When Too Much Usage Is Too Much: Exploring the Process of IT Addiction

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Abstract

Although IT usage is generally known as a desirable behavior, addictive IT usage is likely to have some adverse consequences for individuals, organizations and even societies. This paper investigates IT addiction and aims to identify the mechanisms behind its development. Based on a thorough review of the literature, we conceptualize IT addiction as a psychological dependency on IT that involves excessive use of technology. Furthermore, we identify the elements that are associated with the formation of addiction. Based on the analysis of 12 in-depth interviews and 182 qualitative surveys, we developed a process theory of IT addiction that explains how these behaviors progress through time. The model highlights the key elements that are associated with IT-related addictive behaviors and shows how they relate to the technology, the user and the environment. It also highlights the problematic consequences of such behaviors on the well-being of addicted users.

1. Introduction

Despite the significant number of studies on information technology (IT) adoption and usage [17], little attention has been paid to understanding excessive and abusive forms of IT behaviors. Extant IT research mainly has tried to understand typical IT use and find ways to facilitate enduring usage behaviors (e.g. [32,60]). From an information system (IS) research perspective, increased usage is the most common indicator of IS implementation success [19]. However, the growing use of technology – in its various forms – can have a double-edged effect on our lives.

Arguably, the use of technology is found to enhance the well-being of the majority of users, and to facilitate performing tasks in organizations [6]. Yet, recent research and anecdotal evidence tend to indicate that excessive IT usage is likely to have some adverse consequences for individuals, organizations, and even for societies [37,49]. As a result, for psychology, health and IT researchers, there is growing concern that addiction to technology can result in serious challenges, which previously have been overlooked [50]. Examples are academic failure, sleep deprivation, social isolation, health issues, and, for adults, reduced work performance and even crises in relationships [8,57]. Even though the importance of addictive behaviors and their potential consequences recently have received some attention in IS research [36,54], the nature of such behaviors and the mechanisms by which IT addictions develop have remained largely unexplored.

This paper has two objectives: The first is to conceptualize IT addiction; the second is to develop a process model that explains the formation of IT addiction. We first review IS and non-IS literature to conceptualize IT addiction and to identify the key elements that are important in this process. Then, based on the results of a qualitative study that uses a grounded theory approach, we propose a process theory to show how addictive IT behaviors develop.

Since IS research on addiction is new – though progressing, this paper contributes to this emerging stream of research and helps establish the groundwork for future studies in this area. It also streamlines the literature and offers a clear conceptualization of the IT addiction construct. As well, it reveals the factors and mechanisms that underlie the dynamic process that leads to IT addiction. For managers and firms, the findings will be helpful in understanding the nature of addictive IT use behaviors and in enabling ways to prevent the problems they cause, especially in organizational settings.

2. Literature Review

2.1. Addiction and IT addiction

The original concept of addiction is rooted in psychology, mental health and pharmacology research where it has been referred to as "compulsive, uncontrollable dependence on a substance, habit, or practice to such a degree that cessation causes severe emotional, mental, or physiological reactions" [7:321]. Addictive behaviors usually follow a recurring pattern

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where an individual experiences failure to abandon the use of a substance despite significant negative outcomes [5,9,25,66]. Although classic studies of addiction generally assume that cases of addiction are applicable mainly to situations where dependency on a substance exists, other scholars criticize this view and maintain that the definition of addiction should be extended to cover non-substance-related behaviors that can have negative effects such as eating disorders, extreme gambling and compulsive shopping [43].

Increasing use of technology has resulted in the emergence of new types of addictive behaviors. In some cases, technology simply acts as a medium that facilitates and increases the occurrence of existing addictions. Examples are obsessive gambling (Griffiths 2003), online pornography [62,69], and electronic shopping and auctions [51]. Given the sophistication of new technologies and constant improvement of the technological abilities of users, IT itself has recently been identified as a form of addiction [5,66]. For instance, marketing reports demonstrate that more than half of U.S. mobile users have smartphones and that their use has been fairly intensive. The frequency of smartphone use ranges from 10-200 times per day and between 10-250 seconds per interaction [21]; such broad usage can cause several individual and societal problems [36,56].

The concept of IT addiction is broadly defined and covers many types of obsessive technology uses. Earlier studies focused mainly on behaviors that were related primarily to excessive Internet use. For instance, Young [66] argued that the irregular and extreme use of the Internet leads to an unmanageable life for the user and causes the appearance of several control problems. Such behaviors can manifest in different forms such as cyber-sexual addiction, cyber-relationship addiction, net compulsion, information overload and computer addiction. Subsequent studies examined other closely defined terms related to Internet use such as Internet addiction disorder [45,48], pathological Internet use [29,64], problematic Internet use [9], and Internet dependency [7,61]. In addition, researchers examined dependency on other technologies such as online games [30,39,44] as well as addiction to virtual worlds [27].

Table 1. Review of addiction definitions	
Study/Focus	**Definition of addiction**
Mendelson & Mello (1986)/ Addictive behavior	"Behavior that is excessive, compulsive, uncontrollable, and psychologically or physically destructive" (cited in [39:78]).

Ng & Wiemer-Hastings (2005)/ Online games	Obsessive and compulsive behavior with symptoms such as tolerance, withdrawal, craving and negative life consequences.
Kandell (1998)/ Internet addiction	Psychological dependence on the Internet characterized by increasing investment of resources on Internet-related activities, unpleasant feelings when off-line, increasing tolerance to the effects of being online, and denial of problematic behaviors.
Caplan (2006)/ Problematic Internet use	"A multidimensional syndrome consisting of cognitive and behavioral symptoms that result in negative social, academic, and professional consequences" (p. 721).
Lemmens et al. (2008)/ Game addiction	"Excessive and compulsive use of computer or videogames that results in social and/or emotional problems; despite these problems, the gamer is unable to control this excessive use" (p. 78).
Shapira et al. (2000)/ Problematic Internet use	"An individual's inability to control his or her use of the Internet causes marked distress and/or functional impairment" (p. 267).
LaRose et al. (2003)/ Media addictions	"Addicted consumers feel compelled to consume media despite potentially negative consequences that make continued use appear irrational or out of control, even in their own eyes" (p. 226).
Turel & Serenko (2010)/ Mobile email addiction	"A form of non-substance addiction that involves excessive interaction with both a mobile technology (mobile device) and the content (electronic communication) under conditions of psychological dependency" (p. 41).
Turel et al. (2011)/ Technology addiction	A psychological state of dependency on the use of a technology to such a degree that the following typical behavioral addiction symptoms may arise: (1) salience, (2) withdrawal, (3) conflict, (4) relapse and reinstatement, (5) tolerance, (6) mood modification.

Overall, our review (see Table 1) shows that there is no generally-accepted definition for technology or IT addiction. Many studies borrow definitions from substance or non-substance addiction in order to conceptualize technology addiction [7,38]. Based on our literature review, we find that extant definitions recognize at least two essential elements of addiction. One attribute is the internal (mental) aspect, which is referred to as the psychological or disordered internal

state of dependency on technology [44]; the other attribute addresses the external (physical) part of addiction. In this view, definitions emphasize highly frequent use of a specific technology (Internet, online gaming and online bidding). Building on both aspects, we define IT addiction as *a psychological dependency on IT that involves excessive use of technology*. Accordingly, we argue that a behavior should be considered addictive only if both elements are present. It is important to note that not all types of IT will be addictive. For instance, it is generally unexpected for someone to develop addictive behaviors regarding Enterprise IT systems (such as ERP e.g.). As previous research indicates, for users to develop addictive behaviors, IT use should be continuously reinforced. This means that users should get satisfaction from their IT use and perceive a positive feeling (such as thrill, excitement, connectivity and enjoyment) out of their experience (Armstrong et al., 2000; LaRose et al., 2003). Most cases of IT addiction are associated with the types of IT that provides a hedonic experience for users (Turel & Serenko 2012), such as online games, internet, online auction, online shopping and chat rooms.

2.2. The Process Leading to Addiction

Traditionally, research on addiction has looked at ways that substance addiction and other addictive behaviors can develop in individuals in order to provide preventing mechanisms to remedy such behaviors. Scholars have used various frameworks and proposed several theories to show the development of addictive behaviors. Prominent models of addiction have taken into account the role of elements that address social/environmental factors [4], genetic reasons [40], personality causes [53], and coping and social learning issues [14] that have an influence on addiction. Moreover, researchers have borrowed theories from other disciplines to explain the development of addiction such as classical conditioning [63] as well as compulsive behavior theories and integrative biopsychosocial models [20]. Similarly, in the IT addiction literature, scholars have proposed mainly explanatory models of addiction that take into account the role of various elements such as personality traits and demographics [1,7,66], and have borrowed from theories in psychology to describe addictive behaviors of IT usage.

Although most studies tend to focus on and examine the motives and triggers of IT addiction, some efforts have been made to increase our understanding of the mechanisms underlying addiction (e.g. [3,35]). The majority of studies focused on one key mechanism that can explain addictive behaviors, and based on that,

researchers have tried to develop ways to remedy addictive behavior. Examples are self-control mechanism [9,38], affect regulation, immersion and flow experience [33,49].

Additionally, to understand the molecular and neurochemical mechanisms of reward reinforcement in the brain, medical scientists conducted experiments to understand the rewarding effect of certain drugs [26]. Neuroscientists, for instance, examined the brain mechanism that occurs during substance abuse to explain why some individuals become addicted and others do not. Along with this line of research, Baler and Volkow [3] show how the release of dopamine in the brain and positive reinforcement leads to self-control dysfunction through increased interaction with drugs. In another study, Goodman [26] reviewed the neurobiology literature to conclude that the addictive process can occur through the dysfunction of three brain functions: aberrant motivation-reward, impaired affect regulation, and impaired behavioral inhibition. He then discussed the neurological processes underlying these mechanisms including the changes in Dopamine, Serotonin and other receptors.

Another stream of research has studied individual behavior seeking to understand how a normal/regular behavior can eventually lead to excess. For instance, Grover et al. [31] presented a process model showing the transition from a pre-addiction stage (benign consumption) to an addiction stage (excessive consumption). According to their theory, the decision to perform a behavior begins with low engagement. Depending on different physical, environmental and physiological triggers, an individual might increase time and involvement to the point at which excessive behavior causes harm and dependence.

Despite these process theories that have been developed in other domains to understand and explain substance addiction, in IS/IT discipline there is a paucity of research on the topic and IT research has yet to explain the process leading to IT-related addictive behaviors.

2.3. Key Elements of the IT Addiction Process

While in the IS discipline the IT addiction phenomenon has gained some attention only recently [36,55,56], in other disciplines such as psychology and mental health, addiction to various technological innovations has been studied for many years [8,38,66]. Early studies on IT addiction examined demographic factors (i.e. gender, age and education) to learn how they are differentiated between normal and excessive users. Yet, the findings were inconsistent. For instance, Shotton [52] maintains that computer addicts are dominantly male introverts who are usually highly

educated, whereas Young [67] found that women are 20% more dependent on technology than men. Other researchers borrowed different theories from addiction literature to explain how addictive behaviors develop; the models they proposed emphasized the role of several triggers of the IT addiction process.

In order to understand the elements that are key to the formation of IT addictive behaviors, we focus on the important role of two main elements that had been established previously in the IT addiction literature. These elements are related to the characteristics of individuals and to the technology itself.

2.3.1. Individual-related factors: The role of user traits has been well-recognized in the literature, especially in psychology. Overall, this research maintains that the personality, psychological status and well-being of individuals can influence emergence of problematic behaviors; some users with certain personality traits can develop excessive use habits. Research on substance addiction generally has shown that depression in individuals often is associated with dependency on alcohol or drugs. Subsequent investigations also revealed that non-substance types of addiction such as IT addiction can be developed in users with depression [5,7,65]. Because technology-based communication allows people to hide their personality during anonymous interactions, people who exhibit symptoms such as low self-esteem, poor motivation, fear of rejection and the need for approval have a higher inclination to use technology excessively and become dependent on it. Similar results have shown how users' shyness, social anxiety and locus of control can play a role in the development of addictive behaviors [8,11,42,48]. In order to study the role of these factors during the formation of IT-related addictive behaviors, we classify these factors into two main categories. On one hand, it appears that, psychological causes of addiction must exist in individuals for IT addiction to form; however, their presence does not necessarily result in technology addiction [18]. On the other hand, maladaptive factors can be considered sufficient cause for addiction. These factors include cognitive distress about oneself such as low self-reliance and low self-esteem [18].

2.3.2. Technology-related factors: Our literature review also reveals that excessive and unregulated usage can be triggered by the technology itself and the opportunities it provides for individuals [28,36,44,56]. For instance, accessibility, mobility and speed have been cited as motivations for increasing use of the Internet [28]. To help understand how technology can influence the development of addiction, we draw on adaptive structuration theory's conceptualization of the

IT artifact proposed by Markus and Silver [41]. Building upon this conceptualization, we focus on two technological elements that should be taken into account in studying the process of IT addiction.[1]

Technical objects refer to real entities of technology that have different properties such as technical elements and physical properties. *Functional affordances* identify the relationships between the technology and users and refer to what users might be able to do with technical objects, given their own skills and capabilities. Together, these concepts provide a holistic approach that addresses both the material and relational aspects of technology and helps us understand the complex mechanisms and interactions between users and technology, and their effect on IT usage behaviors.

3. Methodology

The purpose of this study is to explore the process through which addictive IT usage develops. Given the lack of knowledge in this area, a qualitative methodology was deemed appropriate because it enables us to take into account the temporal and processual characteristics of understudied phenomena [59]. To analyze our data, we followed grounded theory [16,23] to identify and make sense of the dynamics that underlies IT addiction.

3.1 Data collection

To collect rich, real-life evidence, our study used two sets of data regarding the use of smartphones. We chose smartphones as they represent one of the most popular IT currently used. Recent statistics show that the use of smartphones has reached a 1.1 billion worldwide user base, including 56% of North Americans [70]. Also, smartphone usage has generally reported as intensive, ranging from 10-200 times per day with an average time of 10-250 seconds per each use [21].

First, we relied on semi-structured interviews with heavy users of smartphones. Theoretical sampling strategy was used to select the interviewees [46]. The 12 face-to-face interviews were aimed at identifying key concepts, providing description of the process leading to addictions and developing a draft of the essential activities that occur during IT addiction process. The interview guide was built based on concepts from the extant literature on addiction and IT addiction. Maximum precautions were taken during development of the guide to avoid inputting preconceptions for respondents about the addiction

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[1] Markus and Silver [41] also discussed the concept of symbolic expressions, which does not apply to the IT addiction context.

process [58]. The initial guide included 18 open questions along with probes and prompts that facilitate the interview. It was further refined using pilot interviews with excessive smartphone users and IT experts. Additional insights revealed during the interviews were also taken into account in order to direct ongoing interviews with the users [16].

The interview guide included questions that tap into both general and specific uses of smartphones. First, the respondents were asked to illustrate their use of technology and to describe when, where, how and in what circumstances they tend to use their smartphones. Subsequent questions were asked to cover the range of motives for differences in behaviors. Throughout the interviews, the focus was on users' behavior – from the beginning of usage to addictive usage to understanding how usage evolved/increased over time. Finally, we asked respondents to fill out a short survey (8 items based on Young's [66] work to assess the level of smartphone addiction objectively). On average, the interviews took 0.5 hour. All interviews were recorded entirely and transcribed verbatim.

In addition to the interviews, we employed an exploratory qualitative survey to collect more information on IT addictive behaviors [36]. The use of a qualitative survey allowed us to collect data on a wider scale and to gain additional insights on the issues that were found to be important and noteworthy in the interviews. The survey included 5 open questions exploring smartphone usage in different situations and the motivation behind the adoption and increased use of technology. Another 9 questions were added to help understand personality and technology characteristics as well as their association with users' behaviors. As we did in the interviews, we used a short questionnaire (8 items) to assess the level of smartphone usage of survey respondents. The survey was initially tested by two senior researchers and 6 users; comments were used to modify the questions as needed. The qualitative survey was administered to undergraduate students enrolled in a large Canadian university. Previous research found that students are among the principal users of smartphones in developed countries [36] and are suitable targets for a study on addiction [50, 54, 55]. The survey was administered to 275 students. The response rate was 66% and we received 182 full responses (57% females; 17 to 29 years old).

3.2 Data coding and analysis

All data from the interviews and survey were recorded in our database for analysis. Standard coding practices were used, following Corbin and Strauss [16] and Charmaz [12]. Consistent with this type of analysis, we proceeded with open, axial and selective coding to analyze the transcripts.

First, using open coding, we analyzed data content to determine classes of relevant concepts, relationships and recurring themes. Second, axial coding was performed to group codes with a similar meaning into categories: motivations, activities, phases. Third, we coded all transcripts with these categories. Selective coding allowed us to integrate analysis of the categories and arrange patterns into coherent core findings. Throughout the entire process, patterns of salient activities that occur during IT addiction formation unfolded. Our analysis continued until saturation was reached; that is, when further analysis only confirmed the already existing understandings [23]. We finally returned to the existing literature to make sense of our findings and refine our understandings of the process of IT addiction. The entire process of theoretical coding, ongoing conceptualization and theoretical development was documented using Nvivo9.

We also analyzed the short addiction questionnaire at the end of the survey. 28 users (15%) answered "yes" to five or more questions and reported having addictive behaviors. They use their phones between 2-20 hours per day with an average of 5.2 hours. Also, 39 users (21%) reported only 1 or no addiction symptoms. The range of usage for this group was between 1-6 hours, with an average of 1.76. The remaining respondents show borderline behaviors, which means that they shared partial characteristics of both addictive and regular usage.

4. Findings

In order to develop a process theory of addiction, we delved into our data to understand the patterns of actions and events that underlie their dynamics. Based on our analysis, we identified some key steps and elements that play a part in the formation of IT addictive behaviors (see Figure 1).

How does the process begin? Not surprisingly, it all begins with fairly regular IT usage. The results of our interviews as well as the qualitative survey showed that there are many reasons why users start using a smartphone. First, the popularity of smartphones and, in addition, the diversity of traits of users who reported smartphone usage in our survey underline our finding that users' psychological profiles are not sufficient to distinguish users of smartphones from non-users. However, most respondents acknowledged that they switched from regular phones to smartphones because the latter are seen as more appealing and beneficial. This translates a positive attitude based on the

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physical/software features of the tool as well as the benefits it provides for individuals. Many interviewees mentioned physical features (size and weight), accessibility (to the Internet, emails, and social networks), portability and user-friendliness as basic reasons that triggered their use of smartphones. Furthermore, the characteristics of the operating software that allow users to run various applications (e.g. email, games, social media), do different actions (multi-tasking), and integrate their schedules and emails also motivate interaction with these tools. As interviewees said:

"It replaces a watch. It replaces an alarm clock. It replaces a camera...tells you what the weather is going to be like. So, it's a replacement of all that stuff right handy… and just so convenient and you feel plugged-in all the time." (Interviewee B)

"It's more accessible and smaller – it's like very portable, you can put it anywhere; unlike a PC." (Interviewee S)

In addition to the general characteristics of smartphones that seem to contribute to their increasing adoption, the environment in which one works or lives can play a role in triggering smartphone usage. Our observations show that peer pressure sometimes leads to smartphone usage as well. In order to update their knowledge of evolving trends and technology, to maintain a social appearance, and to keep up with and connect to their surroundings, many users feel pressured to buy or replace their smartphones with new/more popular products:

"Sometimes, I don't even know what features are added to it…I just like to have a new [smart]phone, 'cause it is cool and all my friends and classmates have one. I don't mind spending money on it." (Interviewee A)

How does usage increase with time? As discussed above, although smartphone usage was triggered for different reasons, users increased usage when they realized the actual benefits of use. These benefits can be experienced in different forms that fulfill occupational, entertainment, informative and social needs of users. Based on our data analysis, respondents use smartphones to check emails, surf the Internet for fun, engage in social networking sites, and keep track of the news. Moreover, we determined that a user's psychological status and personality seem important in increasing the level of usage. Interestingly, almost all respondents (from both the interviews and the survey) mentioned that they spent more time with their smartphone when they are bored. Some personality elements were also important in distinguishing between regular users and excessive users. Our qualitative survey data show that fear of rejection (64% for addicts vs. 36% for regular users), need for approval (75% for addicts vs. 36% for regular users), loneliness (64% vs. 38%), and anxiety (64% vs. 36%) can trigger excessive usage. To a lesser extent, addicts also reported that they are shy, introverted and emotional, and that they had experienced depression. In contrast, the more restrained users were highly motivated and enjoyed an active social life.

What happens after usage increases? In the case of IT addictive behaviors, it seems that perceived benefits combined with the experience of positive feelings further triggered users to increase their use of the technology. As a result of such increased interaction with smartphones, users may develop obsessive feelings and start to show dependent IT-use behaviors. Results of the qualitative survey data analysis indicate that more than half of addicted users show one or more signs of dependency such as feeling deeply involved (50% of addicts) and being preoccupied with excessive levels of use (54%). Respondents also said that they use their smartphones excessively to escape from problems (32%), to relieve guilt, anxiety or depression (25%), or to feel positive emotions (29%). Furthermore, our results show that most addicts (64%) lose control of their use behaviors over time and were unable to reduce usage. In almost all cases of addictive use, users never try to reduce their usage (10%) or their attempts usually fail (85%). Smartphone addicts feel frustrated when they do not have access to or cannot use their smartphones. Some interviewees recognized these as symptoms of addiction:

"I will go crazy, if I leave it at home… no matter how far I am I'll go back to get my iPhone. I feel unsafe without it." (Interviewee E)

"It's a friend of mine… I want it with me and I feel naked without it. I feel like I'm missing something." (Interviewee B)

What happens when addiction actually forms? The excessive and addictive use of smartphones and the emergence of problematic behaviors appear to impact users and may undermine some aspects of their work and social life, and may harm their psychological/physical well-being. Many respondents (41%) acknowledged that smartphone usage can conflict with important tasks. Addicts were found to use their phone during class (96%) and important meetings (54%). In many cases, smartphone usage was associated with lower productivity:

"It distracts me from studying and sometimes a simple assignment can take twice as long because of that." (Interviewee K)

The consequences of smartphone use on social life seems to be more pervasive because both addicts (57%) and regular users (25%) said that it conflicts with their social life and inhibits interaction with the people around them (e.g. family and friends). Moreover, most addicts said that they use their phones while eating or socializing (89%). One addict stated:

"I know, I'm so used to it that [it] annoys my parents. When I'm at lunch or dinner with them, you know, I check the phone every 5 [to]10 minutes so does my sister. I can say, like, every time, there's a conflict." (Interviewee L)

In addition to these harmful effects, addictive use can be associated with potentially serious physical damage caused, for example, by texting and driving (50% for addicts who exhibit such behavior vs. 9% for regular users), eye strain caused by staring at their device for long hours, and sleeping disorders due to excessive use at night:

"It's very distracting. It happened to me that I was about to crash my car and it's not good at all." (Interviewee E)

In summary, based on our data, we found that the addiction development process starts with fairly regular use. The characteristics of the environment (e.g. peer pressure, popularity, advertisements) or of the technology (e.g. capabilities, features, games, cool design) in addition to the expected benefits seem to trigger the adoption of technology for most individuals. With time, the adoption and use of a smartphone provides an opportunity for users to connect to technology, evaluate the gains, and realize the potential benefits associated with use. To get more from the technology, some users increase their level of engagement and the time spent on different tasks and activities while using their phones. Individuals with some specific personality traits were found to be more prone to increasing their usage. Increased usage appears to lead to the emergence of unregulated IT-use behaviors, which is when users show signs of dependency on a technology. In addition to dependency, many other symptoms of addiction such as preoccupation and obsession begin to emerge. In

these situations, users reported having trouble controlling their behaviors; their efforts to regulate the behavior back to normal levels usually fails – in some cases, they do not even try. The persistence of addictive behavior is followed by problematic behaviors that bring challenges to the well-being of individuals. Addictive behaviors can limit the amount of time spent on productive tasks, inhibit social relationships with other individuals, and cause psychological (e.g. stress, anxiety, depression) and physical (eye strain, backache, sleep disorder) issues for users. Figure 1 illustrates our findings regarding the process of IT addiction.

5. Discussion and Conclusion

In this paper, we propose a model of IT addiction where addictive behaviors emerge following an ongoing increase in usage. This occurs due to the perceived benefits and positive feelings experienced through excessive interaction with technology. The persistence of addictive behaviors results in many problems for users. As we stated previously, there is not much research in the IS/IT discipline that focuses on the process that leads to IT addiction. In other disciplines (e.g. medicine, economics, or educational psychology), there have been efforts to explain the process of addiction to a substance [2,3,26,31,35]. Our findings were similar to those of prior models that emphasized different stages of behavior to show how a normal behavior can become problematic [31]. For instance, Grover et al. [31] divided this process into pre-addiction and addiction, and described how everyday seemingly-benign consuming behaviors such as texting and shopping become harmful and transform over time into addiction.

Studies of addiction in the psychology discipline also have discussed the reinforcement mechanism, where one is being stimulated to continue to perform a behavior due to the persistence of rewards that can be achieved by repeating the behavior [1,38]. Our study found that the reinforcement loop continues without self-intervention/regulation to a point where addictive symptoms appear. In addition, in the case of IT
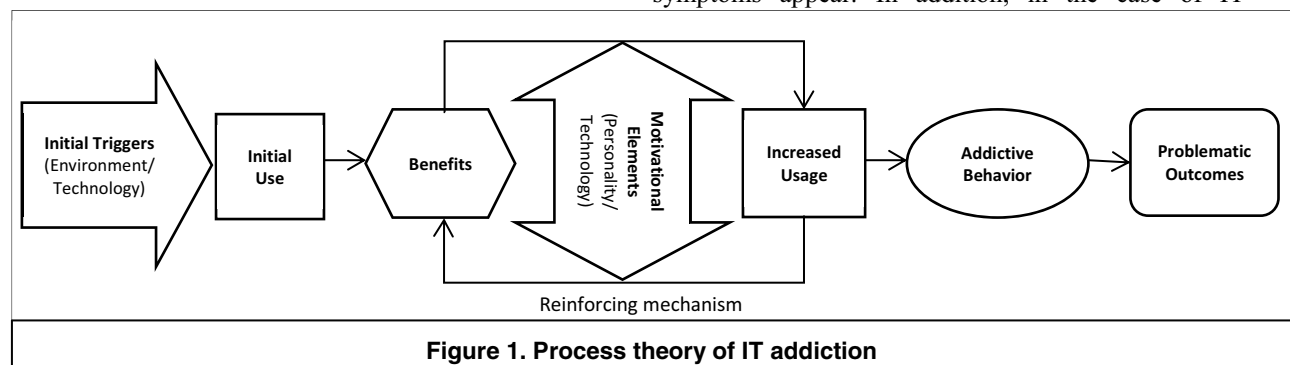

Figure 1. Process theory of IT addiction

addiction, this complex mechanism is influenced by the characteristics of the technology (features and affordances) and the personality of the user. Some researchers highlight the concept of "brain reward," which is produced by addictive substance use such as drugs and alcohol [2]. In these studies, addiction has been framed as a physiological process that produces "the inherently pleasurable" brain reward for individuals; to reinforce the same feeling, individuals increase self-administration of the substance to the point of losing self-control [1,2]. The reward-deficiency theory also maintains that individuals with certain personality traits (e.g. high sensation seeking or boredom proneness) increase their consuming behaviors to enhance stimulation of rewards [43,47]. In our case, smartphone use seems to provide a quick and immediate reward (through texts, emails, games and social networks) that is similar to the stimulation provided by addictive substances. Despite the similarities, our model adds to existing models because it uniquely takes the interactions that exist between technology, user and environment and integrates them into one process, showing how IT-use behaviors emerge and evolve into problematic behaviors.

The results of our study suggest that the IT addiction process is also triggered by elements associated with the nature of technology. Extant literature on addiction has widely addressed the role of addictive substances (e.g. opium, alcohol) and the influence of their specific characteristics on addictive behaviors [34]. In our case, respondents indicated that the motivation to start use can come from the physical features of a technology (technical objects) such as weight, connectivity, interface, application and operating software. This is also consistent with the existing literature on Internet and game addiction, which argues that the structural characteristics of technology such as accessibility, mobility and communicative features play an important role in developing dependency on the Internet [28,44,56]. Besides technical objects, the opportunities that technology provides for users, i.e. technology affordances, were found to be important in initiating use. In line with Markus and Silver [41], some respondents mentioned the capabilities of technology, which allow them to integrate their schedules and emails, connect to friends and family, and fill up their free time by working with different applications and playing online/offline games, as reasons for buying smartphones.

In addition to the characteristics of technology, environmental factors were found to be important in initial IT-use decision making. Our results indicate that peers and friends, the popularity of certain products, and advertising can all trigger initial usage. The role of environment has not been well-recognized in prior research on IT addiction. Nonetheless, our results are aligned with those from the general addiction literature that support the importance of contextual factors – such as the surrounding conditions and culture – as both enablers and inhibitors of addiction during the course of addiction formation [4,10,22]. This literature also asserts that the potential interaction between certain traits (e.g. self-esteem) and environment (peer pressure) can explain addictive behaviors. Our model contributes to this literature because it shows different stages in which these factors are important; while environmental factors come into play during initial regular use, personality traits are associated with an increased engagement with technology over time.

When users increase their smartphone usage without any self-regulatory mechanisms, symptoms of addiction and problematic behaviors begin to appear. Throughout the literature, the notion of symptoms has been used as a guide to identifying dependency and addiction in different contexts, and has helped researchers to better understand addicts' behavior [7,28,66]. For instance, Goldberg [24] discussed four attributes of Internet addiction: withdrawal, craving, tolerance, and negative life consequences. In our study, we were able to distinguish addicts based on their excessive smartphone use that is accompanied by the domination of thoughts, dependence, preoccupation, irritability, and lack of control over behavior. Previous research also showed that excessive IT use in the long-term could likely lead to several negative consequences; prior models have discussed instantiation of potential effects associated with excessive IT use [7,45,62,66,68]. Overall, our results show that addiction can impact the interpersonal, occupational, physical and psychological well-being of users who show a dependence on smartphones.

We must acknowledge that our study has limitations. First, our data was collected mainly at one point in time (cross-sectional). Therefore, our interviewees had to recall their smartphone usage behaviors from the start of that use. Because our theory aims to explain the addiction process and the interactions that occur over time, longitudinal data collection could enrich our findings and complement our current database. Having interviews at different points in time (e.g. early usage, continued usage, excessive usage) could shed more light on other mechanisms and how they evolve through time. Even though our respondents showed confidence in their responses to our questions, conducting interviews over a longer time period could identify other interactions that users might overlook when they become addicted to technology. Second, our data was collected mainly from students, which could affect the generalizability

of our findings. However, one should note that numerous scholars have used students in IS/IT studies because they are representative of and relevant to the context of technology use and addictive behaviors.

Despite its limitations, our study shows that IT addiction is a complex process that is affected by several elements related to environment, the user and the technology per se. IT addictive behaviors can develop gradually, based on earlier engagement with the same or similar technology. Although the IT addiction process will likely be the same for all *addicted* users, the length of the process will not be the same for all. We expect that the supporting conditions (e.g. younger age, higher education, sensation-seeking personality, tech-savvy environment) might play a role in speeding up this process. Our results also indicate that, as a result of addictive use, users can undergo serious physical, psychological and occupational problems. Overall, given the novelty of the IT addiction research in the IS/IT discipline, this paper contributes to the extant conceptualization of the phenomenon and identifies elements that distinguish addiction from other common IT behaviors (e.g. IT habit). Moreover, it contributes to theories of addiction by illustrating how these behaviors develop and clarifying potential triggers as well as identifying negative consequences associated to them.

For practitioners, this study helps identify the process leading to IT addictive behaviors and understand how addictive behaviors could develop through time for some IT users, depending on the type of technology, the environment surrounding people and the user personality. By understanding the nature of the IT addiction process, managers can potentially alter the reinforcement process and bring change to the culture and environment of the workplace, so as to control access to the type of technologies that could be addictive for some employees.

Future research should aim at developing further our framework and eventually test it, using rich qualitative or quantitative data also pertaining to other relevant addictive IT types such as social media networks and/or online games.

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