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Towards a Formative Measurement Model for Trust

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Towards a Formative Measurement Model for Trust

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Abstract

IS research has shown the importance of trust in domains such as e-commerce or technology acceptance. Researchers also emphasize the importance of the identification of factors that influence trust. Unfortunately, the currently dominant reflective measurement does not offer these insights, and thus this contribution aims at developing a formative measurement model for trust. To achieve this, we address three research questions: a) How can trust be measured, considering trust and measurement theory? b) What indicators should be included in a formative measurement model for trust? c) What is the value of a formative measurement of trust compared to a reflective one? Our results show that the formative measurement model offers detailed insights on the impact of single factors influencing trust. We show that in our study, ability affects trust over twice as much other factors such as benevolence or trustor's propensity.

Keywords: Trust, Structural Equation Modeling, Formative Measurement Model

1 Introduction

When research commences in a new field it is common to build on previous work and to trust former results that are reported in several publications. As we started our research

on trust, we found that many researchers emphasize the need for insights on factors that build (Gefen, Karahanna & Straub 2003), support (Leimeister, Ebner & Krcmar 2005) or create (Bart et al. 2005) trust. Due to this emphasis, we expected many promising contributions that addressed this need. Unfortunately, we found only few answers in previous literature concerning the factors influencing trust.

This lack is confirmed also by an examination of Petter, Straub and Rai (2007) who showed a lot of incorrectly specified measurement models in IS research. The authors confirmed Bollen's (1989) suggestion that in many cases a formative measurement model would be more appropriate than the often used reflective models. Additionally, Albers (2009) argues that formative measurement models are better suited to finding the factors influencing a construct. Thus, a formative measurement model seems best suited to find factors that build, support or create trust.

The aim of this contribution is to show how a current reflective measurement model of trust can be transformed into a formative one, and the surplus of explanation that can be achieved by this change. The remainder of this paper is structured as follows. We present theory on trust and construct measurement, and derive a formative measurement model of trust. Next, we provide our underlying hypotheses and data gathering details of the study. Thereafter, we present and discuss the results. The contribution closes with a conclusion and a call for future research.

2 Trust

The word trust is widely used in everyday language, and the concept trust is addressed by many different disciplines in many different contexts. The multifarious (Abdul-Rahman & Hailes 2000; Ebert 2009) occurrence of trust leads to different definitions depending on the point of view.

Regardless of the discipline, the common core of trust definitions are positive expectations and vulnerability (Rousseau et al. 1998). We build upon the well accepted remarks and the often cited definition of Mayer, Davis and Schoorman (1995, p. 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." Further, the authors differentiate between antecedents and consequences of trust.

Antecedents represent factors that cause the trustor to trust the trustee. This decision is based on characteristics of the trustee as well as the trustor's general propensity to trust. These antecedents – ability, benevolence, integrity and trustor's propensity – are shown in Mayer, Davis and Schoorman's (1995) trust model (Figure 1).

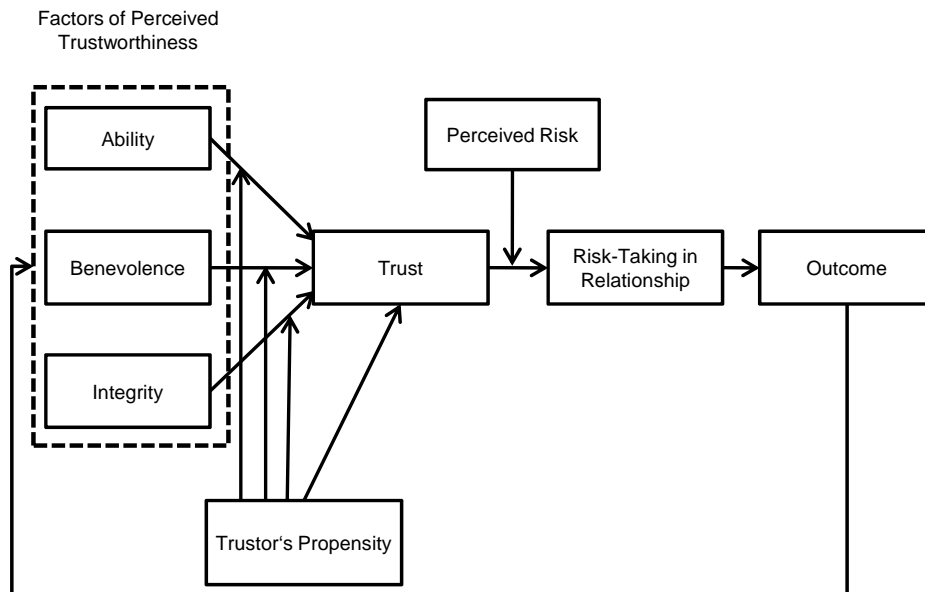


Figure 1: Trust Model based on Mayer, Davis and Schoorman (1995)

Ability is that group of skills, competencies and characteristics that enable the trustee to have influence within a specific domain. Benevolence is the extent to which the trustee is believed to want to do good to the trustor, in addition to focusing on his own profit. Integrity represents the trustor's perception that the trustee follows a set of principles that the trustor finds acceptable. The trustor's propensity is an expectancy held by an individual or a group that the promises or statements of others can be relied upon (Mayer, Davis & Schoorman 1995).

According to Mayer, Davis and Schoorman (1995), the consequence of trust is risk-taking in relationship. This term represents a group of actions that depend on the situation that the trustor is in. As an example, Mayer, Davis and Schoorman (1995) describes a supervisor who allows an employee to handle an important account rather than handling it personally. Another example could be the decision to transact with an online store (Gefen, Karahanna & Straub 2003).

3 What do we need to determine trust in IS research?

IS research has shown the importance of trust, as, for example, in e-commerce (Gefen & Straub 2004), virtual organizations (Leimeister, Weigle & Krcmar 2001) and technology adoption (Gefen, Karahanna & Straub 2003; Resatsch et al. 2008). In the cited examples, trust is an important root of acceptance. Thus, the main tasks in trust research are trust building (Gefen, Karahanna & Straub 2003), trust support (Leimeister, Ebner & Krcmar 2005) and the identification of factors for the creation of trust (Bart et al. 2005). In other words, we need to find and promote the antecedents of trust.

3.1 Different Types of measurement models

To find an appropriate measurement model for trust, we now compare the different types of measurement models. Trust is usually measured as a latent variable (Söllner & Leimeister 2010a). Figure 2 presents the two different types of measurement models which are prevalent in the literature.

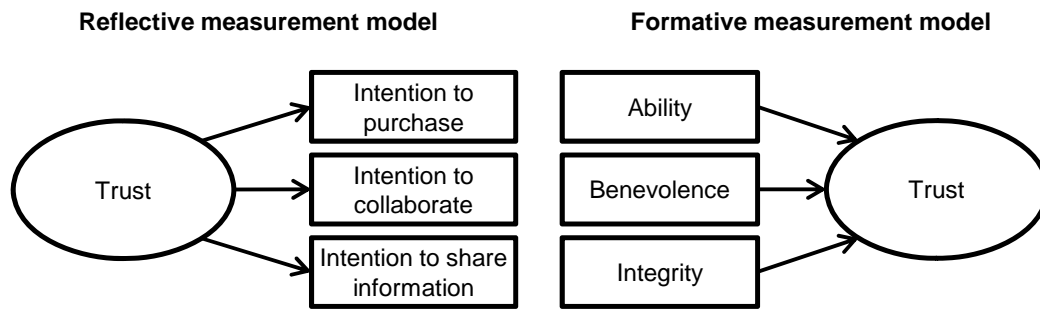


Figure 2: Types of Measurement Models

In the principal factor (reflective) model, the covariation among the indicators is caused by, and thus reflects, variation in the underlying latent factor. In the composite latent variable (formative) model, changes in the indicators are hypothesized to cause changes in the underlying latent variable (Jarvis, Mackenzie & Podsakoff 2003).

Based upon the theoretical differences, Jarvis, Mackenzie and Podsakoff (2003) have created guidelines to decide whether a measurement model should be interpreted as being reflective or formative (Table 1).

	Formative model	Reflective model
1. Direction of causality from construct to indicators implied by the conceptual definition	Direction of causality is from indicators to construct	Direction of causality is from construct to indicators
2. Interchangeability of the indicators	Indicators need not be interchangeable	Indicators should be interchangeable
3. Covariation among the indicators	Not necessary for indicators to covary with each other	Indicators are expected to covary with each other
4. Nomological net of the construct indicators	Nomological net for the indicators may differ	Nomological net for the indicators should not differ

Table 1: Summary of the decision rules provided by Jarvis, Mackenzie and Podsakoff (2003)

3.2 Which measurement model for trust?

According to these criteria, we now check whether a reflective or a formative measurement model is appropriate to measure the factors influencing trust.

First, we need to investigate the direction of causality between the latent variable and the indicators. The measurement model is a reflective model if the causality flows from the latent variable to the indicators, and is a formative model if it flows from the indicators to the latent construct. The model provided by Mayer, Davis and Schoorman (1995) shows that the flow of causality comes from the following antecedents: ability, benevolence, integrity and trustor’s propensity leading to trust (Figure 1). From trust, the causality proceeds to the consequences of trust which are grouped as risk-taking in relationships. Following the criteria by Jarvis, Mackenzie and Podsakoff (2003) presented above (Table 1), a formative measurement model has to be used to measure trust using indicators such as ability, benevolence, integrity and the trustor’s propensity.

Second, we have to determine whether the indicators are interchangeable or whether dropping an indicator causes a conceptual problem. For reflective measurement models, the indicator should be interchangeable because a change in the latent variable causes changes in all of the indicators. Due to the fact that formative indicators define and cause the latent variable, they cannot be interchangeable. Dropping an indicator would change the definition of the latent variable. Trust is caused and defined by its antecedents (Figure 1). Thus, a formative measurement model must be used to measure trust using its antecedents because removing one antecedent (e.g., ability) would alter the definition of trust.

Our third step is to investigate whether the indicators should correlate with each other or not. For reflective measurement models, the indicators need to correlate highly with each other because changes in the latent variable are supposed to cause changes in all respective indicators. For formative measurement models, a correlation is not forbidden, but high correlations between two indicators would suggest that both cover a rather similar aspect and therefore could be redundant. In trust, the antecedents are supposed to be separable and should cover different facets of trust (Mayer, Davis & Schoorman 1995). A Formative measurement is thus appropriate, using the antecedents to measure trust.

As a fourth and final step, we investigate the antecedents and consequences of the single indicators. Reflective indicators should all have the same antecedents and consequences because they need to be interchangeable and reflect the whole latent variable. Formative indicators, on the other hand, need not have the same antecedents and consequences because they usually capture different aspects of the whole latent variable. The indicators for trust do not necessarily share the same antecedents. An antecedent of ability is not necessarily an antecedent of benevolence. In summary, a formative measurement model must be used to measure trust using its antecedents (Table 2).

	Trust Model	Measurement
1. Direction of causality	Indicators cause trust	Formative
2. Interchangeability of the indicators/items	No, it would change the nature of trust	Formative
3. Covariation among the indicators	Not necessary	Formative
4. Nomological net of the construct indicators	Antecedents and consequences of the indicators are not necessarily the same	Formative

Table 2: Summary of the four decision rules applied to trust

4 Towards a formative measurement model for trust

Based on trust and measurement theory, we now explain how we derived a simple formative measurement model for trust. Mayer, Davis and Schoorman (1995) provide four factors they consider to be very important for determining trust: the trustee's ability, benevolence, integrity and the trustor's propensity to trust (Figure 1). Guided by this theoretical foundation, we decided to use these four factors to measure trust in a formative way.

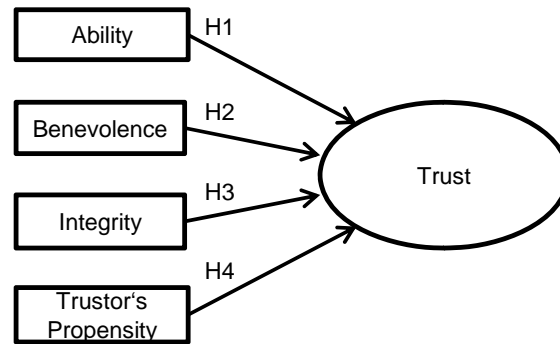


Figure 3: Hypotheses of the formative measurement model

Thus, we test four main hypotheses in our contribution, shown in Figure 3:

- H1: Perceived ability will positively affect trust
- H2: Perceived benevolence will positively affect trust
- H3: Perceived integrity will positively affect trust
- H4: Trustor's propensity will positively affect trust

Using these four measures, we are able to capture the four dimensions that Mayer, Davis and Schoorman (1995) consider to be very important for trust. In this early phase of research, we decided not to include the moderator effects of trustor's propensity on H1 to H3 because it would make the whole analysis much more complex than it contributed to the insights we were actually seeking.

Due to the fact that the problem of measurement model misspecification in IS (Petter, Straub & Rai 2007) also affects trust research (Söllner & Leimeister 2010b), we could not find a correctly specified reflective measurement model for trust to evaluate our formative measurement model using a MIMIC analysis as Chin (1998) did, or Cenfetelli and Bassellier (2009) propose. We thus decided to evaluate our measurement model by including the formative measurement model into the structural model used in Wang and Benbasat (2005), as shown in Figure 4. As our focus was not on the evaluation of the structural paths, we decided not to add additional hypotheses. The structural model served as an example to test our formative measurement model because a formative model cannot be evaluated without any structural relationships (Diamantopoulos, Riefler & Roth 2008).

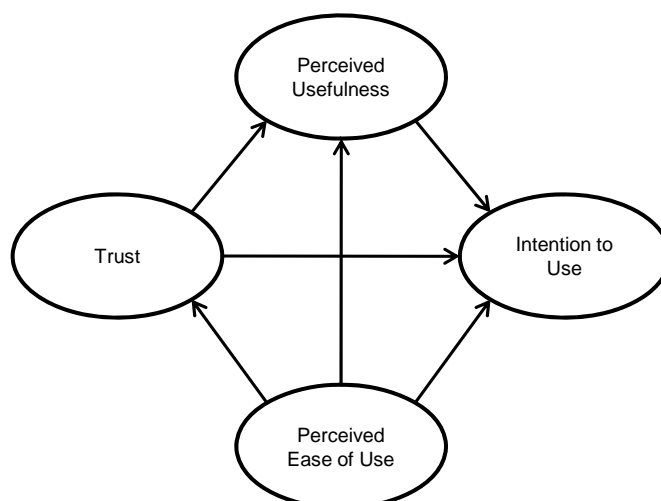


Figure 4: Structural model adapted from Wang and Benbasat (2005)

5 Research Method

To gather the data for our analysis, we conducted an experiment with undergraduate students at a German university. The students were asked to use a mobile phone service that allowed them to gather and share real time recommendations for event locations in an urban area for 10 minutes and requested them to fill out a survey afterwards. Responses were recorded on a seven-point Likert scale, with the endpoints labeled as “extremely disagree” and “extremely agree”, with the additional option for students to answer, “I do not know” when they did not want to rate a statement. In total, we recruited 192 undergraduate students. To achieve high quality results, we decided to exclude all cases where a participant checked “I do not know” even once, as well as cases that were obviously not to be taken seriously (e.g., always “extremely disagree” or “extremely agree”). After eliminating these cases, we had a total of 153 cases that were included in the analysis. Due to the early stage of our research and our interest in factors influencing trust, we decided to use the Partial Least Squares (PLS) approach (Albers 2009; Chin & Newsted 1999). We used SmartPLS 2.0 (Ringle, Wende & Will 2005) as a tool for our analysis.

All measures for the latent variables were adopted from the literature (Table 3). Wang and Benbasat (2005) argue that humans attribute human characteristics to technical artifacts. Following this argumentation, Mayer, Davis & Schoormans' (1995) antecedents of trust are appropriate to measure user's trust in a mobile recommendation service.

Latent Variable	References
Perceived Ease of Use	Kamis, Koufaris and Stern (2008)
Perceived Usefulness	Kamis, Koufaris and Stern (2008)
Intention to Use	Bhattacharjee and Sanford (2006)
Trust (Ability, Benevolence and Integrity and Trustor's Propensity)	Wang and Benbasat (2007)

Table 3: References of measures used

For our formative trust measurement, we decided to use one indicator each for: ability, benevolence, integrity and trustor’s propensity from Wang and Benbasat (2007). This is appropriate because Wang and Benbasat (2007) showed that all trust measurements

were reliable, meaning that every indicator belonging to the same group had a high reliability in measuring its related latent variable.

5.1 Results using the reflective measurement model for trust

To begin the presentation of our results, we highlight the quality criteria for the reflective measurement models to assess the reliability of our measurement. Similar to Wang and Benbasat (2005), we used the factor scores as indicators for the reflective measurement of trust. Table 4 shows the composite reliability (pc) and the cross-loadings for the single indicators (Chin 1998).

	Perceived Ease of Use (pc = 0.9747)	Intention to Use (pc = 0.9841)	Trust (pc = 0.9058)	Perceived Usefulness (pc = 0.9824)
eou1	0.9623	0.2689	0.3361	0.3606
eou2	0.9708	0.3226	0.3385	0.3653
eou3	0.9563	0.3155	0.3216	0.3734
int1	0.3117	0.9759	0.6462	0.5929
int2	0.2968	0.9821	0.6457	0.6047
int3	0.3129	0.9719	0.6496	0.5937
Ability	0.3851	0.6558	0.9360	0.7560
Benevolence	0.2826	0.5599	0.8940	0.6172
Integrity	0.2092	0.5063	0.7835	0.4836
use1	0.3888	0.5929	0.7164	0.9672
use2	0.3743	0.5920	0.7036	0.9736
use3	0.3486	0.6020	0.6912	0.9816

Table 4: Cross-loadings and composite reliability for the reflective measurement

The results presented in Table 1 show that all loadings are greater than 0.707 and every indicator has the highest loading on its desired variable; therefore, the measurement models fulfil the desired quality criteria (Chin 1998). Additionally, we need to check the Average Variance Extracted (AVE) and the correlation among the latent variables. The AVE should be greater than 0.5 and additionally should be greater than any correlation with other latent variables (Chin 1998). The AVE and correlations among the latent constructs are presented in Table 5 and show that the measurement models fulfil these two criteria as well.

	Perceived Ease of Use	Intention to Use	Trust	Perceived Usefulness
Perceived Ease of Use	0.9277			
Intention to Use	0.3145	0.9538		
Trust	0.3447	0.6627	0.7631	
Perceived Usefulness	0.3805	0.6114	0.7225	0.9490

Table 5: AVE and correlation among construct scores (AVE in diagonals) for the reflective measurement

The results of our evaluation of the structural model using the reflective measurement model are shown in Figure 5. The R² scores for intention to use (R² = 0.4788) and perceived usefulness (R² = 0.5417) are both at a moderate level. For trust, the R² score is just 0.1188 and does not even reach the score for a weak level (Chin 1998). A

bootstrapping test shows that direct effect from perceived ease of use on perceived usefulness is significant at the level of 0.05, and the direct effect from perceived ease of use on intention to use is not significant. All other standardized path coefficients are significant at the level of 0.01. These results are now compared with the structural model using our formative measurement model of trust.

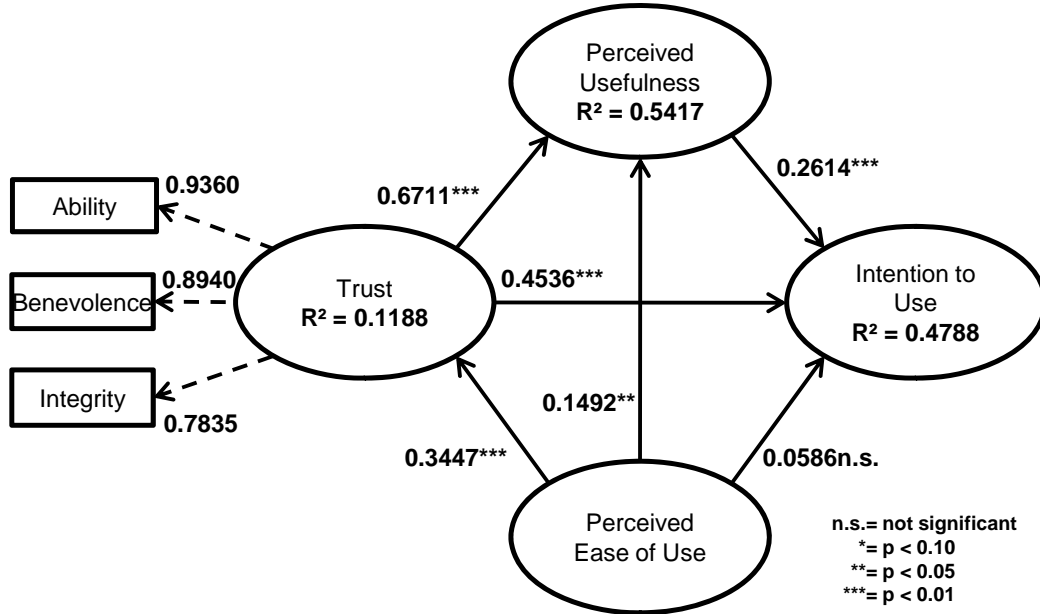


Figure 5: Results of the structural model using the reflective measurement model

5.2 Results using the formative measurement model for trust

Due to the fact that the structural model now includes reflective as well as formative measurements, we need to assess the quality of both kinds of measurement models. We begin with the reflective ones by providing pc, the cross-loading, the AVE and the correlation with other latent variables as above. The results are presented in Table 6 and Table 7, and show that the reflective measurement models are reliable.

	Perceived Ease of Use (pc = 0.9746)	Intention to use (pc = 0.9841)	Perceived Usefulness (pc = 0.9824)
eou1	0.9614	0.2688	0.3605
eou2	0.9707	0.3226	0.3652
eou3	0.9572	0.3155	0.3733
int1	0.3121	0.9762	0.5930
int2	0.2972	0.9821	0.6047
int3	0.3132	0.9715	0.5937
use1	0.3888	0.5929	0.9672
use2	0.3744	0.5919	0.9734
use3	0.3488	0.6020	0.9818

Table 6: Cross-loadings and composite reliability for the formative measurement

	PEOU	Intention	PU
PEOU	0.9276		
Intention to Use	0.3148	0.9538	
PU	0.3805	0.6114	0.9490

Table 7: AVE and correlation among construct scores (AVE in diagonals) for the formative measurement

For the evaluation of our formative measurement model of trust, we follow the guidelines provided by Cenfetelli and Bassellier (2009). According to the first guideline, we need to check if there is multicollinearity among the indicators. Multicollinearity arises from conceptual redundancies and can lead to the misinterpretation of factors as unimportant or invalid facets of the construct’s domain. We computed the Variance Inflation Factor (VIF) to check our measurement model. The highest VIF calculated was 1.822 (Table 8) and was thus below the upper boarder recommended by Diamantopoulos and Siguaw (2006).

The second guideline assumes that a large number of indicators will cause many non-significant weights. Due to the fact that our measurement model consists of only four formative indicators, this test is not necessary.

Guideline three assumes the co-occurrence of negative and positive indicator weights, which could lead to a misinterpretation of the results. In our case, we discovered only positive weights (Table 8), and the suppressor affect was thus not tested.

The fourth guideline discusses the absolute versus the relative indicator contribution. Indicators with an insignificant or low weight can still have an important absolute contribution. All related indicators must be independently assessed from other indicators to prevent misinterpretation of formative indicator results. As the results presented in Table 4 show, the factor weights of *ability*, *benevolence* and *trustor's propensity* are all significant at the level of 0.01. *Integrity*, however, is not found to be significant and the absolute contribution, resembled by the factor loading, is also quite low (Table 8) (Chin 1998). Thus, following Cenfetelli and Bassellier (2009), the theoretical relevance of this indicator should be questioned if similar results are achieved in other studies because a theoretical overlap can be excluded due to the provided trust theory by Mayer, Davis and Schoorman (1995).

Considering the fifth guideline, we were not able to conduct a nomological network analysis to further strengthen our results. A possibility named suggested by Cenfetelli and Bassellier (2009) is to conduct a MIMIC analysis to assess how well the new formative measurement model captures the facets of a well defined reflective measurement model. We decided not to conduct such an analysis because based upon our trust and measurement theory, the reflective measurement model used by Wang and Benbasat (2005) is mis-specified, because they used antecedents instead of consequences of trust for a reflective measurement. Thus, it is inappropriate as benchmark for the formative model. Nevertheless, future research should address this lack and include the nomological network analysis in its analysis.

According to the last guideline, we need to mention that the choice of the PLS technique can lead to inflated weights (meaning that they are slightly higher compared to using a CB technique).

	VIF	Factor Weights	p-value	Factor Loadings
Ability	1.822	0.7125	<0.01	
Benevolence	1.630	0.2844	<0.01	
Integrity	1.448	0.0513	>0.50	0.5788
Propensity to trust	1.004	0.2009	<0.01	

Table 8: VIF, factor weights, p-value and factor loadings for the formative measurement model of trust

After showing that our measurement model fulfils the guidelines (guideline 5 could not be tested) of Cenfetelli and Bassellier (2009), we now continue with the interpretation of the structural model (Figure 6).

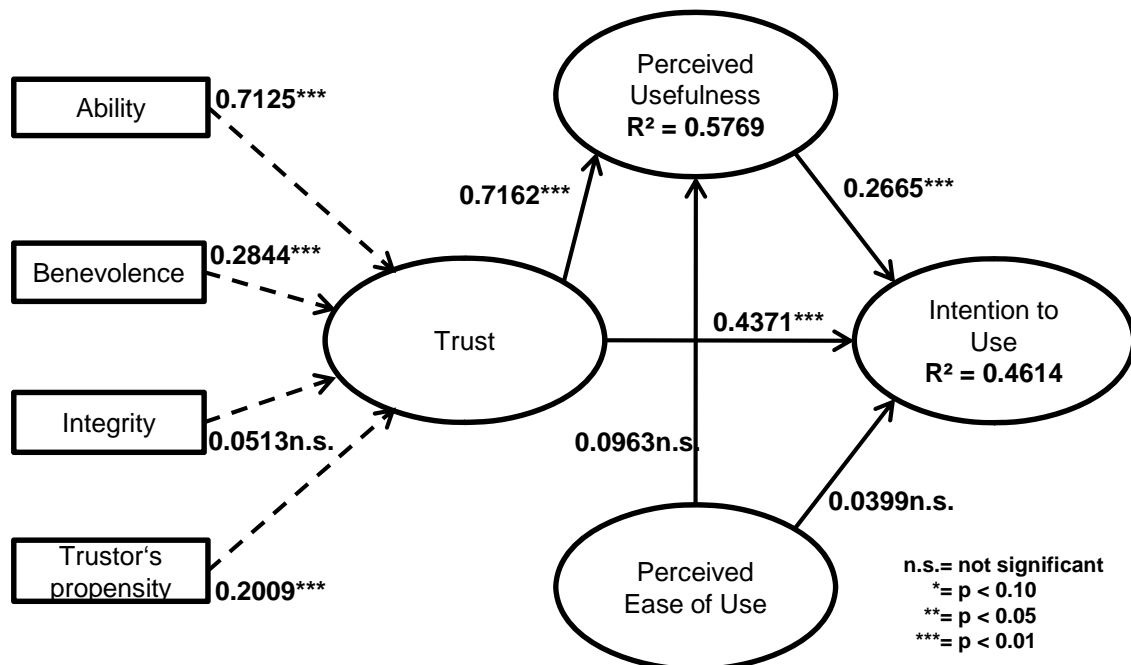


Figure 6: Results for the structural model using the formative measurement model

First, we need to mention that we had to alter the model due to the formative nature of our trust measurement. As described in the theory section, the formative indicators are

said to define the variable they are measuring. It is thus not theoretically correct to model trust as an endogenous latent variable because this would mean that trust would be influenced by factors other than its indicators (Diamantopoulos, Riefler & Roth 2008). Accordingly, we removed the structural path between *perceived ease of use* and *trust*.

Concerning the evaluation of the structural model, the R^2 of *perceived usefulness* ($R^2 = 0.5769$) and *intention to use* ($R^2 = 0.4614$) are again at a moderate level. With regards to the standardized path coefficients, we need to mention that both paths from *perceived ease of use* to other latent variables were found to be not significant. In contrast, the three other paths are all significant at the level of 0.01. The value of the formative measurement model is now discussed by comparing the formative with the reflective measurement model.

6 Discussion

First, we need to mention a few limitations of our contribution. We had only students as participants and thus the results and the interpretation are limited to this group and cannot be generalized. Nevertheless, we do not consider this to be a problem because the aim of our contribution was not to achieve a statement of cause and effect concerning the structural model but to show the value of a formative measurement.

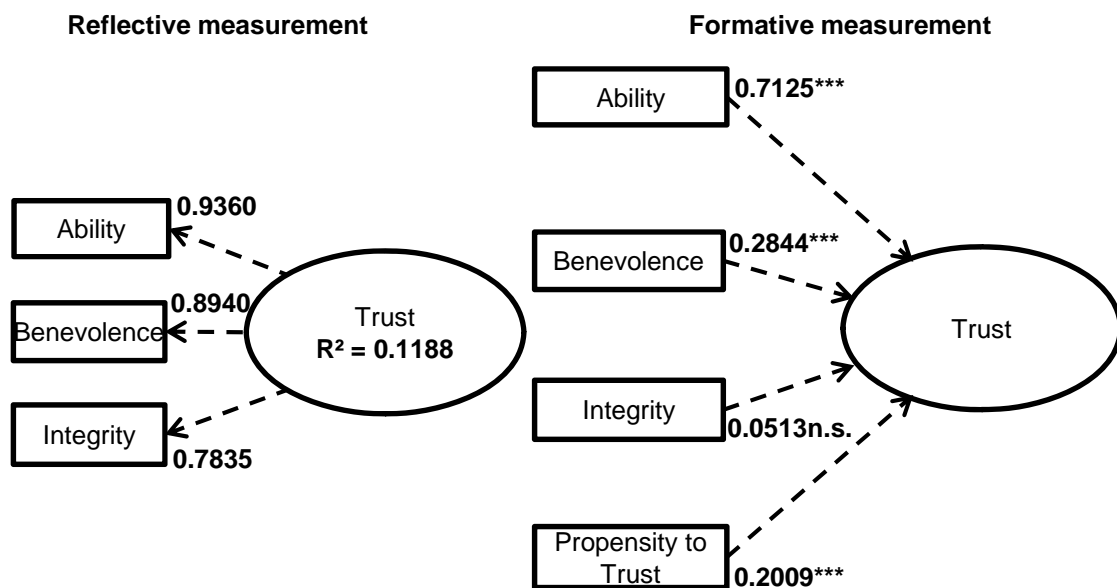


Figure 7: Reflective versus formative trust measurement

As our results indicate, there are only minor changes in the structural model when using our formative measurement model (Figure 6) instead of the reflective one (Figure 5). The value of the formative measurement model of trust is that we gain additional insights about the influence of single factors on trust. When using a reflective measurement model we could only state that ability, benevolence and integrity are important parts of user’s trust in a service. Now we can state, for example, that ability has by far the highest influence on trust and that the relation between integrity and trust was found not significant (Figure 7). We nevertheless decided to include integrity in our

formative measurement model because Cenfetelli and Bassellier (2009, p. 701) also state that “very few reasons, if any, would lead to the decision to remove an item after a single study showing some concerns in the results, when the theoretical definition of the construct justifies its inclusion.”

The big advantage of our formative measurement model is that we achieved a higher level of detail with only very little effort because we did not need to gather new data, that is, we just combined the indicators in a different way. From a design-oriented point of view, we can now state that practitioners should focus on design aspects that support the user’s belief that the service has a very high ability, instead of focusing on aspects supporting the belief of integrity.

7 Conclusion and Call for Research

In this contribution we have addressed three research questions. Concerning our first research question, we showed that a formative measurement is correct if antecedents of trust are used. Regarding our second research question, we used Mayer, Davis and Schoormans' (1995) trust model and included their indicated four important factors in our formative measurement model for trust. Based on our results, we could then answer our third research question. The formative measurement of trust offers insights on the impact of single factors influencing trust. We showed that in our study, ability affects trust more than twice as much as the other factors. We thus recommend that practitioners should focus on design aspects that support the user's belief that the service has a very high ability instead of focusing on aspects supporting, e.g., the belief of integrity.

Nevertheless, our approach should be seen as just the beginning of a formative measurement of trust. Mayer and Davis (1999) call for an examination and consideration of the dimensionality of trust. Our formative model lacks this point and future research should focus on including this dimensionality into a formative measurement model. Another point that should be addressed is that our recommendations to practitioners are on a very high level but they can serve as a basis for practitioners, such as banks and e-marketplaces, to develop e.g., new prototypal algorithms and thereby use and evaluate the presented results. Nevertheless future research should address the development and evaluation of detailed and theoretically-derived design choices that promise to influence the user's belief of, e.g., the ability of a service. This would further strengthen the relevance for practitioners by allowing them to systematically increase user's trust in their services, thereby leading to a higher probability of acceptance and thus success.

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