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FROM DESIGN PRINCIPLES TO IMPACTS: A THEORETICAL FRAMEWORK AND RESEARCH AGENDA

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Abstract

This paper integrates three streams of research in information systems─i.e., IS success, technology adoption, and human-centered design principles─to extend our understanding of technology use. A theoretical framework that incorporates the core ideas from these three streams of research, along with task, is presented. We leverage the proposed framework to present propositions that could guide future work. Specifically, the propositions developed relate system design principles to use and net benefits (i.e., job performance and job satisfaction) and rich use to job performance. We further suggest several broad potential future research directions.

1. Introduction

Several related yet distinct streams of research in information systems (IS) have built nomological networks around technology use.[1] The major streams are: IS success (Cecez-Kecmanovic et al., 2014; Delone and McLean, 1992, 2003; Petter et al., 2008), technology adoption (Brown et al., 2014; Brown et al., 2015; Thong et al., 2011; Venkatesh and Bala, 2008; Venkatesh et al., 2003, 2012, 2016; Xu et al., 2010), and human-centered design principles (HCDP; Zhang, 2008, 2013; Zhang et al., 2011). The IS success model presents relationships between types of quality and net benefits (e.g., individual benefits) mediated by technology use and user satisfaction. The technology adoption stream relates individual reactions to using technology to technology use mediated by intentions to use the technology. Finally, HCDP research suggests that various design principles and design characteristics[2] can be employed to enhance technology use. Although these streams have evolved fairly independently, there have been some references within each of these streams to research in the other streams. Yet, there have also been a few integrative efforts. For example, Wixom and Todd (2005) integrated design characteristics that are studied in the HCDP stream with the IS success model and technology acceptance model (TAM; Davis et al., 1989). Likewise, Hoehle et al. (2015) studied how various design characteristics would influence intentions to use a specific technology in different countries. Despite these isolated efforts, sorely needed is an examination of these streams of research with a view toward integrating them into a cohesive framework that can be used to

[1] Prior research has used at least four different terms, i.e., system, technology, information system, and information technology, to refer to the core idea of a computer-based software and/or hardware. We use these terms interchangeably in this paper as we endeavor to stay faithful to the original sources.

[2] Zhang (2008) distinguishes design principles from design guidelines (or characteristics). Design principles are the broad term that refers to ideas to which designers should adhere that are technology-independent. In implementing design principles, the specific design characteristics used may vary depending on the particular system. For instance, autonomy is a design principle that will be implemented in technologies differently depending on the type of technology.

guide future work. In addition, there is still a lack of theorization and understanding of the fit among system, user, and task, an important condition noted in prior literature, necessary to foster success of technology implementations (e.g., Burton-Jones and Straub, 2006; Dishaw and Strong, 1999; Fuller and Dennis, 2009; Zhang, 2017). Against this backdrop, this conceptual paper has the following objectives:

(1) Summarize the three major streams of research—IS success, technology adoption and HCDP—as they relate to technology use;

(2) Provide a theoretical framework that integrates the above three streams of research and incorporates task to gain a better understanding of how the fit among system, user, and task affects the success of technology implementations; and

(3) Leverage the theoretical framework and develop testable propositions to further our current understanding of technology use and guide future research at the nexus of these streams.

This paper makes three key contributions. First, although the three streams of research—IS success, technology adoption and HCDP—have evolved concurrently and cross-referenced each other, the "big picture" that emerges from the collection of works in these streams has not been previously demonstrated. The proposed framework is expected to fill this void. Second, by presenting a set of testable propositions building on the framework, this work will provide opportunities not only for research at the nexus of these three streams, but also to advance knowledge about technology use. Finally, although HCDP-related discussions in IS research have increased in recent years, ties between design principles and technology use are somewhat limited (see Zhang, 2008, 2013). Such ties are key to advancing our understanding about technology use and to give the technology artifact a central role in theory development (e.g., Leonardi, 2011; Orlikowski and Iacono, 2001). Our propositions, as noted earlier, will provide the impetus for such work.

2. AN INTEGRATIVE FRAMEWORK

In this section, we present a brief overview of the three streams of research that we seek to integrate—namely, IS success, technology adoption, and HCDP. We follow this with a discussion of the framework that integrates these major streams of research.

2.1 IS Success Model

The IS success model that was initially presented in Delone and McLean (1992) was then extended based on about a decade of research on the model and presented in Delone and McLean (2003, see also Seddon, 1997). Figure 1 shows this model. These two papers by Delone and McLean are well cited and are among the most-cited papers in *Information Systems Research* and *Journal of MIS*, respectively. The model relates different concepts of IT quality to technology use and user satisfaction that in turn lead to net benefits, which are broken down into personal impacts and organizational impacts. One major change, which was an addition, to the IS success model in the 2003 paper was the inclusion of service quality. The major constructs in the IS success model and their definitions are shown in Table 1. As we can see, the IS success model identifies, describes, and explains the relationships among six of the most critical criteria, i.e., information quality, system quality, service quality, intention to use or actual use, user satisfaction and net benefits, for evaluating the success of information systems implementations.

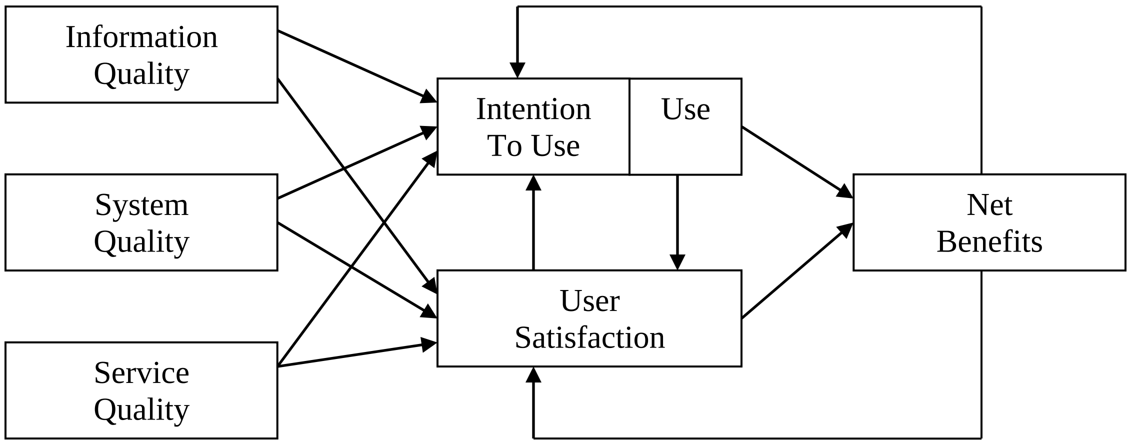

Figure 1. IS Success Model (Delone and McLean 2003)

Table 2. Constructs and Definitions (Delone and McLean 1992, 2003)

Construct	**Definition**
Information quality	The degree of excellence of the information product along the dimensions of accuracy, meaningfulness, and timeliness, etc.
System quality	The degree of excellence of the information system along the dimensions of reliability, ease of use, usefulness, flexibility, timeliness, error rate of the information system, etc.
Service quality	The degree of excellence as related to the overall support delivered by the service provider of the information system.
User satisfaction	Users' opinion of the system.
Net benefits	Capture the balance of both positive and negative impacts on both individuals and organizations to describe the final success of information system.
Intention to use	The subjective probability of using the technology.
Use	Describe the nature and level of use.

2.2 Technology Adoption

The individual-level technology adoption stream was sparked primarily by the development of TAM (Davis, 1989; Davis et al., 1989). Eight competing models of technology adoption have been synthesized into a unified theoretical model—termed unified theory of acceptance and use of technology (UTAUT; see Venkatesh et al., 2003), which is one of the most widely used models in this domain in particular and most influential IS theories in general (see Venkatesh et al., 2016) including research both in the workplace and home setting (see

Thong et al. 2011 IEEETEM; Venkatesh et al. 2003; Venkatesh et al. 2012). Venkatesh et al. (2003) present an overarching framework, shown in Figure 2, that captures the essence of these different models. The various models suggest that a variety of individual reactions to technologies and using technologies predict intentions to use a technology that in turn predict actual use of the technology. The major constructs of UTAUT, along with their definitions, are shown in Table 2 (Venkatesh et al., 2003). As we can see, UTAUT uses performance expectancy, effort expectancy, social influence, and facilitating conditions to predict behavioral intention and use; UTAUT also incorporates gender, age, experience, and voluntariness of use as moderators (Venkatesh et. al., 2003).

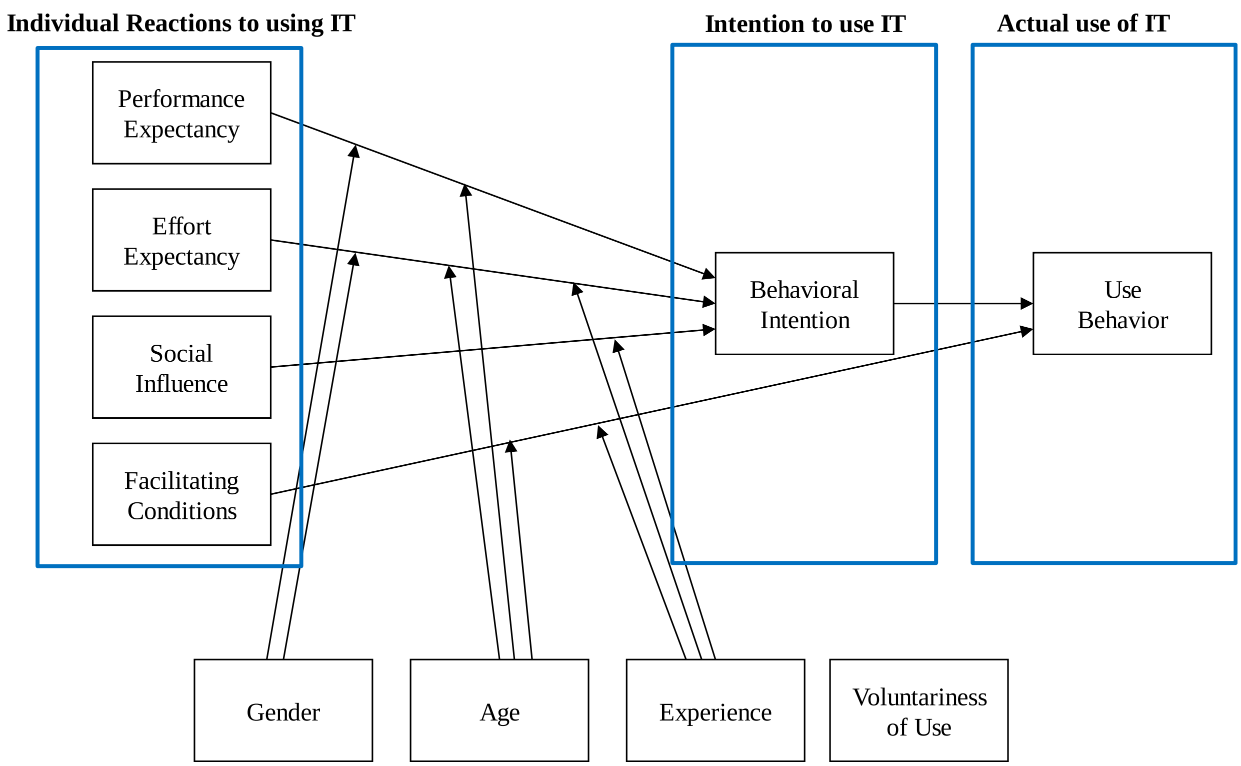

Figure 2. UTAUT: A Synthesis of Technology Adoption Models

Table 2. Constructs and Definitions (Venkatesh et al. 2003)

Construct	**Definition**
Performance expectancy	The degree to which an individual believes that using the system will help him or her better attain significant rewards.

Effort expectancy	The degree of ease associated with the use of the system.
Social influence	The degree to which an individual perceives that important others believe he or she should use the new system.
Facilitating conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.
Behavioral intention	The degree to which a person has formulated conscious plans to perform or not perform some specified future behavior (see Venkatesh et al., 2006 OBHDP; Venkatesh et al., 2008 MISQ).
Gender, age, experience, voluntariness	Gender and age are demographic variables. Experience: degree of prior use of the target technology. Voluntariness: the degree to which use of the technology is perceived as being voluntary or of free will.
Technology use	The actual behavior of using the technology.

2.3 Human-centered Design Principles

Prior literature has indicated the importance of drawing from a system design perspective to understand what causes people to use a system and why the usage behaviors vary in intensity (e.g., Zhang, 2008, 2013). Zhang and Li (2005) present a framework that illustrates the issues and components that are pertinent to human interaction with technologies. The identification of the important factors in the research area of human-computer interaction (HCI) provides a broader theoretical foundation for system design. Interest in HCI in IS research has been more recent and has seen increasing activity due to a stronger push to give the IT artifact a more central role in IS research (e.g., Leonardi, 2011; Orlikoswki and Iacono, 2001) and to design systems that will enhance effective utilization of the system. For instance, Agarwal and Venkatesh (2002) identified various design guidelines that could enhance web site use (see Venkatesh and Agarwal 2005) and Hoehle et al. (2015) found that various design features affected individuals’ continued intention to use mobile phones. Zhang (2008) proposed a variety of system design principles and characteristics related to human motivational needs that could enhance technology use. In essence, Figure 3 presents a summary of the current work that conceptualizes and defines HCDP related to human motivational needs in IS. System design principles are conceptualized and defined based on the psychological, social, cognitive, and emotional sources of human motivation. System design characteristics are the application of system design principles in developing an IT artifact that conveys and expresses the kernel of the design principles. Technology use is the actual behavior of using the target technology. However, evidence linking such design characteristics and principles to technology use is still somewhat limited (for examples, see Hoehle et al., 2015; Venkatesh and Agarwal, 2006; Venkatesh and Ramesh, 2006). There have been continuing calls for more research at the nexus of HCI and IS (see Galletta and Zhang, 2006; Johnson et al., 2014; Te'eni et al., 2007). A more detailed explanation of the design principles and design characteristics from Zhang (2008) are shown in Table 3.

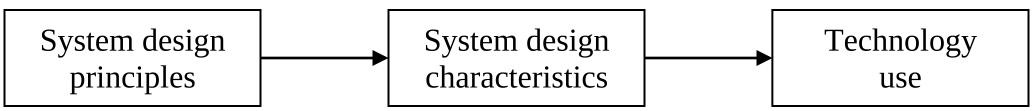

Figure 3. Human-centered Design Principles

Table 3. Human-centered Design Principles (Zhang 2008)

System Design Principles	**Definitions**	**System Design Characteristics**
Principle 1. Support autonomy.	Principle 1: An autonomy-supporting style that fulfills the psychological need to experience choice in the initiation and regulation of behavior.	Principle 1: Allow users to decide how they want to express themselves.
Principle 2. Promote creation and representation of self-identity.	Principle 2: Define and create the self to realize the quality of one's psychological well-being.	Principle 2: Allow users to decide how they want to do things in distinctive ways.
Principle 3. Design for optimal challenge.	Principle 3: The need for competency and achievement through attaining goals with different levels of challenges	Principle 3: Allow users to identify and set different challenge levels.

Principle 4. Provide timely and positive feedback.	Principle 4: The provision of informational feedback in a timely manner such that the “flow” of cognition and action will not break.	Principle 4: Allow users to know how far it is from achieving the goal at an appropriate time.
Principle 5. Facilitate human-human interaction. Principle 6. Represent human social bond.	Principles 5 and 6: The innate desire to belong, a social and psychological need for relatedness.	Principle 5: Let users feel they are related to or connected with each other by showing interaction results. Principle 6: Allow users to feel the social bond, e.g., the extent, the intensity, and the nature of the bond.
Principle 7. Facilitate one’s desire to influence others. Principle 8. Facilitate one’s desire to be influenced by others.	Principle 7: The desire to make the physical and social world conform to one’s personal image or plan. Principle 8: The desire or need to follow.	Principle 7: Allow realization of leadership. Principle 8: Allow realization of followership.
Principle 9. Induce intended emotions via initial exposure to ICT. Principle 10. Induce intended emotions via intensive interaction with ICT.	Principle 9: Affect and emotion regulated by biological system. Principle 10: Affect and emotion regulated by cognitive system.	Principle 9: Induce intended affect and emotion invoked by initial exposure to the system. Principle 10: Induce intended affect and emotion through intensive cognitive activities using the system.

2.4 Fitting the Streams Together

Our discussion thus far, with a focus on the key papers in these three streams, has suggested fairly independent approaches to develop the nomological network around technology use. Among the three streams of research, the IS success model has focused on the system and user, e.g., system quality, users’ performance gains. The theories related to technology adoption have focused on the user, e.g., users’ reactions, intentions, and behaviors. The theories related to

HCDP have focused on the system, e.g., system design principles and characteristics. However, there has been some work that has cut across these streams of research. System design characteristics have been shown to influence key beliefs, such as performance expectancy and effort expectancy (see Venkatesh and Davis, 1996; Venkatesh et al., 2003). A more recent paper by Brown et al. (2010) examined the effects of collaboration technology characteristics, i.e., social presence, immediacy, concurrency, on performance expectancy and effort expectancy. At the core of the IS success model lies people's perceptions of the quality of IT that cover information, system, and service quality (see Table 2). It represents three aspects of IT that are critical with regard to upstream implications for system design and downstream impact on system use and user satisfaction. Although the IS success model has largely related perceptions of quality to technology use and user satisfaction, Wixom and Todd's (2005) study related the perceptions of quality to intentions to use a technology via individual reactions that were identified in the technology adoption stream, as shown in Figure 2. Specifically, Wixom and Todd (2005) related the quality constructs from the IS success model to intentions via performance expectancy and effort expectancy (see also Table 2). Further, Wixom and Todd (2005) demonstrated that a variety of design characteristics influenced quality perceptions. Likewise, Seddon (1997), building on the IS success model, suggested performance expectancy is a construct that is potentially influenced by the various quality constructs in the IS success model. Similarly, Hoehle et al. (2015) demonstrated the effects of different mobile phone design characteristics on consumers' continued intention to use mobile phones. This suggests that system design characteristics would affect individual reactions to using technology.

Despite the advances in knowledge from the above studies, none of them incorporate task into the theory development. Task is an important factor that was found to affect technology implementations but has largely been overlooked (e.g., Dishaw and Strong, 1999; Serrano and Karahanna, 2016; Strong and Volkoff, 2010). Drawing from the task-technology fit (TTF) theory, we incorporate task into our integrated framework. Task-technology fit (TTF) theory suggests that when technology is used for tasks it is designed to support, it is more likely to have a positive impact on job outcomes, e.g., task performance (Goodhue, 1998; Goodhue and Thompson, 1995; Zhang, 2017; Zigurs and Buckland, 1998), because when there is a fit between a task and technology, users do not need to spend extra time and effort to modify the technology to support the task. Consequently, users can utilize their cognitive resources and concentrate on completing the task. In contrast, when a technology does not support the particular task, users may need to allocate additional mental resources to increase the fit between the task and the technology.

Our integrated framework also seeks to develop a better understanding of the nomological network related to technology use by looking beyond the traditional lean conceptualizations of technology use (see Burton-Jones and Straub, 2006). Burton-Jones and Straub (2006) argued that a rich conceptualization of technology use would lead to better explanation and prediction of individual performance. Rich use is conceptualized to capture not only the entire content of use activity, such as use/nonuse, duration of use, frequency of use or extent of use, but also the pattern or the extent to which users use different technology features and enjoy their use (e.g., Sun, 2012). Thus, a more precise conceptualization of use, such as what is achieved with rich use, can help us predict the outcomes of use (e.g., performance) better. Further, a precise conceptualization of use results in a more accurate operationalization of use that can lead to a better and more accurate prediction of outcomes of use, whereas an imprecise conceptualization (i.e., omnibus use) results in less accurate operationalization that can obscure the relationship between use and outcomes.

Specifically, two key new conceptualizations of technology use were proposed by Burton-Jones and Straub (2006): *cognitive absorption* and *deep structure use*. Cognitive absorption describes the relationship between a user and technology, or the extent to which a user interacts with technology. Deep structure use indicates the extent to which system features that related to core aspects of the task have been used with respect to the breadth of use (i.e., number of features used) and depth of use (i.e., extent to which a feature is exploited). The concept of rich use is fairly new and only a few studies have validated the positive relationship between rich use and use outcomes (e.g., Burton-Jones and Straub, 2006; Robert and Sykes, 2017; Sykes and Venkatesh, 2017; Zhang, 2017). We integrate the concept of rich use into our framework to offer theoretical arguments for why rich use of technology will lead to job performance, which is a broad and an important assessment of employees' effectiveness in organizations.

Taken together, this suggests the integrative framework in Figure 4. The major difference between our integrated framework and the model proposed by Wixom and Todd (2005) is that our framework extends Wixom and Todd's model by incorporating and highlighting the important role of HCDP in understanding the nomological network related to technology use. Our framework sheds light on our understanding of the antecedents and determinants of system quality and information quality from a system design perspective. In addition, by adopting a rich conceptualization of technology use, our framework extends Wixom and Todd's model by developing a better understanding of the relationship between technology use and individual performance. Moreover, by relating design principles to individual consequences directly and indirectly via technology use, we gain a better understanding of the mediational role of technology use. In other words, we will have a better picture of what design principles would influence individual consequences directly and what would influence individual consequences via technology use. Clearly, this cannot be achieved by an isolated and independent view that focuses only on one stream of research. Moreover, by integrating these three streams of research, we gain a more holistic understanding of IS use and success.

3. Proposition Development

Figure 5 shows the key elements of the integrated framework presented in Figure 4 to highlight the relationships that have been well studied. We focus on developing propositions that articulate these relationships. The first set of propositions that we present relate rich use of technology to a specific individual-level net benefit, namely job performance (see P1 in Figure 5). The second set of propositions that we present broadly relate design principles to the two different rich conceptualizations of use in both the workplace and personal contexts (see P2 in Figure 5). A personal context refers to the use of technologies for nonwork-related purposes, such as shopping, chatting with friends, and playing games. The third set of propositions relates HCDP to individual benefits in the workplace , e.g., job performance and job satisfaction (see P3 in Figure 5). This set of propositions does not consider the mediating role of technology use, thus illustrating the direct impact of HCDP on individual benefits. All three sets of propositions are meant to be illustrative of, but not necessarily exhaustive, how future empirical work at the nexus of the streams can proceed. For instance, it is also possible to envision research on other net benefits, such as job commitment. Likewise, only by theorizing and conducting studies at the level of specific design principles/characteristics can we develop a rich understanding of how rich use can be fostered.

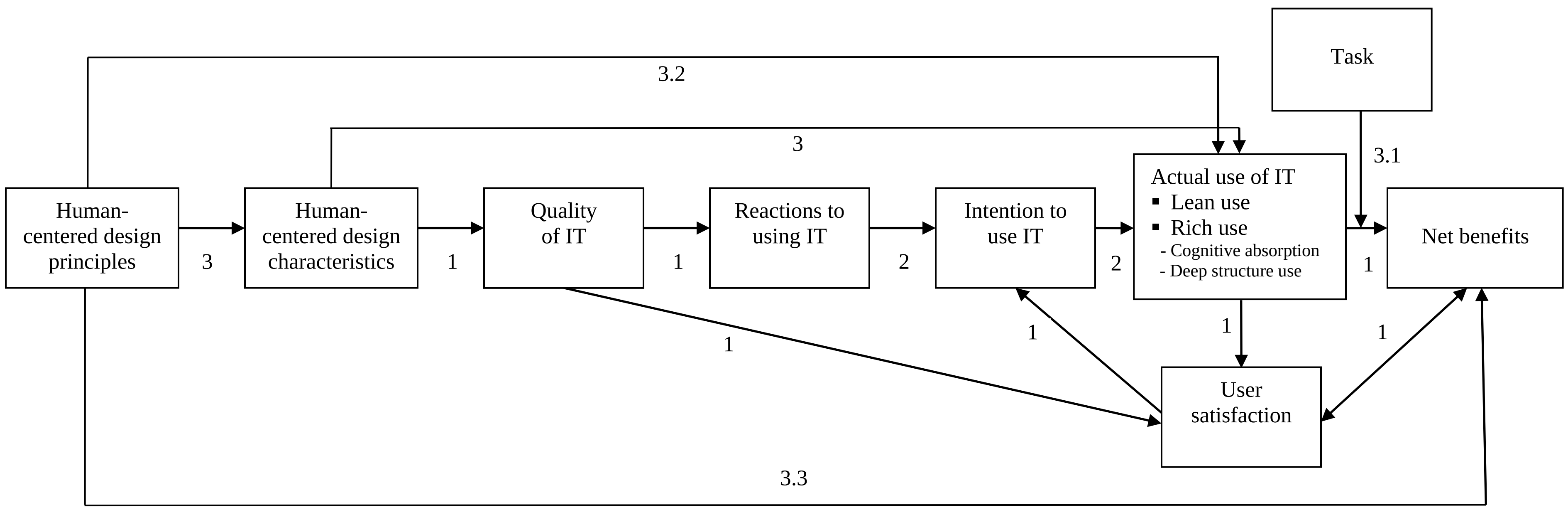

Figure 4. An Integrative Framework

Note:
1: IS success model
2: Technology adoption
3: Human-centered design principles

3.1, 3.2 and 3.3 correspond to the three sets of propositions in this paper.

Actual use of IT: Rich use (Burton-Jones and Straub, 2006) is the new conceptualization of IT use that includes two components: cognitive absorption and deep structure use.

Net benefits: At the individual level, they refer to job performance, job satisfaction, etc.

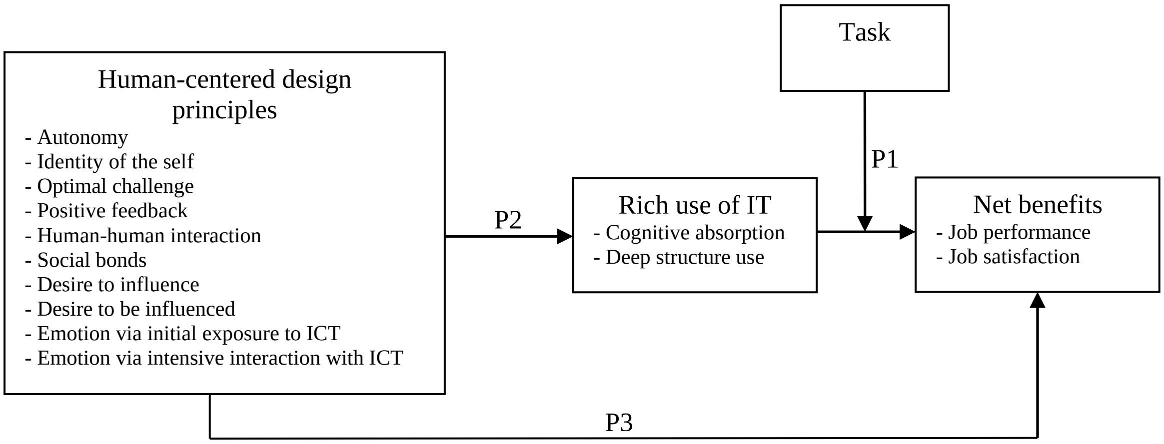

Figure 5. Propositions Matching Key Elements of the Integrated Framework

3.1 Predicting Job Performance

3.1.1 Cognitive absorption. Cognitive absorption is an important type of rich use that describes the interaction between a user and technology (Burton-Jones and Straub, 2006). It indicates user's level of involvement with a technology—"a state of deep attention and engagement—i.e., the individual is perceptually engrossed with the experience." (Agarwal and Karahanna, 2000, p. 667). Cognitive absorption has five dimensions: *temporal dissociation*, *focused immersion*, *heightened enjoyment*, *control*, and *curiosity* (Agarwal and Karahanna, 2000). According to Agarwal and Karahanna (2000), when users interact with technology: (1) they feel that they can manage the interaction (control); (2) they have a strong sense of inquisitiveness (curiosity); (3) they feel great pleasure in using it (heightened enjoyment); (4) they occupy themselves totally with it (focused immersion); and (5) they may not even realize how much time they have spent on it (temporal dissociation).

When users really enjoy using technology, they are less likely to feel bored or tired and they are more likely to work harder and longer using a technology, resulting in higher productivity (Zhang, 2017). Prior research has indicated the amount of effort and the degree of persistence driven by the motivational process of goal setting have a significant impact on performance outcomes (e.g., Locke, 1997). When users occupy themselves totally with a technology, they are less likely to be distracted by other non-work-related problems that might slow down their progress. In addition, if users concentrate on their work, they might make fewer mistakes. Consequently, they are likely to perform their tasks more efficiently and effectively, resulting in better job performance. Prior research has indicated the detrimental effects of divided attention at encoding on later memory performance (Naveh-Benjamin et al., 2007). Moreover, cognitive absorption is a situational intrinsic motivator (Agarwal and Karahanna, 2000) and intrinsic motivation is an important driver of performance (Vallerand, 1997). Although not linked to ultimate performance, prior work in technology use contexts has demonstrated that intrinsic motivation can have positive impacts on key drivers of performance (see Venkatesh, 1999, 2000; Venkatesh and Speier, 1999; Venkatesh et al., 2002). Mitchell (1997) found that the strength of motivation was strongly related to performance. If users are cognitively absorbed with a technology, they will enjoy using it and concentrate more on performing their tasks that will in turn lead to effective task completion and enhanced productivity, thus resulting in better job performance. Empirical evidence, including from our prior work in this domain, also supports such a relationship in the context of different technologies (Robert and Sykes, 2017; Sykes et al., 2014; Sykes and Venkatesh, 2017; Zhang, 2017; Zhang and Venkatesh, 2017). Therefore, we propose:

P1a: Cognitive absorption will positively influence individual job performance.

3.1.2 Deep structure use. A technology may have many features to support the underlying structure of a task. Deep structure use indicates the extent to which the core features related to the task have actually been used by a user. If the features used are relevant to the task, they are more likely to support the task (Goodhue, 1998; Goodhue and Thompson, 1995). Prior studies indicated that decision-making performance was dependent on the fit between data presentation format and task (e.g., Benbasat et al., 1986; Dickson et al., 1986), and a misfit would slow down the decision-making processes (e.g., Vessey, 1991; Vessey and Galletta, 1991). If the features of the technology used are relevant for task completion, their use will facilitate effective task completion. If deep structure use is high, i.e., the more the core features are used or the more in-depth such features are used, task performance is more likely to be positively affected because the users are likely to leverage more useful resources to generate outcomes, thus increasing the likelihood of producing higher quality output. For example, if a task requires intensive computations, users might combine different features of a technology to optimize performance. In addition, when more features are used, users can perform tasks more efficiently, as different features can facilitate different aspects of a task. For example, a task can involve data access and data analysis. Using the storage and retrieval features of a technology can facilitate data access and make it easier and faster. In the same way, using the analysis and reporting feature can facilitate data analysis. Moreover, when more such features are used, the data analysis can be completed more accurately. While each feature may have its strengths and weaknesses, comparing and integrating results generated by different features may improve accuracy of the task output.

Similarly, we argue that use of the core features of a technology will enhance job performance because such use is more likely to result in better solutions to problems. When specific features of a technology are used in ways that are beyond the common uses of those features, users can strengthen or extend the functionalities associated with those particular features. Customization can be a form of such use because customization can strengthen or extend how specific features of a technology are used. For example, users can customize the display of information when using a technology such that the information is easy to organize and process. When users can process the information more effectively, they are more likely to perform better. Users can also extend functionalities of specific features to improve task efficiency. For example, users can develop add-ins to the information processing feature of a technology to reduce processing time and improve processing accuracy.

When deep structure use is low (i.e., not many core features are used or a specific core feature has not been adequately explored), the benefits of the particular technology may not be realized, especially when the combined use of different features or exploitation of specific features to a greater extent are necessary for completion of task. For example, when the use of a video conferencing feature could facilitate communication of complicated knowledge, i.e., knowledge consisting of parts intricately combined, difficult to analyze, understand, or explain, such a feature might need to be complemented with a file sharing feature so that users can exchange important documents to facilitate the conference meeting or a taping feature such that important parts of a conference can be recorded for later review. The combined use of these features should improve communication effectiveness, resulting in better job performance.

Before closing our arguments related to the relationship between deep structure use and job performance, we need to clarify the boundary condition related to specific technology application contexts. For some applications, such as transaction systems used by operational staff, it is likely their assigned tasks will require them to use certain number of features (no more or no less) that match their tasks. In this case, TTF is high and the objective of optimized features and deep structure use of those features for high TTF becomes less relevant. For other applications, such as unstructured decision-making tasks, users may have more freedom to mix and match various features to address different problems. In this case, the extent of relevant features explored is more likely to affect job performance. Given this boundary condition, future research that leverages this framework to build specific research models should incorporate technology type and application context. Therefore, we propose:

P1b: Deep structure use will positively influence individual job performance.

P1c: The positive influence of deep structure use on individual job performance will be stronger when there is a fit between the usage behavior and the task.

3.2 Relating System Design Principles to Rich Use

Zhang's (2008) work related to system design principles provides an excellent base to theorize about the potential relationship between system design and technology use. Although early research related to system design and usability frequently examined how design characteristics affected task performance (e.g., Adipat et al., 2011), Zhang's work emphasizes how design can create positive motivational mechanisms. As discussed earlier, such motivational mechanisms have been related to technology use in the technology adoption stream (e.g., Venkatesh and Speier, 1999; Venkatesh et al., 2002). In addition to the effects on technology use through motivational mechanisms, we believe that the design principles can directly influence rich use, i.e., different dimensions of cognitive absorption and deep structure use.

3.2.1 Cognitive Absorption

Principles 1 and 2: Support Autonomy and Identity of the Self

Zhang's (2008) first two design principles of *autonomy* and *identity of the self* are tied to *psychological* motivational needs for the *same* (*autonomy* and *identity of the self*) and are said to have their roots in self-determination theory (Deci and Ryan, 1985). When a technology allows for the creation and maintenance of an identity and the associated autonomy in such a context, three dimensions of cognitive absorption are expected to be enhanced.

Autonomy and the creation and preservation of a unique identity are important human needs, and supporting these needs have positive benefits in workplace and personal contexts (see Carter and Grover, 2015; Hackman and Oldham, 1980; Hogg and Terry, 2000). A technology can create a direct, positive impact on cognitive absorption by consideration to these principles. For instance, if an organizational knowledge management system has a blog wherein users can create and maintain their identities that are perhaps different from their traditional work roles, they will find heightened enjoyment when using the blog due to the variety introduced by the secondary identity; it is also likely that the identity and the freedom in controlling the identity and the activities therein will provide users with a sense of control; and finally, it is likely that as users engage in a variety of exploratory behaviors when using the blog, their curiosity will be peaked and fed in the process of such use. Cognitive absorption is a situational intrinsic motivator (Agarwal and Karahanna, 2000) and a high level of intrinsic motivation is fostered by the satisfaction of the needs of both competence and autonomy (Deci and Ryan, 1985; Ryan and Deci, 2000). Thus, autonomy is likely to have a positive impact on cognitive absorption. Therefore, we propose:

P2a: Technologies designed to foster autonomy will positively influence cognitive absorption.

P2b: Technologies designed to foster an identity of the self will positively influence cognitive absorption.

Principles 3 and 4: Support Optimal Challenge and Positive Feedback

Zhang's (2008) second set of principles of *optimal challenge* and *positive feedback* relate to the *cognitive* motivational needs of *competence and achievement,* with roots in flow theory (Csikszentmihalyi, 1975, 1990). When a technology supports optimal challenge, two dimensions of cognitive absorption can be expected to be enhanced; likewise, when a technology provides meaningful feedback, at least one dimension of cognitive absorption is expected to be enhanced.

Interestingly, the idea of challenge is also related to ease of use in the technology adoption stream (Venkatesh, 1999, 2000; Venkatesh et al., 2003; Venkatesh and Bala, 2008). The view in the technology adoption literature has been to design for ease of use and relatedly, minimize challenge so as to allow users to get over the hurdle (e.g., Venkatesh, 1999). However, designing for optimal challenge suggests giving the users a sense of accomplishment. Although these may seem to be competing arguments, we suggest that they may not necessarily be. It is possible to envision a scenario where the early learning of the basics is accomplished easily, as suggested by Venkatesh (1999), and the use of the system so as to leverage greater benefits is such that it is optimally challenging, as suggested by Zhang (2008). Optimal challenge is critical as both too little or too much can result in non-fulfillment of the competence need (e.g., Malone, 1981; Yerkes and Dodson, 1908). It is readily possible to see from the Venkatesh (1999) experiments related to telecommuting how optimal challenge can be fostered without harming ease of use. By designing a system and associated training that allowed for quick learning of the system, his experiments demonstrated that the hurdle related to ease of use can be overcome but clearly, the challenge of telecommuting still remained for the telecommuters if they strived for high levels of performance by using the telecommuting system (see Venkatesh, 1999 for a detailed discussion). Such challenge and the resultant flow state when using a technology will contribute favorably to temporal dissociation and focused immersion as those who are in a flow state are known to spend much more time than intended on a task and/or lose track of time (see Venkatesh, 1999), or concentrate on the task or be less distracted by other things when working on the task (Agarwal and Karahanna, 2000). Therefore, we propose:

P2c: Technologies designed to foster optimal challenge will positively influence cognitive absorption.

Insofar as feedback is concerned, there is a vast literature on the job characteristics model (e.g., Hackman and Oldham, 1989; Morris and Venkatesh, 2010; Venkatesh et al., 2010) that has associated feedback with positive affective reactions to the job, such as job satisfaction. Likewise, in a technology environment, employees can perhaps more readily and easily receive feedback from a technology. Consequently, employees may find heightened enjoyment by using the system. For instance, a system can track a user's performance on specific tasks and over time, provide a comparative analysis of the user's current performance against his or her own historical performance; and/or a system can provide comparisons against performance averages of other employees within the business unit. Such feedback can not only be far more immediate than what a supervisor may be able to give, but also serve as a motivator, regardless of whether the current performance is better or worse because a better performance may give the employee a sense of accomplishment or a poorer current performance may spur the employee to perform better. Therefore, we propose:

P2d: Technologies designed to foster feedback will positively influence cognitive absorption.

Principles 5 and 6: Support Human-human Interaction and Social Bonds

Zhang's (2008) third set of principles of facilitating *human-human interaction* and *social bonds* relate to the *social, psychological* motivational need of *relatedness,* with roots in *social interaction studies* (Baumeister and Leary, 1995). When a technology satisfies these needs for psychological relatedness, at least one dimension of cognitive absorption is expected to be enhanced.

Human beings are social animals and the need to belong is a well-understood one. Even research on computer-mediated communication has found that those who prefer to avoid face-to-face social settings, perhaps due to social anxiety, frequently seek online channels in search of friends or even romantic partners (e.g., Ang et al., 1993). Also, online communication tools provide an opportunity to level the playing field by allowing even those who are not very vocal to participate on an equal footing in meetings, e.g., brainstorming sessions (e.g., McLeod et al., 1997). Designing a technology that fosters creation of a social bond and more favorable interactions among people is likely to be the result of enhanced social richness, telepresence (Venkatesh and Johnson, 2002) and other positive reactions as articulated in media synchronicity theory (Dennis et al., 2008). Adherence to these principles will undoubtedly result in heightened enjoyment as it will replace the more impersonal and machine-like interaction that is typically attributed to technologies and technology-mediated communication with a more warm and personal feel (see Venkatesh and Johnson, 2002). Therefore, we propose:

P2e: Technologies designed to foster positive human-human interaction will positively influence cognitive absorption.

P2f: Technologies designed to foster social bonds will positively influence cognitive absorption.

Principles 7 and 8: Support Desire to Influence and Desire to be Influenced

Zhang's (2008) fourth set of principles of facilitating one's *desire to influence and be influenced* relate to the *social, psychological* motivational needs of *power, leadership and followership*, with roots in affect control theory (Heise, 1985). When a technology satisfies these needs to lead/follow, at least one dimension of cognitive absorption is expected to be enhanced.

New technologies have the potential to alter the power structure in organizational settings (Brass, 1984). Frequently, technologies result in a shift in power as those who were previously powerful due to control of information are no longer powerful because a newly introduced technology makes the previously controlled information available to different people. Such newly empowered employees are likely to enjoy the system. Technologies can be designed to empower employees with information. For instance, standard reports that make available vast amount of information, which would be otherwise difficult to get, in a condensed form can empower employees with information. Also, allowing employees to create custom reports is another approach that can increase the power and influence of employees who leverage such features. Similarly, as noted already in Zhang (2008), when technologies, such as a blog, provide for groups of people to share information with each other, those who have a desire to be influenced (i.e., follow) will find it to be appealing as they can learn from others, acquire best practices and follow effectively. Online communication technologies provide a platform for collaborative learning that has been found to be superior to traditional learning (Johnson and Johnson, 1989). In both cases, i.e., technologies that provide the opportunity to influence and technologies that provide the opportunity to be influenced, user enjoyment is likely to be enhanced because leading and following, as one desires, will result in positive affective responses. Therefore, we propose:

P2g: Technologies that provide a user with an opportunity to influence others will positively influence cognitive absorption.

P2h: Technologies that provide a user with an opportunity to follow others will positively influence cognitive absorption.

Principles 9 and 10: Support Emotion and Affect

Zhang's (2008) fifth set of principles of inducing *intended emotions* relate to the motivational need of *emotion and affect*, with roots in affect and emotion studies (Russell, 2003;

Sun and Zhang, 2006). When a technology satisfies these needs for emotion and affect through the deployment of surface or interaction features, various dimensions of cognitive absorption are expected to be enhanced (Zhang et al., 2006). Surface features are those that induce intended affect and emotion when users initially interact with the system, whereas interaction features are those that induce intended affect and emotion after users intensively interact with the system (e.g., Venkatesh, 1999; Venkatesh and Speier, 1999).

There is a significant body of prior research that is related to emotion and affect in the design of systems. For instance, Van der Heijden (2004) found that hedonic systems can drive enjoyment and shift the focus away from utilitarian outcomes. Likewise, Venkatesh (1999) found that game-based training can also reduce the emphasis on the utility of a technology. Venkatesh and Agarwal (2006) specifically identified four different affective design characteristics related to web site usability that were said to influence web site use (see also Agarwal and Venkatesh, 2002; Venkatesh and Ramesh, 2006). Although there is some evidence that such an emphasis on affect in the design process can have a positive impact, other research has established that affect itself does not have a direct effect on rational intentions or technology use (see Venkatesh et al., 2003). We contend, however, that when design can induce intended positive emotions in particular, a favorable effect on various dimensions of cognitive absorption will ensue. But, given that emotion and affect are particularly subjective, it can also trigger negative emotions or negative side effects. For instance, it is possible that a bright flashing red banner, i.e., a surface feature, may be appealing and will result in an enjoyable experience for one user but be particularly annoying to another user. Another example is “Clippy,” who was part of the help feature in earlier versions of Microsoft Office, engendered strong negative reactions among many users although the idea was to introduce a positive affect toward the software. Interaction features in a technology that can trigger positive affect can make users lose track of time when they are greatly immersed in the technology (see Venkatesh, 1999; Venkatesh and Speier, 1999). Likewise, when technologies have features that are known to trigger such positive affective reactions, user curiosity may be peaked due to the opportunity to explore the technology. For example, using "live view" of Dreamweaver, one of the most popular software for web development, is nearly twice as fast as previewing rendered pages in a browser. This may trigger users' curiosity to get to know more about the technology. Therefore, we propose:

P2i: Technologies that induce positive emotions via surface features will positively influence cognitive absorption.

P2j: Technologies that induce positive emotions via interaction features will positively influence cognitive absorption.

3.2.2 Deep Structure Use

Although cognitive absorption can be influenced in various ways through design principles, deep structure use represents a choice related to using the correct technology features for the task at-hand (Burton-Jones and Straub, 2006). Beyond motivational influences that may drive such use, the design of technology with certain principles can promote deep structure use. Given that our objective is to make a case that design principles can influence deep structure use, we offer two illustrative propositions in this paper. We specifically argue that principles related to autonomy (#1) and timely feedback (#4) will positively influence deep structure use. If a technology is designed with autonomy in mind, the user will have greater freedom in selecting the means to accomplish a goal. Such freedom will allow the user to compare different approaches to completing a task depending on the situational demands and goals. Further, as deep structure use is a perceptual assessment of the use of the right features for the task at-hand, technologies that have greater autonomy will allow the user to hear and learn from peers about different features in a technology such that any particular user can choose the approach that is best for him or her. Prior research has discussed how autonomy was related to making important decisions in various task contexts (Thomas and Velthouse, 1990). Therefore, we propose:

P2k: Technologies designed to foster autonomy will positively influence deep structure use.

The role of timely feedback can also foster deep structure use. Frequently, when a user uses a technology to accomplish a task, there is little or no feedback about alternative ways to accomplish the task. If a system were to be designed not only to provide task-related feedback (e.g., performance metrics), but also to provide rich feedback that can consider collections of keystrokes by users to infer the task that the user is performing and the features put to use by the user, the technology may be able to provide greater guidance on alternative ways (i.e., features available) to accomplish the task. The user can then assess the options available and identify the best way to accomplish the task. Prior research has indicated the role of feedback in providing employees with useful work-related information to help them improve decision-making (Kluger and DeNisi, 1996; Rosen et al., 2006). Therefore, we propose:

P2l: Technologies designed to foster feedback will positively influence deep structure use.

3.3 Relating System Design Principles to Individual Benefits

We now discuss how Zhang's (2008) work related to HCDP will have a direct effect on individual benefits in the workplace. As discussed in the previous section, such design principles create positive motivational mechanisms that result in rich use of technology. We extend our argument to examine the impact of some HCDP on certain individual benefits in the workplace. Specifically, we relate some design principles to job performance and job satisfaction. Before further discussing each proposition, we need to clarify that even though there is a possibility of relating all design principles to job performance and job satisfaction, given that this is not the sole focus of the paper, we present illustrative propositions. In addition, it is possible that some design principles are more likely to affect job performance than they would affect job satisfaction. In the following section, we develop our propositions to make the case that relates HCDP to individual benefits in the workplace.

3.3.1 Support Autonomy and Identity of the Self

As organizations continue to make huge investments to build virtual, information and communication technology (ICT) platforms to facilitate communication among employees (Gartner, 2017), employees have more opportunities and freedom to express their ideas and thoughts in the workplace. For example, online discussion forums provide a platform where employees can share their views on various issues related to work, social lives, etc. Studies indicate that people would feel less influenced by others and develop a higher level of autonomy when interacting with others online, especially when it is anonymous (e.g., McLeod et al., 1997; Tan et al., 1998). Autonomy is one of the five job characteristics in the job characteristics model (Hackman and Oldham, 1980) and prior research has found a positive relationship between autonomy and job satisfaction (e.g., Ilgen and Hollenbeck, 1991; Singh, 1998). In an online discussion forum, employees who actively participate in the exchange of ideas or knowledge with others may increase their visibility and identity in the online community. Such visibility and identity may create favorable perceptions among their supervisors and coworkers, thus satisfying those employees' psychological needs of being acknowledged and recognized. Consequently, such employees are more likely to be satisfied with their jobs. Therefore, we propose:

P3a: Technologies designed to foster autonomy will positively influence employees' job satisfaction.

P3b: Technologies designed to foster an identity of the self will positively influence employees' job satisfaction.

3.3.2 Support Optimal Challenge

As noted earlier, users' psychological needs of fulfillment and competence would increase when there is an optimal level of challenge perceived by the users (e.g., Malone, 1981). If using the system is too easy, users are less likely to have a sense of achievement of using the system and/or develop greater confidence in using the system for more difficult tasks in the future. There would be certain level of challenge associated with using the system if users try to achieve high levels of job performance (e.g., Venkatesh, 1999; Yerkes and Dodson, 1908). The sense of achievement or competence would increase as users overcome bigger challenges to achieve higher levels of job performance. However, if the level of challenge is too high, users may be demotivated in doing their work (e.g., Malone, 1981; Yerkes and Dodson, 1908). When using the system results in a sense of fulfillment and competence at work, users are likely to feel satisfied with their job. Prior research has related motivational mechanisms driven by psychological needs of fulfillment and competence to affective outcomes, such as job satisfaction (e.g., Vallerand, 1997). Therefore, we propose:

P3c: Technologies designed to foster optimal challenge will positively influence job performance.

P3d: Technologies designed to foster optimal challenge will positively influence job satisfaction.

3.3.3 Support Positive Feedback

Prior research has examined the role of feedback in performance improvement in the workplace (London, 2003) as well as discussed the mechanisms through which feedback influences performance (Kluger and DeNisi, 1996; Rosen et al., 2006). Systems can be designed to provide performance feedback, such as task performance, to employees and such feedback is likely to be more detailed and objective after the system systematically analyzes various aspects of employees' performance data. Using such feedback, employees are likely to find out what they have done well and what needs to be improved. Such information would not only motivate them to keep up with their good work, but also contain suggestions for improvement that employees can follow to achieve better job performance. Moreover, providing employees with feedback is likely to make employees believe that the organization cares about them and makes an effort to help them improve their work through the use of performance feedback, thus creating positive reactions among employees. Under these circumstances, employees are likely to feel more content with their job and associated environment, resulting in higher job satisfaction. Therefore, we propose:

P3e: Technologies designed to foster feedback will positively influence job performance.

P3f: Technologies designed to foster feedback will positively influence job satisfaction.

3.3.4 Support Human-human Interaction and Social Bonds

As discussed earlier, technology can be designed to facilitate human-human interaction. Interpersonal interactions are critical for information exchange in the workplace, such as task-related advice or knowledge (e.g., Zhang and Venkatesh, 2013, 2017). Communication technologies can be designed to foster human-human interaction to facilitate effective information exchange in resolving task-related problems. Consequently, technology that fosters human-human interaction can positively affect job performance. For example, media synchronicity theory (Dennis et al., 2008) has noted that the use of asynchronous communication media (e.g., email) can sometimes enhance communication effectiveness and subsequent task performance due to their support of message rehearsability and reprocessibility. In addition, use of synchronous communication technologies may strengthen people’s social bonds due to their support of enhanced social richness or telepresence (Venkatesh and Johnson, 2002). In the workplace, social bonds provide the basis for the development of virtual relationships and the formation of online communication networks (Boase et al., 2006; Koh et al., 2007; Wellman and

Hampton, 1999). Having a large number of contacts in the workplace network (e.g., communication network, advice network) makes it easier to access important resources, such as knowledge or social support, resulting in better job performance (e.g., Ahuja et al., 2003; Sykes 2015; Sykes et al., 2014; Sykes and Venkatesh, 2017; Zhang and Venkatesh, 2013, 2017).

P3g: Technologies designed to foster human-human interaction will positively influence job performance.

P3h: Technologies designed to foster social bonds will positively influence job performance.

3.3.5 Support Influence Others

As discussed earlier, technology can be designed to change the power structure of an organization (Brass, 1984). The more power employees have, the more likely they can exert influence on their supervisors and peers. For example, employees may leverage technology to empower themselves, such as becoming sources of knowledge or where other coworkers may get assistance and creating a positive impression on their supervisors or coworkers, thereby receiving better performance ratings (e.g., Borman et al., 1995; Motowidlo and Van Scotter, 1994; Shore et al., 1992; Sparrowe et al., 2001; Welbourne et al., 1998). Therefore, we propose:

P3i: Technologies that provide employees with opportunities to influence others will positively influence job performance.

3.3.6 Support Emotion and Affect

Prior research has demonstrated that system design characteristics related to manipulating users' emotion and affect would influence system use, such as shifting the focus away from utilitarian outcomes (Stein et al., 2015; Venkatesh and Agarwal, 2006; Zhang, 2013). One such manipulation is to foster a positive mood when using the system by modifying the surface, interaction or training features (Venkatesh and Speier, 1999). Positive mood can affect job satisfaction. The link between affective experience at work, such as positive mood resulting from using a hedonic system, and affective outcomes, such as job satisfaction, has been theorized and examined (e.g., Leftheriotis and Giannakos, 2014). Therefore, we propose:

P3j: Technologies that induce positive emotions via surface features will positively influence job satisfaction.

P3k: Technologies that induce positive emotions via interaction features will positively influence job satisfaction.

4. Discussion

This paper presented an integrative framework tying together research from three major streams of IS research, namely IS success, technology adoption and HCDP. Additionally, task was incorporated to shed light on our understanding of how the fit among system, user, and task affects the success of technology implementations. We leverage the framework to present directions for future empirical work. Specifically, we developed propositions linking key elements of the framework that have been understudied. In developing the propositions, we not only build upon and extend prior thought on the nomological network around technology use, but also challenge some of the traditional thinking related to this topic. Overall, we hope that this paper will spark future research at the nexus of one or more of these three dominant streams of IS research. In the remainder of this section, we identify several broad future research directions.

We have presented an integrative theoretical framework and some illustrative propositions. Future work should build on this framework to develop rich theoretical models, especially related to the impacts of design principles and design characteristics. Researchers should also identify and investigate moderators and mediators, above and beyond what is already known, that will relate system design principles to technology use and performance. For instance, moderating variables could include individual differences, such as personality or dispositional variables related to technology. As Zhang (2008) has noted, translating design principles to design characteristics will be tied to specific types of technologies and thus the generalizability of the models derived from the framework must be examined by studying different technologies. For instance, Dennis et al. (2008) have noted how different communication technologies are different in terms of various attributes and it can be expected that deploying these principles will play out quite differently in terms of design characteristics in the context of each of these technologies. In addition, there has been an emergence of great interest around technology-based services (see Setia et al., 2013; Venkatesh, 2006, 2013). It is quite likely that in the context of different types of services, the principles will translate to very different characteristics.

The models that are developed based on the framework must be tested. In examining the research in the three streams, it is clear that IS success and technology adoption research are dominated, especially more recently, by field studies, whereas HCI research features experiments. Each of these methods has its strengths and only a series of complementary studies using different methodologies, with longitudinal data and even qualitative data (see Venkatesh et al., 2013, 2016) being gathered, can shed light on the core underlying phenomena. Also, relating HCDP to individual consequences directly and indirectly via technology use helps develop a better understanding of the mediational role of technology use. This can have significant practical implications for system design. Given that we develop a better understanding of what features are likely to have a direct impact on individual consequences and what features are likely to have an indirect impact, we can better leverage those features.

Like Zhang (2008), we emphasize the need to understand different types of technologies. We further suggest that it is important to examine important system contexts in order to add not only to the body of knowledge related to these streams, but also to the literature related to the particular type of system. For instance, a vast body of research exists related to knowledge management systems (e.g., Zhang, 2017; Zhang and Venkatesh, 2017); likewise, there is enormous prior research on collaboration systems (e.g., Brown et al., 2010). By richly relating system design principles to performance outcomes in these unique contexts, these research areas will also benefit. Such work will also give a central role to the technology context in general and the IT artifact in particular (Hong et al., 2014).

Although each of these three streams has received a good bit of research attention, they have mostly been piece-meal efforts. In order for a rich and complete picture to emerge, one way would be for a holistic test of the nomological network that has been proposed in this paper. As noted earlier, perhaps such a holistic test can only occur through a careful multimethod approach that also gathers data longitudinally (Venkatesh et al., 2013, 2016). Without adequate consideration to the holistic nomological network, it will be difficult to understand how constructs studied typically in only one or two streams of research fit into the bigger puzzle.

We have integrated three dominant streams of research, each of which has focused significant attention on technology use. In addition, we incorporate task and emphasize its role as an important contextual factor affecting the success of technology implementations. The emphasis on a cumulative tradition suggests that it is necessary to examine and consider other streams of research that could be integrated. It is foreseeable that technology use can influence different other outcomes beyond job performance. For instance, various elements of the proposed framework could influence job characteristics and/or other job-related outcomes, such as job satisfaction and organizational commitment. Yet again, careful theory development will be essential to push the boundaries of our knowledge in this regard.

In discussing the various streams of research and the connections between/among them, there was an implicit assumption that much of the conceptualizations and related operationalizations are based on user perceptions. Although user perceptions have their merits and importance in terms of the nomological network, future work should focus on potential objective assessments of various constructs, such as design quality. In this context, it may be possible to conduct multilevel studies, with individuals' perceptions nested within systems, in order to gain a rich understanding of how technologies (conceptualized objectively) relate to user perceptions and how both of these sets of factors influence various outcomes—ranging from technology use to performance.

Going beyond just design interventions is an important next step for research and practice. Managerial interventions are triggers that are controlled via training and other types of support that are offered. Not only can such interventions complement design principles, but also can help highlight specific efforts that are made in the design process to adhere to principles. By drawing users' attention to specific design principles and/or design characteristics, managerial interventions could have a strengthening effect in terms of the relationship between design principles and various outcomes—ranging from technology use to performance.

5. Conclusions

We reviewed three major streams of research, namely IS success, technology adoption and HCDP. We presented a theoretical framework that integrated these three major streams of IS research. We also incorporated task as an important contextual factor into our framework. With an eye toward future research, we presented several propositions linking various parts of the theoretical framework. In addition to presenting propositions, we identified several directions for future research. Overall, we hope that our paper will serve as a call for more research that cuts across streams and more importantly, will provide guidance to researchers on specific ideas/propositions to test.

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