

**Empirical Studies on
Technology Acceptance of Mobile Services
and
Information Security Management**

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Diplom-Ökonomin Nadine Guhr
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I Abstract/Abstrakt

Information and communication systems as well as mobile services are essential for corporate and private actions and are therefore of high relevance. Their success is determined by different factors that we must consider. One reason is that mere availability of information systems (IS) and mobile services does not provide any direct value. Understanding the use and individual acceptance are some of the most mature streams in many fields of research. This is due to the fact that the lack of technology acceptance can lead to loss of resources and money and is increasingly viewed as an important element for IS success. Furthermore, information security management has become increasingly important for organizations because global networks expand the interconnection of global IS. Thus, security threats can have dire consequences. In the research areas technology acceptance of mobile services as well as information security management, using specific examples, research gaps and a discrepancy between the status quo in research and practice are identified. In both research areas the focus is on empirical studies. Models from different research disciplines are used for analysis and further developed. This illustrates the interdisciplinary nature of this thesis. In order to analyze the complex relationships between latent variables multivariate analysis methods, e. g. structural equation modeling (SEM), are carried out. The considered research area in general, is very complex, multifaceted and characterized by a methodological pluralism. By involving users and experts, an active exchange between science and practice is realized.

Informations- und Kommunikationssysteme sowie mobile Dienstleistungen sind essentiell für unternehmerische und private Handlungen sowie Vorgehensweisen und sind daher von hoher Relevanz. Ihr Erfolg wird durch verschiedene Faktoren bestimmt, die berücksichtigt werden müssen. Ein Grund dafür ist, dass die bloße Verfügbarkeit von Informationssystemen (IS) und mobilen Services keinen direkten Mehrwert bietet. Das Verständnis der Nutzung und der individuellen Akzeptanz sind einige der am meisten ausgereif-

ten Streams in vielen Bereichen der Forschung. Dies beruht auf der Tatsache, dass der Mangel an Technologieakzeptanz zum Verlust von Ressourcen und Geld führen kann und diese zunehmend als wichtiger Bestandteil für IS Erfolg angesehen wird. Darüber hinaus gewinnt das Informationssicherheitsmanagement zunehmend an Bedeutung für Unternehmen, da globale Netzwerke die Verbindung bzw. Kopplung der globalen IS erweitern. So können Bedrohungen fatale Folgen haben. In den Forschungsbereichen zur Technologieakzeptanz mobiler Services sowie Informationssicherheitsmanagement, werden anhand konkreter Beispiele, Forschungslücken und Diskrepanzen zwischen dem Status quo in Forschung und Praxis identifiziert. In beiden Forschungsbereichen liegt der Fokus auf empirischen Studien. Modelle aus verschiedenen Forschungsdisziplinen werden für die Analyse verwendet und weiterentwickelt. Dies verdeutlicht den interdisziplinären Charakter dieser Arbeit. Um die komplexen Beziehungen zwischen latenten Variablen zu analysieren, werden multivariate Analyseverfahren verwendet, wie z. B. die Strukturgleichungsmodellierung (SEM). Das Forschungsgebiet im Allgemeinen ist sehr komplex sowie vielfältig und ist gekennzeichnet durch einen Methodenpluralismus. Durch den Einbezug von Anwendern und Experten, wird ein aktiver Austausch zwischen Wissenschaft und Praxis realisiert.

II Management Summary

Mobile services are considered as a driver of innovation in many areas of the economy. This is promoted among others by the rapid technological developments in the market for mobile devices and the development of mobile networks. Recent observations lead to the assumption that this trend will continue over the next few years or even increase further. The IT market research and consulting company GARTNER announced in November 2012 that e. g. smartphone sales have increased by 47 % in comparison to the third quarter of 2011 (Garnter, 2012). Technology acceptance plays a major role, in particular in the area of mobile services, but also almost in all areas of IS research as well as in practice. In this global context the study of technology acceptance has been important since about 27 years. This is due to the fact that lack of technology acceptance can lead to loss of resources and money and is increasingly viewed as an important element for IS success. Furthermore, information security and, more specific information security management have become increasingly important to organizations as global networks expand the interconnection of the global IS. Today, security threats can have dire consequences and an important issue in organizations is to determine how to create efficient and sustainable information security. In this context, the way information security executives or in general the management of an organization cope with this issue and react in different situations should be considered.

The focus in both research areas is on empirical studies, in order to close the specific research gaps. Therefore, models from different research areas (e. g. IS research, marketing, sociology and psychology) are used for analysis and are developed further. This illustrates the interdisciplinary nature of this thesis. The considered research area is very complex, multifaceted and characterized by a methodological pluralism. For this reason, it is elaborated in more detail. In the respective sub areas, open issues and problem areas were identified and concrete examples are used to answer the research

questions in the overall research field. The research topics will be examined by the following examples:

- Technology acceptance as part of a sustainable business model for m(-obile) learning,
- Technology readiness in customers' perception and acceptance: the example of m(-obile) payment,
- Information security management and personality traits: an empirical study.

Regarding these open research areas explained in the above mentioned examples, there are no or almost no research results. To fill these research gaps, possible solutions are developed and presented.

Technology Acceptance as Part of a Sustainable Business Model for Mobile Learning:

The mobilization of our society as well as the technological advancements encountered in a dynamic private and professional world require lifelong education and training concepts, and thus provide a large market potential for m(-obile) learning services, which can be utilized regardless of temporal and formal boundaries and allow learning even within periods of mobility. But the mere existence of such services does not implicate market readiness. M-learning providers have to successfully and sustainably introduce m-learning services to the market in order to reach sustainable market success. In the past, m-learning projects started in part as enthusiastic idea at academic or industrial institutions but never gained sustainable success in the market due to didactical, technical and/or economical restrictions. For this reason, business models are considered to be critical for success and it is necessary to develop appropriate and sustainable business models for m-learning that provide added value for all parties. The status of research in the area of technology acceptance of mobile services which is an integral component of a sustainable business model, particularly in the area of m-learning is still in its beginnings. However, previous research highlights that the lack of technology acceptance can lead to loss of resources and money. Thus, it is increasingly viewed as an important element for the measurement of IS suc-

cess. In this context, m-learning providers cannot fully rely on the existing findings of earlier research in the area of technology acceptance of mobile services, or systems.

The use of the design-science approach (cf. Figure M-1) is justified on the grounds of this research project and provides a framework for the evaluation of models and/or artifacts. In this specific case, this approach is intended to contribute to the knowledge base of the scientific community in general in an explanatory way as well as to help managers design sustainable m-learning services. Based on an extensive literature review three characteristic aspects of added values that an m-learning service can provide were identified: anywhere, anytime and anyway m-learning.

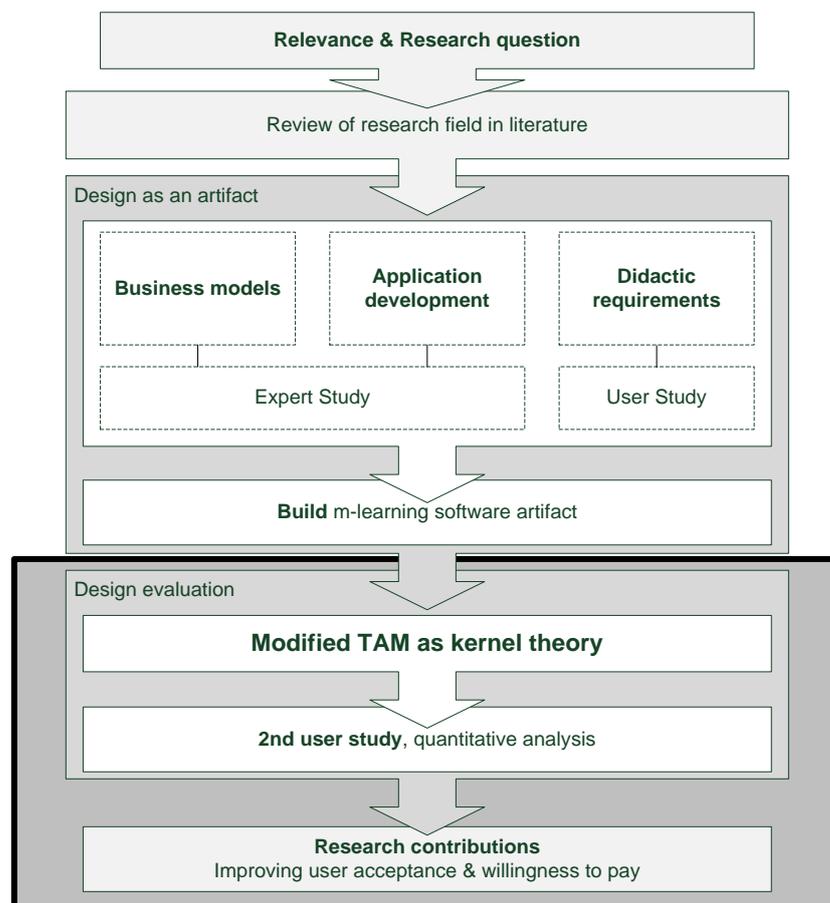


Figure M-1: TAM as Kernel Theory

Furthermore, feedback from users was used to create an m-learning application and several courses, inter alia, didactical requirements, that represent

the artifact. To adjust the didactical requirements, that are necessary to gain m-learning added value, a field study has been conducted with a randomly selected sample of 150 students in several economic courses. For this purpose an exemplary m-learning course was created.

Prior to building the artifact, an expert study (31 German experts from science and industry) was also performed to determine which type of revenue sub model is suitable for business models and which delivery method is acceptable, cf. Table M-1.

Table M-1: Application Development and Revenue Sub Models for M-learning Services

	Median	Frequency suitable or very suitable
M-learning application development		
Offer a web application compatible to all platforms	4	17
Development native applications for each platform	4	17
Users have to use a standardized mobile devices	2	8
M-learning revenue sub models		
Fees per use	4	18
Mobile advertising	3	12
Revenues by brokerage	3	10
Usage-independent fees	3	6
<i>Likert scale: 5=very suitable, 4=suitable, 3=neutral, 2=little, 1=low</i>		

The created artifact was then evaluated against the modified technology acceptance model (TAM) on a randomly selected group of 300 students of economics, cf. Figure M-2. The satisfaction of users' needs focused on providing added value to the user. Added value is necessary to attract new users as well. Predictive functions were identified for the usefulness of anywhere and anyway learning. In order to build an appropriate and sustainable business model for m-learning the positive influence of anytime and anyway learning on the perceived usefulness should be considered. Besides the technological and didactical dimension, the economic dimension plays a significant role in the development, implementation and operation of an m-learning application.

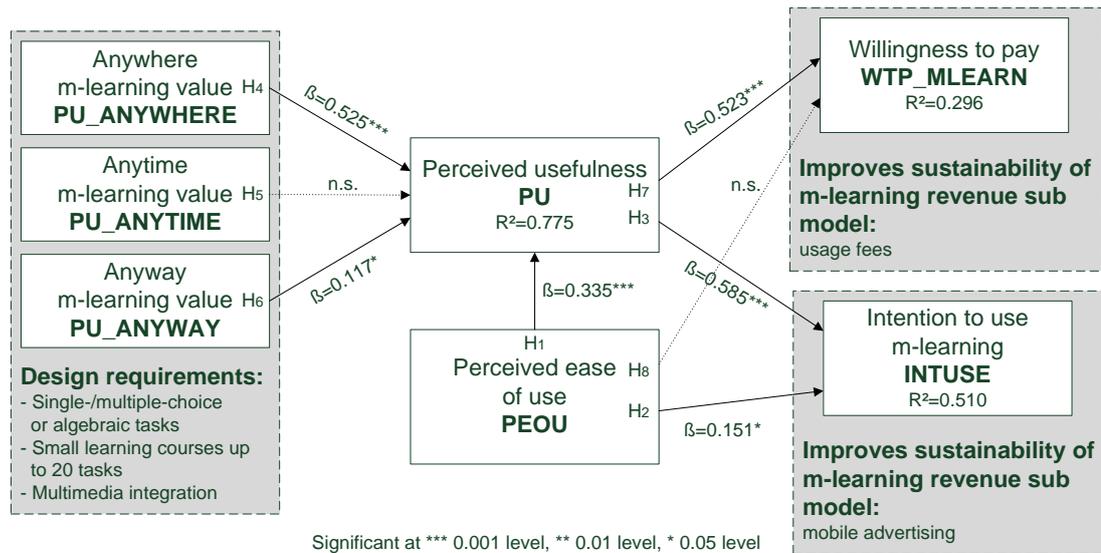


Figure M-2: Modified TAM – Results of the Empirical Analysis

Here, sustainable business models are of major importance because they are close connected with the acceptance of m-learning applications. The costs of application development and maintenance should be balanced against the revenues. The most suitable revenue types for m-learning business models were specified in an expert study and later evaluated in the modified TAM. Empirical studies and the use as well as development of theoretical models e. g. TAM and their evaluation by statistical analysis can aid practitioners and academics in the development of sustainable business models.

This work describes the status quo of research, the further development of the research topic and the transfer of scientific knowledge and methods, especially in the practice in the design of sustainable business models for m-learning. The results of this research were presented at the European Conference on Information Systems (ECIS) 2011 and are published as an essay by Maske, Guhr, Köpp & Breitner (Maske, Guhr, Köpp, & Breitner, 2011) in the Proceedings of the ECIS.

Technology Readiness in Customers' Perception and Acceptance: The Example of Mobile Payment:

Companies today are facing multiple challenges. The increasing globalization and the rapid diffusion of communication and information technologies,

make cross-cultural studies necessary to meet the requirements of the current and future users. Particularly in the area of m-payment, these differences are clearly visible. Some countries use m-payment intensively, while the use in other countries is far below expectations. Since inadequate user acceptance has long been an obstacle to the successful adoption of mobile services or technologies in general, it is imperative to consider which factors drive users in different countries and cultures to adopt m-payment solutions or restrain them from doing so. Overall, however, it is expected that m-payment will be gaining in importance in the future. The IT market research and consulting company GARTNER, announced in May 2012 that the worldwide m-payment transaction values will surpass \$ 171.5 billion in 2012 and the number of m-payment users will reach 212.2 million in 2012. Despite the importance of m-payment, particularly in the context of m-commerce, the state of cross-cultural empirical research on use and acceptance has lagged behind technological developments and are therefore scarce. The work by (Guhr, Loi, Wiegard, & Breitner, 2013) addressed this gap by developing and testing an extended TAM across cultures and aims to the following theoretical and practical contributions. It is empirically tested how technology readiness influences customers' perception and acceptance of m-payment in an intercultural setting.

Existing scientific approaches to technology acceptance of m-payment are limited mostly to factors such as trust and security etc., but transnational studies across countries, taking into account the cultural dimensions could not be found. Furthermore, although there are approaches that combine the cultural dimensions with TAM as well as the enablers (innovativeness, optimism) and inhibitors (insecurity, discomfort) in the overall construct TR with TAM, but there is a lack of a holistic approach in the specific context of m-payment, especially taking into account cultural differences.

Based on theory, hypotheses were derived as basis for an empirical examination of the relationships and the latent construct were conceptualized and operationalized and further statistically analyzed using SEM, cf. Figure M-3.

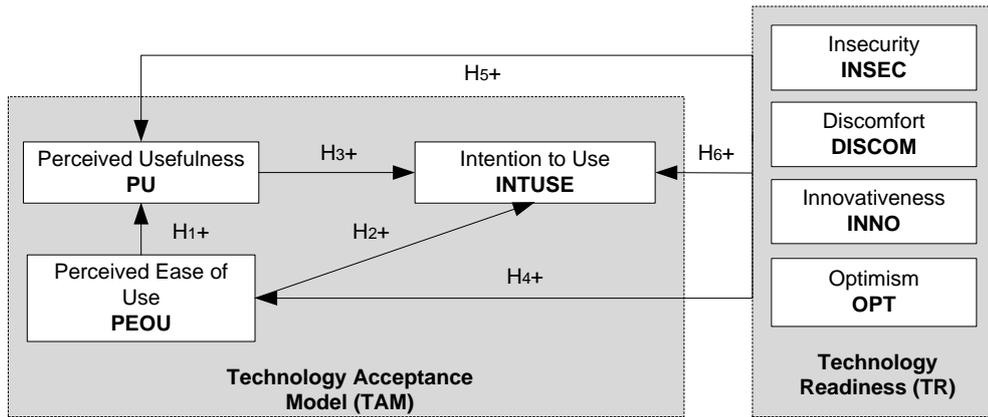


Figure M-3: Research model

To verify the causal relationships mentioned above which are based on theory a quantitative study in the countries Finland, Germany, the USA and Japan was conducted. A summary of the sample can be taken from Table M-2.

Table M-2: Composition of the Sample

	FIN = 50		GER = 115		USA = 52		JPN = 53	
	N	%	N	%	N	%	N	%
Gender								
Female	35	70,0	41	35,7	36	69,2	35	66,0
Male	15	30,0	74	64,3	16	30,8	18	34,0
Age								
<18	3	6,0	0	0,0	2	3,8	3	5,7
18-25	26	52,0	86	74,8	25	48,1	31	58,5
26-35	9	18,0	29	25,2	16	30,8	9	17,0
36-45	1	2,0	0	0,0	3	5,8	6	11,3
46-60	9	18,0	0	0,0	5	9,6	2	3,8
>60	2	4,0	0	0,0	1	1,9	2	3,8
Profession								
Student	22	44,0	96	83,5	31	59,6	29	54,7
Employee	13	26,0	15	13,0	14	26,9	15	28,3
Public officer	4	8,0	3	2,6	0	0,0	1	1,9
Self employed	5	10,0	1	0,9	4	7,7	5	9,4
Pension	0	0,0	0	0,0	0	0,0	2	3,8
Not specified	6	12,0	0	0,0	3	5,8	1	1,9

The results of the analysis (cf. Table M-3) show that the TR in intercultural comparison varies across countries and thus has a different impact on the technology acceptance of m-payment. To give an example which results from the findings, it can be stated that countries that are more masculine (e. g. Japan) are more technology ready than less masculine countries (e. g. Finland) and this in turn has a positive influence on the technology acceptance of m-payment.

Table M-3: Results of the Analysis

Hypotheses	Path coefficient				T-Value				Hypothesis supported			
	FIN	GER	USA	JPN	FIN	GER	USA	JPN	FIN	GER	USA	JPN
H1 PEOU positive influences PU	0.623	0.447	0.559	0.493	6.169***	5.713***	4.694***	3.381*	●	●	●	●
H2 PEOU positive influences INTUSE	0.299	0.257	0.292	0.249	1.650°	2.607*	1.968**	2.591*	●	●	●	●
H3 PU positive influences INTUSE	0.390	0.403	0.458	0.447	1.745°	4.839***	2.777*	4.269***	●	●	●	●
H4 TR positive influences PEOU	0.736	0.718	0.641	0.415	9.551***	17.791***	10.248***	3.310*	●	●	●	●
H5 TR positive influences PU	0.288	0.406	0.360	0.335	3.022*	5.283***	3.236*	2.181**	●	●	○	●
H6 TR positive influences INTUSE	0.206	0.308	0.175	0.325	1.255 n.s.	3.707***	1.548 n.s.	3.273*	○	●	○	●

Hypothesis supported = ●; Hypothesis not supported = ○

° denotes significance at the $p < 0.10$ level
* denotes significance at the $p < 0.05$ level
** denotes significance at the $p < 0.01$ level
*** denotes significance at the $p < 0.001$ level

The results of this research were presented at the International Conference on Wirtschaftsinformatik (WI) 2013 in Leipzig and are published as an essay by Guhr, Loi, Wiegard & Breitner (Guhr, Loi, Wiegard, & Breitner, 2013) in the Proceedings of the WI.

Information Security Management and Personality Traits: An Empirical Study:

Information security and especially information security management, which is affected by multiple distinctive dimensions, is one of the most important topics in IS research and is widely discussed in both, the Anglo-American "Information Systems Research" as well as in the German "Wirtschaftsinformatik" and has become increasingly important for organizations as well. Security threats in all its facets can have dire consequences, e. g. loss of prestige and credibility, monetary damage and corporate liability. The way information security executives or in general the management of an organization cope with this and react in different situations depends heavily on their personality or individual characteristics as well as other cognitive factors. This clearly shows, inter alia, that individual differences have become an important area of focus in information security research. However, it should be noted that the study of personality, particularly empirical studies, within the behavioral IS literature is sparse and there is no research that has explored the influence of personality on top management in regards to security. Previous studies in the field of information security were limited to users or employees. Furthermore, focusing on the research problem from a multidimensional, holistic approach allows the examination and evaluation of infor-

mation security phenomena from the individual information security executives' perspective.

To receive a valid theoretical foundation, perspectives of prior research in combination with national and international information security standards (ISO/IEC 27001; ISO/IEC 27002 and the special publications SP 800-39 from the National Institute of Standards and Technology) were used. In the research work, it was outlined that holistic security management aims to maximize the number of prevented security breaches by the management applying an efficient set of five non-technical components and one technical component. Because individual differences play a ubiquitous role in the IS domain the "NEO-FFI" format by Costa and McCrae was also considered. With regard to the research topic and based on a theory, hypotheses about the influence of an information security executive's personality traits on the above mentioned six dimensions of information security management were developed. To test the revised model and the underlying hypotheses, existing empirical data was used (Pomes, 2011) in the form of a secondary data analysis. A secondary data analysis is defined as the re-analysis of existing data for answering the original or new research questions with more adequate statistical methods (Glass, 1976; Schell, Hill, & Esser, 2011; Kromrey, 2009). The data basis, which consists of 174 information security executives, was collected in prior work at the Institute of Information Systems, Gottfried Wilhelm Leibniz Universität, by Robert Pomes and was published in (Pomes, 2011). To analyze the data, which were partly adapted from (Pomes, 2011), several statistical methods were used in this thesis e. g. factor analysis and SEM. The results of the empirical analysis (cf. Figure M-3) show that personality traits are influential in determining attitudes towards holistic information security management cf. Figure M-3. This work describes the status quo of research, the further development of the research topic and the transfer of scientific knowledge and methods, especially in the practice in information security management. The results were presented at the International Conference on Information Systems (ICIS) 2012 and are published as essay by Uffen, Guhr, & Breitner (Uffen, Guhr, & Breitner, 2012) in the Proceedings of the ICIS 2013.

The research and the resulting publications are used to initiate a debate in the scientific community. This relates to the field of mobile services as well as information security management. It is assumed that the presented research papers, including those who could not be described in detail, contribute to increasing knowledge in the respective research areas.

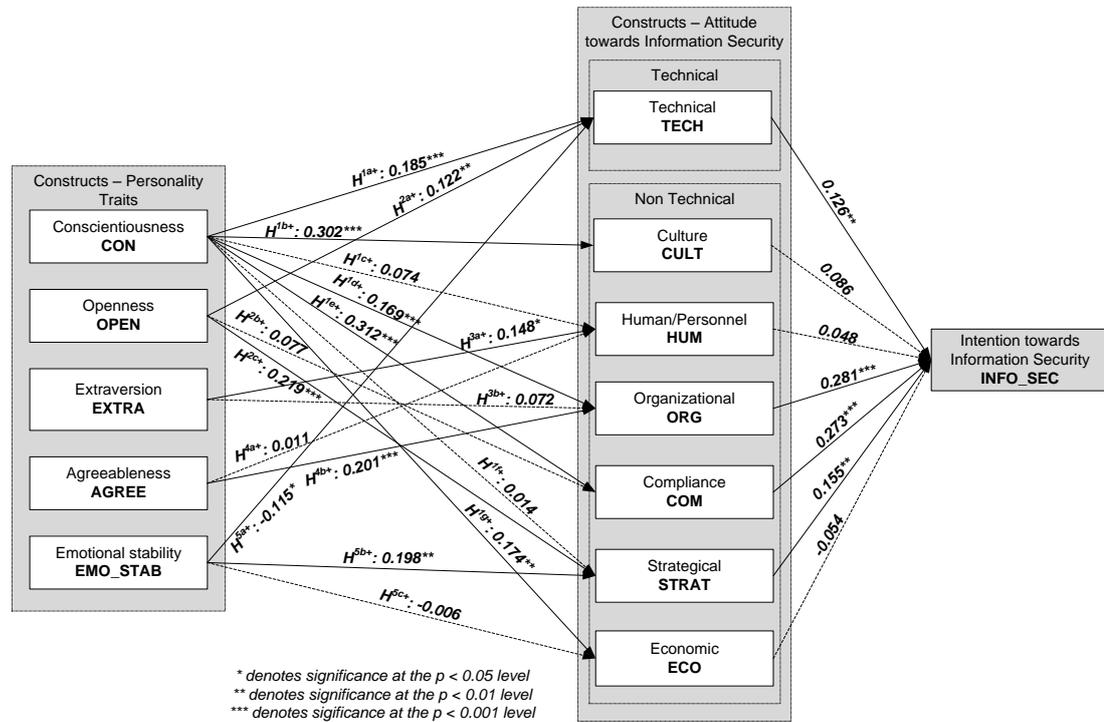


Figure M-3: Research model

Among other things, this can be justified by the fact that the research papers were published in the proceedings of generally accepted conferences. This reflects the acceptance of the scientific community. By evaluating the publications by professional colleagues within the double-blind peer review process e. g. of the European Conference on Information Systems, the International Conference on Wirtschaftsinformatik and the International Conference on Information Systems the scientific quality of the publications was secured.

Keywords: Technology Acceptance, Mobile Services, Information Security Management

Schlagworte: Technologieakzeptanz, mobile Services, Informations-sicherheitsmanagement

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