Data security and consumer trust in FinTech Innovation in Germany

Abstract

The advancement of mobile devices and their usage has increased the uptake of financial technology (FinTech) or financial technology innovation (FTI) in Germany. The financial sector and start-ups see FinTech as a gateway to increase business opportunities; however, mobile applications and other technology platforms must be launched to explore such opportunities. Mobile application security threats have increased tremendously and have become a challenge for both users and FinTech innovators. In this paper, we empirically consider factors that influence the expectations of both users and organizations in adopting FinTech, such as customer trust, data security, value added, the user design interface and FinTech promotion. The results confirm that customer trust, data security and the user design interface affect the adoption of FinTech. Our research proposes a model called "Intention to adopt FinTech in Germany," constructs of which were developed based on the Technology Acceptance Model (TAM) and five additional components, as identified. The outcomes of this study can be used to improve the performance of FinTech strategies and enable banks to achieve economies of scale for global intensity.

Keywords: FinTech, cyber security, mobile banking, data security, information security.

1. Introduction

A considerable amount of revenue has been invested in the information technology (IT) infrastructure of banks to enhance their performance, but investment in IT remains a substantial risk regarding the return on investment (Carlson, 2015). Most banks and financial organizations around the globe are subject to extreme pressure from their customers and competitors to enhance IT. In the 21st century, the main sources of revenue generation for German banks are interest margins and the provision of services such as wealth management, mortgage lending and financial advice. However, the benefit from these services has declined, causing many challenges for these banks as they strive to return to a period of profit. Today, most of these banks are embracing financial technology (FinTech), due to the promise of its ability to generate new revenue streams, personalize offers, target cross-selling and improve customer services. However, in order to explore such opportunities, mobile applications and other technology platforms need to be launched.

Germany has implemented various regulations and programs to encourage FinTech adoption; for example, during the Bundesbank 19th banking symposium, it was argued that banks in Germany need to adopt disruptive digital innovation to acquire technical awareness in advances (Patel, 2000; Stolterman & Fors, 2004). Furthermore, today's digital banking has broadened from standard online banking to inventive ideas that involve video consultancy services, credit brokerage and the incorporation of social media. The need for awareness of global cyber-attacks and their mitigation was also stressed. Furthermore, cooperation between the Bundesbank, the BaFin, the European Banking Authority (EBA) and the European Central Bank (ECB) was suggested to establish an information technology audit service, with the intention of developing a supervisory regime to enhance security (Deutsche Bundesbank Eurosystem, 2015; Carlson, 2015). In the face of ongoing cyber-attacks, financial institutions must continue to strengthen their cyber security framework by investing assets in gathering, examining and

sharing cyber-attack intelligence information to better comprehend the change in complex security risks (Carlson, 2015).

Cyber-attacks on FinTech services could bring about huge economic, social and organizational damage, which could also affect the trust of customers of these services (Kranz et al., 2013; Möller et al., 2012). The tremendous increase in mobile technology in Germany has increased mobile device convergence, internet and integration since 2013. In 2015, statistics gathered by ComScore demonstrated that 43. 6 million people use mobile devices to access social network platforms, online banking, emails and general internet usage; this figure is expected to rise to 58 million in 2018 (statista.com, 2015). Figure 1 demonstrates the adoption rate of mobile usage in Germany, which clearly shows its rapid expansion since 2013, making it a potential medium for the financial sector.

FinTech can be characterized as the utilization of mobile devices and other technology platforms to access a bank account, transaction notifications, and debit and credit alerts by means of push notification via APP, SMS or other forms of notification. It includes multi-banking features, block-chain, funds transfer, robot-advisory and concierge services from payments to wealth management, using mobile applications (Swift, 2010; Donner & Tellez, 2008). Cheney (2008) depicted such applications as "mobile financial services" and Datta (2011) described the advantages of mobile applications over standard online banking. Contrary to FinTech opportunities, the substantial security risk (Safa et al., 2015) has increased the need for information systems (IS) research regarding the quest for banks in Germany to establish a strategy for the successful adoption and implementation of FinTech innovation. Today, digital security is a bigger issue than it has ever been. Numerous prominent data breaches (Yeniman et al., 2011) over the past few years have resulted in a huge amount of lost income and have kept numerous banks from embracing FinTech. For example, in 2013, a cyber gang attacked more than 100 banking entities around the globe, which resulted in a total loss of $1 billion to the banks (Kaspersky, 2015). This kind of attack is regarded as a Carbank attack (Kaspersky, 2015).

Several innovative banks have recognized the importance of security risk (Mannan & van Oorschot, 2007) and the barriers to the adoption of FinTech (Ndubisi & Sinti, 2006). In 2004, White and Nteli researched the barrier that security risk creates for digital banking in the UK and Australia. Poon (2008) argued the importance of security for individuals, regardless of age group, education or income. Subsequently, Manzano et al. (2009) researched the effects of security risk impacts on a bank account, a password and a customer's identity. Sonja and Rita (2008) also studied information risk, while Gerrard and Cunningham (2003) researched the outcomes of weak security measures and the ways that hackers take advantage of this weakness. Phelps et al. (2000) studied the importance of privacy concerns and customer behaviour when it comes to providing personal information. Culnan (1993) focused on consumer conduct in the context of information usage. Similarly, Mahatanankoon et al. (2005) studied customer attitudes in the context of mobile applications, while Joubert and Belle (2013) researched trust and risk in the context of mobile commerce adoption. Therefore, in this paper we raise the following questions:

1. What are the main inhibitors of FinTech innovation adoption?
2. Do customers prioritize FinTech value added over data security?
3. To what extent do data security and trust matter in the context of FinTech?

Due to the disregard of existing studies on the motivation for embracing FinTech in Germany, we intend to close the gap in the literature regarding this subject. This article analyses the key elements of customer trust, data security, value added, user design interface and promotion that influence FinTech

services in Germany. Data security and trust play a central role in this regard, and we aim to consider them in the context of and in relationship to other aspects (such as usability), because we agree with other researchers who believe that these aspects should be considered together.

The first section has introduced the issues for this study and the research questions, while the second section gives a brief background of the issues. The third section provides a literature review on the topic, and the fourth section plots the motivation of our model, our research design and the hypothetical structure of this study. Our fifth section reports the empirical results and section six addresses the ramifications of the empirical key strategies to enhance FinTech in Germany. Section seven addresses the limitations of this study, and the last section outlines the paper's conclusions and future work.

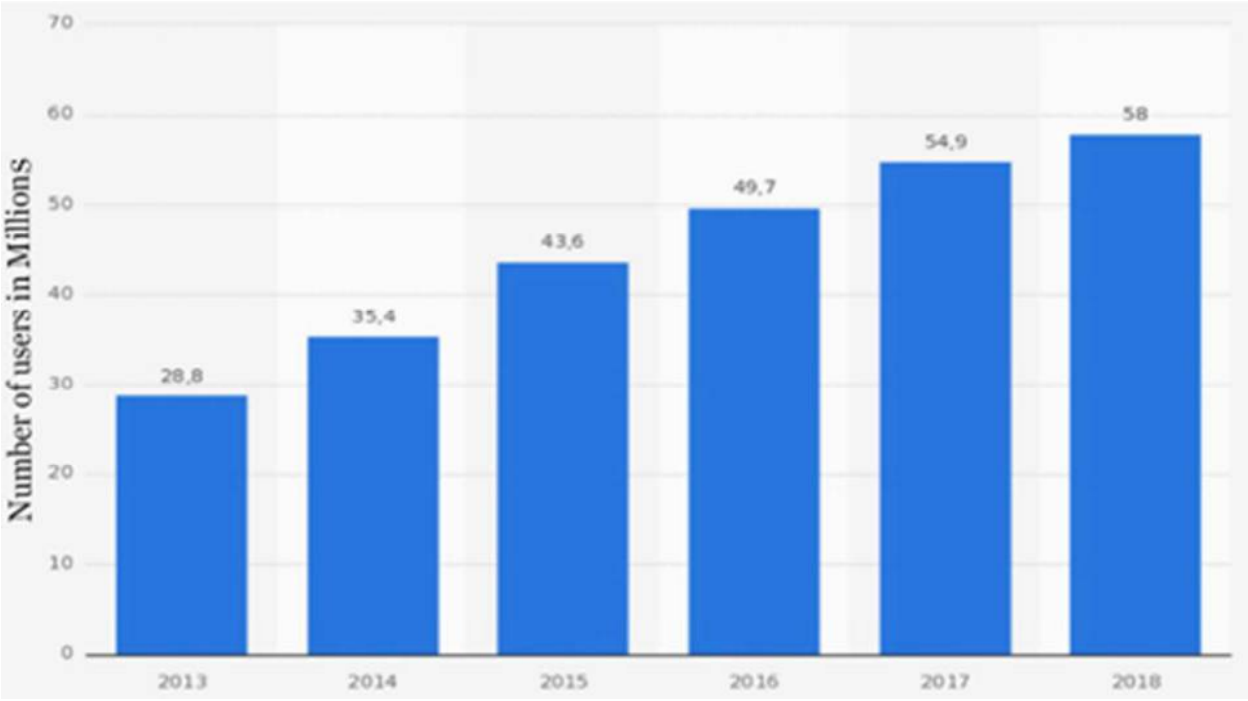

Figure-1: Total Number of Mobile Internet Users in Germany in 2013 and a Forecast to 2018
Source:http://de.statista.com/statistik/daten/studie/180578/umfrage/anzahl-der-nutzer-des-mobilen-internets-in-deutschland-seit-2005

2. Background

2.1 Concerns relating to FinTech data security

As described in the international standard for information security management systems (ISO 27002), data security is the confidentiality, integrity and availability of data. This is also known as the CIA triad (ISO/IEC 27002, 2013). The CIA triad has always been the business and industry standard in terms of data security; however, it is unsuitable for addressing the perpetually rapid dynamics of financial technology innovation. According to Whitman and Mattord (2009), data security is the insurance of both data and its crucial assets, e.g. the equipment in used for data gathering, data storage and the transmission process. Therefore, Whitman and Mattord (2009) included exactness, legitimacy, usefulness and ownership in data security measures.From a critical perspective, these varying definitions of data security require

analysis. First and foremost, data protection should not be classified as an item or a product of technology, but rather as a process (Mitnick & Simon, 2002, p. 4). As indicated by Introna and Wood (2004), data security was previously considered technical; however, due to the massive utilization of both computers and networks today, data security must necessarily go beyond the technical perspective. Safa et al. (2015) proposed information security awareness for better understanding, familiarity, and the capacity to manage and overcome crises. We also include human factors (Werlinger et al., 2009) in the data security definition, since FinTech organization leaders and employees play a major role in securing data which will influence customers' trust in FinTech services.

2.2 Trust in FinTech

According to Lewis and Weigert (1985), trust is a complex, multidimensional phenomenon that plays a major part in business relationships. There are many elements that influence trust in FinTech innovation adoption, for example, data confidentiality, availability, integrity, constant wireless connection (Zhang & Lee, 2003), mobile application usability, transaction security, cultural influences and the trustworthiness of organizations (Whitman & Mattord, 2009; Siau et al., 2003). According to Joubert and Belle (2013), trust is essential in risky circumstances, and mobile applications come with numerous vulnerabilities that expose users to various risks. Furthermore, an essential component of trust is institution-based trust, which is an individual's belief that the platform they trade on is secure, as reported by Vance et al. (2008). Additionally, information security elements such as confidentiality, integrity, availability, authentication, accountability, assurance, privacy and authorization can essentially influence the beliefs and intentions of trust (Vance et al., 2008; Whitman & Mattord, 2009; Siau et al., 2003). Importantly, Vance et al. added that institution-based trust influences online platform trust. According to Vance et al. (2008), elements that determine system quality are applicable to the concept of trust, due to the technical aspects of information technology artefacts. In addition, Wang et al. (2003) elucidated solid support for the relationship between trust and usability. Specifically, usability enhances mobile-trade engagements and the trust impact in IT innovation.

3. Literature Review

Despite the substantial amount of research examining the process and techniques employed to effectively accept the adoption of FinTech, there is still the absence of a complete model to depict the disruptive FinTech innovation process in terms of data security and trust. Current innovation adoption theories and models must be modified and improved to highlight the perspectives necessary for the FinTech adoption process.

Ajzen and Fishbein (1980) proposed the Theory of Reasoned Action (TRA) to study the elements affecting an individual's conduct when embracing specific technologies. Specifically, TRA recognizes behaviour and subjective standard as the imperative indicators of an individual's intention to use a specific technology. TRA suggests that an individual's behavioural intention is a combination of their attitude toward behaviour and subjective norm factors. In this model, an individual's performance of the behaviour is referred to as an attitude, as opposed to an individual's general performance (Fishbein & Ajzen, 1975). The subjective norm is the individual's recognition that people who are beneficial to him/her

think that he/she must or must not perform the behaviour being referred to. Therefore, TRA will not be appropriate for our study, since it foresees behaviour when the volitional control of individuals is violated (Ajzen, 1991). Furthermore, it lacks the ability to determine convictions which are pertinent to a specific behaviour.

Davis (1989) proposed the Technology Acceptance Model (TAM) that was later supported by Yang (2005) as the most robust model in the literature to study technology adoption designs. The fundamental objective of TAM was to declare factors which influence computer utilization. Accordingly, Davis took a few fundamental factors which were characterized as significant determinants of computer utilization in past studies and applied a psychological-based hypothesis – the Technology Acceptance Model (TAM) – for modelling and hypothesizing the connections among these factors (Davis et al., 1989). The TAM proposes that perceived usefulness (U), perceived ease of use (E), behaviour and usage influence a person's intention to use new technologies. Perceived usefulness is the degree to which individuals believe that utilizing a specific technology would upgrade their job performance. Perceived ease of use is the degree to which individuals believe that utilizing a specific technology would be free of effort (Davis, 1989). Simply put, as regards the TAM, it is believed that the utilization of a specific technology is influenced by intention to use, and intention to use this technology is determined by perceived usefulness and perceived ease of use. Therefore, Davis' study revealed that the relationship between usage and usefulness is more grounded than the relationship between ease of use (usability) and usage.

However, the validity of the measurement scales for TAM has also been scrutinized by other researchers. Ives and Olson (1984) and Venkatesh and Davis (2000) argued the deficiencies of the TRA, the TPB and the TAM. Furthermore, Straub et al. (1997) and McCoy et al. (2007) added that the TAM is not universally applicable and might not have the capacity to anticipate technology use in different cultures, since the model was developed in the United States. Venkatesh and Davis (2000) extended the TAM to TAM2 to eliminate the aforementioned limitations, by incorporating social impact and cognitive instrumental procedures as essential elements of information system adoption and usage, respectively. Luarn and Lin (2005) also argued that the TAM emphasises only U and E, and both tend to ignore the constraints that hinder the utilization of information systems. Moreover, Liu et al. (2009) questioned the significance of TAM in the context of mobile banking services, and highlighted the various impacts of the usage of computer-based systems and wireless-based systems. Luarn and Lin (2005) stressed the need for the advancement of the TAM to incorporate a trust element (perceived credibility) and two asset elements (perceived self-viability and perceived financial cost). They found that trust indirectly affects the customer's intention to adopt mobile banking based on E. Here, it is clear that awareness of inadequate data security measures for FinTech transactions among users equates to slower adoption of FinTech.

Tang et al. (2004) and Wang et al. (2003) contemplated the adoption of mobile banking by utilizing the TAM as a blueprint. They included customers' data security and protection concerns. Further, Luarn and Lin (2005) highlighted data security risks and data transmission concerns as vital elements that impact users adopting electronic conveyance channels. In addition, Clark (2002) and Lanford (2006) highlighted user design interface and usability as extra elements that need to be incorporated to address the data security concerns of users. As previously mentioned, the two distinct TAM constructs have been converged with the TRA model to form the value-added construct. Therefore, we explore the elements affecting FinTech in this study by extending the TAM to incorporate the components of data security and customer trust; we have excluded the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) due to its complexity. Furthermore, UTAUT analyses the construct of social influences, which is not needed in the current work.

4.0 Methodology

Many studies, as examined in the literature section, have identified different factors which can impact the adoption of FinTech. As stated earlier, our work considered the variables or factors that would be more relevant for Germany, as well as factors in the TAM. The new model proposed has five factors, namely, data security, trust, value added, FinTech promotion and user design interface. We assume these are the factors that impact the behavioural intentions of customers in Germany to adopt FinTech services. The expanded TAM, as outlined in Figure 2, will be named the "Intention to adopt FinTech in Germany" model. In this study, the customers' acknowledgement of FinTech services is measured by their behavioural intention to utilize this innovation (Dillon & Morris, 1996; Tang et al., 2004; Sun, 2003). The decision to use the TAM as our research model to clarify customers' intention to adopt FinTech is attributed to its steady ability to clarify the changes between intentional behavioural and actual behavioural (King & He, 2016). The five determinants that constitute the aforementioned research questions are shown in Table A.

In this paper, we empirically inspect the components that influence the expectations of both users and organizations to adopt FinTech, such as, customer trust, data security, value added, user interface design and FinTech promotion. Thus, security and trust play a central role in this work, and we aim to consider them in the context of, and in relationship to, other aspects (such as usability), because we agree with those researchers who believe that these aspects should be considered together.

4.1 Research design and theoretical framework

Based on our research, we grouped our methodology into two segments. In the first segment, we develop a theoretical framework based on the literature and information security hypothesis in this study. The second segment depicts the empirical framework used to analyse the key elements that improve the adoption of FinTech in Germany.

Table-A: Factors Impacting FinTech

Factors	Meaning
VA	Value added
CT	Customers' trust
DS	Data security
UI	User design interface
FP	FinTech promotion

The internal and external elements that influence the adoption of FinTech are represented by the determinant value added (VA) in our model. The two main TAM constructs: U and E, represent the internal elements that determine the VA. In accordance with the TAM, U is the belief among individuals that they can be more productive by adjusting to a new technology (Lu et al., 2003), while E is the belief that the new technology is easy to use. In this context, customers will use the tool of interest in the event that they perceive it to be useful and free of effort. Thus, we have characterized our VA as any enhancement concerning the U, and the ability to better serve customers with less effort: E. In this manner, VA captures the TAM variables U and E as antecedents to the intention to use FinTech services. This can be compared to the TRA, due to the aggregation of effort and usability, but dissimilar to TAM, where these two constructs are treated differently (Pikkarainen et al., 2004). The external factors of our VA are determined by the efficiency of secured telecommunication connectivity and coverage that gives customers simple and consistent access in embracing FinTech innovation (Venkatesh et al., 2003). In this paper, the connection speed of data transfer illustrates the motivation behind the intention to use FinTech (Carlsson et al., 2006). Various hypotheses were formed for testing, as summarized in Table B.

Table-B: Research Hypotheses in this Study

	Hypotheses	Source
Ha	Customers' intention to adopt FinTech is not always influenced by the value added.	(Grazioli & Jarvenpaa, 2000) (Datta, 2011)
Hb	Trust does not always influence customer s' intention to adopt FinTech.	(Whitman & Mattord, 2009) (Yao et al., 2003)
Hc	The willingness of customers to trust FinTech is not influenced by data security.	(Amoroso & Hunsinger, 2009) (Joseph et al., 2012)
Hd	Data security does not influence customers' intention to adopt FinTech.	(Lee & Chung, 2009)
He	Customers' intention to adopt FinTech is not influenced by the user design interface.	(Lanford, 2006) (Laberge & Caird, 2000)
Hf	The user design interface does not influence the willingness of customers to adopt FinTech.	
Hg	Value added is not a vital determinant of trust in customers' intention to adopt FinTech.	(Pikkarainen et al., 2004) (Howcroft et al., 2002)
Moreover, financial institutions with rigid security measures (Kritzinger & vom Solms, 2010; Parker et al., 2015) should use promotion to promote their services. Along these lines, this study proposes the following theories:		
Hh	Promotion of FinTech services does not influence customers' intention to adopt FinTech.	
Hi	Promotion of FinTech services is not influenced by data security.	
Hj	Promotion of FinTech services is not influenced by the value added.	
Hk	Promotion of FinTech services is not influenced by the user design interface.	
Hl	Promotion of FinTech services does not influence trust in customers' intention to adopt FinTech.	

The above research analyses the previous links between the hypothetical constructs and variables. We illustrate these links in Figure.2. The hypothetical structure developed in our work aims to demonstrate that data security, trust, added value, user design interface and FinTech promotions are the conceivable antecedents for the adoption of FinTech in Germany. This gives refinements to existing hypotheses for FinTech adoption in Germany.

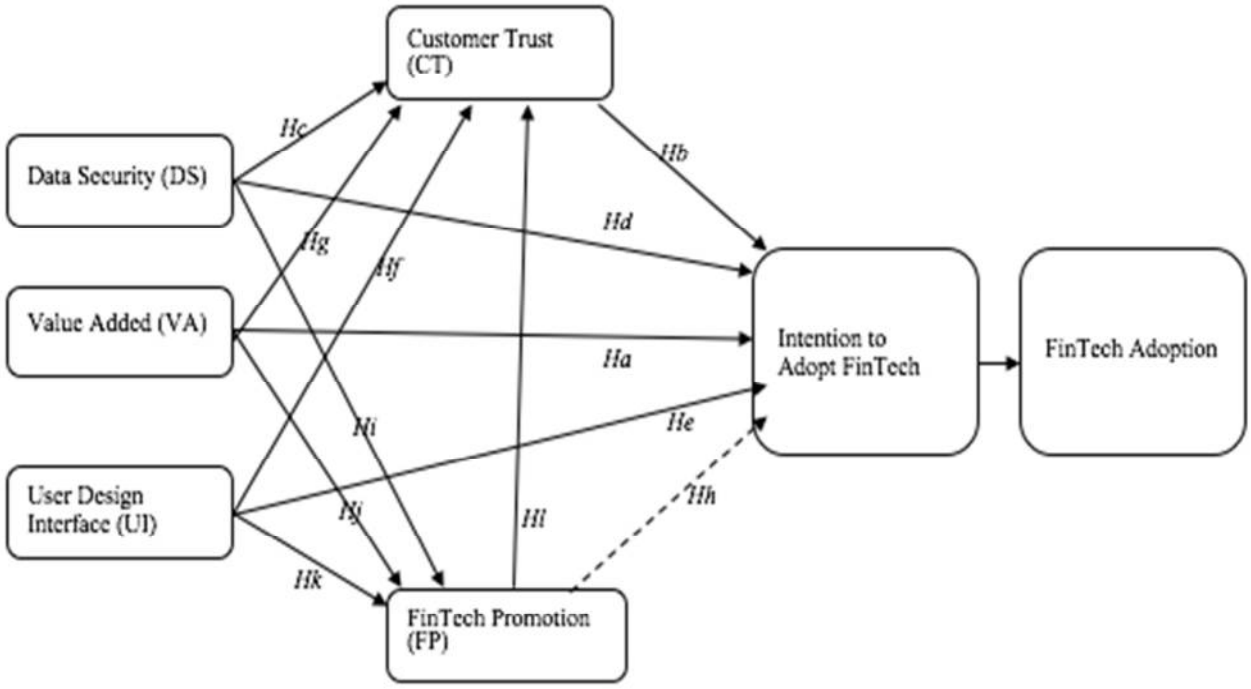

Figure-2: Proposed Research Model - Intention to Adopt FinTech in Germany

With the aid of the TAM and our testable hypothesis, we have been able to determine both the internal and external constructs that might determine FinTech adoption. However, at this time we cannot relate our hypothesis derived from our testable hypothesis to our research questions, due to the uncertainty of the results of our hypotheses and the competitive balance in our five determinants. At this point we can only assume that these five determinants might motivate and influence customers' intention to adopt FinTech.

5. Empirical Method

In this part of the research we employed a quantitative methodology, with the goal of evaluating customers' perception with respect to data security concerns and trust in the intention to adopt FinTech services (Ashley & Boyd, 2006). A questionnaire survey was used to collect data. This methodology enables us to use numbers to clarify issues based on research conducted by Lundahl and Skärvad (1992) and sum up the outcomes for the populace, as in the work of Burns and Grove (2001). Questionnaires were conducted through individual interviews and electronic email to bank customers in Germany.

We distributed the questionnaires between August 8th and 14th, 2016. A questionnaire, consisting of 36 separate questions, was sent to 700 respondents. From this original sample, 308 completed questionnaires were returned. Of these, 99 questionnaires were discarded as unsatisfactory or redundant. The remaining 209 questionnaires were deemed to constitute an acceptable sample size - as they represent

a 41.8% response rate. We used a stratified sampling design to choose our sample respondents. Table C illustrates the relation between the questions, variables and hypotheses.

Table-C: Survey Questions, Hypotheses, Variables

Data Security	Hd	Q4 – Q16
Customer Trust	Hc, He	Q17 – Q22
Value Added	Ha, Hg	Q23 – Q29
User Design Interface	Hf	Q30 – Q35
FinTech Promotion	Hh, Hi, Hj, Hk, Hl	Q36

Data analysis was carried out with SPSS and AMOS. The analysis includes a validity test, descriptive statistical analysis, confirmatory analysis, exploratory factor analysis (EFA) and univariate analysis. This study attempts a three-phase approach. In the first phase, we analyse data utilizing EFA and a canonical correlation matrix for data decrements. A preparatory workshop for a pilot test disclosed the questions to participants and ensured that every participant understood the research motives. Here, 90 samples were used for the pilot test. We used EFA by employing the principal axis factoring technique on a Promax rotation to limit the items of every latent factor loaded. Every question was deciphered with different approaches to ensure that all participants understood all questions in the same way. We received five different eigenvalue factors that confirmed the five factors in the literature review and further tested their reliability with Cronbach's Alpha (Cuieford, 1965). Cronbach's Alpha is used to measure dependability of different Likert questions in a questionnaire that forms a scale (Allen & Yen, 2002; Bland & Altman, 1997; Cuieford, 1965). According to Cuieford, 0.7 of Cronbach's Alpha is high enough in an exploratory research test, and therefore researchers should target between 0.35 and 0.7 and discard all values less than 0.35.

The second phase of the approach includes measurement model estimation employing confirmatory factor analysis (CFA). Here, the discriminant validity, reliability and convergence of our factors are converted to a data set of 199 samples. Thirdly, we used a structural equation model (SEM) that was derived from all models employed to test our hypothesis. In our work, the structural equation framework from the SPSS AMOS is used.

In this study, X*i* signifies the latent variable that measures the intention of customers to adopt FinTech from the total respondents. The relationship that exists between X*i* and an explanatory set of variables is indicated by r*i*.

$$Xi = r'i\ \beta+\varepsilon \quad (1)$$

The factors that influence FinTech adoption are indicated by the vector:

r′=[VA, CT, DS, UI, FP]′

Our explanatory variables are exogenous and represent latent variables (V) which are measured by two or more perceived marker variables (Y). This then generates:

$$Yi = LvV+\varepsilon_v \quad (2)$$

where:

Y_i = The V vector of the marker
L_v = Loadings
V = Exogenous construct
ε_v = Measurement or estimation error hi

Figure 2 represents a model to predict the perceived intention to adopt FinTech in Germany from the variables data security, customer trust, value added, user design interface andFinTech promotion, with the help of AMOS and the Statistical Package for Social Science (SPSS). We used the structural equation model (SEM) to test hypothesized relationships among our constructs and to validate the scientific behavioural approach of our study, as well as to estimate multiple correlations. This helped us to construct all our theories, which enabled us to present them with latent factors (Sadeghi & Hanzaee, 2010).

5.1 Applying SEM

In general, we followed six basic steps. In the first step, also termed as model specification, we formulated the hypothesized relationships among the manifested variables (MV) and our latent variable (LV). Here we derived our relationships from current literature and past theories. As shown in Figure 2, our latent variable is depicted by "intention to adopt FinTech" and manifest variables (DS, CT, FP, UI and VA), shown by rectangles. The arrows display the hypothesized relationships, as shown in Figure 3. The next step was to identify our model (also known as model identification) in order to verify whether our model is appropriate for the degree of freedom we need to calculate. The degree of freedom of the model is ascertained by subtracting the number of parameters to be evaluated from the number of known components. According to Gefen et al. (2000), the model is over-identified if the degree of freedom is above zero. However, it was vital to make sure that our model would be over-identified, to enable us to analyse it.

The next step was to select the data that is needed for our work. This was very important, since SEM has issues with multicollinearity, sample size, missing data, normality and outliers. Several researchers have proposed that the minimum sample size should be 10, multiplied by the number of items during complex constructs (Gefen et al., 2000), while Weston et al. (2006) cited the work of Kline (1998) that 10 to 20 participants are needed per hypothesized relationships between two variables. Weston et al. (2006) proposed a standard sample size of 200 for SEM. Multicollinearity alludes to the circumstance where there is a solid relationship among measured variables ($r > 0.85$). In our work, we made sure to remove all items that might cause any multicollinearity (Weston et al., 2006). Since our work was focused only on Germany, we made sure to adhere to cases that were relevant in Germany, and classified cases that were not relevant to Germany as outliers. As per Field (2005), outliers allude to cases which are

considered abnormal in relation to the main pattern of the data. Both outliers and missing data were removed from our data before we applied the SEM analysis, to prevent our model from being biased.

We then estimated our model by determining the value of obscure parameters and the error relationship with the estimation value. Here, we initially adopted confirmatory factor analysis to test the measurement model before we estimated the structural model, as in the work of Anderson and Gerbing (1988), and cited in Weston et al. (2006). We then evaluated our model (also known as model fit and interpretation). We then evaluated our fit based on the following: the strength and the significance of our hypothesized relationships, variance accounted for by our latent variables and origin (endogenous) observed, and how well our general model fits our observed data.

In general, SPSS, MS Excel and AMOS were used to analyse our data in this study. SPSS was used to conduct descriptive analysis, explanatory factor analysis, the normality test, the reliability test, outliers' detection and missing data detection. We saved our data in MS Excel and transmitted the data from SPSS to AMOS. Both our CFA and structural model analysis were done using AMOS.

6. Findings

In Figure 1, we demonstrated that the number of mobile users in Germany is rapidly increasing, yet the adoption of FinTech is extremely sluggish. It is intriguing to observe that 99% of respondents had mobile devices, but only 10% recognized FinTech. Further, it is significantly discouraging to perceive that only 10 out of the 209 respondents had ever used FinTech services, representing under 1% of the surveyed respondents. It is obvious that the FinTech incubators and banks offering FinTech services need to persuade their customers of the usefulness and value added advantages of FinTech.

This study has been carried out to determine the key factors that influence and provoke FinTech adoption. Our exploratory factors are data security (DS), customer trust (CT), user design interface (UI), value added (VA) and FinTech promotion (FP) (Robinson et al., 1991). We tested the discriminant validity, convergence and reliability of each variable, utilizing CFA. We illustrate these results in Tables D and E.

To determine customers' intention to adopt FinTech, we initiated several surveys to test our hypotheses. We set our Cronbach's Alpha to a rate higher than 0.7, based on standards set by Cuieford (1965) and Hair et al. (1998). Hair et al. added that a rate of 0.6 is acceptable in an exploratory study. As illustrated in Table E, the normal loading factor for the DS is 0.96 and the Cronbach's Alpha is 0.58, falling below both standards recommended by Cuieford (1965) and Hair et al. (1998). Normal loading factor is defined as a statistical method that represents correlations between items and factors (Tucker & MacCallum, 1993). The normal loading factor for the construct customer trust (CT) is 0.67, with a Cronbach's Alpha of 0.78. The normal loading factor for the construct value added (VA) is 0.58. with a Cronbach's Alpha of 0.94. The normal loading factor for the construct user design interface (UI) is 0.97, with a Cronbach's Alpha of 0.92. All our Cronbach's Alpha values are higher than 0.7 for all our constructs, apart from data security. In summary, based on confirmatory factor analysis, all the constructs tested in the EFA were important.

Next, we were able to summarize the factors that influence FinTech adoption as VA, CT, UI, and FP, and relate them to DS. Consequently, we conducted a fundamental diagnostic analysis for statistics, exceptions and standards. We examined the convergent validity of our constructs by generating their average variances (AVE) (Farrell, 2009). AVE is a statistical tool defined as the average amount of variance in indicator variables that constructs are administered to define. Additionally, it has been recommended that AVE should surpass 0.5 for all constructs of a measurement framework (Cortina, 1993;

Costello & Osborne, 2005). There was no critical deviation in the reported discoveries in the context of standards and exception.

We identify our suggested relationship model via SEM. Generally, the initial phase in SEM is to recognize the recommended suggestions of the relevant models, such as relative chi-squared (CMIN), comparative fit index (CFI), normed fit index (NFI), Tucker-Lewis Index (TLI), root mean square of approximation (RMSEA) and parsimony comparative fit index (PCFI). Figure 3 demonstrates that the SEM model fits our data best.

Table-D: Mobile Device Users and their Awareness of FinTech Survey Questions, Hypotheses, Variables

Mobile Device Users			FinTech Awareness	
	Frequency	**%**	**Frequency**	**%**
YES	207	99	94	45
NO	2	1	115	55
SUM	209	100	209	100

Table-E: Confirmatory Factor Analysis of Latent Reliability and Convergence Validity

Mobile Device Users			FinTech Awareness	
Construct	**Item**	**Normal Loading Factor**	**Cronbach's Alpha**	**Average Variance Extracted**
Data security (DS)	DS	0.96	0.58	0.68
Customer trust (CT)	CT	0.67	0.78	0.47
Value added (VA)	VA	0.58	0.94	0.54
User design interface (UI)	UI	0.97	0.92	0.93
Promotion (FP)	FP	0.74	0.86	0.48

[FP] FinTech Promotion [DS] Data Security [CT] Customer Trust [VA] Value Added [UI] User Design Interface

As stated earlier, our explanatory variables are exogenous and represent latent variables (V), which we measured by two or more perceived marker variables (Y) and grouped into items, as illustrated

in Table E. Now we validate the discriminant validity of our confirmatory factor analysis, as illustrated in Table F.

Table-F: Confirmatory Factor Analysis of Discriminant Validity

FP	DS	CT	VA	UI	
0.478					FP
0.213	0.668				DS
0.056	0.350	0.025			CT
-0.111	0.26	0.098	0.34		VA
0.156	0.02	0.026	0.089	0.783	UI

[FP] FinTech Promotion [DS] Data Security [CT] Customer Trust [VA] Value Added [UI]

We now assess parsimonious indices that recommend that our model fits (PCFI = .84). Table G discoveries recommend that all calculated parameters in our hypothesis are essential. However, our CMIN is not exactly at the required cut-off value of 3.0, as recommended by Chau (1997). Here, our relative chi-square (CMIN) is $\chi 2/df$ =1.83, which is less than the required value. Our RMSEA is .06, which is appropriate, since it is between the 0.05 and 0.08 range recommended as a suitable model fit, as in the work of MacCallum et al. (1996). As in the work of Steenkamp and Van Trijp (1991) our comparative fit indices likewise show a model fit as follows:

(CFI = 0.98), (NFI = 0 .91) and (TLI = 0 .93).

Consequently, these observations conclude that our model fit the sample data in our work properly.

Table-G: Final Confirmatory Factor Analysis Model for our Model Fit

Fit Measures	Values Proposed	Values Observed
CMIN (χ^2/df)	≤ 3.0	1.79
Normed Fit Index	≥ .90	0.91

Parsimony adjusted to CFI	___	0.81
Tucker-Lewis Index	≥ .90	0.93
Comparative Fit Index	≥ .90	0.98
Root mean square error of approximation	≤ .08	0.05

After analysing our model fit, our empirical results indicate that the VA has much potential to influence the intention to adopt FinTech. UI also plays a major role in FinTech adoption. Here, our results indicate a 1% level of influence, and the empirical results illustrate that customers are more motivated to adopt FinTech when the user design interface is improved. The discoveries in this work verify that the effect of FinTech promotion does not have a direct or indirect impact on willingness of customers to trust FinTech.

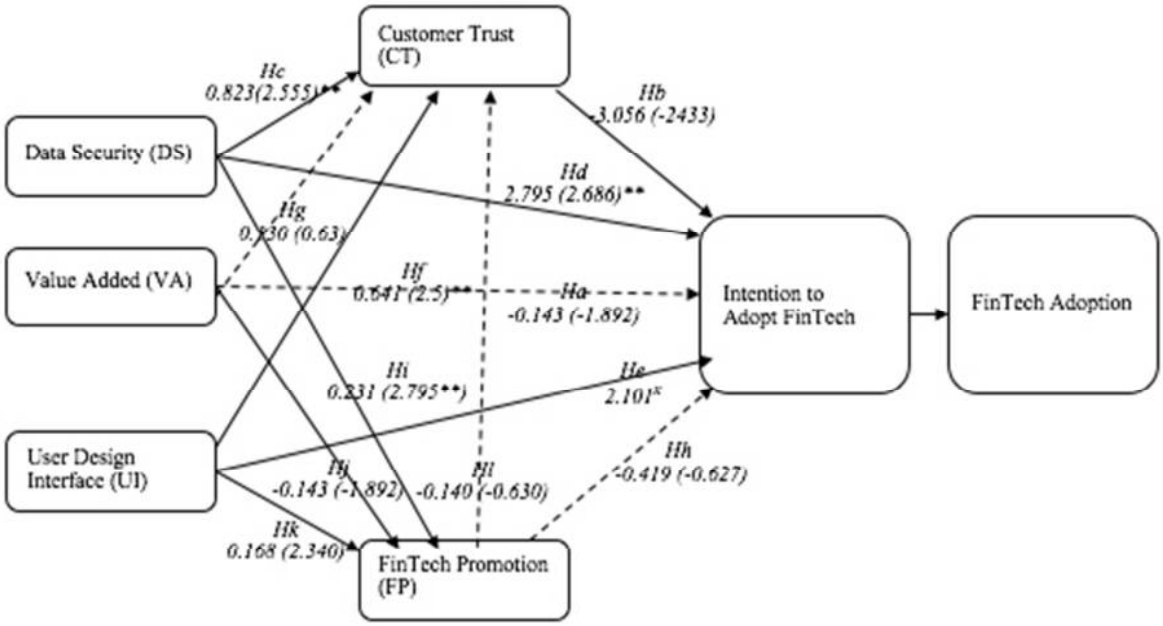

Figure-3: Proposed Research Model Fit- Intention to Adopt FinTech in Germany

Our standardized regression weight is based on y value, where **y < 0.01,
*y < 0.05 .x path that had been fixed at 1.0 for model identification.

6.1 Univariate Analysis

Table-H: Univariate Analysis Results

	Hypothesis	Univariate Analysis
Hb	Trust does not always influence customer s' intention to adopt FinTech.	Rejected
Hc	The willingness of customers to trust FinTech is not influenced by data security.	Rejected
Hd	Data security does not influence customers' intention to adopt FinTech.	Rejected
He	Customer s' intention to adopt FinTech is not influenced by user design interface.	Rejected
Hf	User design interface does not influence the willingness of customers to adopt FinTech.	Rejected

Based on the results generated in this study, as illustrated in Table H, there is sufficient evidence to reject Hb, Hc and He. Thus, we can deduce that data security and user design interface do influence customer trust, since there is a strong relationship between quality and trust. In the context

of interface issues, Egger (2002) stressed attractiveness, perception and usability as vital factors of trust models. According to Donahue et al. (1999), usability is seen as a vital determinant of a smooth online trade. Kim and Moon (1998) also suggested that online commerce will win more trust than traditional commerce, due to the appeal of the web interface and its quality of information. Berger and Sasse (2001) argued that various interface factors can be clarified as trust, and Egger (2003) argued that customers are willing to explore websites that are relevant to them.

Moreover, Hc is rejected, since data security strongly influences customer trust, with approximately a 99% confidence level. In addition, the results fail to reject Hi, Hj, Hg and Hk. These indicate that data security, customer trust and user design interface do influence FinTech promotion. According to the results, Hb, Hc, Hd, He and Hf are all rejected at a 99% confidence level. Taken together, this implies that there is a hierarchy of important variables where data security, user design interface and customer trust are the principal components of customers' intention to adopt FinTech. However, the difference in mean score is small, particularly between user design interface and data security. It can then safely be concluded that all three constructs are influential over the intention to adopt FinTech.

For Hh, there is insufficient evidence to conclude that promotion influences the intention to adopt FinTech. Hl is also not rejected. This analysis answers our research questions regarding the primary hindrances of FinTech innovation adoption and what variables customers prioritize in the context of FinTech.

7. Limitations of the Study and Risk to Validity

There are a few limitations in this study. Initially, our study focuses on FinTech implementation in Germany and not the whole of Europe. In addition, demographic and regional factors could be consolidated to inspect their particular impact on the intention to use FinTech services, particularly among younger users with a high interest in technology. Without these constraints, we could have gathered additional data for a more robust result and obtained new knowledge to further upgrade polices to enhance the FinTech adoption process. Future analysts can assist exploration of this topic by altering determinants in the UTAUT model. Additionally, because the cluster sampling technique was used, the reported outcomes are not 100% generalized to the German population. To accomplish a complete generalization, a basic random sampling strategy for the whole population is essential. We could also alleviate some limitations by examining how online vendors are performing with regard to FinTech to satisfy the needs of customers via case studies.

This study was conducted in Germany and might have produced different results if held in other countries, since technology acceptance is different in a different environment. For instance, we suspect that the results would be somewhat different, were the research to be conducted in the United Kingdom, where take-up of FinTech appears to be far greater than in Germany. Therefore, our results are only generalized for the country of Germany and not other geographical areas.

Furthermore, respondents may have been influenced by past experiences about FinTech usage which might have led them to neglect to answer some questions. In spite of this, our study did not consider the influence of moderating variables such as age, education and FinTech services experience.

We also neglected social impact and control factors, since their corresponding items disregarded the instrument dependability. Accordingly, we could not quantify social impact and control factors on FinTech use.

8. Conclusion

In this work, we empirically analysed the key factors, namely, customer trust (CT), data security (DS), value added (VA), user design interface (UI) and FinTech promotion (FP), that influence the intention to adopt FinTech, by using the TAM and Wang et al. (2003) model. Going beyond the standard TAM was indeed an important goal of this research to enable us to eliminate all the limitations that come with the TAM, by incorporating data security, trust, user interface and promotion as essential elements of FinTech adoption and usage. It was also vital for us to go beyond the standard TAM, since it only emphasizes perceived usefulness and perceived ease of use, and both tend to ignore the constraints that hinder FinTech adoption. The outcome, underpinned by statistical analysis, confirms that DS, CT and UI are the solid foundation in FinTech adoption. Importantly, these three factors have critical impact on FinTech adoption, while DS significantly influences CT.

Based on our results, we can positively answer our first question with a strong argument that the principal hindrance to FinTech innovation are data security issues, poor user design interface and the absence of customers' trust. It is therefore essential that data security issues and the user design interface in FinTech need to be addressed effectively from the planning phase, to increase customers confidence in FinTech. Examples have been given that delineate circumstances where information security and usability have been misjudged and discriminant validity has not been adequately evaluated or done well, which turns out to be a major hindrance in FinTech innovation. Customers' awareness of how data is being collected and used is still a major issue in the context of technology in Germany.

Consumers value their data and their privacy, and they have expectations. Today, through the media and social networks, customers are aware of the rapid increase of cyber-attacks on bank networks and data breach issues. Furthermore, they are also aware that little has been done by the industry to mitigate or prevent these attacks. Likewise, customers want to improve their standard of living, but are still cautious as regards the security of their data. They are disappointed when their essential data is intercepted by an unauthorized person or revealed to third-party companies. With respect to usability, customers are willing to explore products that are attractive and meet usability standards (Egger, 2002). According to Egger (2002) usability, attractiveness and perceptions are essential determinants of the trust model, and many other researchers have also stressed this (Egger, 2002; Donahue et al., 1999; Kim & Moon, 1998; Berger & Sasse, 2001; Egger, 2003). Furthermore, the increase in cyber-attacks on the wireless networks and operating systems of mobile banking platforms is still a major issue in the context of data security research. These attacks have brought about a high level of mistrust in the context of online payment transactions, due to the high risk of unapproved transactions from unauthorized persons.

It is obvious that the main deterrents to the adoption of FinTech are privacy and data security issues. It is therefore clear that such risks are more of a concern to customers than the quality of the product. It is also vital for financial institutions to enhance and sustain the CIA of customers' financial data and enhance the rules and legislation that accompany mobile applications (Yousafzai et al., 2005). In summary, the main hindrance to FinTech innovation adoption is data security, since this has a major influence on trust.

Our results also answer our second research question. Here, the current analysis demonstrates that perceived usefulness with respect to fraud protection and privacy has an immediate impact on the intention to adopt FinTech (Hoffman et al., 1999). Likewise, customers want to discover simple and strategic methods of preventing fraud and increasing the security of their data. In the context where customers feel safe and not threatened, their trust increases, and this thereby enhances their intention to adopt FinTech. This study reaffirms that data security has a strong influence on trust, but that value added, as any enhancement concerning the ability to better serve customers with less

effort (U) and the belief that using FinTech would enhance customers' performance (perceived ease of use (E)), do not influence customers' intention to adopt FinTech. This indicates that customers do not prioritize value added over data security.

Our last research question is related to the extent that data security and trust matter in the context of FinTech. Here, we demonstrated that trust decreases the perception of risk in adopting FinTech, t hat is, there is a belief that an online company with a good reputation might provide secure encryption technologies and guarantees, should there be a dispute. All of these factors increase customers' trust and influence their desire to adopt FinTech services provided by a particular vendor. The more customers are educated about and assured of their data being kept securely, the more their trust in financial technology will increase. It is therefore important that FinTech innovators understand customers' attitudes with regard to data and that they increase data transparency and security to enable customers' awareness of how data is being used and stored securely. Today, 82% of Germans are reluctant to share information with FinTech organizations, since they want to maintain their privacy (Statista, 2015). In a conjoint analysis survey, Germany was seen to be the country where people placed the most value on their personal data, such as health data, credit cards, assets and government identities, when compared to the UK and the USA. We can therefore answer our third research question, that data security and trust matter greatly in FinTech adoption, and therefore FinTech innovators should enhance the security of their products and their online reputation in order to increase customers' trust. Customers can be educated and introduced to the advantages of FinTech, including its data security measures and benefits, through workshops, magazines, guidelines and consultancy.

Our study confirms that data security, customer trust and user design interface strongly affect the intention to adopt FinTech. These outcomes can be used to improve the performance of FinTech strategies and enable banks to accomplish economies of scale for global intensity. We hope that this paper will serve to encourage FinTech innovators in their approach to this field, and enable FinTech researchers to make use of past work with more certainty, resulting in future hypothesis improvement.

Our survey results are available at:
https://www.dropbox.com/s/yquzrfylx6jgren/2016FintechSurvey.xls

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