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TRUST IN TECHNOLOGY: DEVELOPMENT OF A SET OF CONSTRUCTS AND MEASURES

Harrison McKnight
Michigan State University, mcknight@bus.msu.edu

Michelle Carter
Clemson University, mscarte@clemson.edu

Paul Clay
Washington State University, pclay@wsu.edu

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RESEARCH-IN-PROGRESS

D. Harrison McKnight
Michigan State University
mcknight@bus.msu.edu

Michelle Carter
Clemson University
mscarte@clemson.edu

Paul Clay
Washington State University
pclay@wsu.edu

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ABSTRACT

Trust plays an important role in many Information Systems (IS)-enabled situations. Most IS research employs trust as a measure of interpersonal or interfirm relations, such as trust in a Web vendor or a virtual team member. Although trust in other people is important, this paper suggests that trust in the information technology (IT) itself may also play a role in shaping IT-related beliefs and behavior. To advance trust and technology research, this paper presents a set of trust in technology construct definitions and measures. These construct measures will be examined using tests of convergent, discriminant, and nomological validity. This study will contribute to the literature by offering a) a framework for distinguishing between trust in people and trust in technology, b) offering a theory based set of definitions necessary for investigating different forms of trust, and c) developing measures useful to research and practice for evaluating trust in technology.

Keywords

Trust, Trust in Technology, Construct Development.

TRUST IN TECHNOLOGY: DEVELOPMENT OF A SET OF CONSTRUCTS AND MEASURES

Research has found trust to be not only useful, but also central (Golembiewski and McConkie, 1975) to understanding individual behavior in diverse domains such as work group interaction (Jarvenpaa and Leidner, 1998; Mayer, Davis, and Schoorman, 1995), and commercial relationships (Arrow, 1974). For example, Gefen, Karahanna, and Straub, (2003) provide evidence that trust in a Web business influences individual beliefs about Internet transactions. Similarly, Jarvenpaa and Leidner (1998) report swift trust influences how "virtual peers" interact in globally distributed teams. Trust is crucial to almost any type of situation in which either uncertainty exists or undesirable outcomes are possible (Fukuyama, 1995; Luhmann, 1979).

In the Management Information Systems (MIS) domain, research has examined ties from trust in people to IT-related beliefs and behavior. For example, trust in certifying organizations (McKnight, Choudhury, and Kacmar, 2002), and/or specific Internet vendors (Gefen et al., 2003; Kim, 2008; Lim, Choon, Lee, and Benbasat, 2006; Stewart, 2003) have been found to influence Web consumers' beliefs and behavior (Clarke, 1999). Additionally, a subset of interpersonal trust attributes—i.e., ability, benevolence, and integrity—have been applied to study trust in web sites (Vance, Elie-Dit-Cosaque, and Straub, 2008) and trust in online recommendation agents (Wang and Benbasat, 2005). In general, Internet research provides evidence that trust in another actor (i.e., a web vendor or person) and/or trust in an agent of another actor (i.e. a web site or recommendation agent) influences individual decisions to use technology. Trust in a specific information technology's features and performance, in contrast, has hardly been researched.

One reason for examining trust in people is that it seems more "natural" to trust a person than to trust a technology. In fact, people do present considerable uncertainty to the trustor because of their volition—something that technology lacks. However, some researchers have stretched this idea so far as to doubt the viability of the trust in technology concept: "People trust people, not technology" (Friedman, Kahn, and Howe, 2000: 36). This extreme position assumes that trust exists only when the trustee has volition and moral agency, i.e., the ability to do right or wrong. It also assumes that trust is to be defined narrowly as "accepted vulnerability to another's…ill will (or lack of good will) toward one." (Friedman et al., 2000: 34). Without its own will (good or bad), technology cannot fit within this human-bound definition of what trust is. We find that the literature on trust employs a large number of definitions, many of which extend beyond this narrow view (see McKnight and Chervany 1996).

We wonder if technology does not have some attributes on which people rely. Perhaps the most basic dictionary meaning of trust is to depend or rely on another (McKnight and Chervany, 1996). Thus, if one can rely or depend on a technology's attributes, then trust in technology is a viable concept in at least that limited way. A good test is to use the word trust in

natural language combinations with technologies. We say, "I trust my email system to deliver my messages." A pilot can say, "When visibility is bad, I trust the radar to keep us from running into another plane." A printer says, "I trust this copier to produce quality product for my customer." In each case, the trustor relies on the technology. With reliance on another party comes vulnerability to that party (Mayer et al. 1995).

We therefore argue that trust has to do with making oneself vulnerable to another person or object regardless of the will or moral agency of the object of trust. Trust involves more than depending on the goodwill, benevolence, or integrity of the other person or object. Trust can involve depending on the capability of the other to perform a particular action. Capability (or competence) has little to do with moral agency, but still relates closely to trust (Barber, 1983; Mayer et al., 1995). For example, when we rely on a brain surgeon to operate on us, we primarily rely on that doctor's ability or skill—since almost every doctor will try to operate well, but not all have the necessary skill. If competence is a viable trust issue, and if technology can be said to have the capability or functionality to do for us what we want it to, then trust in technology in terms of believing that a technology is competent is just as viable a concept as trust in the competence of a doctor.

While trust in others may be germane to IT use in transactional relationships, it makes sense that users' trust in the attributes of a specific information technology, which translate into attitudes and intentions, are more salient predictors of IT use. For example, some studies suggest that trust in knowledge management systems (KMS) influences salient beliefs such as perceived ease of use and usefulness as well as post-adoption intentions towards technology use (Thatcher, McKnight, Baker, Arsal, and Roberts, forthcoming). Although similar to trust in others (henceforth referred to as trust in people), trust in technology involves beliefs about the context and features of technology. To better understand trust in technology, this study begins with the following research question: what distinguishes trust in technology from trust in people?

The paper unfolds as follows: First we review theoretical differences in trust in people and trust in technology. Then we offer definitions of trust in technology constructs. Next, we operationalize a subset of trust in technology constructs. The paper concludes with a description of the proposed methodology for validating the measures, and reports progress to date.

THEORETICAL FOUNDATION

One of the most commonly used ways to define trust is as follows: trust means one is willing to depend on another party because of characteristics of the other (Rousseau, Sitkin, Burt, and Camerer, 1998). For example, when one crosses a bridge, one depends on the bridge to provide safe passage across a specific physical obstacle such as a river. Trust in technology refers to individuals depending on, or being willing to depend on the technology to accomplish a specific task (e.g., support one's weight across a bridge) because the technology has positive characteristics. When one uses a computer system, one trusts by depending on the system to complete the specific requested task (Friedman et al., 2000).

Whether involving people or technology (Table 1), trust situations feature risk and uncertainty. Trustors lack total control over outcomes because they depend on another party (Riker, 1971). Depending on another requires that the trustor risks that the trustee may not fulfill expected responsibilities, intentionally or not. That is, under conditions of uncertainty, one relies on another who may intentionally (i.e., by moral choice) not fulfill their role or who may lack the capability (i.e., without intention) to fulfill their role. Regardless of the source of failure, risk represents negative consequences (Bonoma, 1976) that the trustor incurs if the trustee fails to prove worthy of the trust extended. Both trust in people and trust in technology involve risk.

	Trust in People	Trust in Technology
Contextual Condition	Risk, Uncertainty, Lack of total control	Risk, Uncertainty, Lack of total control
Object of Dependence	People—in terms of volitional and non-volitional factors	Technology—in terms of non-volitional factors only
Nature of Expectations	1. Do things for you in a competent way. (ability [Mayer et al. 1995])	1. Possess the functionality to do a needed task.
	2. Be caring and considerate of you; be benevolent towards you; possess the will to help you when needed. (benevolence [Mayer et al. 1995])	2. Possess the ability to provide you help when needed (e.g., help menu).
	3. Be consistent in 1.-3. above. (predictability [McKnight et al. 1998])	3. Operate reliably or consistently.

Table 1: Conceptual Comparison—Trust in People versus Trust in Technology

However, trust in people and trust in technology differ in terms of the nature of the object of dependence. With the former, one trusts a person (a moral and volitional agent); with the latter, one trusts a specific technology (a human-created artifact

with a limited range of capabilities and that lacks moral agency). For example, when commercial airline pilots select between turning the controls over to a co-pilot or to auto-pilot, their decision reflects comparisons of the co-pilot's willingness (reflecting agency) to take a turn flying the plane and the auto-pilot's capability (reflecting no agency) to keep the plane on course or warn of dangerous conditions. Because technology lacks moral agency, IT-related trust necessarily reflects beliefs about a technology's capability (or functionality) rather than its will or its motives.

When forming trust in people and technology, individuals consider different attributes of the object of dependence (see Table 2). The following comparisons illustrate different attributes that influence trust in people and technology:

- Competence vs. Functionality – With trust in people, one relies on the efficacy of the other party in terms of their competence or ability or power to do something for us (Barber, 1983). With technology (Table 2, entry 1.), we talk about its functionality or whether the technology has the features necessary to complete a task (McKnight, 2005).
- Benevolence vs. Helpfulness – With people, we hope that they care enough to help us when we need it (Rempel, Holmes and Zanna, 1985). With technology (Table 2, entry 2.), we sense no caring emotions; but we hope that the technology will provide help when needed, such as through an online help function (McKnight, 2005).
- Integrity vs. Reliability – In both cases (Table 2, entry 3.), we hope the trustees are consistent or reliable (Giffin, 1967; McKnight, 2005). With people, integrity implies volitional will and refers to the degree to which an individual can be relied upon to keep commitments, tell the truth, and act consistently. Technology has no volition but, by operating continually in the manner it was designed to operate, it too can demonstrate consistency and reliability.

Trust in People			Trust in Technology	
Study	Label	Definition	Label	Definition
McKnight and Chervany, 2001-2002	Trusting Belief-Predict-ability	One's actions are consistent enough that another can forecast what one will do in a given situation.	1. Trusting belief-specific technology-Reliability	The belief that the specific technology will consistently operate properly.
Mayer, et al., 1995	Factor of Trustwor-thiness-Ability	That group of skills, competencies, and characteristics that enable a party to have influence within some specific domain.	2. Trusting belief-specific technology-Functionality	The belief that the specific technology has the capability, functionality, or features to do for one what one needs to be done.
McKnight and Chervany, 2001-2002	Trusting Belief-Compe-tence	One has the ability to do for the other person what the other person needs to have done. The essence of competence is efficacy…		
Mayer, et al., 1995	Factor of Trustwor-thiness-Benevo-lence	The extent to which a trustee is believed to want to do good to the trustor, aside from an egocentric profit motive.	3. Trusting belief-specific technology-Helpfulness	The belief that the specific technology provides adequate and responsive help for users.
McKnight and Chervany, 2001-2002	Trusting Belief-Benevo-lence	One cares about the welfare of the other person and is therefore motivated to act in the other person's interest….does not act opportunistically toward the other...		
Mayer, et al., 1995	Trust	The willingness of a party to be vulnerable to the actions of another party…irrespective of the ability to monitor or control that other party.	4. Trusting intention-specific technology	A willingness to depend on the specific technology in a given situation in which negative consequences are possible.
McKnight, et al., 1998	Trusting intention	One is willing to depend on the other person in a given situation.		

Table 2: Comparison of Concept and Construct Definition

Mayer, et al., 1995	Propensity to trust	A general willingness to trust others.	5. Propensity to Trust General Technology	The general tendency to be willing to depend on technology across a broad spectrum of situations and technologies.
McKnight, et al., 1998	Disposi-tion to trust	[The] extent [to which one] demonstrates a consistent tendency to be willing to depend on others across a broad spectrum of situations and persons.		
McKnight, et al., 1998	Faith in humanity	Others are typically well-meaning and reliable.	6. Faith in General Technology	One assumes technologies are usually consistent, reliable, functional, and provide the help needed.
McKnight, et al., 1998	Trusting stance	Irrespective of whether people are reliable or not, one will obtain better interpersonal outcomes by dealing with people as though they are well-meaning and reliable.	7. Trusting Stance-General Technology	Regardless of what one assumes about technology generally, one presumes that one will achieve better outcomes by assuming the technology can be relied on.
McKnight, et al., 1998	Situation-al Normality	The belief that success is likely because the situation is normal, favorable, or well-ordered.	8. Situational Normality-Technology	The belief that success with the specific technology is likely because one feels comfortable or favorable when one uses the general type of technology of which this specific technology is an instance.
McKnight, et al., 1998	Structural Assurance	The belief that success is likely because contextual conditions like promises, contracts, regulations and guarantees are in place.	9. Structural Assurance-Technology	The belief that success with the specific technology is likely because, regardless of the characteristics of the specific technology, one believes structural conditions like guarantees, contracts, support, or other safeguards exist in the general type of technology that make success likely.

Table 2: Comparison of Concept and Construct Definitions continued.

Having described similarities and differences between trust in people and trust in technology and delimited a role for trust in technology, we turn to developing definitions of different types of trust in technology.

CONCEPTUAL DEFINITIONS

Rooted in the trust definitions offered by Mayer et al. (1995) and McKnight, Cummings, and Chervany (1998) (Table 2), we define and operationalize trust in technology constructs as components of three second order concepts (Figure 1): a) trust in specific technology, referring to a person's relationship with a particular technology (e.g., Microsoft Excel); b) propensity to trust general technology, a personal tendency (dispositional) concept , and c) institution-based trust in technology, a structural concept.

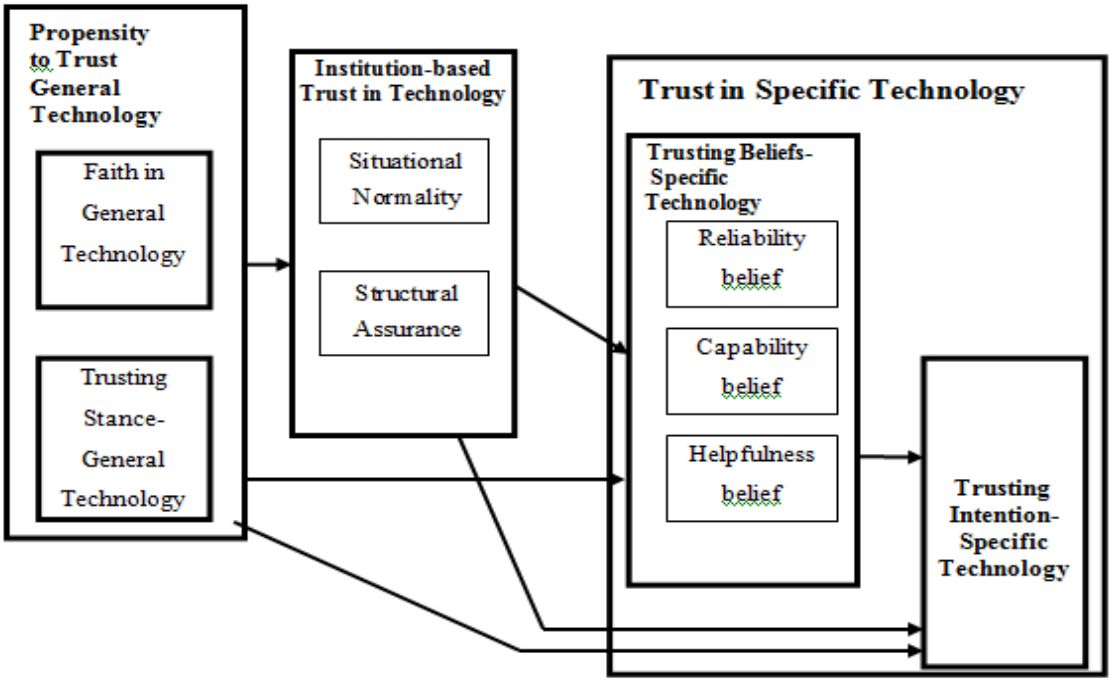

Figure 1: Relations among Technology-Related Constructs

Trust in a Specific Technology

Broadly defined, trust in technology refers to a willingness to depend on the specific technology in a given situation in which negative consequences are possible. Similar to trust in people (McKnight et al, 1998), trust in a specific technology is formed by two distinct components – trusting intention and trusting beliefs. Trusting intention-specific technology refers to an individuals' willingness to depend on a specific technology (Table 2, entry 4). When trusting intentions are high, individuals express a willingness to depend on a specific technology in uncertain, risky situations.

Trusting beliefs reflect judgments that the other party has suitable attributes for performing as expected in a specific situation (Mayer, et al., 1995). McKnight, et al. defined trusting beliefs in people as a perception that another "person is benevolent, competent, honest, or predictable in a situation" (1998: 474). The notion of predictability applies to technology because one expects a technology to work consistently and reliably. The term reliable (i.e., without glitches or downtime) is probably used more frequently regarding technology than the terms predictable or consistent (Balusek and Sircar, 1998). Hence, trusting belief-specific technology-reliability refers to the belief that the technology will operate properly (see Table 2, entry 1).

In addition to reliability, trusting beliefs in people reflect one's judgment that a trustee has the capability and desire required to perform a task. Similarly, trusting beliefs-specific technology-functionality reflects one's beliefs that the target technology has the capacity (i.e., features) to complete a required task (see Table 2, entry 2). In contrast to trust in people, trusting beliefs-specific technology-helpfulness excludes volition (i.e., desire) and refers to a feature of the technology itself—the help function, i.e., is it adequate and responsive (Table 2, entry 3)? Trusting beliefs are positively related to trusting intention because individuals are more willing to depend on a specific technology when they perceive it has desirable attributes (McKnight et al. 2002).

Propensity to Trust in General Technology

Propensity to trust is a tendency to trust other persons (Table 2, entry 5) (Rotter, 1971). The term "propensity" distinguishes this concept from a fixed personality trait (Mayer, et al., 1995) by suggesting that it is more of a dynamic individual difference than a stable, unchangeable trait (Thatcher and Perrewe, 2002). Propensity is neither person-specific (as are trusting beliefs/trusting intention), nor situation-specific (as are institution-based trust beliefs, discussed below). When applied to technology, propensity to trust suggests that one is willing to trust technology across situations and persons (see Table 2, entry 5).

Consistent with the literature on trust in people (McKnight et al., 1998), trust in technology in general is comprised of two dimensions—faith in general technology and trusting stance-general technology. Faith in general technology refers to individuals' beliefs about attributes of information technologies (IT) in general (Table 2, entry 6). For example, an individual with higher faith in general technology assumes technologies are usually consistent, reliable, functional, and provide the help needed. As opposed to beliefs about IT's attributes, trusting stance-general technology refers to the degree to which one believes that positive outcomes will result from assuming one can rely on the other (Table 2, entry 7). When one has higher trusting stance-general technology, one is likely to trust a technology until it provides a reason not to. In harmony with trust in people models, we propose that faith in general technology and trusting stance-general technology will predict institution-based trust in technology constructs, which will not fully mediate their effects on trusting beliefs-technology (Figure 1).

Institution-based Trust in Technology

Institution-based trust refers to the belief that success is likely because of supportive situations and structures. One institution-based trust construct is situational normality (Table 2, entry 8)... This belief reflects a feeling that when a situation is normal, well-ordered, or favourable, one can trust something new in a similar situation. For example, one may perceive using spreadsheets as a normal work activity, and consequently be predisposed to feel comfortable working with a new spreadsheet application. Hence, situational normality-specific technology reflects the belief that success with a specific technology is likely because one feels comfortable using the general type of technology of which this specific technology is an instance.

Whereas situational normality focuses on the work setting, structural assurance directs attention to the infrastructure supporting technology use. It refers to the belief that adequate support—be it legal, such as contractual obligations, or physical, such as replacing faulty equipment—exists to ensure successful use of an IT (see Table 2, entry 9). For example, regardless of what one believes about a new software application, one may project successful implementation because of legal guarantees provided by the vendor. Structural assurance contributes to individuals forming confidence in the software, thereby fostering a willingness to depend on the specific software.

Situational normality and structural assurance differ from trusting beliefs/trusting intention and propensity to trust-general technology in that situational normality and structural assurances relate to beliefs about the context in which a specific technology is used. Following the reasoning that institutional constructs predict trust of those in specific relationships (McKnight, et al., 1998; McKnight and Chervany, 2001-2002), situational normality and structural assurance should relate positively to trusting beliefs and trusting intention in specific technology (Figure 1).

OPERATIONALIZING A SUBSET OF CONSTRUCTS

Based on past trust instrumentation (McKnight et al., 2002), an initial subset of measures for trust in technology was developed in several rounds. The subset of constructs developed initially consisted of trusting intention-specific technology (5 items), trusting belief-technology-reliability (6 items), and situational normality-technology (5 items). For this pilot, students using Microsoft Excel and Access responded to the questions. The items we used reflect the definitions above. These constructs exhibited good reliability (Cronbach's alpha > 0.89), so it was decided to expand the list of constructs to those shown in the Appendix. The new set of subjects used Oracle Developer tools.

The authors assessed face validity by comparing the items (Appendix) to construct definitions in Table 2. An adequate match was found. For example, trusting intention-specific technology item 4 matches the corresponding Table 2 definition in that it assesses the extent to which the respondent is willing to depend on the specific technology in an important situation. Trusting belief-specific technology-reliability item 5 reflects the belief (Table 2, entry 2) that the specific technology operates in a consistent way. Situational normality-technology item 3 uses the term "DBMS" (explained in the questionnaire as a Data Base Management System) to describe the general context for using Oracle.

Earlier people relationship versions of these measures went through several phases of pretesting and were used in several previous studies, with Cronbach's alphas near or over 0.90 (McKnight et al., 2002). Thus, we felt comfortable adapting interpersonal trust measures by rewording them to specify a technology referent instead of a person referent. The trusting belief-specific technology-reliability items were refined by determining synonyms of consistent and predictable and by adding two items measuring beliefs that the software won't fail. The remaining items were adapted from McKnight et al. (2002).

CONSTRUCT RELIABILITY AND VALIDITY METHODOLOGY

We measured the constructs using a sample of volunteers from sections of systems development courses for systems majors taught by three instructors. All 172 enrolled students participated. Total sample size after listwise deletion was 148. Preliminary analysis involved tests of skewness, kurtosis, and outliers. We also inspected mean values and standard deviation for each item (Tabachnick and Fidell, 1996). Results suggested the items were acceptable for further analysis, as nothing unusual was found. The internal consistency of each construct was then measured, using Cronbach's alpha (Table 3).

We will collect a second dataset to evaluate the strength of our measures using Web 2.0 technologies in the Fall of 2009. Our reason for doing so is to validate our items in a distinct context with a population of experienced users of a specific technology. By conducting two studies, we hope to offer strong evidence of our measures' utility and contribute to the discourse in the increasingly mature literature examining trust's relationship to technology use.

Construct	Number of Items	Cronbach's Alpha
Trust in Specific Technology		
Trusting Intention-specific technology	4	.97
Trusting Belief-specific technology-Reliability	6	.95
Trusting Belief-specific technology-Capability	4	.94
Trusting Belief-specific technology-Helpfulness	5	.97
Institution-based Trust in Technology		
Situational Normality-Technology	4	.95
Structural Assurance-Technology	4	.95
Propensity to Trust General Technology		
Faith in General Technology	4	.95
Trusting Stance-General Technology	3	.91
Sample Size: list wise n = 148		

Table 3: Reliability of Constructs

FUTURE VALIDITY STEPS

We will examine the psychometric properties of the proposed measures in three steps. First, to cull unacceptable items, we will use exploratory factor analysis to examine ties between items and the second-order constructs. Items that do not load on the construct of interest or cross-load at too high levels on other constructs will be dropped. Next, confirmatory analysis will be used to establish the measures' convergent, discriminant, and nomological validity. We will use structural equation modelling techniques to assess the factor structure as well as the overall fit of the proposed nomological network. In terms of validity tests, we will calculate item loadings, model fit statistics, internal composite reliability, and average variance extracted (AVE) vis-à-vis established standards (Gefen, Straub, and Boudreau, 2000). Discriminant validity will be tested by seeing whether the AVE square roots exceed each respective latent variable intercorrelation (Fornell and Larcker, 1981). Nomological validity will be tested in two steps: (1) we will empirically examine relationships among trust constructs, i.e., how do trust in technology constructs relate to trust in other actors such as vendors or people; (2) we will propose and test linkages between the trust in technology measures and established IT constructs such as computer anxiety, computer self-efficacy, perceived usefulness of IT, and personal innovativeness. By determining whether trust in technology differs from other forms of trust and placing trust in technology within the broader nomological network of IT-focused constructs, we hope to provide greater insight into the role of trust in the acceptance and use of information technologies.

CONCLUSION

Trust is an important concept, and trust in technology needs to be explored further, as it will likely affect technology use. To this end, the current paper provides a set of trust in technology constructs and measures that can aid researchers. Because one is more likely to adopt a technology if one trusts it, trust in technology may complement adoption models like TAM. Our initial data indicates that trust in technology and several TAM variables are positively correlated. Future research should explore this question.

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APPENDIX A. TRUST IN TECHNOLOGY—MEASURES

Trusting Intention—Specific Technology

1. When I have an important class assignment, I feel I can depend on Oracle Developer.
2. I can always rely on Oracle Developer in completing a tough class assignment.
3. Oracle Developer is a product on which I feel I can fully rely when working on an essential class assignment.
4. I feel I can count on Oracle Developer when working on an important class task.

Trusting Belief-Specific Technology—Reliability

1. I think Oracle Developer is a very reliable product.
2. Oracle Developer is not going to fail me.
3. To me, Oracle Developer is extremely dependable.
4. Oracle Developer is a highly consistent piece of software.
5. Oracle Developer behaves in a predictable way.
6. Oracle Developer functions the same way each time I use it.

Trusting Belief-Specific Technology—Functionality

1. I think Oracle Developer has the functionality I need.
2. Oracle Developer has the features required for my task.
3. Oracle Developer has the ability to do what I want it to do.
4. Overall, the Oracle Developer product has the capabilities I need.

Trusting Belief-Specific Technology—Helpfulness

1. When I need some kind of user help, Oracle Developer supplies my need online.
2. Oracle Developer provides competent online guidance.
3. Oracle Developer provides me the online help I need to complete tasks effectively.
4. Oracle Developer provides very sensible and effective online advice.
5. When I do get stuck, I feel that I can quickly get the online aid I need from Oracle Developer.

Situational Normality—Technology

1. I am totally comfortable working with DBMS products.
2. I feel very good about how things go when I use DBMS products.
3. I always feel confident that the right things will happen when I use DBMS products.
4. It appears that things will be fine when I utilize DBMS products.

Structural Assurance—Technology

1. I feel okay using DBMS products because they are backed by vendor protections.
2. Product guarantees make it feel all right to use DBMS software.
3. Favorable-to-consumer legal structures help me feel safe working with DBMS products.
4. Having the backing of legal statutes and processes makes me feel secure in using DBMS products.

Faith in General Technology

1. I believe that most technologies are effective at what they are designed to do.
2. A large majority of technologies are excellent.
3. Most technologies have the features needed for their domain.
4. I think most technologies enable me to do what I need to do.

Trusting Stance—General Technology

1. My typical approach is to trust new technologies until they prove to me that I shouldn't trust them.
2. I usually trust a technology until it gives me a reason not to trust it.
3. I generally give a technology the benefit of the doubt when I first use it.