UNDERSTANDING THE FORMATION OF TRUST IN IT ARTIFACTS

Completed Research Paper

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Abstract

IT artifacts often take the role of a trustee in a trust relationship between users and IT artifacts. The goal of this paper is to increase the understanding of the formation of trust in such trust relationships. Instead of using the predominant theoretical foundation of interpersonal trust, we use the theoretical foundation of trust in automation from the HCI discipline for studying the formation of trust. Since we aim at creating insights on the formation of trust and its dimensions, we develop a formative first-order, formative second-order measurement model for trust. To evaluate the impact of the single indicators and dimensions on trust, we conduct a laboratory experiment. Our results show that the dimensions performance, process and purpose have a comparable impact on trust, and that indicators related to user data are especially important. The results complement existing insights, deepening the understanding of the formation of trust in IT artifacts.

Keywords: Trust, IT artifacts, Human-computer interaction

Introduction

The importance of trust for Information Systems Research has been shown in different domains such as e-commerce (Gefen and Straub 2004), virtual communities (Leimeister et al. 2006), and generally in the adoption of new technologies (Gefen et al. 2003). Until now, IS trust research focused mainly on trust relationships between human beings, interpreting the role of IT artifacts as a means for communication (Mediator Role, Figure 1). Consequently, insights on trust relationships between humans or organizations (e.g., Mayer et al. 1995) served as a theoretical foundation of these works. Using this foundation, IS trust research managed to create valuable insights on trust relationships between human beings that are mediated by IT artifacts, e.g., buyer trust in a web-vendor in the area of e-commerce (Benbasat et al. 2008; McKnight et al. 2002a; McKnight et al. 2002b). With the increasing automation of IT artifacts (Lee and See 2004) and the advent of ubiquitous information systems (Vodanovic et al. 2010), IT artifacts can take another role. They are increasingly often directly providing support to its users helping him to achieve a certain goal, e.g., by providing recommendations (Komiak and Benbasat 2006) or controlling processes (Lee and See 2004). As a result, IT artifacts can take the role of a trustee in a trust relationship between a user and an IT artifact (Trustee Role, Figure 1).

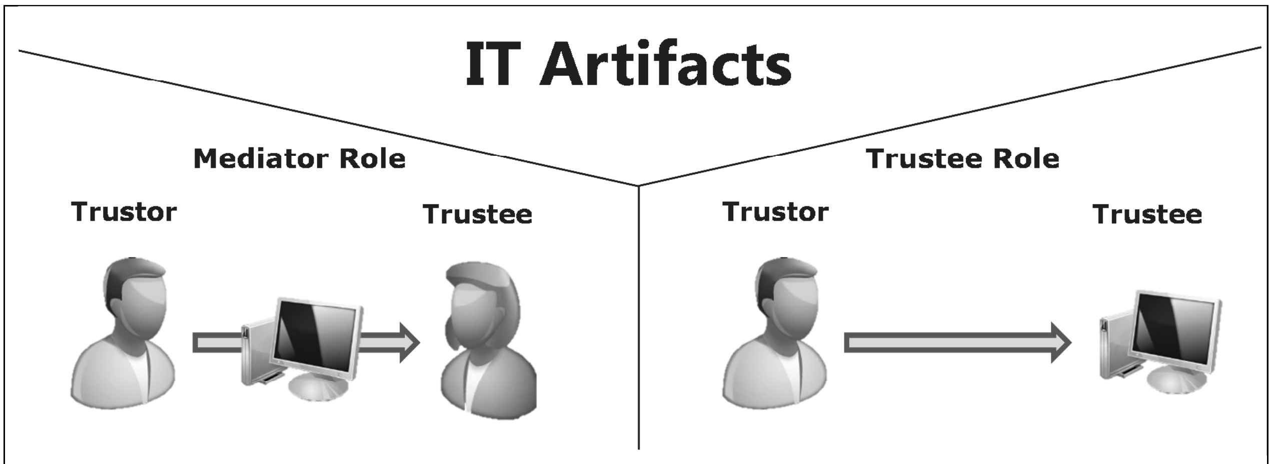

Figure 1. Two possible roles of IT artifacts in IS trust research

We focus on initial trust that is formed after users have a first experience with such increasingly automated IT artifacts McKnight et al. 2002b). Despite we are aware of the fact that trust building is a dynamic process, the focus on initial trust can be justified using two reasons (Wang and Benbasat 2005). First, when users interact with an IT artifact they are not familiar with, their perceptions of uncertainty and risk about using the IT artifact are especially salient (McKnight et al. 2002b). Consequently, sufficient initial trust is needed to overcome these perceptions. Although trust research has shown that initial trust beliefs may change over time (McKnight et al. 1998; Rempel et al. 1985), users will first rely on initial trust to determine the extent to which future interactions will take place (Koufaris and Hampton-Sosa 2004; McKnight et al. 2002b). Second, low switching costs, high pressure of competition, and vendors' high expenses to attract new customers increase the importance to gain high initial trust from users (Koufaris and Hampton-Sosa 2004). Consequently, we consider examining initial trust in IT artifacts is important.

IT artifacts taking the trustee role pose challenges to both, designers of IT artifacts, and IS trust researchers. Focusing on IT artifacts taking the mediator role, designers of IT artifacts usually had to ensure that the IT artifact is designed in a way that the communication partner (human being or organization) of the trustor is perceived as being trustworthy. For designing IT artifacts taking the trustee role, the designers face the challenge to ensure that the IT artifact itself is perceived as being trustworthy by its users. Since IT artifacts are no human beings, the portability of existing trust-related design knowledge remains questionable (Gefen et al. 2008).

Understanding human behavior in IT artifact usage, and guiding designers of IT artifacts in accounting for observed issues are core goals of the IS discipline in general (Benbasat and Zmud 2003), and IS trust research in particular (Gefen et al. 2008). Consequently, one objective of IS trust research is to understand the formation of trust in IT artifacts taking the trustee role. Creating these insights would also help designers of such IT artifacts to address important trust-related issues. For understanding the formation of trust in IT artifact taking the trustee role, IS trust research has to complete two tasks. First, it has to be investigated which theoretical foundation is best suited for studying trust relationships between users and an IT artifacts (Gefen et al. 2008). Second, the formation of trust in such kind of a trust relationship should be investigated as detailed as possible for understanding the mechanism of trust in IT artifacts, giving designers as detailed advice as possible (Benbasat and Barki 2007; Söllner et al. 2012).

This paper aims at helping to solve both tasks. First, we discuss the suitability of two possible theoretical foundations for studying trust relationships between a user and an IT artifact. Second, based on the theoretical foundation that we consider as being more suitable, we develop and evaluate a formative first-order, formative second-order measurement model for trust in IT artifacts. This approach allows us to create more detailed insights on the formation of trust than alternative measurement approaches (Albers 2010; Petter et al. 2007).

To achieve the presented aims, the remainder of the paper is structured as follows. First, we will present related work on the theoretical foundations used to study trust in IT artifacts as well as on measuring trust in IT artifacts. Afterwards, we will discuss which theoretical foundation we consider to be better, and develop a formative first-order, formative second-order measurement model based on this theoretical foundation. Then, we present details on our research method used to evaluate our model. Section 6 presents the results of the evaluation which are discussed in section 7. Section 8 covers the limitations of our study and our paper, and outlines areas for future research, before the paper closes with a conclusion.

Related Work

Since the late 1990s the interest in trust has greatly increased. This is evident in publication of several special issues in major journals in: Management (Rousseau et al. 1998), IS (Benbasat et al. 2008; Benbasat et al. 2010) and HCI (Corritore et al. 2003). The main value of trust is that it serves as a mechanism to reduce perceived social complexity (Luhmann 1979). This becomes important for many disciplines because of the increasing complexity of organizations and technology (Gefen et al. 2003; Lee and See 2004).

Two Different Theoretical Foundations of Trust in IT Artifacts

With various disciplines using trust in different contexts, trust is widely used, and the interpretations of trust become multifarious resulting in a plethora of definitions (Abdul-Rahman and Hailes 2000; Ebert 2009; Hoffmann et al. 2012). The most common approach is to define trust as an intention or willingness to act. This approach is also followed by most IS trust researchers, who rely on the most widely used and accepted definition of trust (Rousseau et al. 1998) by Mayer et al. (1995, 712): "trust […] is the willingness of a party [trustor] to be vulnerable to the actions of another party [trustee] based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party." The definition by Mayer et al. (1995) and other definitions applied in IS research (e.g., Gambetta 1990) have their roots in the management discipline, and focus on trust between people, groups of people, or organizations. Thus, they are especially valuable for areas of IS research dealing with different kinds of IT-mediated relationships between people, such as e-commerce (Gefen et al. 2003) and virtual communities (Leimeister et al. 2005). Since early IS trust research focused on studying such kinds of relationship, most researchers adopted Mayer et al.'s (1995) three dimensions of trustworthiness – ability, benevolence and integrity – to assess trust (e.g., McKnight et al. 2002a; McKnight et al. 2002b). Ability reflects the trustor's perception that the trustee has the necessary skills, competencies, and characteristics enabling him to have influence in a specific domain. Benevolence reflects the trustor's perception that the trustee does not only follow an egocentric profit motive, but also wants to do good to the trustor. Integrity reflects the trustor's perception that the trustee adheres to a set of principles that is acceptable for the trustor (Mayer et al. 1995). Some researchers extend these dimensions, e.g., by adding predictability (Gefen and Straub 2004) or omit one of the three, e.g. integrity (Singh and Sirdeshmukh 2000). Nevertheless, the underlying logic is to use these or related dimensions to assess trust in IT-mediated trust relationship between humans and organizations.

IS trust research discovered that IT artifacts are not only used to mediate trust-relationships between humans and organizations, but are increasingly often used as a tool providing, e.g., recommendations (Komiak and Benbasat 2006). The consequence for IS trust research is that these IT artifact take the role of a trustee in a trust relationship between a user and an IT artifact. As a result, a stream of IS trust research began researching this class of IT artifacts separately from IT artifacts used as a means for communication (e.g., Komiak and Benbasat 2006; Vance et al. 2008; Wang and Benbasat 2005). For researching such trust-relationships, researchers adopted the definitions and dimensions of trust used to study computer-mediated trust relationships between humans and organizations (e.g., Komiak and Benbasat 2006; Lowry et al. 2008; Vance et al. 2008; Wang and Benbasat 2005; Wang and Benbasat 2009). Their main argument for the suitability of this adoption is that HCI researchers established the computers are social actors paradigm (Nass and Moon 2000) purporting that people enter relationships with IT artifacts and respond to them in a way comparable to responding to other people (Nass et al. 1996; Nass et al. 1995; Nass et al. 1994; Reeves and Nass 1996). As a result, they argue the IT artifacts can be compared to human beings making the existing definitions and dimensions of trust suitable for researching trust relationships between people and IT artifacts (Wang and Benbasat 2005). However, this adoption has encountered skepticism by some IS researchers (Gefen et al. 2008).

Another approach for assessing trust in IT artifacts taking the trustee role can be found in the HCI discipline. Since the early 1990s HCI researchers study trust in complex automated systems, such as supervisory control systems and auto-pilots (e.g., Lee and Moray 1992; Lee and See 2004; Muir 1994; Muir and Moray 1996). Automated systems are defined as "technology that actively selects data, transforms information, makes decisions, or controls processes (Lee and See 2004, 50)." With the increasing automation of IT artifacts and the advent of ubiquitous information systems, this definition is suitable for numerous IT artifacts studied in the IS discipline. Recommender systems, e.g., are automated systems, since they are defined as software programs that carry out a set of operations on behalf of the users, and provide decision advice based on users' needs, preferences, profiles or previous activities (Ansari et al. 2000; Wang and Benbasat 2008). For assessing trust in automated systems, researchers use the dimensions by Lee and Moray (1992): performance, process, and purpose. Performance reflects the capability of the automated system in helping the user to achieve his goals. Process reflects the user's perception regarding the degree to which the automated systems algorithms, and processes are appropriate. Compared to the performance dimension, the process dimension focuses on specific characteristics of the IT artifact. Purpose reflects the user's perception of the intentions the designers of the automated system had, and his estimation of the future value of using the IT artifact. Compared to the process dimension, the purpose dimension focuses on more general issues like the perceived benevolence of the designers (Lee and See 2004).

Measuring Trust in IT Artifacts

In most cases, trust is measurement using reflective indicators, whereas a formative measurement is only used sporadic (Söllner and Leimeister 2010). In their analysis of the validity, and reliability of measurement models used in the Marketing discipline, Jarvis et al. (2003) concluded that about 30% of all measurement models used are mis-specified. Petter et al. (2007) conducted a similar analysis focusing on the IS discipline, showing that this problem is also prevalent in IS research. Especially focusing on IS trust research, Söllner and Leimeister (2010) observed similar results for the measurement models used in IS trust research. The major issue all three studies identified is that usually causal indicators of latent variables are used as reflective indicators, which is conceptually wrong. Causal indicators need to be used as formative indicators, whereas consequences of a latent variable are suited for a reflective measurement (Jarvis et al. 2003; Petter et al. 2007). The consequence of measurement model mis-specification is the occurrence of Type I and Type II errors. In a Type I error scenario, paths in the structural model are labeled as statistically significant when there is actually no relationship between the constructs. In a Type II error scenario, an existing relationship is found to be insignificant (Petter et al. 2007). Both errors have been shown to be extremely harmful for the validity and reliability of the statistical result, and consequently, for theoretical implications drawn upon these results (Petter et al. 2007). As a result, IS trust research adapted their measurement models, e.g., by building valid unidimensional formative (e.g., Söllner et al. 2010) and reflective (e.g., Cyr et al. 2009), as well as reflective first-order, formative second-order multidimensional measurement models for trust (e.g., Lowry et al. 2008; Vance et al. 2008). Since MacKenzie et al. (2005) point out that the suitability of the measurement model used depends on the researcher's theoretical interest, this plethora of measurement approaches is in general unproblematic, given the guidelines provided by Jarvis et al. (2003), and Petter et al. (2007) are respected for avoiding Type I and II errors.

Cyr et al. (2009), e.g., research the impact of human images, image appeal and perceived social presence on trust using a unidimensional reflective measurement model. Vance et al. (2008), e.g., research the impact of two dimensions of system quality on trust in IT artifacts, and use a reflective first-order, formative second-order approach. Given their interest in researching the impact of distinct structural constructs on trust, a unidimensional reflective measurement or reflective first-order, formative second-order approach seems suitable (MacKenzie et al. 2005).

When aiming at creating detailed insights on the formation of trust in IT artifacts, Albers (2010) point out that a formative measurement approach is more suitable, since this approach provides insights on the impact of single factors building trust. Söllner et al. (2010), e.g., aim at creating insights on the impact of the three dimensions of trustworthiness by Mayer et al. (1995), using a unidimensional formative measurement model. Söllner et al. (2012), e.g., use theory to point out that a formative first-order, formative second-order measurement approach is especially suited for creating detailed trust-related design knowledge, since the double formative measurement provides insights on the formation of the dimensions of trust, and trust itself (Jarvis et al. 2003; Petter et al. 2007).

Formation of Trust in IT Artifacts

The first possible theoretical foundation for studying trust in IT artifacts taking the trustee role are the insights on trust between humans and organizations, created, e.g., by Mayer et al. (1995). One advantage of this theoretical foundation is that IS trust research has used this theory for a decade, creating huge pool of theoretical insights (e.g., Gefen et al. 2003; McKnight et al. 2002a; McKnight et al. 2002b; Pavlou and Gefen 2004) future research can build upon. Another advantage is that due to the fact that this theoretical foundation has been used in a huge number of studies, there are plenty of evaluated measurement instruments that can be used in future studies. The main disadvantage of this theoretical foundation is that it is designed to study trust relationships between people, groups of people, or organizations. Even when we assume that the computers are social actors paradigm holds, it remains questionable that the dimensions of trustworthiness by Mayer et al. (1995) are suitable for studying trust relationships between users and IT artifacts, since some dimensions resemble human character traits of a trustee. Considering, e.g., using Mayer et al.'s (1995) dimension benevolence to assess the trustworthiness of an IT artifact would imply that we assume that an IT artifact is able to actively decide whether to keep the interests of the trustor – its user – in mind or not. We argue that such a decision cannot be made by an IT artifact, as the artifact follows a specific predefined algorithm or logic, and thus is not comparable to human decision making. Additionally, using the dimensions of trustworthiness by Mayer et al. (1995) would imply the assumption that users deciding whether or not to trust an IT artifact rely on the same dimension as people deciding whether or not to trust other people or organizations. However, recent NeuroIS studies question whether this assumption holds. Riedl et al. (2011), e.g., show that the human brain distinguishes between humans and human-like avatars, since different brain regions are especially active during the decision phase to trust a human compared to a human-like avatar. Since Dimoka et al. (2011) point out that brain regions are related to cognitive processes, this questions whether people rely on the same dimensions of trustworthiness when deciding whether or not to trust other people or organizations compared to deciding whether or not to trust an IT artifact.

The second possible theoretical foundation for studying trust in IT artifacts are the insights on trust in automated systems, created, e.g., by Lee and Moray (1992), Muir and Moray (1996), and Lee and See (2004). The main advantage of this theoretical foundation is that it was especially designed for studying trust relationships between operators (users) and automated systems (IT artifacts). As a result, the dimensions by Lee and Moray (1992) – performance, process, and purpose – are especially chosen to resemble properties of a technical system. The main disadvantage is that this theoretical foundation is new to IS research. Consequently, there are fewer theoretical insights we can build upon. Additionally, since the HCI discipline uses different evaluation methods, there are fewer evaluated measurement instruments available compared to the first possible theoretical foundation.

For our study, we decide to build upon the second possible theoretical foundation for studying the formation of trust in IT artifacts taking the trustee role – insights on trust in automated systems. We argue that the disadvantages are outweighed by the main advantage of this theory – the fact that it was especially designed for researching trust in trust relationships between operators and automated system, which are in our opinion comparable to trust relationships between users and IT artifacts. This argumentation is based on the facts that a) a technical system takes the role of a trustee in both, trust relationships between operators and automated systems, as well as trust relationships between users and IT artifacts, and b) automated systems are comparable to IT artifacts serving as tools to support their users. Consequently, we expect the dimensions by Lee and Moray (1992) to be better suited for understanding the formation of user trust in IT artifacts taking the trustee role, since they all resemble properties of a technical system, instead of human character traits.

We aim at creating detailed insights on the formation of trust in IT artifacts, and at creating detailed design knowledge for IT artifact designers. Consequently, we decide to build a formative first-order, formative second-order measurement model for trust in IT artifacts, since the double formative measurement provides insights on the formation of the dimensions of trust, and trust itself (Jarvis et al. 2003; Petter et al. 2007).

As argued above, we use the theoretical insights on trust in automation as a foundation for our study, and consequently a formative first-order, formative second-order measurement model for trust in IT artifacts. The three dimensions for studying the formation of trust in automation, which are well accepted within literature on trust in automation are performance, process and purpose (Lee and Moray 1992; Lee and See 2004). These three dimensions will serve as a basis for the formative second-order part of our measurement model. For identifying suitable formative indicators for these dimensions, we use Lee and See's (2004) work as a basis, since they conducted a thorough literature review summarizing the numerous constructs they found in published studies under Lee and Moray's (1992) dimensions: performance, process and purpose.

Since we are aware of the already discussed measurement model mis-specification problem (Jarvis et al. 2003; Petter et al. 2007), we checked the constructs summarized under each dimension for the suitability of being a formative indicator for that dimension and for redundancy among the different indicators. Additionally, more recently, issues such as security, and especially privacy of IT artifacts gained increasing attention. One reason for this development is the increasing automation of IT artifacts, making it increasingly hard for users to understand, what the IT artifact exactly does (see e.g., Spiekermann 2007). Consequently, we use insights from this stream of research to enrich the formative indicators that we identified based on Lee and See's (2004) literature review.

For the performance dimension we use the three formative indicators: *responsibility*, *information accuracy*, and *reliability*. *Responsibility* covers the users' perception whether the IT artifact has all functionalities necessary for achieving the users' goal. This is essential, since missing functionalities would hinder the users from achieving their intended goal. *Information accuracy* covers the users' perception whether the information provided by the IT artifact is accurate. Both, automated systems, as well as IT artifacts provide information for supporting its user, e.g., by controlling a power plant (Muir 1994) or finding a suitable digital camera (Wang and Benbasat 2005). *Reliability* covers the users' perception whether the IT artifact could be relied to perform its task. Since IT artifacts are comparable to tools to support its users to achieve a certain goal, it is important that they can be relied upon. Otherwise the users will abandon the IT artifact (Muir 1994).

For the process dimension we use the five formative indicators: user *authenticity*, *understandability*, *predictability*, *confidentiality*, *authorized data usage*, and *data integrity*. *User authenticity* covers the users' perception that no one can act in his name unauthorized. This is important, since e.g., in Muir's (1994) nuclear power plant example, only specific users will have access to view or change specific important or sensible data. *Understandability* covers the users' perception regarding his understanding on how the IT works, e.g. in the case of Wang and Benbasat (2005) how recommendations of suitable digital cameras are generated. This is important, since e.g., the work of Spiekermann (2007) indicate that the users want to understand how a specific technology – in her case RFID – works. Otherwise they are unable to recognize malfunctions of a system (see e.g., Lee and See 2004) *Predictability* covers the users' perception how good he is able to predict the next action of the IT artifact. Since the users want to understand how an IT artifact works and perceive themselves as being in control, it is important for the users to predict the next actions of a system to some degree (Muir and Moray 1996). *Confidentiality* covers the users' perception that he can control who else is able to access which of his data (e.g., Pfleeger and Pfleeger 2011). This is also related to the users' wish to understand how an IT artifact works, and being in control. *Data integrity* covers the users' perception that his personal data cannot be changed without being noticed (e.g., Pfleeger and Pfleeger 2011). This is important, since the users' personal data are usually used to provide tailored information or recommendation, so each user wants to be in control of the data used.

For the purpose dimension, we use the four formative indicators: *authorized data usage, benevolence of the designers*, and *faith*. *Authorized data usage* covers the users' perception whether the data he provides is only used as indicated or expected (e.g., Andress 2011). This is important, since by providing his data, the user makes himself vulnerable to possible misuse of his data by the recipients. *Benevolence of the designers* covers the users' perception whether the designers of the IT artifact keep the interests of the users in mind. This is important, since it would be possible that, e.g., the recommendation system as used by Wang and Benbasat (2005) always recommends cameras of a certain company, since they pay the designers of the recommender system, ignoring the interests of the user. *Faith* covers the users' perception whether the IT artifact can be relied upon in the future. Our complete formative first-order, formative second-order measurement model for trust in IT artifacts is presented in Figure 2.

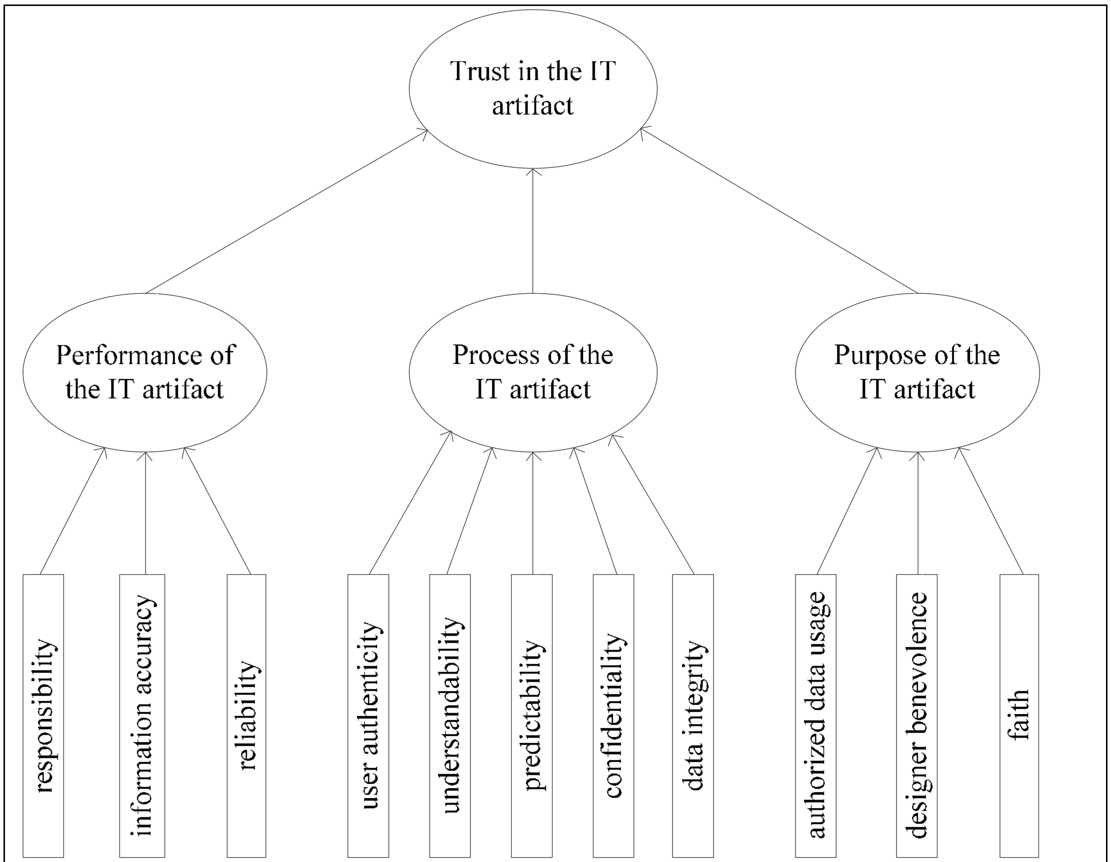

Figure 2. Formative first-order, formative second-order measurement model for trust in IT artifacts

Research Method

We used a laboratory experiment with 284 undergraduate business students to evaluate the impact of the single indicators and dimensions on trust in IT artifacts using our formative first-order, formative second-order measurement model for trust in IT artifacts. This decision is based on the fact that using a laboratory experiment, we are able to control for external factors, since all participants were in the same environment, used the same mobile application on the same devices, and completed the same tasks. The participants used a mobile application that was developed within a multi-disciplinary research project. The mobile application allows its users to organize and manage meetings which can take place at public or private events, such as watching a movie in the cinema or visiting a birthday party. It supports the whole process for creating an event, and inviting friends (e.g., by recommending friends with fitting preferences), from traveling to the event (e.g., by reminding the user that he has to leave in 10 minutes if he wants to be at the event in time), to visiting the event (e.g., by providing a map of the points of interest at the event). Additionally, the mobile application can also be used to generate recommendations for suitable and available events, based on the preferences of the user. Consequently, the mobile application is a tool for supporting its user in creating and managing events, and takes the role of a trustee in the trust relationship between the user and the mobile application. Within the laboratory experiment, the students received information on the idea of the system, how it works, and how to interact with the application. Afterwards, the students were asked to complete four predefined tasks using the mobile application, ensuring that participants recognized all functionalities of the system. It took participants about 25 minutes to complete the tasks. The following sections provide information regarding our data collection and analysis techniques, measurement instrument, as well as actions taken to prevent common method variance.

Data Collection and Analysis Techniques

After the participants completed their tasks, they were asked to fill out a questionnaire, including the statements as presented in Appendix 1. Responses were recorded on a bipolar 9-point Likert response format, with the endpoints labeled as "extremely disagree" and "extremely agree," and participants could answer "I do not know" when they did not want to rate a statement. To achieve high quality results, we implemented several reverse coded items into the questionnaire, and checked all cases regarding the consistence of the answers given to the items relevant for our data analysis and the reverse coded control items. We decided to use the PLS approach (Chin 1998) to analyze our data, since the PLS algorithm is better suited to analyze models including formative indicators (Chin and Newsted 1999; Ringle et al. 2012). We used SmartPLS 2.0 (Ringle et al. 2005) and SPSS 20 as the tools for our analysis. To assess the quality of our formative first-order, formative second-order measurement model, we use a redundancy analysis as used in Chin (1998), and recommended by Cenfetelli and Bassellier (2009), and Ringle et al. (2012) for assessing the quality of a newly introduced formative measurement model. For conducting our redundancy analysis, we follow Cenfetelli and Bassellier (2009), and modeled the three dimensions as separate exogenous latent construct with formative indicators and trust as our endogenous latent construct with reflective indicators.

Instrument Development

For conducting a redundancy analysis, we need to measure trust in a formative as well as reflective way. Since the reflective measurement serves as a benchmark for assessing the quality of the formative measurement model, we used indicators that were recently reported in major journals, and not mis-specified based on the guidelines of Jarvis et al. (2003) and Petter et al. (2007). The formative indicators were already identified in the previous section. If accessible, we used the statements as provided in the original sources of the indicator. Otherwise, we formulated new indicators based on the definition of the indicators as provided in the previous section. All statements including their sources, mean values and standard deviations can be found in Appendix 1.

Common Method Variance

Recently, a number of researchers have brought up the problem of common method variance in behavioral research (Podsakoff et al. 2003; Sharma et al. 2009). These publications point out that a significant amount of variance explained in a model is attributed to the measurement method rather than to the constructs the measures represent (Podsakoff et al. 2003). In extreme cases even more than 50% of the explained variance can result from common method variance (Sharma et al. 2009). Due to the fact that we used only one data source and gathered the data for the exogenous and endogenous constructs from the same participants, our study could have been affected by common method variance (Podsakoff et al. 2003). To account for this problem, we followed the guidelines of Podsakoff et al. (2003), and used procedural as well as statistical remedies to reduce and assess the probability that common method variance impacts the results of the laboratory experiment.

Regarding the procedural remedies, we first assured anonymity to the participants by explicitly stating in the introduction of the questionnaire that all answers would be anonymous, and no relationship between any answers and a participant would be established. Second, the introduction also stated that there are no right or wrong answers, emphasizing that we were interested in the participants' honest opinion. Third, we provided verbal labels for the extreme points and the midpoints of the scales. Fourth, we developed a cover story for the questionnaire in order to make it appear to the participants that the exogenous and endogenous constructs were not connected.

Regarding the statistical remedies, we conducted the Harman' single factor test and extracted three factors with an eigenvalue greater than 1. In this test, all indicators are included in an exploratory factor analysis, and the result is crucial regarding the existence of common method variance, if only a single factor emerges or if one general factor emerges accounting for the majority of covariance among the indicators. Since in our analysis three factors with an Eigenvalue higher than 1 could be extracted, according to this test, common method variance is not a problem in our study (Podsakoff et al. 2003).

Results

Because we use a reflective measurement model for trust as a benchmark for our formative measurement model (Cenfetelli and Bassellier 2009), we first need to assess the quality of the reflective measurement model. We check the average variance extracted (AVE), the composite reliability and the indicator loadings as quality criteria (Chin 1998; Gefen et al. 2011). Due to the fact that we only have one reflective construct, we do not need to check for cross-loadings or the correlation between the reflectively measured constructs. The evaluation showed that all values were well above the necessary thresholds. The AVE for trust was 0.7810(> 0.5), the composite reliability for trust was 0.9144 (> 0.6), and the lowest indicator loading was 0.8249 (> 0.7). Thus, the reflective measurement is suitable to serve as a benchmark for our formative measurement model.

Table 1. VIF, Factor Weights, p-value and Factor Loadings for the Indicators of the Formative Measurement Model.

Construct	Indicator	VIF	Factor Weights	p-value
Performance	Responsibility	2.158	0.211	< 0.05
	Information accuracy	1.697	0.209	< 0.05
	Reliability	2.631	0.718	< 0.001
Process	User authenticity	1.681	0.340	< 0.001
	Understandability	1.585	0.211	< 0.01
	Predictability	1.485	0.152	< 0.05
	Confidentiality	2.052	0.371	< 0.001
	Data integrity	2.143	0.316	< 0.001
Purpose	Authorized data usage	2.373	0.593	< 0.001
	Designer benevolence	1.638	0.253	< 0.001
	Faith	2.548	0.374	< 0.001

After having shown that the reflective measurement model fulfills the desired quality criteria, we now focus on the evaluation of the formative first-order, formative second-order measurement model. We will start with the formative second-order part of our measurement model. For this evaluation, we rely on the six guidelines for evaluating formative measurement models presented by Cenfetelli and Bassellier (2009); a summary of the key indicators is presented in Table 1. According to the first guideline, we checked for multicollinearity by computing the Variance Inflation Factor (VIF). The results show that multicollinearity is not a problem in our study because the highest VIF value (2.631) is below the limit of 3.33 (Diamantopoulos and Siguaw 2006). In their second guideline, Cenfetelli and Bassellier (2009), state that a large number of indicators could cause many non-significant weights. Since we observed no non-significant weights (at the level of 0.05), this issue is not a problem in our study. The third guideline deals with the co-occurrence of positive and negative weights. Due to the fact that we did not observe any indicator with a negative weight, there was no need to worry about this point in our study (Cenfetelli and Bassellier 2009). Guideline four suggests that researchers should check the indicator loadings when finding indicators that have only a small indicator weight. As a reason, they suggest that the indicator could have only a small formative impact on the construct (shown by a low weight), but it still could be an important part of the construct (shown by a high loading). Since all factor weights are significant, there is empirical support to keep all indicators, thus, we do not need to check the indicator loadings (Cenfetelli and Bassellier 2009). In the fifth guideline, Cenfetelli and Bassellier (2009) recommend testing for nomological network effects and construct portability. They suggest comparing the factor weights of the indicators across different studies. Due to the fact that, to the best of our knowledge, this is the first study using these indicators and dimensions to assess trust in IT artifacts. We cannot compare the factors weights across different studies. Nevertheless, for this particular case, Cenfetelli and Bassellier (2009) and Ringle et al. 2012) recommend using a redundancy analysis to assess the validity of the formative measurement model, as a substitute. The results of our redundancy analysis will be presented in the subsequent paragraphs. The sixth guideline cautions that the indicator weights can be slightly inflated when using the PLS technique (Cenfetelli and Bassellier 2009). As we used the PLS technique, this is a limitation of our study. In summary, the evaluation of the formative second-order part of our measurement model shows that this part fulfills the requirements posed by the guidelines of Cenfetelli and Bassellier (2009).

We can now confidently turn to the evaluation of the formative first-order part of our measurement model. Here, we observed that all three dimensions of trust in IT artifacts had a significant impact on trust, with purpose (0.356, $p < 0.001$) being the most important dimension, followed by process (0.337, $p < 0.001$), and performance (0.233, $p < 0.001$).

For finally evaluating our whole formative first-order, formative second-order measurement model for trust in IT artifacts, we conduct a redundancy analysis using an evaluated reflective measurement model as a benchmark. As stated above, our reflective measurement model fulfills all the necessary quality criteria, and thus may serve as a benchmark. The observed R^2 value of trust in IT artifacts is 0.673, which is a good result since a formative measurement model for a construct should at least explain 64% of the variance of the reflectively measured benchmark (Chin 1998). Based on this evaluation, we can conclude that our formative first-order, formative second-order measurement model fulfills all the quality criteria. Consequently, we can state that the conceptualization used for developing our formative first-order, formative second-order measurement model is suitable for studying trust in IT artifacts. The results of the whole evaluation are summarized in Figure 3.

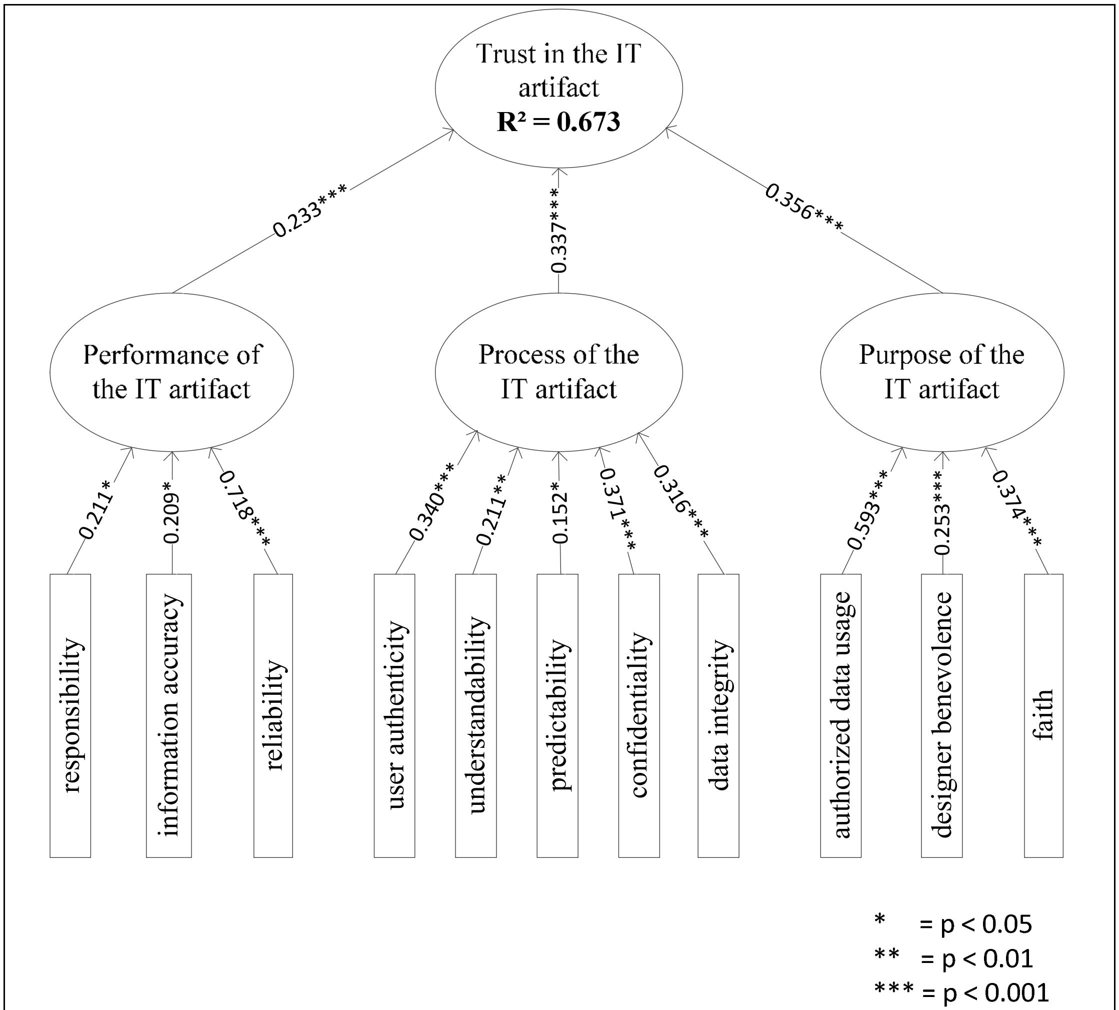

Figure 3. Evaluated measurement model.

Discussion

Our paper makes several important contributions. For answering our first research question, we compare the suitability of two theoretical conceptualizations for studying trust relationships between users and IT artifacts. We conclude that the conceptualization of trust in automation from the HCI discipline is more suitable for studying such kinds of trust relationships than the foundations of interpersonal trust. Our main argument is that IT artifacts cannot be compared to human beings in a way necessary for relying on the foundation of interpersonal trust. In line with Gefen et al. (2008), we argue that the "computers are social actors" paradigm has its limitations, and even if the paradigm holds, it remains questionable whether the interpersonal dimensions of trustworthiness – ability, benevolence and integrity – can be used to assess trust in IT artifacts, since they rate human character traits. We argue in particular that benevolence - the decision whether to keep the interests of the trustor in mind or not (Mayer et al. 1995) – cannot be made by an IT artifact, since it follows predefined algorithms or logic, and cannot actively make decisions like human beings. This argumentation is backed by the results of Riedl et al. (2011), who showed that the human brain distinguishes between humans and human-like avatars, e.g., by attributing different characteristics to a human compared to a human-like avatar. As a consequence, we use the three dimensions from Lee and Moray (1992) – performance, process and purpose – to assess trust in IT artifacts, since these dimensions are conceptualized to rate characteristics of technology.

Using this theoretical foundation, we were able to develop a formative first-order, formative second-order measurement model that explains 67.3% of the variance in trust in IT artifacts which is a good result based on Chin's (1998) statement that a formative measurement model should explain at least 64% of a construct's variance.

We are aware of the fact that this R^2 value is high, compared to R^2 values reported in other studies throughout the IS discipline. Consequently, we addressed the common method variance issue raised by Podsakoff et al. (2003), and Sharma et al. (2009), and used procedural remedies prior to data collection to prevent the occurrence of common method variance, and the Harman' single factor test afterwards to check for common method variance. The results of the test indicate that common method variance is not a serious issue in our study. Although it is hardly possible to ensure that common method variance is no problem at all in a study, we argue that common method variance is not a significant problem in our study.

We are aware of the fact that the discussion about the best theoretical foundation for studying trust in IT artifacts is an ongoing and vivid discussion within our discipline. Based on our study, we cannot prove that the theoretical foundation we have chosen is the better one. Nevertheless, the results of our study show that it is suitable for studying trust in IT artifacts, since it explains a high amount of variance.

Since one aim of our study was to create detailed insights on the formation of trust in IT artifacts, we argued that a formative first-order, formative second-order measurement model is best suited to achieve this goal. Consequently we developed such a formative measurement model, using existing theoretical insights on trust in automation, as well as insights from privacy and security research. The evaluation of our measurement model shows that it fulfills Cenfetelli and Bassellier's (2009) guidelines for a valid and reliable formative measurement model. Regarding the impact of the single dimensions on trust in IT artifacts (see Figure 3), we show that all dimensions had a significant and comparable impact, with purpose having the highest impact, followed by process and performance. This result confirms our assumption that the three dimensions from trust in automation are our suitable for studying the formation of trust in IT artifacts.

When checking the impact of the single indicators, we can observe that among the six indicators with the highest impact on their dimensions are four indicators related to the user data: user authenticity, confidentiality, data integrity and authorized data usage. We argue that this reflects that task-solving alone is no longer the most important aspect as observed, e.g., by Muir and Moray (1996), but the "how?" is becoming increasingly important. The users of course expect an IT artifact to help them achieve their goal, but they also want to be able to understand, and in some way control how the support is provided.

Our results help designers of IT artifacts taking the trustee role by identifying the importance of single factors for the formation of trust. Information on how these factors can be addressed during IT artifact design is provided by other studies. For example, our results suggest that confidentiality and authorized data usage are crucial for the formation of initial trust. Wang and Benbasat (2007) showed that explanations help reducing the information asymmetry between a user and an online recommender agent, thus increasing the users' trust in the generated recommendations. Focusing on website design, e.g., Cyr et al. (2009) found out that a high level of perceived social presence will increase a user's trust in the website, and that a high level of perceived social presence can be reached by increasing the human appeal of a website. Furthermore, Riedl et al. (2011) studied whether users' have a higher trust in humans or human-like avatars, and found out that users trust both to a similar degree. Combining these insights, detailed design implications for designers of IT artifacts can be derived. Since it is hard for the users to follow whether he can really control who is able to access his data, and whether their data are used only for the intended purposes, the IT artifact should provide explanations regarding how confidentiality, and authorized data usage are ensured. Since human appeal increases perceived social presence, and by thus the users' trust, these explanations should be provided by either a human or a human-like avatar, since both increase the human appeal of the IT artifact, and do not different regarding the degree of trust. Since we studied the formation of initial trust, this explanation of a human or human-like avatar should be presented right when the user starts using the IT artifact.

This example demonstrates the contribution of our results as well as the interplay with existing insights. Our results on the formation of trust in IT artifact provide detailed insights on what factors should be addressed to create trust. Based on our results we can derive that an IT artifact needs to be, e.g, reliable, provide accurate information, should ensure that the users' data are safe, and only used for the intended purposes, and we know roughly, how important each of this factors is. These insights needs to be enriched by existing works focusing on "how" such factors should be addressed. Consequently, we contribute to IS research by providing detailed information on which factors should be addressed to build trust. This also contributes to practice, since detailed design implications empowering designers to design more trustworthy IT artifacts can be derived.

Limitations and Future Research

This study is not without limitations, which also provide opportunities for future research. Trust building is a dynamic process (see e.g., Lewicki and Bunker 1996 and Singh and Sirdeshmukh 2000), and we focused on initial trust in this study. Consequently, the results are limited to this trust building phase. Insights on interpersonal trust (see e.g., Rempel et al. 1985) showed that the importance of the single dimensions changed as the relationship matures. This observation could also hold for relationship between users and IT artifacts. Thus, future research should empirically investigate whether the importance of single dimensions or indicators change as the relationship matures.

We accounted for the increasing importance of privacy and security issues regarding the users' data, by integrating related indicators into our formative first-order, formative second-order measurement model. Nevertheless, we are aware of the fact that not all IT artifacts taking the role of a trustee in a trust relationship between an user and an IT artifact include the provision of user data. Using a navigation system, e.g., does not include the provision of a comparable amount of user data like, e.g. using Facebook. Consequently, our measurement model for studying the formation of trust in IT artifacts needs to be adapted when studying IT artifact taking the trustee role, but work without user data.

To the best of our knowledge, this study is the first to use insights on trust in automated systems to build a formative first-order, formative second-order measurement model for trust in IT artifacts. Even though we reviewed a huge number of contributions, and the statistical results are good, we cannot rule out that there are additional formative indicators that should be included in the measurement model. As a result future research should identify additional formative indicators, and test whether they enrich our model.

Furthermore, numerous recent contributions on trust have shown that factors like gender and culture affect trust (see e.g., Awad and Ragowsky 2008; Cyr 2008; Gefen and Ridings 2005; Kim 2008; Riedl et al. 2010; Vance et al. 2008). Since we did not control for gender or cultural effects, this is a limitation of our study. Future research should investigate whether factors like gender or culture affect, e.g. the impact of single indicators on the dimensions or the impact of the dimensions on trust.

Additionally, some portion of the indicator weights should be expected to vary based on the structural model the construct is embedded in (Diamantopoulos and Siguaw 2006; Howell et al. 2007). As Cenfetelli and Bassellier (2009) point out, large changes would indicate a lack of portability of the construct and thus threaten the generalizability of the formative measurement model. Since we developed our formative first-order, formative second-order measurement model for trust in IT artifacts in this paper, and applied it for the first time using a redundancy analysis, we cannot test for construct portability. Nevertheless, Cenfetelli and Bassellier (2009) point out, that conducting a redundancy analysis is the right choice when a new formative measurement model is introduced. Furthermore Ringle et al. (2012) recently called for using a redundancy analysis for testing the construct validity when using a formative construct. Consequently, our approach to use a redundancy analysis to assess the quality of our formative measurement model was right, but future research should embed the model in different structural models to test for construct portability and generalizability.

Finally, several limitations are caused by our research method used to evaluate our model that might threaten the external validity of the study. First, for collecting our data we conducted a laboratory experiment with undergraduate business students. To the extent that undergraduate business students are typical of users of IT artifacts, the results will hold across are more general population (Gordon et al. 1986). Remus (1986) found that business students were good surrogates for managers, but we could not find any insights regarding their suitability to serve as surrogates for users of IT artifacts in general. Second, we used only one particular IT artifact – a mobile application –, and one usage setting to collect our data. When reviewing other papers this is common practice, nevertheless it remains to be confirmed that the results hold across different IT artifacts, and different laboratory settings, as well as other types of studies (e.g., field studies).

Conclusion

In this paper, we aim at deepening our understanding on the formation of trust in IT artifacts taking the role of a trustee in a trust relationship between a user and an IT artifact. Therefore, we discuss the suitability of two possible theoretical foundations for studying the formation of trust in IT artifacts, and identify the impact the dimensions of trust and their single indicators have on the formation of trust in IT artifacts. We provided arguments that theory on trust in automated systems seems better suited to study trust in such IT artifacts, since this theoretical foundation is a) designed to study trust relationship between users and technical systems and b) because the dimensions of Lee and Moray (1992) all rate characteristics of a technical system. Based on this theory, we built a formative first-order, formative second-order measurement model for trust in IT artifacts, since this approach allows us to created very detailed insights on the formation of trust. The results of the evaluation of our model show that the theoretical foundation chosen is suitable for studying the formation of trust in IT artifacts. Our results show that the dimensions performance, process and purpose have a comparable impact on trust, and that indicators related to user data are especially important. Whereas our results contribute to IS trust research by pointing out, what factors are important for the formation of trust, existing studies provide insights on how these factors should be addressed. Consequently, combining our results and existing insights leads to a more detailed understanding of the formation of trust in IT artifacts taking the trustee role, allowing the derivation of detailed design implications for IT artifact designers.

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Appendix A. Indicators Used in the Study.				
Indicator	Statement	Source	Mean	Standard deviation
Performance (formative)				
Responsibility	______ has all functionalities needed to fulfill its goal.	Adapted from Muir and Moray (1996)	6.35	1.75
Information accuracy	I can count on the information provided by ______ to be accurate.	Developed based on the definition on Page 5.	6.74	1.58
Reliability	I can rely on ______ to work.	Developed based on the definition on Page 5.	6.32	1.81
Process (formative)				
User authenticity	I think that no one can pretend to be me within the ______ environment.	Developed based on the definition on Page 6.	4.49	2.39
Understandability	I understand how ______ works.	Developed based on the definition on Page 6.	6.69	1.97
Predictability	During usage, I can anticipate what ______ will probably do next.	Adapted from Muir and Moray (1996)	5.35	1.93
Confidentiality	I can control which user can access which of my data.	Developed based on the definition on Page 6.	5.54	2.1
Data integrity	I think that no one can change my data unauthorized without being noticed.	Developed based on the definition on Page 6.	5.53	2.35
Purpose (formative)				
Authorized data usage	I think that my data is used for delivering the services _______ offers.	Developed based on the definition on Page 6.	5.69	2.17
Designer benevolence	I think that the designers of _______ want to help me in achieving my goal.	Developed based on the definition on Page 7.	7.23	1.69
Faith	I think ______ will be an useful tool for planning and managing events in the future.	Adapted from Muir and Moray (1996)	6.75	1.73
Trust (reflective) for redundancy analysis				
Trust1	_______ is trustworthy.	Adapted from Gefen (2002)	5.77	1.91
Trust2	I have a good feeling when relying on _______.	Adapted from Komiak and Benbasat (2006)	5.29	2.06
Trust3	I can trust the information presented by _______.	Adapted from Cyr et al. (2009)	5.85	1.87