of 220 respondents with less than 4.5 TB of data and n_2 of 225 respondents with over 9 TB of data) were compared for the significant differences in relation to the three-digital hoarding sub-constructs. The results of the t-test comparison between more vs. less of digital storage (samples n_1 and n_2) indicated no significant differences between the three sub-constructs, demonstrating that the 'amount of storage' is *unlikely* to influence digital hoarding.

Next, two PLS models were constructed with the polarized samples (n_1 and n_2) (Becker et al. 2012; Benitez et al. 2018; Henseler and Sarstedt 2013; Wold 1989). The results of the path coefficient and the r^2 indicated that (Figure 4): (i) for both samples, there is a significant and substantial impact of digital hoarding on personal stress and (ii) the sample with more storage has a lesser effect of digital hoarding (yet significant and substantial) creating personal stress.

Demographics on Digital Hoarding

Next, employing several demographic details presented in Table 1, several analyses were conducted with the intention of seeking better insights on digital hoarding. These analyses are driven to answer 3 facets that arise from the literature on (i) the number of digital spaces, (ii) age and (iii) gender. The three variables are deemed important in the IS literature (Vodanovich et al. 2010) and using them in the analyses would make us identify additional boundary conditions on digital hoarding and predict its nature and effect.

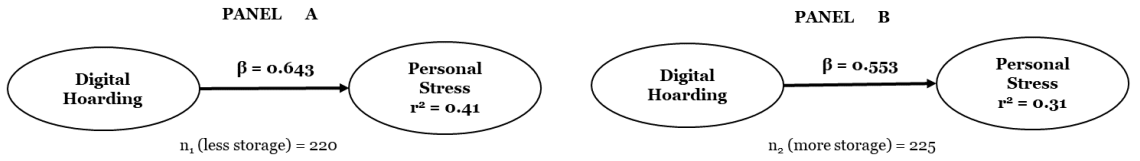

Figure 4. Comparing the PLS models of the polarized samples

Number of Digital Spaces

It may be tautological to argue that the *number* of digital spaces would increase the likelihood of digital hoarding, as it allows more acquisition and makes it difficult to discard given the difficulties in identifying material in number of digital spaces. To the contrary, one could argue that number of digital spaces would decrease digital hoarding as it allows to minimize clutter. In order to test whether the number of digital spaces may provide an individual a high likelihood of acquisition, increase the difficulties in discarding digital content, and perhaps feel less cluttered, four samples were drawn on the number of digital spaces that an individual possess. The samples included those who have up to two digital spaces ($n_{1\text{-}2}$ = 161), 3-4 digital spaces ($n_{3\text{-}4}$ = 245) 5-6 digital spaces ($n_{5\text{-}6}$ =228) and more than 6 spaces (n_{6+} = 212). The results of the t-test comparison between the four samples did not yield significant differences for the composite digital hoarding construct, demonstrating that the number of digital spaces an individual possess is unlikely to influence digital hoarding. The four PLS models drawn from the samples revealed that the effect of digital hording on personal stress on the number of digital spaces is high for $n_{1\text{-}2}$ sample (β = 0.601 and r^2 = 0.41), low for $n_{3\text{-}4}$ sample (β = 0.520 and r^2 = 0.35) and highest for n_{6+} sample (β = 0.633; r^2 = 0.47). In relation to the number of digital spaces, there were no parallel studies that we could draw comparisons from the traditional hoarding disorder literature, given that an individual is unlikely to increase the space over time (Frost and Hartl 1996).

Age

Next, we investigate whether there are substantial differences in digital hoarding across three age groups of individuals aged between 20-30 ($n_{20\text{-}30}$ = 228); aged between 31-40 ($n_{31\text{-}40}$ = 245) and aged between 41-50 ($n_{41\text{-}50}$ = 271)[9]. In past literature, 'age' has been identified as an important determination for certain influence behaviors and conditions. For example, studies argue that certain age groups, for example, digital natives are more likely to have a positive association with digital content (Prensky 2001a; Prensky 2001b). The results of the t-test comparison between the three samples yielded significant differences across all three samples for the digital hoarding composite construct, demonstrating that the age (as classified in this study) is likely to influence digital hoarding. Three PLS models were drawn from the samples to understand the effect of digital hording on personal stress. The results showed that $n_{20\text{-}30}$ sample has the highest beta for personal stress (β = 0.622 and r^2 = 0.39), lowest for the $n_{41\text{-}50}$ sample (β = 0.301 and r^2 = 0.27) and moderate for $n_{31\text{-}40}$ sample (β = 0.410; r^2 = 0.31).

Gender

Finally, in relation to gender (n_{male} = 440 and n_{female} = 406), we found statistically significant differences between males and females on the composite digital hoarding construct. The comparison did not show significant differences on acquisition of digital content. However, the two samples demonstrated significant differences on difficulty of discarding (p = 0.005; t = 11.43) and digital clutter (p = 0.005; t = 10.69). Reports of gender differences in hoarding disorder (*traditional*) have mixed viewpoints. Labad et al. (2008) found

[9] The samples of aged less than 19 and over 50 were too small to conduct the t-tests and PLS tests.

no gender differences in hoarding, whereas Wheaton et al. (2008) reported greater hoarding disorder symptom severity among women with versus without hoarding, although no such differences emerged among men. Two PLS models drawn from the two samples revealed that the effect of digital hording on men's personal stress ($\beta = 0.475$; $r^2 = 0.33$) is less than that of women ($\beta = 0.621$; $r^2 = 0.43$), indicating that women are more likely to suffer from digital hoarding.

Conclusion

Hoarding Disorder, in its traditional sense, affects 4-5% of the world population. It is a serious psychological illness with substantial health, social, economic issues (Wheaton 2016). As such, hoarding disorder has received much discussion in the psychological literature (Grisham et al. 2005; Mataix-Cols et al. 2010). Hoarding disorder describes when an individual acquires content, finds it difficult to discard and feels cluttered. The diagnostic measurement of hoarding disorder using the three key sub-constructs is now well established. This study is motivated by the widespread anecdotal commentary that these three diagnostic conditions (i.e. acquisition, clutter and difficulty of discarding) seem to exist with most individuals in relation to *digital content*.

The proliferation of social media platforms, the advancements in devices like smart phones, drones, wearables and relative affordability of (and dropping) device prices make easy to acquire and store digital content (Beck 2012). Moreover, the ease of gaining access to digital storage and spaces encourages the accumulation of digital content, with less attention to discarding them. The relative ease-of-access to abundance of digital storage, the ubiquity of digital spaces and increasing digital engagement of individuals would mean that digital hoarding, if established and detected, would have an effect to a large percentage of the world's population, leading to substantial psychological illnesses, social problems and economic losses. In order to explore this emerging issue, we developed a research that utilizes a well-established survey instrument based on the three salient sub-constructs of the hoarding disorder. The three sub-constructs, termed as digital content acquisition, difficulty of discarding digital content and digital clutter were treated as parts of a formative composite variable that measures the overarching notion of 'digital hoarding.'

Next, the a-priori model of digital hoarding was tested using a sample of 846 respondents using the PLS-SEM software ADANCO, following the guidelines of Benitez et al. (2018). The analyses, which was completed in six steps, demonstrated that the three sub-constructs adequately measure digital hoarding. Next, the effect of digital hoarding was observed on the individual's level of stress, where personal stress has been recognized as an important consequence of the hoarding disorder (Grisham et al. 2005). The analyses revealed that digital hoarding, similar to that of traditional hoarding disorder, could cause higher levels of personal stress.

Research Implications

Raising the awareness of this new concept of *digital hoarding* is a salient contribution of this research. While there are ample signs of digital hoarding in the day-to-day lives of every individual, this topic has received very little attention in any literature. While we are far from being able to claim that digital hoarding as an *illness*, we believe we have commenced a vital discussion that would lead to a cumulative tradition of research. Unlike traditional hoarding, if clinically established, digital hoarding would have widespread repercussions due to the sheer number of people engaged in this behavior. The growth of digitization initiatives world-wide (e.g., social media) (Sedera et al. 2016b), accessibility to free and affordable digital storage and affordable digital devices like smart phone (Palekar et al. 2015), digital cameras and wearables would increase the chance of one's inclination to hoard unknowingly. Raising an understanding of digital hoarding would allow researchers of medical science, psychology, social science and management to contribute to a better knowledge of digital hoarding. The conceptualization of digital hoarding as a formative composite construct makes a valuable contribution to research. Adapted from the studies in the field of psychology, digital hoarding was conceived using three well-established sub-constructs employed in the Diagnostic Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association 2013). The items to measure each sub-construct were carefully constructed from an extensive literature review, following the approach of Burton-Jones and Straub (2006). The validation of the measures of digital hoarding, the analyses and their related discussions provided first insights into the formation of digital hoarding and its projected impact.

Although the cross-sectional approach is often criticized for temporality, a snapshot of digital hoarding was precisely sought. Thus, we suggest that the validated sub-constructs and measures of digital hoarding can be used in combination as sub-constructs of a measurement model for evaluating overall effect of digital hoarding. Alternatively, these same sub-constructs and their related, validated measures may be used in a nomological network to test causality; in doing so however, close attention must be paid to the timing of the measurement and the consequent direction of the paths (e.g., Sedera et al. 2016a). It is further noted that the validation of these constructs, either within a nomological network or a predictive chain or within a measurement model, lends credence to the constructs for either purpose[10]. To answer the provocative question "are these sub-constructs and related measures specific *only* to digital hoarding?" requires further testing. The specificity of the *measures* and the 86% variance explained provide evidence of a model that has both parsimony and completeness. The nomological network test between digital hoarding and personal stress provided further confidence that the model derived herein can be applied to gauge digital hoarding.

This paper has stringently treated the model as composite formative model (e.g., Gable et al. 2008; Sedera and Gable 2010). The authors have, manifested in extensive attention to the completeness, mutual exclusivity and necessity of the dimensions and measures of the model. Overall, the model statistics (e.g., variance explained, CVR, VIF and AVE) evidenced a strong model, with adequate attention to model parsimony. At the same time, the model evidenced significant differences in views on theoretically informed relationships of digital hoarding. Without taking digital hoarding as a direct adaptation of traditional hoarding disorder, our research logically contested the application of acquiring digital content, difficulty in discarding digital content and digital clutter through important considerations of information systems. For example, considering the seemingly abundant digital storage and spaces (or the ability for one to acquire new digital spaces), we examined the effect of storage availability, number of digital spaces available to the individual, age and gender of the individual on digital hoarding. Developing a further understanding of such agreements and disagreements on digital hoarding will lead to possible identification of reasons why certain boundary conditions are much more prevailing and influential in digital hoarding.

Practical Implications

This study makes several practical contributions. First, this study provides early empirical evidence of how acquisition of digital content, difficulty of discarding digital content and digital clutter could lead to digital hoarding. Digital hoarding, whether it be classified as a psychological condition like the hoarding disorder through the Diagnostic Statistical Manual of Mental Disorders (DSM-5) or not would have negative connotations. Any individual can use the survey instrument to make an early diagnosis of the symptoms of digital hoarding using the survey instrument to get a better understanding of their own status on digital hoarding.

Second, practice frameworks can be derived on preventing and controlling digital hoarding. At present, there is no evidence-based discussion on the dangers of engaging in digital hoarding. For example, when an individual in the sample has access to data as much as 47 TB (with an average of 3.7 TB), some guidelines of personal data management would minimize the threat of digital hoarding. Companies like Google are already engaged in this space on how to create best access, storage and discarding processes to individuals. Amongst the most cited practitioner work on personal data management are some patents approved for Google (Causey III et al. 2003; Ghosh 2013; Matsunaga et al. 1996; Ram and Kubo 2008; Ram and Kubo 2012). Third, the clinicians of psychology and social workers can pay proactive attention to this emerging issue. When observing or treating conditions like conduct disorder, obsessive-compulsive and related disorders, eating disorders, learning disorders, stress and depression, they can look to see the habits of the individual in the digital space – in this case on digital hoarding.

Limitations

To the best of our knowledge, this is the first major study in information systems on digital hoarding. As such, by design too, there are many limitations. The objective of the study is not to understand the full

[10] Having said this, we further encourage researchers to heed the caution of Burton-Jones and Straub (2006) that operationalization must be undertaken in full light of the specific theory and hypotheses being tested.

spectrum of conditions that should be considered as digital hoarding. Instead, it was more of an exploration, given the tautological observations of how individuals acquire digital content. The study relied on the existing conditions of the hoarding disorder. While this approach was exactly what was sought as an initial study, it leaves the possibility of missing the conditions, sub-constructs and scope more specific to digital content. Another potential limitation of the present study is the exclusive reliance on self-reporting on digital hoarding and personal stress. The inclusion of objective evidence like the amount of digital storage, types of digital spaces and the demographics minimize the risk of self-report. Moreover, this research gathered data using a web-survey instrument. Although several studies now show that data collection over the internet yields results comparable to those using a paper-and-pencil formal (Carlbring et al. 2007; Gosling et al. 2004), adding qualitative data such as interviews would have increased the reliability. Finally, while the sample size was adequate for the intended data analyses, it was gathered from one geographical location. Individuals from largely western, Anglo-Saxon, developed world may limit the generalizability of the study findings.

Future Research

In general, while the initial findings are encouraging, we request the research community to engage in more inductive approaches to better recognize the roots of digital hoarding. Exploring new theoretical expansions on sub-constructs, conditions and the scope of digital hoarding are highly recommended. We note that it took nearly over 20 years of research on the hoarding disorder before it was finally classified in the DSM-5 as a disorder. As such, generalizing the study in various contexts and conditions (e.g., low infrastructure, developing nations, individual traits) would provide greater insights into the nature and effects of digital hoarding. While we seek a better understanding of digital hoarding as an independent variable, we can also see the complete nomological net of digital hoarding. That would allow researchers to investigate both antecedents and consequences of digital hoarding. For example, how certain emotions lead to excessive acquisition could provide insightful findings. With a prevalence rate that almost quadruples the rates of bipolar disorder and schizophrenia (Timpano et al. 2011), hoarding disorder has been found to be associated with substantial impairment in social, occupational, and economical domains (Tolin et al. 2008a; Tolin et al. 2008b). In addition, hoarding puts individuals at risk for the development of serious and sometimes life threatening medical and mental health conditions (Tolin et al. 2008b), highlighting the need for research on the effects of digital hoarding. We also recommend future research to take more of a technology focus in improving our understanding on digital content. For example, while digital spaces are accessible and affordable, switching to / acquisition of new digital storages on cloud requires certain degree of self-efficacy. Moreover, akin to Frost et al. (1995), future studies can observe the patterns of use of digital content, emotional value of possessions and environmental consciousness and responsibility of digital hoarding. Finally, researchers can engage in a longitudinal study of digital hoarding to understand how such hoarding begins, resides and when such conditions increase for it to become an issue. For example, we speculate that digital hoarding will have a 'seasonal effect,' meaning that special celebratory events like Christmas and Diwali, marriage, birthdays and holidays will increase the digital hoarding. In such conditions, the individual is more likely to 'binge' with digital content but bear the risk of making the new behavior permanent.

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Appendix A: The items of digital hoarding and personal stress

Digital Hoarding [Adapted from Frost et al. (2004)]

1. To what extent do you have difficulty deleting your digital contents?
2. How distressing do you find deleting the digital contents?
3. To what extent do you have so digital contents that the storage spaces are full and cluttered?
4. How often do you avoid trying to discard digital contents because it is too time-consuming?
5. How uncomfortable would you feel if you were to stop acquire new digital content?
6. How much of the storage space is cluttered with digital contents?
7. How much does the digital contents in your possession interfere with your social, work or everyday functioning?
8. How often do you feel compelled to acquire digital content?
9. How strong is your urge to acquire free digital content which you have no immediate use?
10. How much control do you have over your urges to acquire digital content?
11. How often do you decide to keep digital content that you do not need?
12. To what extent does digital content make you look for new digital storage?
13. To what extent does the clutter in your digital spaces cause you distress?
14. How frequently does the clutter in your digital spaces make you difficult to find what you need?
15. How often do you acquire digital content for which you have no immediate use or need?
16. How strong is your urge to save digital content you know you may never use?
17. How much control do you have over your urges to save digital content?
18. How much of your digital spaces is occupied with content that you had no immediate use?
19. How upset or distressed do you feel about your digital content acquiring habits?
20. To what extent does the clutter in your digital storage prevent you from saving important digital content?
21. To what extent do you feel unable to control the content in your digital spaces?
22. To what extent has your acquiring of digital content required you to extend digital storage?
23. How often are you unable to discard a digital content you would like to get rid of?

Personal Stress (Lovibond and Lovibond 1995)

1. I find hard to wind down
2. I find myself getting upset by quite trivial things
3. I find myself getting agitated
4. I tend to over-react to situations
5. I find that I am very irritable
6. I feel that I am rather touchy or impatient
7. I am intolerant of anything that keeps me from getting on with what I was doing
8. I find myself getting impatient when I am delayed in any way
9. I find it difficult to tolerate interruptions to what I am doing