JITTA

JOURNAL OF INFORMATION TECHNOLOGY THEORY AND APPLICATION

ISSN: 1532-3416

Web Science: A Golden Opportunity for Applying Information Systems Theories

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Abstract:

Even though the Web has changed the world to a remarkable extent, researchers have suggested relatively few truly descriptive theories and prescriptive models that treat it as the primary focus of attention thus far. The Web as a scientific discipline is still being shaped. Computing science suggests a basis for shaping it, but we need explanatory theories and a systems approach that combines both how to design desirable Web properties and understand the Web as a phenomenon. The information systems (IS) discipline, with its strong theory-driven approaches, has a special capability to help advance the Web as a sound discipline. IS scholars have a golden opportunity to actively participate in molding Web science through transferring lessons learned in IS into it, introducing theories adopted and developed in IS for it, and integrating the two disciplines. In this paper, I examine how researchers can and should use prominent theories to explain Web properties and phenomena. I differentiate between original IS theories and theories adopted from reference disciplines and propose individual user behaviors, social behaviors, and organizational behaviors as a practical taxonomy for categorizing IS theories.

Keywords: Web Science, Information Systems, Theory Building, Socio-Technical Systems, Systems Approach.

Nancy Russo was the Senior Editor for this paper.

1 Introduction

The World Wide Web has had a huge transformative influence on the academic world, consumers' everyday lives, business and industry, and society as a whole (Oinas-Kukkonen & Oinas-Kukkonen, 2013). However, all too often, the Web is studied as merely the delivery vehicle for either technical or social content (Hendler, Shadbolt, Hall, Berners-Lee, & Weitzner, 2008). For instance, researchers have traditionally regarded the TCP/IP protocol as belonging to the core of computer science and Web as mostly just as an application running on top of the Internet. Researchers have studied general properties of social networks and interconnected systems in conjunction with the Web, but they have often treated the Web only as a specific instantiation of more general principles. Some have suggested that it is due time for computer science to shift to treating the Web as the key focus of attention (cf. Berners-Lee et al., 2006b; Shneiderman, 2007; Hendler et al., 2008).

In this regard, Shneiderman (2007) refers to Web science: he describes it as a new way of thinking about computer science in which computer scientists are encouraged to learn from design, the teaching of innovations, media, and games and to draw inspiration from, for example, medical informatics and information schools. Some Web science advocates have declared that "a systems approach…is needed if we are to be able to understand and engineer the future web" (Hendler et al., 2008, p. 60). Berners-Lee et al. (2006b) describe Web science as the science of decentralized information systems that involves both engineering practices and social interactions. Berners-Lee et al. (2006a, p. 3) describe Web science as a deliberately ambiguous phrase and acknowledge its eclectic nature:

> *At the micro scale, the Web is an infrastructure of artificial languages and protocols; it is a piece of engineering. But the linking philosophy that governs the Web, and its use in communication, result in emergent properties at the macro scale (some of which are desirable, and therefore to be engineered in, others undesirable, and if possible to be engineered out). And of course the Web's use in communication is part of a wider system of human interaction governed by conventions and laws. The various levels at which Web technology interacts with human society mean that interdisciplinarity is a firm requirement of Web Science.*

One of the greatest challenges in Web science stems from the fact that the Web needs to be both studied and engineered.

However, the Web is much more than merely access to decentralized information via software systems; it has the capability to empower individuals, improve their collaboration, and foster innovation (Oinas-Kukkonen & Oinas-Kukkonen, 2013). Web science is also more than simply modeling the current Web: it is about how society uses the Web and how individuals can create new beneficial systems; it tackles both micro-level Web properties and macro-level Web phenomena and the relationships between them. According to Shneiderman's (2007) manifesto, we need to move away from studying information technology (IT) to studying what users can do with IT and the Web. This means, for instance, addressing user needs via better using requirements engineering techniques, and customer relationship management systems (Chesbrough & Spohrer, 2006), via less technology-focused ideas such as social networks and social network analysis (see, e.g., Agarwal, Gupta, & Kraut, 2008; Ferneley & Helms, 2010; Oinas-Kukkonen, Lyytinen, & Yoo, 2010).

But much of this will undoubtedly sound familiar to IS scholars. After all, this is, to a great extent what Web IS research and much off-the-Web IS research has been doing for a long time now. Even if the Web as a science stems from computer science, it is intertwined with psychology, sociology, and business and management (among others) to such an extent that Web science (WS), by definition, is necessarily interdisciplinary (cf. Berners-Lee et al., 2006b). It is not merely a subdivision of computer science.

Contribution:

With this paper, I address information systems (IS) scholars at large. I illustrate an emerging discipline of research called "Web science". Regardless of whether one should call this a "science" of its own or not (which is not at the core of the paper), I focus on the link between Web science (WS) and IS to raise a debate and awareness among IS scholars about the opportunity that lies ahead. I claim that one could easily apply IS theories to reach a much wider audience than that of IS alone. I suggest easy entry points for IS scholars to start contributing to WS. Indeed, with this paper, I call for contributions from IS scholars. Overall, I hope to raise a (perhaps even heated) debate among IS scholars regarding the nature of Web science and its relationship to and overlap with the IS discipline.

However, again, Web science resembles IS's interdisciplinary nature as a science and its strong emphasis on using reference disciplines to support it. Another striking similarity between WS and IS is that other scientific disciplines and operational businesses use the Web to support their own processes and purposes as they use many different types of information systems. Moreover, in a manner similar to how many currently think of WS, IS was years ago considered only a bridge between the business world and computer science.

Researchers have debated the identity crisis of the forty-something-year-old IS school of thought (see, e.g., Benbasat & Zmud, 2003; Galliers, 2003; Klein, 2003; Robey, 2003; Lyytinen & King, 2004; Agarwal & Lucas, 2005; King & Lyytinen, 2006; Gill & Bhattacherjee, 2009; Taylor, Dillon, & van Wingen, 2010; Lee, 2010; Sawyer & Winter, 2011). Now, when IS, at least to some extent, is shaping its identity and searching for a new direction, the new emerging Web science provides a golden opportunity for IS scholars to reach a wider audience. The focus on traditional management and organizational issues seems to be lessening (but not going away), whereas the individual end user and consumer issues are still growing in importance. At the same time, consumer-related information technologies, particularly around the Web, have gained growing interest among IS scholars, who used to be organizationally focused (Tuunanen, Myers, & Cassab, 2010).

In this paper, I argue why IS scholars should actively participate in the molding of Web science to strengthen its theoretical basis. In Section 2, I argue for the need for explanatory theories in WS and why the IS discipline is so promising for it. In Section 3, I overview prominent theories in IS that the discipline can use to fill the void for advancing WS. Finally, the lessons learned will be discussed, and conclusions and suggestions will be presented.

2 Bringing Together Web Science and Information Systems

2.1 The Need for Explanatory Theories in Web Science

Thus far, Web science research has focused on the mathematical–theoretical computer science view and technological advancements[1]. It has strongly focused on the semantic Web and its applications (e.g., mash-ups, metadata, searching, and ontologies) with a twist of societal issues (e.g., government, citizens, and law). In the beginning, as a research community, Web science research paid limited attention to user processes (e.g., life online and trust), but, later, the interest, particularly concerning the social Web (e.g., user communities, friendships, competition, crowdsourcing, and social network analysis), gained increasing attention. A relatively commonly shared interest in the research community has been developing a Web science curriculum. However, the WS discipline is still only taking shape, and the role of Web scientists is being molded. For this reason, clear-cut answers are not available for such questions as "what do Web scientists and what do they not do?" or "what do Web scientists see as the most pressing research questions and what is excluded from Web science?". Because such answers aren't available, however, also means that disciplines such as IS can contribute to the future of WS in such a manner that it will become something more than merely a technical science—perhaps, ideally, a holistic science just like IS.

Yet, we can still describe Web science as a relatively loose collection of assumptions, abstractions, and algorithms that have been devised for it. Examples of such abstractions include the Web's hypertextual structure, treating hyperlinks as endorsements, and the graph model of the Web (Hendler et al., 2008). Let us consider some examples. Even if a hyperlink at first sight looks simple, there may be meaningful and often complex semantics in what is inside a link that explain why the pieces of information are connected to each other (Oinas-Kukkonen, 1998). Moreover, hyperlink traversal may involve dozens of requests among several services (cf. Bieber, Vitali, Ashman, Balasubramanian, & Oinas-Kukkonen, 1997). Still, many Web developers consider a hyperlink as merely a jump from one piece of information to another piece. Take another example. Backtracking is (still) one of the most frequently used navigational patterns on the Web (cf. Tauscher & Greenberg, 1997). Even though it was enhanced greatly by the introduction of cookies (i.e., ways of representing a page's previous state), this kind of user-dependent state is not directly accounted for in current Web graph-based approaches (Hendler et al., 2008). Different representations of information may be provided for different requesters, but models for doing this remain

[1] See, for example, the majority of presentations in the annual Web Science conference.

unclear. Indeed, more sophisticated metrics are needed to understand the user experience on the Web (Oinas-Kukkonen, 2000).

Information technologies closely related to the Web's ongoing developments include the semantic Web, mobile technologies, and the concept of the social Web (a.k.a. Web 2.0) (Oinas-Kukkonen & Oinas-Kukkonen, 2013). The semantic Web (Berners-Lee, Hendler, & Lassila, 2001; Berners-Lee, Hall, & Shadbolt, 2004) may ideally refer to real-world objects without much or any concern about the underlying documents in which they are described. In the semantic Web approach, predefined Web ontologies provide the key means to embed meanings into the Web structure[2]. Web usage via user interfaces other than the traditional desktop ones is already an everyday phenomenon today. Mobile applications and devices affect social expectations, and they have the capability to offer life-altering and, in some cases, perhaps even life-saving opportunities (Shneiderman, 2007). The Web 2.0 (Sutter, 2009) movement, so to say, has brought end user-generated content, folksonomies, and viral scaling into both academic and public discourse. For example, tagging is basically annotation functionality with user-defined keywords so that they can later be used for improving browsing and searching. In spite of providing clever new software solutions, contemporary social applications are largely isolated from each other, and, to date, the content of many user-generated websites has not been available for any wider analysis (Hendler et al., 2008), even though the opening up of Facebook for searches provided one of the first examples of a change in this situation. However, these conceptual and technological developments have not been able to do much to advance the Web as a science.

According to Hendler et al. (2008), treating the Web as the primary object of study would involve three aspects: social interactions, application needs, and infrastructure requirements, which ideally should be jointly studied. The strong interplay between these points of view implies micro-scale engineering of software properties and a macro-scale understanding of the interaction between human beings. Naturally, they also have a wider impact on communities, organizations, and society as a whole. Thus, Web applications should be designed as "software systems with an envisioned social construct" (cf. Hendler et al., 2008). However, even if systems are interesting mainly for their macro-scale properties, Web information systems are currently designed and built at the micro-scale level; designers usually only "hope for the best" at the macro-scale level (Hendler et al., 2008)[3]. As such, even if new generations of systems often lead to technological improvements, new ways of understanding systems design must still be learned, and the IS at the organizational level needs to be analyzed differently from its technological features. Many large-scale system properties are not even predictable by analyzing the systems at the lower abstraction levels; moreover, the success or failure of Web information systems seems to rely mostly on social features (Hendler et al., 2008). We need a better understanding of the features and functionalities of Web information systems' social aspects and how they influence people. More generally, Web science needs explanatory theories.

Thus, in spite of the Web's transformative power and huge use for so many different kinds of tasks and activities, there is surprisingly little theoretical work regarding the Web *per se*. One of the key reasons that the Web itself has been an understudied research area is the dominance of hardcore computer science and electrical engineering in both the IT industry and academic education in recent years. To alleviate this issue, Shneiderman (2007) both describes and prescribes the current era as a transition in the emphasis of research and education by stating that "the shift is from chips to clicks". We need descriptive theories to explain why some Web-based services succeed and others do not and prescriptive models to guide implementers (Shneiderman, 2007). I suggest that actively drawing lessons learned from related disciplines such as computing, particularly the information systems discipline, helps to better address these questions.

[2] An opposite approach to predefined Web ontologies is latent semantic analysis, which one may use to understand topics of conversation on the Web via natural-language processing through recalculating the intended meanings used in human communication (Berners-Lee et al., 2006b).

[3] Even if Web engineering (Murugesan, Deshpande, Hansen, & Ginige, 2001, Ginige & Murugesan, 2001; Deshpande & Hansen, 2001; Kappel, Pröll, Reich, & Retschitzegger, 2006; Rossi, Pastor, Schwabe, & Olsina, 2007) applies the software engineering principles for systematically analyzing, designing, and constructing Web applications, services, systems, and even platforms, most of the Web has not been built using software engineering best practices.

2.2 Information Systems as a Prominent Sub-discipline of Computing to Advance the Web as a Science

The Association for Computing Machinery's definition of computing (see Figure 1) comprises five sub-disciplines: computer science, computer engineering, information systems, information technology, and software engineering (The Association for Computing Machinery, 2005). An information system is not only the technology an organization uses but also how the organization interacts with the technology and how the technology works with the organization's processes. It is the IS discipline that—much more clearly than the other sub-disciplines of computing—has the capability to help Web science to advance as a discipline because the suggested systems approach (cf. Hendler et al., 2008) is at the core of information systems. However, the linkage of the IS discipline and Web science goes much deeper than merely a pairing of keywords.

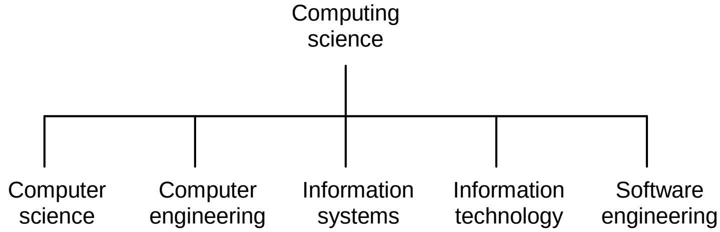

Figure 1. Sub-disciplines in Computing Science (ACM Computing Curricula, 2005)

Web science seeks more systematic and holistic thinking (Hendler et al., 2008), and IS can respond to this request. In a nutshell, the IS discipline provides approaches, methodologies, and tools for studying organizational, social, and end user issues in IT; particularly important is the emphasis on systems analysis and design and the use of IT in organizational and social settings. Topics that have received a great deal of attention include the identification and evaluation of software requirements, IT solutions and their alternatives, the improvement of organizational processes and enterprise architectures, business opportunities created by technological innovations, data security, the management and control of IT-related risks, and systems integration, among many others. There is also a wide variety of application and problem domains in which IS scholars operate, such as organizational knowledge and its management, electronic commerce, and personal health interventions. Most of the research topics in these domains are also central issues for WS. Even though IS as a discipline is not only about the Web, in practice, a multitude of information systems have been "webized", and the Web has become the de facto central vehicle for implementing information systems. In addition, topics important for WS such as human-computer interaction, usability, and participatory design were long studied in the IS discipline before they became mainstream research in the larger computing discipline.

Furthermore, in a manner similar to how many currently think of WS, IS was years ago considered only a transdisciplinary bridge between two worlds: the business world and computer science (see, e.g., Galliers, 2003). However, one can claim that, over the years, it has evolved into a well-defined discipline (Benbasat & Zmud, 2003). IS also resembles WS in its multidisciplinary origin and strong use of reference disciplines. Theories have been adopted from those reference disciplines, and many lessons have been learned from this kind of companionship. Thus, on the one hand, Web scientists should pay close attention to the lessons learned from IS and adopt methodologies and approaches from it, and, on the other hand, IS scholars should actively participate in molding this new science known as Web science.

3 Prominent Theories from IS Explaining Web Properties and Phenomena

In looking at the publications in the first five Web Science conferences from 2009-2013 and a major journal, *Foundations and Trends in Web Science*, it is evident that Web scientists do not much use IS theories[4] even though many of the research questions they raise have long been studied and debated in

[4] An annual conference dedicated to Web science (with a very low acceptance rate) and a scientific journal, known as *Foundations and Trends in Web Science*, have been launched recently. The Web Science Science Trust drives this development of the Web as a science. See http://webscience.org/trust.html.

IS. Rather than simply thinking that WS is still too young a discipline, a major explanation is that IS scholars have not been very successful in introducing the produced research results outside of their own discipline. However, much of the previous and ongoing IS research has the potential to reach a much larger audience through WS than simply staying in the IS discipline.

IS as a discipline involves much more than designing and implementing a single IT system. A wide variety of theories in IS adopt socio-technical or organizational viewpoints. Some of these theories have been adopted from reference disciplines, while some are original IS theories[5]. I categorize the IS theories here for our purposes into:

- Theories explaining *individual user behaviors*, such as the unified theory of acceptance and use of technology, computer self-efficacy theory, and the theory of planned behavior.
- Theories explaining *social behaviors* (of both individual users and groups/networks of users), such as the DeLone and McLean IS success model, the adaptive structuration theory, and the social cognitive theory.
- Theories explaining *organizational behaviors*, such as the soft systems methodology, the work systems method, and the diffusion of innovation theory.

Based on reviewing theoretical IS frameworks, I next list and briefly describe IS theories that are of greatest immediate relevance for WS. I provide references for those who seek to find example applications of these theories, and I highlight potential contributions and publishing opportunities in the IS discipline on WS. In doing so, I hope that IS scholars will see opportunities to frame their efforts and research findings so that Web scientists can adopt them. However, rather than providing an exclusive view of all IS-related theories that may be applied in Web science, I overview the *types* of theories that can be applied for advancing Web science immediately. Tables 1 and 2 summarize the reviewed models and theories.

Table 1. Examples of IS Research Using Theories from Reference Disciplines

Level of analysis	Theory	Value proposition	Example(s) of on- and off-the-Web IS research
Individual	TRA	Individual behavior is determined by behavioral intentions (i.e., an individual's attitude toward the behavior and subjective norms about the behavior) (Fishbein & Ajzen, 1975)	User participation and user involvement influence user behaviors; participation influences user involvement, whereas involvement has little effect on participation (Barki & Hartwick, 1994) TRA and its extension by Barki and Hartwick (1994) explain user participation and involvement in organizational Web information systems well, but it still needs to be modified for specific problem domains such as enterprise resource planning systems (Bagchi, Kanungo, & Dasgupta, 2003)
	TPB	Individuals' perception of the ease with which the behavior can be performed (i.e., behavioral control) influences their behaviors (Ajzen, 1985; Ajzen, 1991)	Perceived trustworthiness toward an e-commerce website and belief in one's own abilities to be able to buy online increase purchasing from the shopping sites (George, 2004) TPB and its extensions can be used to explain the adoption of technology by households (Brown & Venkatesh, 2005; Venkatesh & Brown, 2001) The construct of habits in the Web environment (i.e., subconscious behaviors added to TPB); both conscious and subconscious factors should be taken into account when explaining IS usage behavior (Limayem & Hirt 2003)

[5] For a list of theories used in IS Research, see, for instance, Lim et al. (2013).

Table 1. Examples of IS Research Using Theories from Reference Disciplines

	SET	Individuals who perceive themselves as capable of taking action do take action (Bandura, 1977)	In IT training, self-reported expertise in computer use and performance during the training correlates positively with post-training efficiency; more playful individuals who perform well on hands-on exercises during training assess their post-training efficacy the highest (Potosky, 2002)
	CDT	Individuals seek consistency among their cognitions, such as beliefs and opinions; inconsistency between attitudes or behaviors creates dissonance that needs to be eliminated (Festinger, 1957)	An IS that is intended to persuade a user to adopt a certain attitude or behavior should be built on the view that the user wants one's worldview to be organized and consistent (Oinas-Kukkonen & Harjumaa, 2009)
Social	SCT	Observing others performing a behavior influences the perceptions of individual's own ability to perform the behavior (i.e., self-efficacy) and the perceived expected outcomes (Bandura, 1986)	Observational learning processes explain individual differences in IT training, particularly motivation to learn and self-efficacy (Yi & Davis, 2003) In e-learning applications, instructional strategies need to persuade learners even to follow self-directed and regulated learning strategies; people who are persuaded to follow these strategies achieve better learning outcomes than those who are not (Santhanam, Sasidharan, & Webster, 2008)
	SNA	Systematic means of assessing informal networks by graphically mapping and analyzing relationships among people, teams, departments, organizations, or even geographical regions or markets (e.g., Granovetter, 1973; Granovetter, 1995; Saxenian, 1995)	A group's sustainability is an outcome of interplay between structural and social dynamics over time; few members of an online community will significantly contribute content when measured in message volume; these distributions also change over time (Ridings & Wasko, 2010) The current and ongoing main IS research streams drawing on social networks include: 1) individual and organizational network awareness, 2) use of SNA for better understanding of organizations and IS use, and 3) research into conceptual and technological change in the fast-evolving platforms to manage social networks (Oinas-Kukkonen et al., 2010)
Organizational	OKC	Organizational knowledge is created through a continuous transformation between tacit and explicit forms of knowledge (Nonaka, 1994)	The role of knowing, characterized as an ongoing social accomplishment for getting things done in complex organizational settings (Orlikowski, 2002); description of practices of the knowledge workers (Schultze, 2000); leveraging inter-organizational partnerships into sharing and the creation of new market knowledge (Malhotra, Gosain, & El Sawy, 2005); the assessment of organizational value with regard to knowledge creation investments (Chen & Edgington, 2005)
	DoI	Innovations are communicated through certain channels over a period in a particular social system; individuals have different levels of willingness to adopt innovations (Rogers, 1995)	Eight factors affect the adoption of IT: voluntariness, relative advantage, compatibility, image, ease of use, result demonstrability, visibility, and trialability (Moore & Benbasat, 1991)

Many widely used theories in IS research have been adopted from reference disciplines (see Table 1). Theories explaining *individual user behaviors* include the theory of reasoned action (TRA), the theory of planned behavior (TPB), self-efficacy theory (SET), and cognitive dissonance theory (CDT). TRA (Fishbein & Ajzen, 1975) and TPB (Ajzen, 1985; Ajzen, 1991) originated from social psychology and study how behavioral intentions relate to actual behaviors, particularly attitudes toward behavior and subjective norms. TPB adds individuals' perception of the ease with which the behavior can be performed (i.e., behavioral control). SET originated from cognitive psychology and addresses people's perceptions of their ability to plan and take action to reach a particular goal (Bandura, 1977), whereas CDT studies expectations, disconfirmations, attitudes, and beliefs and posits that individuals tend to seek consistency among their cognitions, such as beliefs and opinions (Festinger, 1957).

Original IS theories explaining individual user behaviors include the technology acceptance model (TAM), the unified theory of acceptance and use of technology (UTAUT), computer self-efficacy (CSE) theory, and the theory of task-technology fit (TTF) (see Table 2). TAM was adapted from the theory of reasoned action for the IS discipline (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). It addresses individuals' behavioral intention to use an IS and actual system usage through the constructs of perceived usefulness and perceived ease of use. UTAUT, similarly to TAM, concerns individuals' behavioral intention to use an IS and actual IS usage behavior (Venkatesh, Morris, Davis, & Davis, 2003). Researchers have simplified TAM by removing the attitude construct. According to UTAUT, performance expectancy, effort expectancy, social influence, and facilitating conditions determine usage intention and usage behavior, whereas gender, age, experience, and voluntariness of use moderate this impact. CSE modifies self-efficacy theory and refers to individuals' judgment of their capabilities to use computers (Compeau & Higgins, 1995b). Beyond outcome expectations, CSE addresses both performance and computer performance. It also discusses anxiety, innovativeness, task characteristics, prior performance, and perceived effort, among other issues. TTF concerns the linkage between IS and individual human performance through the degree to which system characteristics match the user's task(s) (e.g., Goodhue, 1995). The TTF theory states that IT is more likely to be used and to have a positive impact on a user's performance if the system features match the user's tasks.

Table 2. Examples of Research Using Original IS Theories

Level of analysis	Theory	Value proposition	Example(s) of on- and off-the-Web IS research
Individual	TAM	Perceived usefulness and perceived ease of use determine an individual's intention to use a system, which leads to actual system use; perceived ease of use affects perceived usefulness; actors with an intention to act are free to act without limitations; based on TRA (Davis, 1989; Davis et al., 1989)	Demonstration of TAM's feasibility for work-related Web IS; ease of understanding and ease of finding predict ease of use, and information quality predicts usefulness for revisited Web sites (Lederer, Maupin, Sena, & Zhuang, 2000) The combination of trust and TAM in online shopping (Gefen, Karahanna, & Straub, 2003); the integration of TAM with the measuring of user experience through the construct of flow (Oinas-Kukkonen, 2000; Koufaris, 2002); the integration of TAM with user satisfaction (Wixom & Todd, 2005)
	UTAUT	Performance expectancy, effort expectancy, social influence, and facilitating conditions determine usage intention and usage behavior, whereas gender, age, experience, and voluntariness of use moderate this impact; extended from TAM (Venkatesh et al., 2003)	Perceived risk and technology type influence users' acceptance of technology; the role of user experience downplayed (Im, Kim, & Han, 2008) Extension of UTAUT with SNA; social network constructs can significantly enhance organizational understanding of system use; network density and network centrality are key predictors of system use; an individual's co-workers can be important sources of help to overcome knowledge barriers that may constrain the use of complex systems (Sykes, Venkatesh, & Gosain, 2009)

Table 2. Examples of Research Using Original IS Theories

	CSE	One's judgment of their capabilities to use computers for both performance and computer performance; anxiety, innovativeness, task characteristics, prior performance, and perceived effort play a role; modification of SET (Compeau & Higgins, 1995b)	There is a difference between general Internet self-efficacy and Web-specific self-efficacy (Hsu & Chiu, 2004)
	TTF	IT is more likely to be used and to have a positive impact on a user's performance if system features match the user's tasks (Goodhue, 1995; Goodhue & Thompson, 1995; Vessey, 1991; Vessey & Galletta, 1991)	Findings related to user's tasks in group support systems (Zigurs, Nuckland, Connolly, & Wilson, 1999; Dennis, Wixom, & Vandenberg, 2001) and electronic commerce systems (Gebauer & Shaw, 2004) An extension of TTF for the social level (Zigurs & Buckland, 1998)
Social	D&M	IS success results from information, system, and service quality, intention to use, user satisfaction, and net benefits; the quality categories affect intention to use and user satisfaction; the net benefits influence user satisfaction and further information system use (DeLone & McLean, 1992, 2002)	Predicting IS success in quasi-voluntary settings (Rai, Lang, & Welker, 2002) and in mandatory usage settings (Iivari, 2005) An extension of the IS success model for measuring knowledge management success (Kulkarni, Ravindran, & Freeze, 2006-7)
	AST	The perceptions of groups and organizations toward using IT for their work influence the actual use and outcomes of using the IT; adaption of Gidden's (1979, 1984) structuration theory (Poole & DeSanctis, 1990, 1994)	A study of adapting IT in teams experiencing misalignments among the pre-existing organizational environment and group and technology structures (Majchrzak, Rice, Malhotra, King, & Ba, 2000) Analysis of cross-cultural software production (Walsham, 2002)
Organizational	SSM	Context-specific problem solution; well-defined hard problems can be resolved early in systems design; seven-stage process model for resolving extremely challenging soft or "wicked" problems, which involve social elements (Checkland, 1981)	SSM-based software design methodology and illustration of it with examples from the health sector (Atkinson, 2000)
	WSM	Systems to perform work using information, technology, and other resources to produce products and services for customers; IS are instantiations of work systems rather than treated as more specific system types; projects, supply chains, and e-commerce websites are special cases of work systems (Alter, 2002; Alter, 2008)	Multiple examples of using the WSM (Alter, 2006)

Theories explaining *social behaviors*, whether focusing on an individual user or groups/networks of participants, include social cognitive theory (SCT) and social network analysis (SNA). SCT originated from psychology and builds on self-efficacy theory. According to SCT, observing others performing a behavior influences the perceptions of their own ability to perform the behavior (i.e., self-efficacy) and the perceived expected outcomes (Bandura, 1986). SCT helps one to understand and predict both individual and group behavior, and to identify ways of potential behavior change. SNA or, more briefly, network analysis (Granovetter, 1973; Granovetter, 1995; Saxenian, 1995) provides a rich, systematic means of assessing informal networks by graphically mapping and analyzing relationships among people, teams, departments, organizations, or even geographical regions or markets (Cross, Parker, Prusak, & Borgatti, 2001)[6]. It originated from a mix of mathematical sociology and social psychology.

Original IS theories explaining social behaviors include the DeLone-McLean IS success model and adaptive structuration theory (AST). The IS success model comprises interrelated IS success dimensions: information quality, system quality, service quality, intention to use, user satisfaction, and net benefits (DeLone & McLean, 1992, 2002). According to the IS success model, the three categories of quality affect intention to use and user satisfaction. The net benefits influence user satisfaction and further information system use. AST focuses on decision support, particularly decision outcomes, and emerging new social structures (Poole & DeSanctis, 1990; DeSanctis & Poole, 1994). It is based on sociology. The theory adapts the structuration theory (Giddens, 1979; Giddens, 1984) to study the interaction of groups and/or organizations with IT (with an emphasis on social factors). According to AST, the perceptions of groups and organizations toward using IT for their work influence the actual use and outcomes of using the IT.

Theories related to *organizational behaviors* include the theory of organizational knowledge creation (OKC) and the theory of diffusion of innovation (DoI). OKC addresses the dynamics of knowledge creation in organizational settings (Nonaka, 1994). It originated from a variety of disciplines such as organizational theory and cognitive psychology. The theory of diffusion of innovation (DoI) concerns innovations being communicated through certain channels over a period in a particular social system (Rogers, 1983; Rogers, 1995). It originated from a variety of disciplines such as management and sociology. Individuals are treated as having different levels of willingness to adopt innovations, and they are categorized as innovators, early adopters, early majority, late majority, or laggards.

Original IS theories explaining *organizational behaviors* include the soft systems methodology (SSM) and the work systems method (WSM). SSM focuses on solving context-specific problems (Checkland, 1981). According to SSM, problems are either hard or soft problems. Because of the uniqueness of these problem types, they must be resolved using different approaches. Well-defined hard problems can be resolved early in systems design, whereas soft or “wicked” problems involve social elements that, by definition, are extremely challenging. SSM’s strength is that it recognizes situations that have significant social effects but are poorly defined or structured. Checkland (1981) suggests a seven-stage process model for resolving these kinds of problems. The main idea behind the WSM is to analyze how the various elements of a work system make the whole (Alter, 2002; Alter, 2006). The WSM differentiates between a work system and an IS; an IS is an instantiation of a work system. Alter (2008, p. 451) defines an IS in this context as “a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce informational products and/or services for internal or external customers”. Infrastructure, environment, and strategy also play a significant role in taking care of this process. In addition to information systems, the WSM treats projects (“limited time” work systems) and supply chains (inter-organizational work systems) as special cases of work systems. In a similar manner, an e-commerce website is also viewed as a work system between a buyer and a seller through the information exchange and transactions that may take place through the system. One of the major ideas behind this approach is that most information systems can be defined and studied through the concept of a work system instead of thinking of special system types, such as enterprise resource planning systems or customer relationship management systems.

4 A Research Agenda

Thus far, I have argued that the IS body of knowledge is a prime candidate to advance Web science. In my view, the most prominent topics and approaches for contemporary WS research fall into three major categories: Web science applications of IS research, informing Web science from previous IS research, and shaping the emerging discipline by using the fundamentals of IS research.

[6] Although social networking has become a popular term, it has little to do with SNA as such (Steiny & Oinas-Kukkonen, 2007).

4.1 Web Science Applications of IS Research

The *user-centeredness* of IS research has a high value proposition for WS. Human-computer interaction has long been a central area in IS, and it has more recently become a popular research area in practically all subdisciplines of computing. Similarly, there was significant research activity on participatory design in IS well before it became "big" in computer science and software engineering. However, IS has its own flavor in these areas, which has a lot to offer WS (e.g., the Scandinavian tradition of studying user participation, involvement, and communities; see Hirchheim, 1985; Bødker, 1996). IS research has also been able to demonstrate many interesting user-related findings, such as differences between voluntary, quasi-voluntary, and mandatory use settings of IT (Rai et al., 2002; Iivari, 2005) and differences between hedonic, work-related, and other utilitarian uses of the IT (van der Heijden, 2004). In addition, IS research's strong emphasis on micro-level processes such as human behavior, behavior change, and user experience, including matters such as habits, social learning, and persuasive systems design, is noteworthy (see, e.g., Limayem & Hirt, 2003; Santhanam et al., 2008; Oinas-Kukkonen & Harjumaa, 2009). All these topics have a high appeal for contemporary WS research.

Research on *social behaviors* in IT has a very strong tradition in IS (see, e.g., Mumford, 1983)[7]. According to Oinas-Kukkonen et al. (2010), especially prominent areas are individual and organizational network awareness (Steiny & Oinas-Kukkonen, 2007), use of network analysis for better understanding organizations and IS use (Wasko & Faraj, 2005), and research into conceptual and technological change in the fast-evolving platforms to manage social networks (Yoo, 2010). Some of the theoretical frameworks used in IS research on social behaviors can even be used to inform design (cf. Gregor, 2006).

The vast IS research on *organizational behaviors* is only starting to gain momentum in WS, with one exception: electronic commerce systems and applications have been of great interest for several years already. A particular area into which IS can immediately bring its lessons learned is the issue of trust and distrust (Gefen et al., 2003). For other near-future efforts, IS possesses a vast amount of highly relevant expertise on knowledge work, knowledge management, and business intelligence that ranges from new knowledge creation to business models to net benefits (e.g., Kulkarni et al., 2006-7). The by-product of coming up with these results is the establishment of solid research approaches on the joint workings of IT and organizations. There is also a plethora of research into other aspects of business, management, and collaboration, such as enterprise architectures and IT governance and societal issues, such as those related to governmental issues and citizenship, which are of growing interest in WS. In fact, I believe that even many "old" findings from IS research on organizational, inter-organizational, and group decision support systems may gain "new" importance when brought into WS.

4.2 Informing Web Science

Some of the potential approaches that can be used in WS may perhaps be surprising to new IS scholars. The dominant role of the IT artifact in IS research (Benbasat & Zmud, 2003), which has also been criticized by the IS research community itself (e.g., Galliers, 2003; Robey, 2003), is an undeniable strength of the IS discipline and should be brought to the WS discipline's attention. Likewise, the research traditions and approaches in studying IT success and failure (cf. DeLone & McLean, 1992) are highly relevant. This is particularly so with those researchers whose scope is at a finer grain than treating an IS as only a black box. In addition, approaches such as matching system features and a user's tasks (e.g., Gebauer & Shaw, 2004) are yet mostly unknown in WS.

User acceptance and IT adoption have been very widely studied in IS (Venkatesh et al., 2003; van der Heijden, 2003), whereas they have been rather little studied in WS. Thus, studying perceived usefulness, ease of use, and other TAM derivatives, such as perceived trustworthiness, risk, ease of finding, and ease of understanding, as determinants of intention to use and their effect on actual system use are highly valid research constructs for contemporary WS (cf. Davis et al., 1989). Similarly, UTAUT and other TPB-based constructs, such as performance expectancy, effort expectancy, and social influence, as determinants of usage intention and usage behavior are highly relevant (Venkatesh et al., 2003). Despite the criticism they have faced, perceptions and intentions work relatively nicely as proxies for IT use and its outcomes, and,

[7] One noteworthy factor in the IS discipline is the desire to go across multiple abstraction levels (the individual, social, and organizational levels) rather than treating them only as fully exclusive or perhaps even non-related levels of abstraction.

perhaps even more importantly, they have the power to influence actual usage. None of these types of IS studies is well known in WS.

Through the emphasis on systems work the IS discipline has built an immense amount of *problem domain-specific IT expertise* related to people's online and offline lives and work in areas such as management information systems and medical/health informatics, contemporary WS researchers are seeking to operate in these areas. Many lessons have been learned and approaches have been developed, including studying computer/Internet/Web self-efficacy for Web-based health interventions (cf. Compeau & Higgins 1995b), which can be introduced into WS.

4.3 Shaping the Emerging Discipline

The IS as a discipline emphasizes a strong theoretical basis for its research. Theory-based conceptualizations, such as separation between information, system, and service quality (DeLone & McLean, 1992), have proven useful. The original IS theories and elaborations of theories from reference disciplines that have already been applied in IS can be brought into WS in a relatively straightforward manner.

Similarly, IS research has traditionally emphasized rigorous methodological approaches for studying the development and use of IT; in fact, this has been the case to a much larger extent than what is currently typical in WS, which is mostly dominated by proof-of-concept and experimental approaches. Thus, aspects related to increased methodological rigor are something that IS scholars can attempt to introduce into WS.

Finally, the IS discipline has a keen interest in the usefulness and actual benefit of an IT artifact for the good of either an organization or an individual and in conducting studies in real use contexts. Often, to study these requires developing full-strength information systems rather than prototypes or mock-ups. These types of systems, along with a strong research tradition in systems development processes and methodologies, can provide yet another meaningful contribution to WS research.

5 Discussion

Naturally, Web science has not gone totally unnoticed by IS scholars. Research has been directed to a variety of related topics ranging from electronic commerce to social media, Web searching, and crowdsourcing, among others. A more detailed analysis of IS contributions to Web science is beyond the scope of this paper, however. Likewise, the challenge of how to select a suitable theory or a set of theories for a particular research question and approach merits its own discussion. In this paper, I describe a variety of prominent theories from the IS discipline and its reference disciplines that explain individual user, social, and organizational behaviors and that researchers can apply immediately to advance WS. I believe that this analysis will help IS scholars to recognize prominent IS theories and types of lessons learned in IS research, which can be relatively quickly introduced into or further studied in the WS context. Such an analysis will help Web scientists to adopt these and start building on them in their aim to achieve their ambitious goals. Indeed, as Web science is still only taking baby steps, these lessons learned in such a closely related area are useful for formulating strategies to advance it.

Perhaps the IS discipline has now found a new soulmate in WS, which continues to grow and, in fact, even has the potential to overtake computer science. This provides a golden opportunity for IS scholars to keep contributing to this promising new discipline and, in this manner, gain a much wider audience than before. Of course, there is nothing to stop IS scholars from carrying out research with the existing theoretical frames and research methodologies at hand without any reference to Web science. However, as I demonstrate in this paper, Web science, being predominantly thus far based on semantic Web and other computing specificities than IS, is in need of explanatory theories. IS research has been able to produce the kinds of theories that are needed to advance Web as a science, and IS has a chance to become a central player in this emerging new discipline. I believe that it would be much more advisable and beneficial to bring the lessons learned and theories developed in IS to WS rather than to focus on debating whether it is a separate research paradigm or not. IS scholars now have a window of opportunity.

I hope this paper will contribute to the long-standing discourse about the nature of the IS discipline and that it will encourage readers to debate the desirability of establishing yet another "science"; in this case, Web science. Some could argue that the elevation of the Web as a science is part of a recent trend to upscale areas of investigation or perspectives to a “science” status. Consider, for example, services science (cf. Chesbrough & Spohrer, 2006; Williams, Chatterjee, & Rossi, 2008; Alter, 2010) and design science (cf. Hevner, March, Park, & Ram, 2004, Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007; Winter, 2008; Hevner & Chatterjee, 2010). Clearly, neither is on a par with well-established bodies of knowledge such as physics, sociology or even management, but this fact by no means diminishes their scientific value or denies them the title of “science”. Understandably, there are still many open issues regarding the Web as a science. For instance, the epistemological and ontological foundations of Web science need clarification, and researchers need to address even many computer science aspects of the Web, such as software architecture. Approaches for falsifying hypotheses and repeating investigations must be developed (Berners-Lee et al., 2006a). However, even with these limitations, Web science provides a great opportunity to try to shape the future of computing.

Since the goal of any science is, at least to some extent, to change the society around us, the influence of the Web on society is and ought to be high in the research agenda. To do so, Web science should particularly aim at a much deeper understanding of individual user, social, and organizational behaviors on the contemporary and future Web. It should provide methods and tools to design information systems with desired behavioral and/or attitudinal outcomes (Oinas-Kukkonen, 2013). At the same time, something that is not often found in pure computer science publications is studying social responsibility and considering potential side effects. Universal usability is often requested, but, at the same time, end users vary in age, expertise, expertise related to Web use, values, cultural background, education, and so on. There are different kinds of underprivileged users, such as people with disabilities and the elderly. Children may be equipped with the required technical capabilities, but they are not necessarily well equipped to face the challenges of the negative aspects of the Web (e.g., how to judge biased or false information presented on the Web). The digital divide causes additional challenges. All these issues involve ethical considerations. Practitioners are not paying much attention to the unintended outcomes of their designs, and tools and methodologies for helping them to do so are lacking.

Indeed, IS scholars have undeniable strengths that can be used to advance WS. Ways to do so could be to participate in developing the WS curriculum (cf. Topi et al., 2010) or shaping emerging areas such as the prominent emerging health Web science (Luciano, Cumming, Wilkinson, & Kahana, 2013). In any event, the lessons learned in IS should be quickly transferred into WS to help avoid the “re-inventing the wheel” syndrome, to make previous IS research more widely acknowledged, and to seek new avenues for IS research.

This paper has several limitations. First, even if a major claim on which this paper builds is that Web science needs a systems approach, not all Web scientists, naturally, would agree with this claim; in fact, most may tend to think of a system only as a computerized technical artifact. The difficulty of adopting holistic systems thinking could perhaps become a major obstacle in Web scientists turning to IS. Second, the paper builds on the idea that the Web is essentially a large information system; in reality, of course, it is far richer, more complex, and grows without central coordination. Third, similar criticism can be directed toward WS that has been previously directed to IS. Lee (2010, p. 339) criticizes IS researchers for having used the term “system” to refer to just about anything that involves electronic information processing. Similarly, there is the danger of regarding everything the Web touches as “Web science”, which would not be a fruitful definition; we need for greater clarity about basic concepts of Web science.

6 Conclusions

Computing as a science has arrived at a crossroads thanks to the Web’s rapid development in practice. Computing science may choose to continue with technology as its spearhead, but it may also take a leap toward better addressing the organizational, social, and individual user needs and opportunities on par with technological issues. The information systems discipline may play a key role in this regard. In this endeavor, I hope that IS researchers will participate in molding the new discipline known as Web science. Web science may indeed learn substantially from IS methods and approaches because information systems is a computing discipline that is perfectly fitted to advance Web science. The IS discipline has also developed from a multidisciplinary bridge between computer science and the business world into a real discipline with its own identity, which provides a model that could also apply to developing Web science from a multidisciplinary discipline as it is now into a unique discipline of its own. The synergy between IS and Web science can also help researchers discuss and understand the IS discipline’s fundamentals.

In this paper, I claim that the more mature IS discipline can provide the emerging Web science discipline with potentially relevant and useful theories. Ideally, I suggest that, rather than having two disciplines, integrating them somehow would be mutually beneficial. Indeed, Web science forms a natural strategic alliance for of the IS discipline.

Acknowledgements

This research is part of OASIS research group of Martti Ahtisaari Institute, University of Oulu. I thank the anonymous reviewers and the senior editor for their constructive and insightful comments, which helped me to improve the manuscript.

References

The Association for Computing Machinery. (2005). Computing currricula 2005: The overview report. Retrieved from http://www.acm.org/education/curric_vols/CC2005-March06Final.pdf

Agarwal, R., & Lucas, H. (2005). The information systems identity crisis: Focusing on high-visibility and high-impact research. *MIS Quarterly*, 29(3), 381-398.

Agarwal, R., Gupta, A. K., & Kraut, R. (2008). Editorial overview—the interplay between digital and social networks. *Information Systems Research*, *19*(3), 243-252.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action control* (pp. 11-39). Berlin: Springer.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211.

Alter, S. (2002). The work system method for understanding information systems and information systems research. *Communications of the Association for Information Systems*, *9*, 90-104.

Alter, S. (2006) *The work system method: Connecting people, processes, and IT for business results*. Larkspur, CA: Work System Press.

Alter, S. (2008). Defining information systems as work systems: Implications for the IS field. *European Journal of Information Systems*, *17*(5), 448-469.

Alter, S. (2010). Viewing systems as services: A fresh approach in the IS field. *Communications of the Association for Information Systems*, *26*, 195-224.

Atkinson, C. J. (2000). The soft information systems and technologies methodology (SISTeM): An actor network contingency approach to integrated development. *European Journal of Information Systems*, *9*(2), 104-123.

Bagchi, S., Kanungo, S., & Dasgupta, S. (2003). Modeling use of enterprise resource planning systems: A path analytic study. *European Journal of Information Systems*, *12*(2), 42-158.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychology Review*, *84*(2), 191-215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Barki, H., & Hartwick, J. (1994). Measuring user participation, user involvement, and user attitude. *MIS Quarterly*, *18*(1), 59-82.

Benbasat, I., & Zmud, R. W. (2003). The identity crisis within the IS discipline: Defining and communicating the discipline's core properties. *MIS Quarterly*, *27*(2), 183-194.

Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The semantic web. *Scientific American*, *284*(59), 34-43.

Berners-Lee, T., Hall, W., & Shadbolt, N. (2004). The semantic web revisited. *IEEE Intelligent Systems*, *21*(3), 96-101.

Berners-Lee, T., Hall, W., Hendler, J., O'Hara, K., Shadbolt N., & Weitzner, D. J. (2006a). A framework for web science. *Foundations and Trends in Web Science*, 1(1), 1-130.

Berners-Lee, T., Hall, W., Hendler, J., O'Hara, K., Shadbolt N., & Weitzner, D. J. (2006b). Creating a science of the web. *Science*, *313*(11), 769-771.

Bieber, M., Vitali F., Ashman, H., Balasubramanian, V., & Oinas-Kukkonen, H. (1997). Fourth generation hypermedia: Some missing links for the World Wide Web. *International Journal of Human Computer Studies*, *47*(1), 31-65.

Bødker, S. (1996). Creating conditions for participation: Conflicts and resources in systems design. *Human Computer Interaction*, *11*(3), 215–236.

Brown, S. A., & Venkatesh, V. (2005). Model of adoption of technology in households: A baseline model test and extension incorporating household life cycle. *MIS Quarterly*, *29*(3), 399-426.

Checkland, P. (1981). *Systems thinking, systems practice*. London: John Wiley & Sons.

Chen, A. N. K., & Edgington, T. M. (2005). Assessing value in organizational knowledge creation: Considerations for knowledge workers. *MIS Quarterly*, *29*(2), 279-309.

Chesbrough, H., & Spohrer, J. (2006). A research manifesto for services science. *Communications of the ACM*, *49*(7), 35-43.

Compeau, D. R., & Higgins, C. A. (1995b). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, *19*(2), 189-211.

Cross, R., Parker, A., Prusak, L., & Borgatti, S. P. (2001). Knowing what we know: Supporting knowledge creation and sharing in social networks. *Organizational Dynamics*, *30*(2), 100-120.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-339.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, *35*(8), 982-1003.

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research*, *3*(1), 60-95.

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, *19*(4), 9-30.

Dennis, A., Wixom, B., & Vandenberg, R. (2001). Understanding fit and appropriation effects in group support systems via meta-analysis. *MIS Quarterly*, *25*(2), 167-193.

DeSanctis, G., & Poole, M. S. (1994). Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organization Science*, *5*(2), 121-147.

Deshpande, Y., & Hansen, S. (2001). Web engineering: Creating discipline among disciplines. *IEEE Multimedia*, *8*(1), 81-86.

Ferneley, E., & Helms, R. (2010). Editorial. *Journal of Information Technolology*, *25*, 107-108.

Festinger, L. A. (1957). *Theory of cognitive dissonance.* Stanford, CA: Stanford University Press.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention, and behavior: An introduction to theory and research. Reading, MA: Addison-Wesley.

Galliers, R. D. (2003). Change as crisis or growth? Toward a trans-disciplinary view of information systems as a field of study: A Response to Benbasat and Zmud's call for returning to the IT artifact. *Journal of the Association for Information Systems*, *4*(6), 337-351.

Gebauer, J., & Shaw, M. (2004). Success factors and impacts of mobile business applications: Results from a mobile e-procurement study. *International Journal of Electronic Commerce*, *8*(3), 19-41.

Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in online shopping: An integrated model. *MIS Quarterly*, *27*(1), 51-90.

George, J. F. (2004). The theory of planned behavior and Internet purchasing. *Internet Research*, *14*(3), 198-212.

Giddens, A. (1979). *Central problems in social theory*. Berkeley, CA: University of California Press.

Giddens, A. (1984) *The constitution of society: Outline of the theory of structuration*. Berkeley, CA: University of California Press.

Gill, G., & Bhattacherjee, A. (2009). Fashion was versus informing: Response to Baskerville and Myers. *MIS Quarterly*, *33*(4), 667-671.

Ginige, A., & Murugesan, S. (2001). Web engineering: An introduction. *IEEE Multimedia*, *8*(1), 4-18.

Goodhue, D. (1995). Understanding user evaluations of information systems. *Management Science*, *41*(12), 1827-1844.

Goodhue, D., & Thompson, R. (1995). Task-technology fit and individual performance. *MIS Quarterly*, *19*(2), 213-236.

Granovetter, M. S. (1973). The strength of weak ties. *The American Journal of Sociology*, *78*(6), 1360-1380.

Granovetter, M. S. (1995). *Getting a job*. Chicago, IL: University of Chicago Press.

Gregor, S. (2006). The nature of theory in information systems. *MIS Quarterly*, *30*(3), 611-642.

van der Heijden, H. (2004). User acceptance of hedonic information systems. *MIS Quarterly*, *28*(4), 695-704.

Hendler, J., Shadbolt, N., Hall, W., Berners-Lee, T., & Weitzner, D. (2008). Web science: An interdisciplinary approach to understanding the web. *Communications of the ACM*, *51*(7), 60-69.

Hevner, A. R., March, S. T., Park, J., & Ram S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(14), 75-105.

Hevner, A. R., & Chatterjee, S. (Eds.) (2010). *Design research in information systems*. New York, NY: Springer.

Hirschheim, R. A. (1985). User experience with and assessment of participative systems design. *MIS Quarterly*, *9*(4), 295-304.

Hsu, M.-H., & Chiu, C.-M. (2004). Internet self-efficacy and electronic service acceptance. *Decision Support Systems*, *38*(3), 369-381.

Iivari, J. (2005). An empirical test of the DeLone-McLean model of information system success. *The DATA BASE for Advances in Information Systems*, *26*(2), 8-27.

Im, I., Kim, Y., & Han, H.-J. (2008). The effects of perceived risk and technology type on users' acceptance of technologies. *Information and Management*, *45*(1), 1-9.

Kappel, G., Pröll, B., Reich, S., & Retschitzegger, W. (Eds.) (2006). *Web engineering—the discipline of systematic development of web applications*. Hoboken, NJ: John Wiley & Sons.

King, J. L., & Lyytinen, K. (Eds.) (2006). *Information systems, the state of the field.* Hoboken, NJ: John Wiley & Sons.

Klein, H. K. (2003). Crisis in the IS field? A critical reflection on the state of the discipline. *Journal of the Association for Information Systems*, *4*(5), 237-293.

Koufaris, M. (2002). Applying the technology acceptance model and flow theory to online consumer behavior. *Information Systems Research*, *13*(2), 205-223.

Kulkarni, U. R., Ravindran, S., & Freeze, R. (2006-7). A knowledge management success model: Theoretical development and empirical validation. *Journal of Management Information Systems*, *23*(3), 309-347.

Lederer, A. L., Maupin, D. J., Sena, M. P., & Zhuang, Y. (2000). The technology acceptance model and the world wide web. *Decision Support Systems*, *29*(3), 269-282.

Lee, A. S. (2010). Retrospect and prospect: Information systems research in the last and next 25 years. *Journal of Information Technology*, *25*(4), 336-348.

Lim, S., Saldanha, T. J. V., Malladi, S., & Melville, N. P. (2013). Theories used in information systems research: Insights from complex network analysis. *Journal of Information Technology Theory and Application,* 14(2), 5-48.

Limayem, M., & Hirt, S. G. (2003). Force of habit and information systems usage: Theory and initial validation. *Journal of the Association for Information Systems*, *4*(1), 65-97.

Luciano, J. S., Cumming, G. P., Wilkinson, M. D., & Kahana, E. (2013). The emergent discipline of health web science. *Journal of Medical Internet Research*, *15*(8), e166.

Lyytinen, K., & King, J. L. (2004). Nothing at the center? Academic legitimacy in the information systems field. *Journal of the Association for Information Systems*, *5*(6), 220-246.

Majchrzak, A., Rice, R. E., Malhotra, A., King, N., & Ba, S. (2000). Technology adaptation: The case of a computer-supported inter-organizational virtual team. *MIS Quarterly*, *24*(4), 569-600.

Malhotra, A., Gosain, S., & El Sawy, O. A. (2005). Absorptive capacity configurations in supply chains: Gearing for partner-enabled market knowledge creation. *MIS Quarterly*, *29*(1), 145-187.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, *2*(3), 192-222.

Mumford, E. (1983). *Designing human systems for new technology: The ETHICS method*. Manchester: Manchester Business School.

Murugesan, S., Deshpande, Y., Hansen, S., & Ginige, A. (2001). Web engineering: A new discipline for development of web-based systems. In *Proceedings of the International Conference on Web Engineering* (pp. 3-13). Berlin, Heidelberg: Springer Verlag.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, *5*(1), 14-37.

Oinas-Kukkonen, H. (1998). What is inside a link? *Communications of the ACM*, *41*(7), 98.

Oinas-Kukkonen, H. (2000). Balancing the vendor and consumer requirements for electronic shopping systems. *Information Technology and Management*, *1*(1&2), 73-84.

Oinas-Kukkonen H. (2013). A foundation for the study of behavior change support systems. *Personal and Ubiquitous Computing*, *17*(6), pp. 1223-1235.

Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems*, *24*, 485-500.

Oinas-Kukkonen, H., Lyytinen, K., & Yoo, Y. (2010). Social networks and information systems: Ongoing and future research streams. *Journal of the Association for Information Systems*, *11*(2), 61-68.

Oinas-Kukkonen, H., & Oinas-Kukkonen, H. (2013). *Humanizing the Web: Change and social innovation*. Basingstoke, UK: Palgrave Macmillan.

Orlikowski, W. J. (2002). Knowing in practice: Enacting a collective capability in distributed organizing. *Organization Science*, *13*(3), 249-273.

Peffers, K., Tuunanen, T., Rothenberger, M., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, *24*(3), 45-77.

Poole, M. S., & DeSanctis, G. (1990). Understanding the use of group decision support systems: The theory of adaptive structuration. In J. Fulk & C. Steinfeld (Eds.), *Organizations and communication technology*. Newbury Park, CA: Sage.

Potosky, D. (2002). A field study of computer efficacy beliefs as an outcome of training: The role of computer playfulness, computer knowledge, and performance during training. *Computers in Human Behavior*, *18*(3), 241-255.

Rai, A., Lang, S. S., & Welker, R. B. (2002). Assessing the validity of IS success models: An empirical test and theoretical analysis. *Information Systems Research*, *13*(1), 50-69.

Ridings, C., & Wasko, M. M. (2010). Online discussion group sustainability: Investigating the interplay between structural dynamics and social dynamics over time. *Journal of the Association for Information Systems*, 11(2), 95-121.

Robey, D. (2003). Identity, legitimacy and the dominant research paradigm: An alternative prescription for the IS discipline: A response to Benbasat and Zmud's Call for returning to the IT artifact. *Journal of the Association for Information Systems*, *4*(1), 352-359.

Rogers, E. M. (1983). *Diffusion of innovations* (3rd ed.). New York, NY: Free Press.

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York, NY: Free Press.

Rossi, G., Pastor O., Schwabe D., & Olsina, L. (Eds.) (2007). *Web engineering: Modelling and implementing Web applications*. London: Springer Verlag.

Santhanam, R., Sasidharan, S., & Webster, J. (2008). Using self-regulatory learning to enhance e-learning-based information technology training. *Information Systems Research*, *19*(1), 26-47.

Sawyer, S., & Winter, S. J. (2011). Special issue on futures for research on information systems: Prometheus unbound? *Journal of Information Technology*, *26*(2), 95-98.

Saxenian, A. L. (1994). *Regional advantage: Culture and competition in Silicon Valley and Route 128*, Cambridge. MA: Harvard University Press.

Schultze, U. (2000). A confessional account of an ethnography about knowledge work. *MIS Quarterly*, *24*(1), 3-41.

Shneiderman, B. (2007). Web science: A provocative invitation to computer science. *Communications of the ACM*, *50*(6), 25-27.

Steiny, D., & Oinas-Kukkonen, H. (2007). Network awareness: Social network search, innovation and productivity in organizations. *International Journal of Networking and Virtual Organizations*, *4*(4), 413-430.

Sutter, J. (2009). Tutorial: Introduction to Web 2.0. *Communications of the Association for Information Systems*, *25,* 511-518.

Sykes, T. A., Venkatesh, V., & Gosain, S. (2009). Model of acceptance with peer support: A social network perspective to understand employees' system use. *MIS Quarterly*, *33*(2), 371-393.

Tauscher, L., & Greenberg, S. (1997). How people revisit web pages: Empirical findings and implications for the design of history systems. *International Journal of Human-Computer Studies*, *47*(1), 97-137.

Taylor, H., Dillon, S., & van Wingen, M. (2010). Focus and diversity in information systems research: Meeting the dual demands of a healthy applied discipline. *MIS Quarterly*, *34*(4) 647-667.

Topi, H., Valacich, J. S., Wright, R. T., Kaiser, K., Nunamaker, J. F., Jr., Sipior, J. C., & de Vreede, G. J. (2010). IS 2010: Curriculum guidelines for undergraduate degree programs in information systems. *Communications of the Association for Information Systems*, *26*, 359-428.

Tuunanen, T., Myers, M, & Cassab, H. (2010). A conceptual framework for consumer information systems development. *Pacific Asia Journal of the Association for Information Systems*, *2*(1), 47-66.

Venkatesh, V., & Brown, S. A. (2001). A longitudinal investigation of personal computers in homes: Adoption determinants and emerging challenges. *MIS Quarterly*, *25*(1), 71-102.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425-478.

Vessey, I. (1991). Cognitive fit: A theory-based analysis of the graphs versus tables literature. *Decision Sciences*, *22*(2), 219-240.

Vessey, I., & Galletta, D. (1991). Cognitive fit: An empirical study of information acquisition. *Information Systems Research*, *2*(1), 63-84.

Walsham, G. (2002). Cross-cultural software production and use: A structurational analysis. *MIS Quarterly*, *26*(4), 359-380.

Wasko, M., & Faraj, S. (2005). Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. *MIS Quarterly, 29*(1), 35-57.

Williams, K., Chatterjee, S., & Rossi, M. (2008). Design of emerging digital services: A taxonomy. *European Journal of Information Systems*, *17*(5), 505-517.

Winter, R. (2008). Design science research in Europe. *European Journal of Information Systems*, *17*(5), 470-475.

Wixom, B. H., & Todd, P. A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information Systems Research*, *16*(1), 85-102.

Yi, M. Y., & Davis, F. D. (2003). Developing and validating an observational learning model of computer software training and skill acquisition. *Information Systems Research*, *14*(1), 146-169.

Yoo, Y. (2010). Computing in everyday life: A call for research on experiential computing. *MIS Quarterly*, *34*(2), 213-231.

Zigurs, I., Buckland, B., Connolly, J., & Wilson, E. V. (1999). A test of task-technology fit theory for group support systems. *Data Base for Advances in Information Systems*, *30*(3,4), 34-50.

Zigurs, I., & Buckland, B. (1998). A theory of task/technology fit and group support systems effectiveness. *MIS Quarterly*, *22*(3), 313-334.

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JITTA

JOURNAL OF INFORMATION TECHNOLOGY THEORY AND APPLICATION

JITTA is a Publication of the Association for Information Systems
ISSN: 1532-3416