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From Design Principles to Impacts: A Theoretical Framework and Research Agenda

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From Design Principles to Impacts: A Theoretical Framework and Research Agenda

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Abstract:

In this paper, we integrate 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. We present a theoretical framework that incorporates the core ideas from these three streams of research. We leverage the proposed framework to present propositions that could guide future work. Specifically, the propositions we develop 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.

Keywords: IS Success, Technology Adoption, Human-centered Design.

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1 Introduction

Several related yet distinct streams of research in information systems (IS) have built nomological networks around technology use[1]: IS success (Cecez-Kecmanovic, Kautz, & Abrahall, 2014; Delone & McLean, 1992, 2003; Petter, DeLone, & McLean, 2008), technology adoption (Brown, Venkatesh, & Goyal, 2014; Brown, Venkatesh, & Hoehle, 2015; Thong, Venkatesh, Xu, Hong, & Tam, 2011; Venkatesh & Bala, 2008; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012, 2016; Xu, Venkatesh, Tam, & Hong, 2010), and human-centered design principles (HCDP) (Zhang, 2008, 2013; Zhang, Venkatesh, & Brown, 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 one can employ various design principles and design characteristics[2] to enhance technology use. Although these streams have evolved fairly independently, some work in each of these streams has referenced research in the other streams. With that said, some work has also focused on integrating the streams. For example, Wixom and Todd (2005) integrate design characteristics that the HCDP stream studies with the IS success model and technology acceptance model (TAM) (Davis, Bagozzi, & Warshaw, 1989). Likewise, Hoehle, Zhang, and Venkatesh (2015) study how various design characteristics would influence intentions to use a specific technology in different countries. Despite these isolated efforts, we need work that examines these streams of research with a view toward integrating them into a cohesive framework that can guide future work. In addition, we lack work that theorizes and examines the fit among system, user, and task—an important condition that prior research has noted technology implementations need to succeed (e.g., Burton-Jones & Straub, 2006; Dishaw & Strong, 1999; Fuller & Dennis, 2009; Zhang, 2017). Against this backdrop, in this conceptual paper, we

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 these streams of research have evolved concurrently and cross-referenced each other, prior work has not demonstrated the “big picture” that emerges from the collection of works in these streams. Our framework fills this void. Second, by presenting a set of testable propositions building on the framework, this work provides opportunities for research at the nexus of these three streams and advances knowledge about technology use. Finally, although HCDP-related discussions in IS research have increased in recent years, ties between design principles and technology use remain somewhat limited (see Zhang, 2008, 2013). We need such ties to advance our understanding about technology use and to give the technology artifact a central role in theory development (e.g., Leonardi, 2011; Orlikowski & Iacono, 2001). The testable propositions we develop in this paper provide the impetus for such work.

2 An Integrative Framework

In this section, we first briefly review the three streams of research that we integrate: IS success, technology adoption, and HCDP. Subsequently, we discuss the framework that integrates these major streams of research.

[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 to stay faithful to the original sources.
[2] Zhang (2008a) distinguishes design principles from design guidelines (or characteristics). Design principles, the broad term, refer to ideas to which designers should adhere that do not depend on technology. In implementing design principles, the specific design characteristics used may vary depending on the particular system. For instance, autonomy is a design principle that designers implement in technologies differently depending on the technology’s type.

2.1 IS Success Model

DeLone and McLean (1992) initially presented the IS success model, and, based on about a decade of research on the model, subsequently extended it (Delone & McLean, 2003; see also Seddon, 1997). Figure 1 shows this model. The two papers (i.e., DeLone & McLean, 1992, 2003) are among the most-cited papers in *Information Systems Research* and *Journal of MIS*, respectively. The IS success model relates different concepts of IT quality to technology use and user satisfaction that, in turn, lead to net benefits, which the model breaks down into personal impacts and organizational impacts. Among the major changes they made to the model, DeLone and McLean (2003) added service quality to it. Table 1 shows the major constructs in the IS success model and their definitions. As one 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.

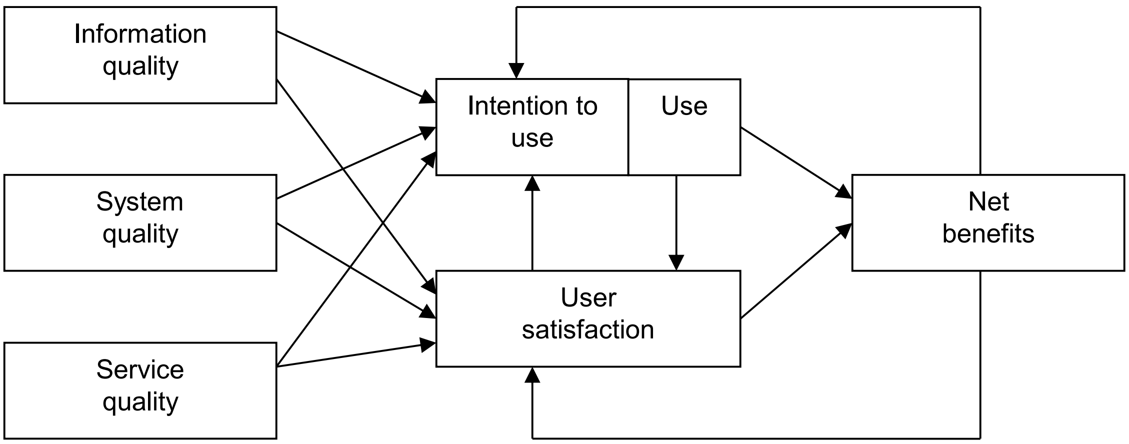

Figure 1. IS Success Model (Delone & McLean, 2003)

Table 1. Constructs and Definitions (Delone & McLean, 1992, 2003)

Construct	Definition
Information quality	The degree of excellence of the information product along the dimensions of accuracy, meaningfulness, timeliness, and so on.
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, and so on.
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

TAM's development (Davis, 1989; Davis et al., 1989) largely sparked the individual-level adoption stream. Venkatesh et al. (2003) synthesized eight competing models of technology adoption into a unified theoretical model, the unified theory of acceptance and use of technology (UTAUT), one of the most widely used models in this domain in particular and most influential IS theories in general (see Venkatesh et al., 2016). Venkatesh et al. (2003) present an overarching framework (see Figure 2) that captures the essence of these different models. The various models suggest that individual reactions to a technology and to using it predict individuals' intentions to use it, which, in turn, predict whether they will actually do so. Table 2 shows UTAUT's major constructs and their definitions (Venkatesh et al., 2003). As one can see, UTAUT uses performance expectancy, effort expectancy, social influence, and facilitating conditions to predict behavioral intention and use. It also incorporates gender, age, experience, and voluntariness of use as moderators (Venkatesh et al., 2003).

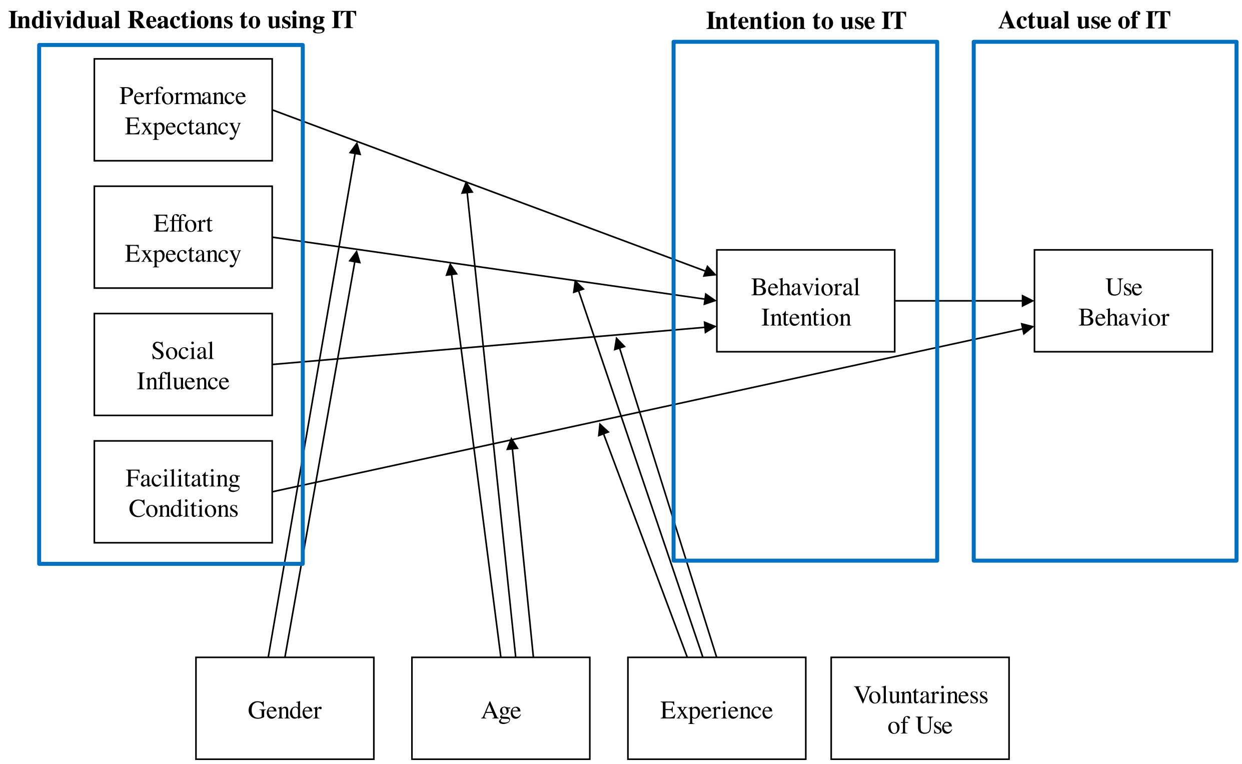

Figure 2. UTAUT: A Synthesis of Technology Adoption Models

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

Construct	Definition
Performance expectancy	The degree to which individuals believe that using the system will help them better attain significant rewards.
Effort expectancy	The degree of ease associated with using the system.
Social influence	The degree to which individuals perceive that important others believe they should use the new system.
Facilitating conditions	The degree to which individuals believe that an organizational and technical infrastructure exists to help them use the system.
Behavioral intention	The degree to which people have formulated conscious plans to perform or not perform some specified future behavior (see Venkatesh et al., 2006; Venkatesh et al., 2008).
Gender, age, experience, voluntariness	Gender and age are demographic variables. Experience: degree of prior use of the target technology. Voluntariness: the degree to which individuals perceive using the technology as voluntary or through their own will.
Technology use	Actually 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 pertain to human interaction with technologies. The important factors that work in the human-computer interaction (HCI) research area has identified provide a broader theoretical foundation for system design. Interest in HCI in IS research has been recently increased due to a stronger push to give the IT artifact a more central role in IS research (e.g., Leonardi, 2011; Orlikoswki & Iacono, 2001) and to design systems that will enhance how effectively users use them For instance, Agarwal and Venkatesh (2002) identified various design guidelines that could enhance website use, 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 summarizes the current work that conceptualizes and defines HCDP related to human motivational needs in IS. This work has conceptualized and defined system design principles based on the psychological, social, cognitive, and emotional sources of human motivation. Technology use refers to the actually using the target technology. However, we still somewhat lack evidence that links such design characteristics and principles to technology use (for examples, see Hoehle et al., 2015; Venkatesh & Agarwal, 2006; Venkatesh & Ramesh, 2006). As such, researchers have continuously called for more research at the nexus of HCI and IS (see Johnson, Zheng, & Padman, 2014; Te'eni, Carey, & Zhang, 2007). Table 3 explains the design principles and design characteristics from Zhang (2008) in more detail.

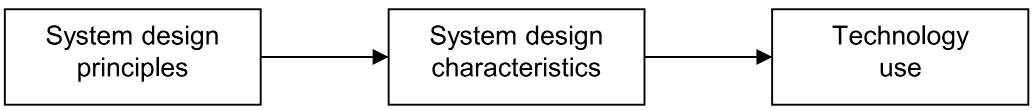

Figure 3. Human-centered Design Principles

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

System design principles	Definitions	System design characteristics
Support autonomy.	An autonomy-supporting style that fulfills the psychological need to experience choice in initiating and regulating behavior.	Allow users to decide how they want to express themselves.
Promote creation and representation of self-identity.	Define and create the self to realize the quality of one's psychological wellbeing.	Allow users to decide how they want to do things in distinctive ways.
Design for optimal challenge.	The need for competency and achievement through attaining goals with different levels of challenges.	Allow users to identify and set different challenge levels.
Provide timely and positive feedback.	Provide informational feedback in a timely manner in a way that does not break the "flow" of cognition and action.	Allow users to know how far they are from achieving goals at an appropriate time.
Facilitate human-human interaction.	The innate desire to belong, a social and psychological need for relatedness.	Let users feel they are related to or connected with each other by showing interaction results.
Represent human social bond.	The innate desire to belong, a social and psychological need for relatedness.	Allow users to feel the social bond (e.g., the extent, the intensity, and the nature of the bond).
Facilitate one's desire to influence others.	The desire to make the physical and social world conform to one's personal image or plan.	Allow users to lead others.
Facilitate one's desire to be influenced by others.	The desire or need to follow.	Allow users to follow others.
Induce intended emotions via initial exposure to ICT.	Affect and emotion regulated by biological system.	Induce intended affect and emotion invoked by initial exposure to the system.

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

Induce intended emotions via intensive interaction with ICT	Affect and emotion regulated by cognitive system.	Induce intended affect and emotion through intensive cognitive activities using the system.

2.4 Fitting the Streams Together

Our discussion above that focuses on the key papers in the three streams suggests 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), and the theories related to HCDP have focused on the system (e.g., system design principles and characteristics). However, some work has cut across these streams of research. It has shown system design characteristics to influence key beliefs, such as performance expectancy and effort expectancy (see Venkatesh & Davis, 1996; Venkatesh et al., 2003). More recently, Brown, Dennis, and Venkatesh (2010) examined the effects of collaboration technology characteristics (i.e., social presence, immediacy, and concurrency) on performance expectancy and effort expectancy. At the core of the IS success model lies people's perceptions of IT's quality, which covers information, system, and service quality (see Table 2). It represents three IT aspects that are critical with regard to upstream implications for system design and downstream impacts on system use and user satisfaction. Although researchers have largely used the IS success model to relate perceptions of quality to technology use and user satisfaction, Wixom and Todd (2005) related the perceptions of quality to intentions to use a technology via individual reactions that research in the technology adoption stream identified (see 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, they demonstrated that various design characteristics influenced quality perceptions. Likewise, Seddon (1997), building on the IS success model, suggested that the various quality constructs in the IS success model potentially influence the construct performance expectancy. Similarly, Hoehle et al. (2015) demonstrated the effects of different mobile phone design characteristics on consumers' continued intention to use mobile phones. Taken together, prior research suggests that system design characteristics affect individual reactions to using technology.

Despite the advances in knowledge from the above studies, none of them incorporate task (an important factor) into the theory development. While some work has found task to affect technology implementations, researchers have largely overlooked it (e.g., Dishaw & Strong, 1999; Serrano & Karahanna, 2016; Strong & 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 one uses technology for tasks that its design supports, it is more likely to have a positive impact on job outcomes (e.g., task performance) (Goodhue, 1998; Goodhue & Thompson, 1995; Zhang, 2017; Zigurs & Buckland, 1998) because users do not need to spend extra time and effort to modify the technology to support the task. Consequently, users can use 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 better explain the nomological network related to technology use by looking beyond the traditional lean conceptualizations of technology use (see Burton-Jones & Straub, 2006). Burton-Jones and Straub (2006) argued that a rich conceptualization of technology use leads to better explanations and predictions of individual performance. They conceptualized rich use 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 individuals achieve with rich use, can help one 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 better and more accurate predictions 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, Burton-Jones and Straub (2006) proposed two new key conceptualizations of technology use: 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 individuals use system features that relate to core aspects of a task 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). Since the concept of rich use is fairly new, only a handful of studies have validated the positive relationship between rich use and use outcomes (e.g., Burton-Jones & Straub, 2006; Robert & Sykes, 2017; Sykes & 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—a broad and an important assessment of employees' effectiveness in organizations.

Taken together, prior research suggests the integrative framework in Figure 4. Our integrated framework and the model that Wixom and Todd (2005) differ mainly in 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. It helps to explain 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 integrated framework extends Wixom and Todd's model by better explaining the relationship between technology use and individual performance. Moreover, by relating design principles to individual consequences directly and indirectly via technology use, our framework better explains the mediational role of technology use. In other words, we obtain a better picture of what design principles influence individual consequences directly and what design principles influence individual consequences via technology use, which an isolated and independent view that focuses only on one stream of research clearly cannot achieve. Moreover, by integrating these three streams of research, we more holistically explain 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 researchers have studied well. 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 non-work-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). These latter propositions do not consider the mediating role of technology use and, thus, illustrate the direct impact of HCDP on individual benefits. We intend all three sets of propositions to illustrate (but not exhaustively) how future empirical work at the nexus of the streams can proceed. For instance, one could 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 one can foster rich use.

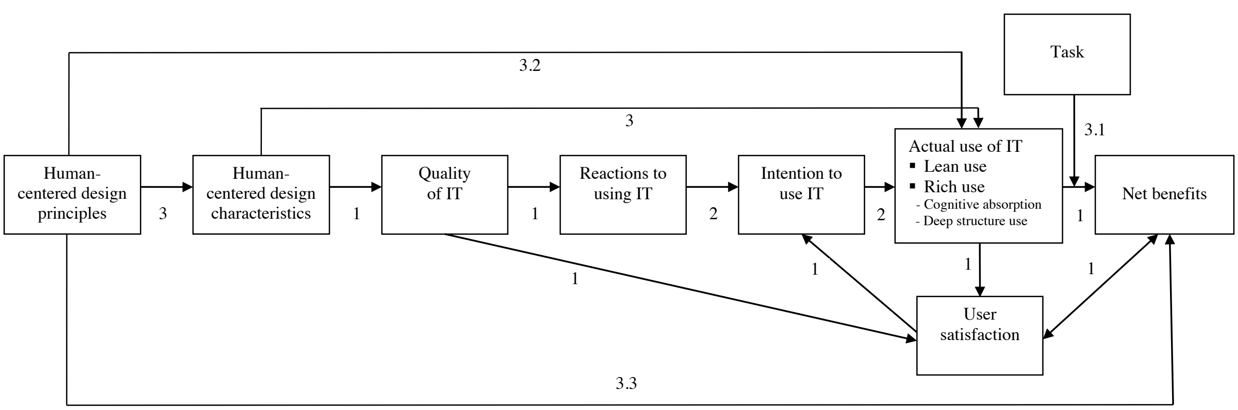

Figure 4. An Integrative Framework

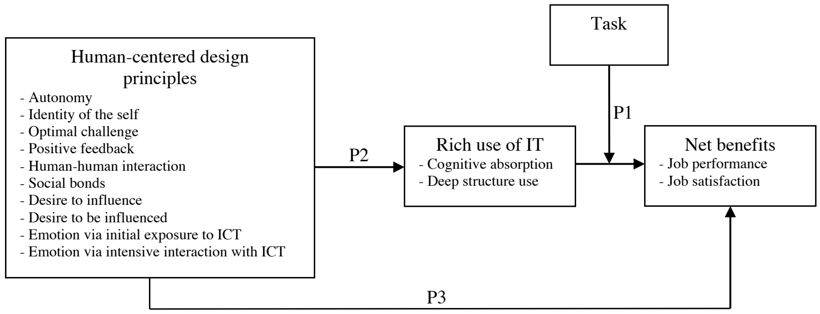

Figure 5. Propositions Matching Key Elements of the Integrated Framework

3.1 Predicting Job Performance

3.1.1 Cognitive Absorption

Cognitive absorption refers to an important type of rich use that describes the interaction between a user and technology (Burton-Jones & 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 & Karahanna, 2000, p. 667). Cognitive absorption has five dimensions: temporal dissociation, focused immersion, heightened enjoyment, control, and curiosity (Agarwal & 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, which results in higher productivity (Zhang, 2017). Prior research has indicated the amount of effort and the degree of persistence that the motivational goal-setting process drives significantly impact performance outcomes (e.g., Locke, 1997). When users occupy themselves totally with a technology, non-work-related problems that might slow down their progress are less likely to distract them. 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, which will result in better job performance. Prior research has indicated the detrimental effects of divided attention at encoding on later memory performance (Naveh-Benjamin, Guez, & Sorek, 2007). Moreover, cognitive absorption is a situational intrinsic motivator (Agarwal & 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 & Speier, 1999; Venkatesh, Speier, & Morris, 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, enhanced productivity, and, thus, better job performance. Empirical evidence, especially from our prior work in this domain, also supports such a relationship in the context of different technologies (Robert & Sykes, 2017; Sykes et al., 2014; Sykes & Venkatesh, 2017; Zhang, 2017; Zhang & Venkatesh, 2017). Therefore, we propose:

P1a: Cognitive absorption positively influences individual job performance.

3.1.2 Deep Structure Use

A technology may have many features to support a task's underlying structure. Deep structure use indicates the extent to which a user actually uses the core features related to a task. If the features users use are relevant to the task, they are more likely to support the task (Goodhue, 1998; Goodhue & Thompson, 1995). Prior studies have found that decision making performance depends on the fit between data presentation format and task (e.g., Benbasat, Dexter, & Todd, 1986; Dickson, DeSanctis, & McBridge, 1986) and that a misfit slows down the decision making processes (e.g., Vessey, 1991; Vessey

& Galletta, 1991). If the features users use are relevant for completing a task, their use will help users effectively do so. Users who exhibit high deep structure use (i.e., they use core features more or use more in-depth such features) are more likely to have positive task performance because they are likely to leverage more useful resources to generate outcomes, which increases the likelihood that they will produce higher-quality output. For example, if a task requires intensive computations, users might combine different features of a technology to optimize their performance. In addition, when users use more features, they can perform tasks more efficiently because different features can facilitate a task's different aspects. 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 analysis and reporting features can facilitate data analysis. Moreover, when users use more of such features, they can more accurately analyze data. While each feature may have its strengths and weaknesses, comparing and integrating the results that different features generate may improve accuracy of the task output.

Similarly, we argue that users who use the core features of a technology will enhance their job performance because such use is more likely to result in better solutions to problems. When users use specific features of a technology in ways that are beyond the common uses of those features, they can strengthen or extend the functionalities associated with those particular features. Such use can involve customization because it can strengthen or extend how users use a technology's specific features. For example, users can customize how a technology displays information such that they can easily organize and process it. 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 a technology's information-processing feature to reduce processing time and improve processing accuracy.

Users who exhibit low deep structure use (i.e., they use few core features or do not adequately explore a specific core feature) may not realize a particular technology's benefits—especially when they need to combine features or use specific ones to a greater extent to complete a task. For example, when using a video conferencing feature to help communicate complicated knowledge (i.e., knowledge consisting of parts intricately combined, difficult to analyze, understand, or explain), a user might need to complement it with a file-sharing feature to exchange important documents to facilitate the conference meeting or a taping feature. Using these features together should improve communication effectiveness and, thus, result in better job performance.

Before closing our arguments related to the relationship between deep structure use and job performance, we clarify the boundary condition related to specific technology-application contexts. For some applications, such as transaction systems that operational staff use, their assigned tasks will likely require them to use certain number of features (no more or no less) that match their tasks. In this case, TTF is high, so using optimized features and at a deep level 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 to which users explore relevant features 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 positively influences individual job performance.

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

3.2 Relating System Design Principles to Rich Use

Zhang's (2008) work on 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, Zhang, & Zhou, 2011), Zhang's work emphasizes how design can create positive motivational mechanisms. As we discuss above, research in the technology adoption stream has related such motivational mechanisms to technology use (e.g., Venkatesh & 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): these principles relate to the psychological motivational needs for autonomy and self-identity and have their roots in self-determination theory (Deci & Ryan, 1985). We expect a technology that allows users to create and maintain an identity and the associated autonomy they gain from doing so to enhance three dimensions of cognitive absorption: 1) heightened enjoyment, 2) control, and 3) curiosity.

Humans need autonomy and to create and preserve a unique identity; thus, supporting these needs has positive benefits in workplace and personal contexts (see Carter & Grover, 2015; Hackman & Oldham, 1980; Hogg & Terry, 2000). A technology can create a direct, positive impact on cognitive absorption by considering these principles. For instance, if an organizational knowledge-management system has a blog wherein users can create and maintain their identities that perhaps differ from their traditional work roles, they may find heightened enjoyment when using the blog due to the variety that the secondary identity introduces. Further, the identity and the freedom in controlling the identity and the activities therein are likely to provide users with a sense of control. Finally, as users engage in a variety of exploratory behaviors when using the blog, they are likely to become more curious and to satisfy that curiosity. Cognitive absorption is a situational intrinsic motivator (Agarwal & Karahanna, 2000), and satisfying both competence and autonomy fosters a high level of intrinsic motivation (Deci & Ryan, 1985; Ryan & Deci, 2000). Thus, autonomy is likely to positively impact cognitive absorption. Therefore, we propose:

> **P2a:** Technologies designed to foster autonomy positively influence cognitive absorption.
>
> **P2b:** Technologies designed to foster an identity of the self positively influence cognitive absorption.

Principles 3 and 4 (support optimal challenge and positive feedback): these principles relate to the cognitive motivational need for competence and achievement and have their roots in flow theory (Csikszentmihalyi, 1975, 1990). We expect a technology that supports optimal challenge to enhance two dimensions of cognitive absorption: 1) temporal dissociation and 2) focused immersion. Likewise, we expect a technology that provides meaningful feedback to enhance at least one dimension of cognitive absorption (i.e., heightened enjoyment).

Interestingly, the challenge idea also relates to ease of use in the technology adoption stream (Venkatesh, 1999, 2000; Venkatesh et al., 2003; Venkatesh & Bala, 2008). The technology adoption literature has posited that one should design for ease of use and, thus, to minimize challenge to allow users to surpass hurdles (e.g., Venkatesh, 1999). However, designing for optimal challenge suggests giving users a sense of accomplishment. Although these arguments may seem to compete with each other, we suggest that one can envision a scenario in which users can easily learn a system's basics (as Venkatesh (1999) suggests) before using it to obtain greater benefits in a way that optimally challenges them (as Zhang (2008) suggests). Indeed, too little or too much challenge can result in users' not fulfilling the competence need (e.g., Malone, 1981; Yerkes & Dodson, 1908). One can see from the Venkatesh (1999) experiments related to telecommuting how one can foster optimal challenge without harming ease of use. By designing a telecommuting system and associated training that allowed telecommuters to quickly learn the system, his experiments demonstrated that one can overcome the hurdle related to ease of use but that the challenge of telecommuting still remained for the telecommuters if they strived for high levels of performance by using the system (for a detailed discussion, see Venkatesh, 1999). Such challenge and the resultant flow state when using a technology will contribute favorably to temporal dissociation and focused immersion because research has shown that individuals in a flow state spend much more time than intended on a task, lose track of time (see Venkatesh, 1999), concentrate on the task more, and/or do not experience as many distractions when working on a task (Agarwal & Karahanna, 2000). Therefore, we propose:

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

As for feedback, a vast literature on the job characteristics model (e.g., Hackman & Oldham, 1989; Morris & Venkatesh, 2010; Venkatesh, Bala, & Sykes, 2010) has associated feedback with positive affective reactions to a job, such as job satisfaction. Likewise, in a technology environment, employees can perhaps more readily and easily receive feedback from technology. Consequently, employees may find heightened enjoyment from using a system. For instance, a system can track users' performance on specific tasks and, over time, provide a comparative analysis of their current performance against their own historical performance. It could also provide comparisons against performance averages of other employees in the same 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 a user has a better or worse performance because the former may give the employee a sense of accomplishment and the latter may spur the employee to perform better. Therefore, we propose:

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

Principles 5 and 6 (support human-human interaction and social bonds): these principles relate to the social, psychological motivational need for relatedness and have their roots in social interaction studies (Baumeister & Leary, 1995). We expect a technology that satisfies the need for psychological relatedness to enhance at least one dimension of cognitive absorption (i.e., heightened enjoyment).

As social animals, human beings have a well-understood need to belong. Even research on computer-mediated communication has found that those who prefer to avoid face-to-face social settings (due to, for example, social anxiety) frequently seek online channels in search of friends or even romantic partners (e.g., Ang et al., 1993). Also, online communication tools can level the playing field by allowing even non-vocal individuals to participate equally in meetings (see, e.g., McLeod, Baron, Marti, & Yoon, 1997). Designing a technology that fosters a social bond and more favorable interactions among people is likely to result from enhanced social richness, telepresence (Venkatesh & Johnson, 2002), and other positive reactions as media synchronicity theory articulates (Dennis, Fuller, & Valacich, 2008). Adherence to these principles will undoubtedly result in heightened enjoyment because it will replace the more impersonal and machine-like interaction typically attributed to technologies and technology-mediated communication with a more warm and personal feel (see Venkatesh & Johnson, 2002). Therefore, we propose:

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

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

Principles 7 and 8 (support desire to influence and desire to be influenced): these principles relate to the social, psychological motivational need for power, leadership and followership and have their roots in affect control theory (Heise, 1985). We expect a technology that satisfies these needs to lead/follow to enhance at least one dimension of cognitive absorption (i.e., heightened enjoyment).

New technologies have the potential to alter the power structure in organizational settings (Brass, 1984) by giving power to some and taking it away from others (e.g., due to who controls information). As a result, newly empowered employees are likely to enjoy new technologies. Designers can design technologies to empower employees with information. For instance, standard reports that make vast amount of information (which would be otherwise difficult to obtain) available in a condensed form can empower employees with information. Also, allowing employees to create custom reports can increase the power and influence of employees who leverage such features. Similarly, as Zhang (2008) has already noted, when technologies such as blogs 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 research has found to be superior to traditional learning (Johnson & 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 positively influence cognitive absorption.

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

Principles 9 and 10 (support emotion and affect): these principles relate to the motivational need for emotion and affect and have their roots in affect and emotion studies (Russell, 2003; Sun & Zhang, 2006). We expect a technology that satisfies the need for emotion and affect through surface or interaction features to enhance various dimensions of cognitive absorption (Zhang, Li, & Sun, 2006). Surface features include those that induce an intended affect and emotion when users initially interact with the system, whereas interaction features include those that induce an intended affect and emotion after users intensively interact with the system (e.g., Venkatesh, 1999; Venkatesh & Speier, 1999).

A significant body of prior research has focused on 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 a technology's technology. Venkatesh and Agarwal (2006) specifically identified four different affective design characteristics related to website usability that influence website use (see also Agarwal & Venkatesh, 2002; Venkatesh & Ramesh, 2006). Although some evidence shows 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 the inherent subjectivity involved in emotion and affect, design that includes intended emotions can also trigger negative emotions or negative side effects. For instance, one user could find a bright flashing red banner (i.e., a surface feature) appealing and, thus, cause that user to have an enjoyable experience, but it could annoy another user. "Clippy" represents a specific example: Microsoft introduced Clippy in Microsoft Office to help users. However, it engendered strong negative reactions among them even though Microsoft intended the idea 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 become greatly immersed in the technology (see Venkatesh, 1999; Venkatesh & Speier, 1999). Likewise, when technologies have features can trigger such positive affective reactions, users' curiosity may grow due to the opportunity to explore the technology. For example, using "live view" in Dreamweaver, one of the most popular software programs for Web development, to preview webpages works nearly twice as fast as previewing them in a browser, which may trigger users' curiosity to want to know more about the technology. Therefore, we propose:

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

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

3.2.2 Deep Structure Use

Although one can influence cognitive absorption 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 & Straub, 2006). Beyond motivational influences that may drive such use, designing technology with certain principles can promote deep structure use. Given that we focus on making 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 (design principle 1) and timely and positive feedback (design principle 4) will positively influence deep structure use. If a technology adopts a design that affords autonomy, users will have greater freedom in selecting the means to accomplish their goals. Such freedom will allow users to compare different approaches to completing a task depending on the situational demands and goals. Further, because deep structure use involves a user's perceptual assessment about whether they use the right features for their tasks, technologies that have greater autonomy will allow users to hear and learn from peers about different features in a technology such that particular users can choose the approach that works best for themselves. Prior research has discussed how autonomy relates to making important decisions in various task contexts (Thomas & Velthouse, 1990). Therefore, we propose:

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

The role of timely and positive feedback can also foster deep structure use. Frequently, when a user uses a technology to accomplish a task, the technology provides little to no feedback about alternative ways to accomplish the task. If one designed a system to provide not only task-related feedback (e.g., performance metrics) but also rich feedback that considered users' keystrokes to infer the tasks they were performing and features they were using, the technology could provide greater guidance on alternative ways (i.e., features available) to accomplish the task. Users could then assess the options available and identify the best way to accomplish their tasks. Prior research has indicated that feedback provides employees with useful work-related information to help them improve their decision making (Kluger & DeNisi, 1996; Rosen, Levy, & Hall, 2006). Therefore, we propose:

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

3.3 Relating System Design Principles to Individual Benefits

In this section, we discuss how, per Zhang's (2008) work, HCDP have a direct effect on individual benefits in the workplace. As we discuss in Section 3.2, design principles create positive motivational mechanisms that result in users' richly using 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 clarify that, even though one could relate all design principles to job performance and job satisfaction, we present only illustrative propositions here since exhaustively relating the principles to job performance and job satisfaction does not constitute the paper's sole focus. In addition, some design principles could affect job performance more than job satisfaction. In Sections 3.3.1 to 3.3.6, 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, 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, their social lives, and so on. Studies indicate that people would feel less influenced by others and develop a higher level of autonomy when interacting with others online, especially when doing so anonymously (e.g., McLeod et al., 1997; Tan, Wei, Watson, Clapper, & McLean, 1998). Autonomy is one of the five job characteristics in the job characteristics model (Hackman & Oldham, 1980), and prior research has found a positive relationship between autonomy and job satisfaction (e.g., Ilgen & Hollenbeck, 1991; Singh, 1998). In an online discussion forum, employees who actively participate in exchanging 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 and, thus, satisfy those employees' psychological need for acknowledgment and recognition. Consequently, such employees are more likely to be satisfied with their jobs. Therefore, we propose:

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

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

3.3.2 Support Optimal Challenge

As we note in Section 3.2.1, users' psychological need for fulfillment and competence would increase when they perceive an optimal level of challenge (e.g., Malone, 1981). If users find a system too easy to use, they are less likely to develop a sense of achievement in using the system and/or develop greater confidence in using the system for more difficult tasks in the future. Users would experience a certain level of challenge in using the system if they tried to achieve high levels of job performance (e.g., Venkatesh, 1999; Yerkes & Dodson, 1908). The sense of achievement or competence would increase as users overcome bigger challenges to achieve higher levels of job performance. However, if users experience overly difficult challenges, they may lose motivation to do their work (e.g., Malone, 1981; Yerkes & Dodson, 1908). When using the system results in a sense of fulfillment and competence at work, users are more likely to feel satisfied with their job. Prior research has related motivational mechanisms that fulfillment and competence drive to affective outcomes, such as job satisfaction (e.g., Vallerand, 1997). Therefore, we propose:

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

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

3.3.3 Support Positive Feedback

Prior research has examined the role of feedback in improving employees' performance in the workplace (London, 2003) and discussed the mechanisms through which feedback influences performance (Kluger & DeNisi, 1996; Rosen et al., 2006). Designers can design systems 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 they need to improve. Such

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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 them believe that the organization cares about them and makes an effort to help them improve their work through performance feedback and, thus, to create positive reactions among employees. Under these circumstances, employees are likely to feel more content with their job and associated environment, which will result in higher job satisfaction. Therefore, we propose:

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

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

3.3.4 Support Human-human Interaction and Social Bonds

As we discuss in Section 2.3, designers can design technology to facilitate human-human interaction. Individuals need to interact with one another for information (e.g., task-related advice or knowledge) exchange to occur in the workplace (e.g., Zhang & Venkatesh, 2013, 2017). Designers can design communication technologies to foster human-human interaction to facilitate employees to exchange information 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) notes that asynchronous communication media (e.g., email) can sometimes enhance communication effectiveness and subsequent task performance because they support message rehearsability and reprocessibility. In addition, synchronous communication technologies may strengthen people's social bonds because they support enhanced social richness or telepresence (Venkatesh & Johnson, 2002). In the workplace, social bonds provide the basis for employees to develop virtual relationships and form online communication networks (Boase, Horrigan, Wellman, & Rainie, 2006; Koh, Kim, Butler, & Bock, 2007; Wellman & 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, which results in better job performance (e.g., Ahuja, Galletta, & Carley, 2003; Sykes et al., 2014; Sykes & Venkatesh, 2017; Zhang & Venkatesh, 2013, 2017). Therefore, we propose:

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

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

3.3.5 Support Influence Others

As we discuss in Section 3.2.1, technology can 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 (e.g., becoming a source of knowledge or someone from whom other coworkers can obtain assistance and creating a positive impression on their supervisors or coworkers) and, thus, receive better performance ratings (e.g., Borman, White, & Dorsey, 1995; Motowidlo & Van Scotter, 1994; Shore, Shore, & Thornton, 1992; Sparrowe, Liden, & Kraimer, 2001; Welbourne, Johnson, & Erez, 1998). Therefore, we propose:

P3i: Technologies that provide employees with opportunities to influence others 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 influences system use, such as shifting the focus away from utilitarian outcomes (Stein, Newell, Wagner, & Galliers, 2015; Venkatesh & Agarwal, 2006; Zhang, 2013). One such manipulation concerns fostering a positive mood when users use a system by modifying its surface, interaction, or training features (Venkatesh & Speier, 1999). Positive mood can affect job satisfaction. Researchers have theorized and examined a link between affective experience at work, such as a positive mood that results from using a hedonic system, and affective outcomes, such as job satisfaction (e.g., Leftheriotis & Giannakos, 2014). Therefore, we propose:

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

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

4 Discussion

In this paper, we present an integrative framework that ties together research from three major streams of IS research: IS success, technology adoption, and HCDP. Additionally, we incorporate task to better explain 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 develop propositions that link key elements of the framework that researchers have insufficiently studied. In developing the propositions, we not only build on 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 this section, we identify several broad future research directions.

We present an integrative theoretical framework and some illustrative propositions. Future work should build on this framework to develop rich theoretical models (especially those related to the impacts of design principles and design characteristics). Researchers should also identify and investigate moderators and mediators, above and beyond what we already know, 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, we need to examine the generalizability of the models derived from the framework by studying different technologies. For instance, Dennis et al. (2008) have noted how different communication technologies differ in terms of various attributes, and we can expect that deploying these principles will play out quite differently in terms of design characteristics in the context of each technology. In addition, great interest around technology-based services has emerged (see Setia, Venkatesh, & Joglekar, 2013; Venkatesh, 2006). It is quite likely that, in the context of different types of services, the principles will translate to very different characteristics.

Researchers need to develop and test models that they develop based on our framework. In examining the research in the three streams, we can clearly see that field studies dominated IS success and technology adoption research dominated (especially recently), whereas experiments dominated HCI research. Each of these methods has its strengths, and only a series of complementary studies that use different methodologies and longitudinal and even qualitative data (see Venkatesh, Brown, & Bala, 2013; Venkatesh, Brown, & Sullivan, 2016) can shed light on the core underlying phenomena. Also, relating HCDP to individual consequences directly and indirectly via technology use helps to better explain the mediational role of technology use, which can have significant practical implications for system design. Given that we contribute to better explaining 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 we need to examine important system contexts in order to add to not only the body of knowledge related to these streams but also the literature related to the particular type of system. For instance, a vast body of research related to knowledge-management systems exists (e.g., Zhang, 2017; Zhang & Venkatesh, 2017); likewise, much prior research on collaboration systems exists (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, Chan, Thong, Chasalow, & Dhillon, 2014).

Although each of these three streams has received a good bit of research attention, it has mostly been piecemeal. One way to ensure that a rich and complete picture emerges would involve holistically testing the nomological network that has we propose in this paper. As we note above, a holistic test might only occur through a careful multi-method approach that also gathers data longitudinally (Venkatesh et al., 2013, 2016). Without adequately considering 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 integrate three dominant streams of research, each of which focuses significantly on technology use. In addition, we incorporate task and emphasize its role as an important contextual factor that affects the success of technology implementations. The emphasis on a cumulative tradition suggests that we need to examine and consider other streams of research as well. It is foreseeable that technology use could 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, we will need careful theory development to push the boundaries of our knowledge in this regard.

In discussing the various streams of research and the connections between/among them, we implicitly assume 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, one could possibly conduct multilevel studies with individuals' perceptions nested in systems in order to better understand how technologies (conceptualized objectively) relate to user perceptions and how both of these sets of factors influence various outcomes (from technology use to performance).

Going beyond just design interventions represents an important next step for research and practice. Managerial interventions are triggers that managers control via training and other types of support. Such interventions can not only complement design principles but also help to highlight specific efforts that designers make 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 (from technology use to performance).

5 Conclusions

In this paper, we summarize three major streams of research: IS success, technology adoption and HCDP. We present a theoretical framework that integrates these three major streams of IS research. We also incorporate task as an important contextual factor into our framework. With an eye toward future research, we present several propositions that link various parts of the theoretical framework. In addition, we identify several directions for future research. Overall, we hope that our paper serves as a call for more research that cuts across streams and, more importantly, provides guidance to researchers on specific ideas/propositions to test.

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