Bachelor Thesis

Influence of Technology Readiness and Age on a Physician's Intention to Prescribe the Artificial Pancreas

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Abstract
Diabetes is globally known as a wide-spread disease which can cause severe health damages. Current treatment options all require an immense amount of manual handling and controlling which can cause problems in the treatment process. In the future those problems can be overcome by using an artificial pancreas with its automated controlling and injection mechanisms. The Dutch company Inreda BV is planning on entering the market with this new medical device within the next years.
To obtain enough information about an efficient market entry, this study focuses on physicians and their intention to prescribe the artificial pancreas to patients. A data analysis on basis of a questionnaire was carried out and a possible influence of the technology readiness of physicians on their intention to prescribe was examined. Furthermore, the age of the surveyed physicians was taken into account as a possible moderating variable between the independent and the dependent variable. The analysis of the data was based on a regression and a correlation analysis with the attempt to accept or reject previously drawn hypotheses regarding the relationships. The only significant relationship was found between the technology readiness dimension optimism and the intention to prescribe the artificial pancreas. It suggests that physicians with a high level of technological optimism have a high intention to prescribe the medical device to their patients. Neither age nor the other technology readiness dimensions – innovativeness, discomfort and insecurity – were found to have a significant effect on the intention to prescribe. Discomfort and Insecurity were found to have similar items and were combined to the new component mistrust. According to the regression analysis the technology readiness plus the moderating effect of age explained 15,4 % of the intention to prescribe.

Keywords:
Artificial Pancreas, Diabetes, Technology Readiness, Age, Physicians, Intention to Prescribe

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1. INTRODUCTION

Looking at today's life it is observable that human society is getting increasingly influenced by novel technological devices. Such innovative products can have the ability to make life easier for consumers and help them to overcome daily barriers by undertaking supportive functions (Park & Jayaraman, 2003; Renard, Place, Cantwell, Chevassus & Palerm, 2010). In modern medicine, technological products open up new possibilities for a physician with regard to the treatment of his patients. In other words: Technological innovations in the medical sector enable the cure of diseases and injuries, which were thought to be untreatable, and enhance diverse ways of treatment (Bronzino, 2014).

In 2013, according to estimates of the International Diabetes Federation (2013), there were approximately 382 Million people living with the chronic disease diabetes. The disease can be categorized into three main categories: Type 1 diabetes, type 2 diabetes and gestational diabetes. All three types of diabetes describe persons who are either not able to produce enough insulin or which have an ineffective utilization of insulin. Together with the hormone glucagon, insulin regulates the blood sugar level. Without accurate treatment diabetes can damage several body parts (heart, eyes, kidney etc.) and will, over time, lead to death (International Diabetes Federation, 2013).

The planned market introduction of a closed-loop, bi-hormonal artificial pancreas (AP) by the Dutch company Inreda Diabetic BV in 2016 represents an entirely new way of treating diabetes patients. Current treatment options like the insulin pen or the insulin pump entail a high degree of individual involvement in terms of glucose measuring and injections (Inreda Diabetic BV, 2015). According to Lin et al. (2004) those self-managed treatment options, including the change in lifestyle and the constant self-monitoring of the glucose level, can represent a high burden for diabetes patients and can, as a matter of fact, lead to a depression. The usage of the AP can take this burden off the patients and will additionally provide a higher accuracy in measurement and medication (Patek, Chen, Keith-Hynes & Lee, 2013).

Before the decision on using a new medical device is made, many patients will seek consultancy from a medical advisor. Among others, one possible source for advice-giving is the consulting of physicians (Kao, Green, Davis, Koplan & Cleary, 1998). However, Renard (2010) observed a lack in the number of well-trained European doctors with regard to the use of insulin pumps, which is expected to lead to the exclusion of the "insulin pump therapy as a common practice" (p. 30). This has to be kept in mind for the marketing strategy of Inreda Diabetic BV when introducing the AP as a new product. Physicians are of high importance within the decision process of a patient concerning their diabetes treatment, since they act as intermediary advisors who give out all the necessary information. Therefore, a physician's intention to prescribe the AP to his patients has to be analyzed. Since Renard (2010) suggested that "younger generations of physicians are more exposed to technology in diabetes care" (p. 31), one focus of this paper is to evaluate a possible influence of a physician's age on his intention to prescribe the AP. Furthermore, the age of a person is believed to influence his or her individual characteristics in terms of technology readiness (Caison, Bulman, Pai & Neville, 2008). In their research Caison et al. (2008) indicated a negative relationship between age and technology readiness. The two observed relationships of both studies, Renard (2010) and Caison et al. (2008), will be combined to obtain a broader view on the specific variables. While Renard's (2010) findings concerning doctor's exposure towards diabetes technology can be seen as an indicator for a negative relationship between age and the intention to prescribe, Caison et al. (2008) observed a negative relationship between age and technology readiness. The outcomes suggest that age is influencing both, the independent variable technology readiness and the dependent variable intention to prescribe. To find out whether age only influences those variables once they are analyzed separately or if it also affects the relationship between them, this study will evaluate available data. Consequently age will be used as a moderating variable between technology readiness and intention to prescribe. Baron and Kenny (1986) suggested that "moderator variables are typically introduced when […] a relation holds in one setting but not in another" (p. 6). Since age seems to influence both the technology readiness and the intention to prescribe, the setting might change among physicians who do not have the same age. Therefore it will be analyzed if those different settings have an influence on the relationship between independent and dependent variable.

In short, the goal of this research paper is to help Inreda Diabetic BV to develop components of an efficient marketing strategy by finding out whether the technology readiness of a physician has an influence on his intention to prescribe the AP to patients and if the physician's age has an effect on the causal relationship. To fulfill this goal, it is intended to answer following research question:

To what extend does the technological readiness and the age of a physician affect his intention to prescribe the artificial pancreas to patients?

In order to answer this research question, two supporting sub-questions were developed:

1. *To what extent is a physician's intention to prescribe the AP influenced by his technological readiness and age?*
2. *Does the age of a physician moderate the relationship between technological readiness and intention to prescribe the AP?*

By answering the research question and the accompanying sub-questions it is intended to close a theoretical gap within existing scientific work. Even though Caison et al. (2008) already found a negative relationship between age and technological readiness within the health care sector and several other sources suggest this negative effect within different sectors (Venkatraman & Price, 1990; Harrison & Rainer, 1992; Steenkamp, Hofstede & Wedel, 1999), there is still need for further research in order to link those outcomes with the intention to prescribe a medical device. Furthermore the relationship between technology readiness of physicians and their intention to prescribe the AP will be analyzed on a possible moderating effect of the physician's age. The usage of age as a moderating variable was observed in several scientific articles, but not with regard to the relationship between technology readiness and the intention to prescribe a medical device (Blanchard-Fields & Irion, 1988; Bertolino, Truxillo, & Fraccaroli, 2011; Rho, Kim, Chung & Choi; 2015). On the one hand this paper will contribute to current theories about technology readiness of physicians and on the other hand it will add new insights to the topic of AP prescription by physicians. Additionally a practical usefulness will be provided towards Inreda by giving new insights on a physician's intention to prescribe the AP. The analyzed data can be used for developing a suitable marketing strategy.

To answer all relevant aspects of the research question in the right way, following structure was developed: First a literature review will create a theoretical foundation, from which the causal model is derived. After presenting hypothesized effects, the methodological part will inform about the data collection, the sample and the measurement of the variables. The findings will be presented and discussed extensively before giving a final conclusion.

2. THEORY

2.1 Literature Review

2.1.1 Focus on Physicians and Their Intention to Prescribe

The decision-making process of patients regarding the treatment of diseases is assumed to be influenced by opinions and advices of physicians. This presumption is based on the findings of Kao et al. (1998), which state that the majority of observed patients "trusted their physicians to act in their best interests" (p. 683). The result derived from the study of 292 patients from Atlanta, Georgia. Trust between the two parties is crucial, since physicians provide patients with information about treatment options and help them to decide on a treatment method by communicating their opinion (Kao et al., 1998). However, each physician has his individual view on different kinds of treatment and is handing out diverse medical information to their patients. Further indication for the influence of doctor's advices on the decisions of patients was found by Berning (2015). His study, which revealed that obese patients who got medical advice were more likely to lose weight than patients who did not get counseling, advocates a higher consistency concerning those advices. Kao et al. (1998) and Berning (2015) are not the only researchers which observed the influence of advice-giving on decision-making (Kraetschmer, Sharpe, Urowitz & Deber, 2004; Bonaccio & Dalal, 2006; Kalaitzidis, 2015). Additionally Renard (2010) analyzed the usage of insulin pumps within Europe and addressed, amongst others, the acceptance by physicians. He discovered that a lack of well-trained physicians leads to a low number of insulin pumps that are prescribed and used in Europe. This can lead to a higher number of treatments which do not involve the usage of an insulin pump, such as the insulin pen. Patients do not get informed properly on the advantages of treatments which involve an insulin pump, like the AP, and decide against them. The intention to prescribe the AP, representing the dependent variable in this study, is founded on the work of Venkatesh and Davis (2000) and is modified from their variable intention to use, which describes the self-prediction of a person to use or not to use a product. The reason to adapt the variable derives from the focus of this article, which lies on physicians, who will not use the product for their own treatment but who will rather prescribe it to their patients. In this case the prescribed product is represented by the AP. As seen in the reviewed literature, physicians have a great influence on behavior and decisions of patients and can therefore be seen as a highly important group, which has to be closely examined for the market introduction of Inreda's AP.

2.1.2 Technology Readiness Index

The linkage of a physician's technology readiness and his intention to prescribe the AP is crucial since technical features play a big role in its composition and functionality. Regarding the technical parts, the AP can be seen as a modified insulin pump which complements the existing technology with new control and sensing systems (Jaremko & Rorstad, 1998). Similar to insulin pumps, the AP is relying on subcutaneous technological components (Kovatchev et al., 2013). Additionally to the present insulin pump technology, further technical mechanisms are part of the AP composition. Harvey et al. (2010) stated that "physiological sensing technology" (p. 60) can remove the need for patient involvement, as the fully automated AP is able to control the glucose level without user operations. This high amount of automation requires a great level of trust in the technological functionality of the medical device (Montague, 2010), which makes it crucial to analyze subjective judgments regarding technology. In order to represent those subjective attitudes, Parasuraman (2000) gave a suitable definition of the so-called Technology Readiness Index; it "refers to people's propensity to embrace and use new technologies for accomplishing goals in home life and at work" (p.308). Based on their technology readiness level, people can be evaluated on the basis of four dimensions: Optimism, innovativeness, discomfort and insecurity. While optimism and innovativeness are indicators for a high technology readiness, insecurity and discomfort are seen as distinctive characteristics for a low level of technology readiness (Parasuraman, 2000). The four dimensions of the Technology Readiness Index will be defined more extensively in Section 2.2: Research Model and Hypotheses.

Caison et al. (2008) used the Technological Readiness Index model of Parasuraman (2000) to obtain the technological acceptance within the medical sector by studying a sample of nursing and medical students of the Memorial University of Newfoundland. This study discovered a relationship between age and technological readiness; students under the age of 25 were more likely to be technological ready than students which are older than 25 (Caison, Bulman, Pai & Neville, 2008).

Within the context of this study, the level of technology readiness determines the propensity of a physician to prescribe the AP while this relationship will be examined on a possible moderating influence of age. Keeping in mind that the AP is an automated technological device, it is crucial for physicians to be able to rely on the machine in order to prescribe it to their patients.

2.1.3 Age as a Moderating Variable

According to Baron and Kenny (1986) "a moderator is a qualitative (e.g. sex, race, class) or quantitative (e.g. level of reward) variable that affects the direction and/or strength of the relationship between an independent or predictor variable and a dependent or criterion variable" (p.1174). In other words, the strength of a relationship can be explained by introducing a moderating variable. Since Caison et al. (2008) indicated a relationship between age and technology readiness for prospective physicians and Renard (2010) discovered that the age of a physician is likely to influence his level of training regarding the usage of an insulin pump and therefore the intention to prescribe the AP; age seems to be an important indicator concerning the strength of the expected relationship. To clarify the term age, the definition of the Oxford Dictionary is used: Age describes "the length of time a person has lived" and is measured in years.

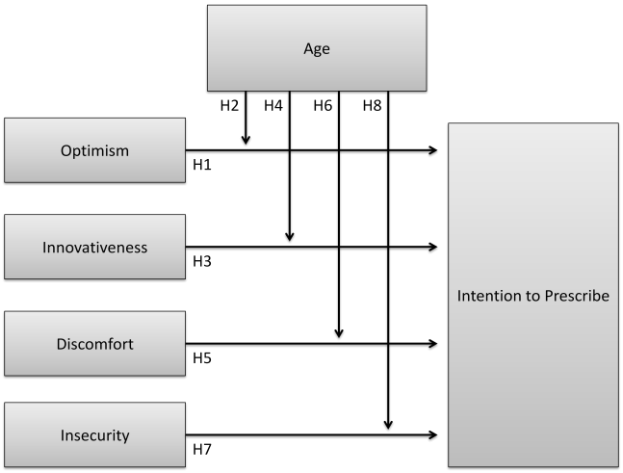
Multiple scientific articles with diverse topics have used age as a moderating variable to explain existing relationships between independent and dependent variables (Blanchard-Fields & Irion, 1988; Halvari, 1997; Bertolino, Truxillo, & Fraccaroli, 2011). The relationship between technology readiness and the intention to prescribe might differ for people with a different age. Due to the negative relationship between age and technology readiness (Caison et al., 2008) and the higher likeliness of younger physicians to prescribe the AP (Renard, 2010), it is predicted that age will also have a negative effect on the relationship

between technology readiness and intention to prescribe. In other words, an increase in age is assumed to weaken the relationship between technology readiness and intention to prescribe. A visual representation of the derivation from two direct relationships towards a moderating relationship can be seen in the appendix (See Appendix – Figure 1).

2.2 Research Model & Hypotheses

As already indicated in the research question, the effect of technology readiness of physicians on their intention to prescribe will be analyzed with an additional focus on the moderating variable age. To demonstrate the hypothesized interactions between independent, moderating and dependent variables a visual representation in form of a model was developed (See Figure 1).

Figure 1. Research Model



The independent variable technology readiness is, based on Parasuraman's (2000) proposed categories, divided into the four sub-dimensions optimism, innovativeness, discomfort and insecurity. Each of the technology readiness dimensions has a hypothesized effect (**H1, H3, H5, H7**) on the intention to prescribe the AP and will be examined extensively. It is intended to test the various hypotheses by analyzing available data and to reject or support them accordingly. In addition to the hypotheses between the four independent variables and the dependent variable, further assumptions (**H2, H4, H6, H8**) regarding the moderating effect of age are made and tested as well.

Optimism

Parasuraman (2000) uses the term optimism as the dimension, which describes persons with an optimistic way of looking at technology. People who are categorized into this dimension tend to trust technology and believe that it contributes to a more controllable, flexible and efficient life. Physicians who belong to this group are expected to be open towards technological medical devices like the AP. However, based on the findings of Renard (2010) and Caison et al. (2008), it is assumed that an increase in age leads to a lower technology readiness level and a lower willingness to prescribe the AP amongst optimistic physicians. Expecting those two negative relationships which both have their foundation in the preceding variable age it is assumed, that age will also act as a moderating variable between technology readiness and intention to prescribe. Age is anticipated to have a negative moderating effect on the relationship, as a higher age will more likely lead to a lower level of technology readiness, in this case a lower level of optimism, and a lower intention to prescribe the AP. Therefore, following hypotheses were developed:

H1: Optimism has a positive effect on intention to prescribe.

H2: Age negatively moderates the positive effect of optimism on intention to prescribe.

Innovativeness

Same as optimism, innovativeness is seen as a driver of technology readiness. Persons that can be classified within this group are usually amongst the first adapters of new technologies. They are seen as trendsetters and pioneers (Parasuraman, 2000). Looking at physicians who are grouped within this dimension, it can be assumed that they are adapting quickly to new technologies. This positive attitude towards innovative products will, in theory, lead to a higher intention to prescribe the AP to patients. However, as in the optimism-dimension, increase in age is supposed to have a negative effect on this relationship (Caison et al., 2008; Renard, 2010). The expected negative moderating effect of age derives from the anticipation that age will influence the two variables technology readiness and intention to use negatively and will therefore have a weakening effect on the relationship between them. In order to demonstrate those assumptions, following hypotheses were formulated:

H3: Innovativeness has a positive effect on intention to prescribe.

H4: Age negatively moderates the positive effect of innovativeness on intention to prescribe.

Discomfort

In contrast to optimism and innovativeness, discomfort describes those kinds of persons, which are burdened by technology. They are worried about not being able to control the technological devices and have a natural aversion towards technology. Furthermore the possible breakdown of technical products is a continuous concern (Parasuraman, 2000). Such a kind of anxiety will, hypothetically, lead towards a low intention to prescribe the AP to other persons. Moreover, this relationship might be positively affected by an increase in age, as it is theorized that older persons are more likely to have a low technology readiness level (Caison et al., 2008; Renard, 2010). Unlike the dimensions which indicate a high level of technology readiness, optimism and innovativeness, discomfort with assesses people as technology-rejecters. Therefore, discomfort is seen as a negative influence on the intention to prescribe and a negative relationship is expected. Furthermore, age is likely to act as a strengthening variable for this relationship as older persons, based on Caison et al. (2008) and Renard (2010), are already more likely to have a low technology readiness and a low intention to prescribe. The following hypotheses are displaying those theories:

H5: Discomfort has a negative effect on intention to prescribe.

H6: Age positively moderates the negative effect of discomfort on intention to prescribe.

Insecurity

According to Parasuraman (2000), insecurity can be defined by the "distrust of technology and skepticism about its ability to work properly" (p.311). Therefore, people who are categorized into this dimension are facing technology negatively. This also applies to physicians, who are assumed to believe that the diabetes treatment by a person is more reliable than the automated treatment of the AP. By being so doubtful, an intention to prescribe a technological medical device is not likely. On top of this, same as for the discomfort dimension an

increase in age is assumed to strengthen this relationship even more (Caison et al., 2008; Renard, 2010), which is also presented in two hypotheses:

H7: Insecurity has a negative effect on intention to prescribe.

H8: Age positively moderates the negative effect of insecurity on intention to prescribe.

For more detailed information about the statements which were used to gather data about each technology readiness dimension, the intention to prescribe and the age of the physicians, a comprehensible overview is available in Table 1 which can be found within Section 3: Methodology.

3. METHODOLOGY

3.1 Setting – Data Collection and Subjects for Study

The data was collected by using a questionnaire that was sent to patients, physicians and nurses. As a result information regarding demographics, buyer readiness, individual characteristics, product characteristics, social influence, treatment satisfaction and the intention to use were gathered.

To get a solid foundation for reliable information about physicians and their opinions on the AP, the developed questionnaire was sent to 558 physicians in Germany (434) and The Netherlands (124). In a second round, 123 more surveys were sent out to additional Dutch physicians. All physicians that were part of the survey are specialized in diabetology or endocrinology. The participants were mostly contacted using the internet, either through databases (www.diabsite.de and www.aerzteverzeichnis.at) or via E-Mail. To reach some of the Dutch physicians, who usually work in hospitals, telephone calls were used. Out of the forwarded surveys, 97 were properly filled out and are thus used for the data collection. The mean age of the 97 respondents is 48,18 years within a range from 28 years to 70 years. Regarding the gender, a few more male physicians (57) than female physicians (40) took part.

3.2 Measurement of Variables

The measurement of the independent variables - age and technological readiness - as well as the measurement of the dependent variable - intention to prescribe the AP - is based on data which was obtained through the questionnaire. Most of the data was collected using questions based on a seven point Likert-scale. While the following sub-sections will explain more extensively how each variable will be measured, the used statements in the questionnaire can be seen in Table 1 at the end of Section 3.3.

3.2.1 Age

According to Babbie (2013), age can be categorized into the ratio measured variables. This level of measurement is based on nominal, ordinal and interval measures but requires an additional "zero point" (pp. 181 ff.). Age fulfills the nominal requirement by showing whether two or more people have a different age or if they are equally old. The ordinal requirement is fulfilled since it is possible to rank people based on their different levels of age and the interval measure is possible due to equal distances between neighboring attributes (e.g. same distance between 7 and 8 years as between 23 and 24 years).The zero point adds the possibility to determine various ratio measures (whether one person is twice as old as another one, thrice as old etc.). Within this particular study, the age of the questioned physicians ranged from 28 years up to 64 years.

3.2.2 Technology Readiness

The measurement of a physician's technology readiness is based on data which derived from the questionnaire. The survey contained areas regarding the four components of technological readiness - optimism, innovativeness, discomfort and insecurity. For each component there were several questions (in the form of statements) to answer. The possibilities to answer those questions were numerical and ranged from one to seven, where one expresses a total denial and seven a total agreement. This type of scaling, which uses standardized possibilities for answering questions, was introduced by Rensis Likert (Babbie, 2013). On this basis, the components of technological readiness will be measured on a scale from one to seven. The statements that were to answer by the participating physicians can be found in Table 1 and are based upon the findings by Parasuraman (2000). Additional literature which backs up the used statements for the innovativeness-, optimism- and discomfort-dimensions was consulted to strengthen the applicability of the questionnaire (Lin & Hsieh, 2005; Godoe & Johansen, 2012).

3.2.3 Intention to prescribe

The obtained data for the technology readiness will be analyzed on possible effects on the dependent variable intention to prescribe, which was evaluated by using two statement-questions. Again, the possibilities to answer range from one, representing total denial of the statement, to seven, total agreement of the statement and represent the Likert-scale (Babbie, 2013). The two statements are based on the literature of Venkatesh & Davis (2000) and are revising the intention and prediction of usage if the artificial pancreas is available.

3.3 Factor Analysis – Validity and Reliability

To analyze the validity of the items used in the questionnaire, which can be seen in table 1, a factor analysis with an oblimin rotation was completed, resulting in a scree plot (See Appendix – Figure 2) and a pattern matrix (See Appendix – Figure 3). The scree plot shows that the eigenvalue starts leveling off with the fourth component and since Field (2009) stated that only those factors should be used which are located on the left side of the inflexion-point; it was decided to use three components.

Therefore, a new factor analysis with a fixed number of three components was carried out. The new results in form of the pattern matrix indicated that some of the items have to be deleted to get results with a higher validity. In Figure 4 of the Appendix the deleted items are indicated by being written in italic style and the used ones are signified with the usage of bold numbers. While INN_01 is not used due to its value which is under 0,5 – namely 0,486; ONG_04, ONG_05, ONG_06 and ONZ_03 are rearranged into the positive technology readiness dimensions as their values are showing negative numbers in the two components which are supposed to show the positive technology readiness dimensions. The rearrangement is done by using the reverse coding technique, involving a multiplication of those negative numbers with the factor -1. The newly created numbers show a positive value and, while ONG_05 and ONG_06 now belong to the dimension optimism, ONG_04 and ONZ_03 are not used because there values are lower than 0,5 with 0,492 and 0,452 respectively. For the data analysis the reverse coding is done by changing the values to their contrary components. So 1 is changed to 7, 2 is changed to 6, 3 is changed to 5 and vice versa. Only a value of 4 was not changed. Based on the pattern matrix, optimism is represented by the first component and has eight items (including the two newly formed ones) whereas innovativeness is represented by the second component and contains four items.

Table 1. Questionnaire Statements of each Variable

Variables (+ Cronbach's Alpha)	Definition	Statements / Items	Sources
Optimism (α=0,856)	"A positive view of technology and a belief that it offers people increased control, flexibility and efficiency in their lives"	Technology gives people more control over their daily lives.	Parasuraman (2000); Lin & Hsieh (2005); Godoe & Johansen (2012)
		Products and services that use the newest technologies are much more convenient to use.	
		You prefer to use the most advanced technology available.	
		Technology makes you more efficient in your occupation.	
		Technology gives you more freedom of mobility.	
		You feel confident that machines will follow through with what you instructed them to do.	
		There should be caution in replacing important people-tasks with technology because new technology can breakdown or get disconnected. → **Rearranged from Insecurity**	
		Many new technologies have health or safety risks that are not discovered until after people have used them. → **Rearranged from Insecurity**	
Innovativeness (α=0,823)	"A tendency to be a technology pioneer and thought leader"	~~Other people come to you for advice on new technologies.~~	Parasuraman (2000); Lin & Hsieh (2005); Godoe & Johansen (2012)
		In general, you are among the first in your circle of friends to acquire new technology when it appears.	
		You can usually figure out new high-tech products and services without help from others.	
		You keep up with the latest technological developments in your areas of interest.	
		You find you have fewer problems than other people in making technology work for you.	
Discomfort (α=0,745)	"A perceived lack of control over technology and a feeling of being overwhelmed by it"	Technical support lines are not helpful because they do not explain things in terms you understand.	Parasuraman (2000); Lin & Hsieh (2005); Godoe & Johansen (2012)
		Sometimes, you think that technology systems are not designed for use by ordinary people.	
		There is no such thing as a manual for a high-tech product or service that is written in plain language.	
		~~If you buy a high-tech product or service, you prefer to have the basic model over one with a lot of extra features.~~	
		Technology always seems to fail at the worst possible time.	
Insecurity (α=0,745)	"Distrust of technology and skepticism about its ability to work properly"	Critics lead people to believe that revolutionary new technologies are less safe than they usually are.	Parasuraman (2000)
		A machine or computer is going to be less reliable in doing a task than a person.	
		~~It can be risky to switch to a revolutionary new technology too quickly.~~	
		If you buy products that are too high-tech, you may get stuck without replacement parts or service.	
		Technological innovations always seem to hurt a lot of people by making their skills obsolete.	

Intention to Prescribe (α=0,945)	Intention of the physician to prescribe the AP to his patients.	Assuming I have access to an Artificial Pancreas, I intend to prescribe it.	Venkatesh & Davis, 2000
		Assuming I have access to an Artificial Pancreas, I predict that I prescribe it.	
Age	"the length of time a person has lived" (measured in years)	What is your age in years (0-99)?	Oxford Dictionary

The third component describes the combination of discomfort and insecurity and is divided into four items of discomfort and four items of insecurity, resulting in a total number of eight items. The formation of a third component through the mixture of discomfort and insecurity items shows that the negative dimensions are similar to each other. For the novel component the new term 'mistrust' will be used from now on. By looking at the Kaiser-Meyer-Olkin measure of sampling adequacy (See Appendix – Figure 5), it can be stated that the size of the used sample lies at a value of 0,786 which is defined as good (Hutcheson & Sofroniou, 1999). This indicates that the sample size is sufficiently large enough. Furthermore, the Bartlett's test of sphericity is significant and thus shows that the correlations are large enough. The reliability of items were measured by using the Cronbach's Alpha and shows how well each item represents the component under which it is filed, in other words the homogeneity among each factor. In some cases it is possible to increase the alpha by deleting items. However, this is neither the case for the three components that are used as the independent variables nor for the dependent variable intention to use. All of the four examined factors have a higher value than 0,7 and are therefore, according to Field (2009), at an acceptable rate for a reliable analysis (See Appendix – Figure 6). Table 1 represents the results of the factor analysis by showing used and deleted statements. Statements which were not used are indicated by being crossed out. In the table, the newly formed component mistrust is still separated into discomfort and insecurity so that it becomes clear which statements belong to which dimension.

3.4 Data Analysis

To analyze the received data, a regression analysis is conducted which links the independent variable and the moderator with the dependent variable and explores possible relationships. The regression analysis will show how the intention to prescribe the AP will vary when either age or technological readiness is changed, while the other variable stays unchanged. The data analysis will be conducted via the statistics software SPSS. Once the analysis is conducted it will be detected whether there is a positive, a negative or no relationship at all between both of the independent variables and the dependent variable. Moreover the significance of those outcomes will be tested.

4. RESULTS

4.1 Descriptive Statistics of Variables

To get an overview about the variables which are used for the regression analysis, a table with descriptive statistics was created (See Table 2). The valid number of physicians is determined by the minimum amount of given answers, which in this case is 97 participants who stated their age in a correct way. The age of the surveyed physicians ranges between 28 and 70 years and has a mean of 48,18 years with an observed standard deviation of 10,11. The dependent variable - intention to prescribe - has a higher mean than all of the independent variables, namely 5,43. The lowest mean was observed for the component mistrust with 3,32. With reference to the mean it can be observed that the surveyed physicians were more likely to agree with the positive technology readiness dimensions, optimism and innovativeness, than with the negative dimension mistrust, which indicates answers for discomfort and insecurity.

Except age, all other variables were measured on a scale from one to seven. Even though the only possibility to answer the statements was by stating integer numbers from one to seven, some of the minimum and maximum values in Table 2 are decimal numbers. The reason for this is that the newly formed variables which are displayed in the table describe the average of all the used items.

4.2 Exploring Assumptions

Testing assumptions is important in order to accurately conclude statistical outcomes. It is crucial to check the assumptions before it is chosen which statistical test can be used (Field, 2009). One assumption that will be tested is the normal distribution of the data. The normality is tested by using histograms (See Appendix – Figures 8-11). Based on those histograms innovativeness, optimism and discomfort and insecurity are seen as normally distributed variables. In contrast, the histogram of intention to use does not give evidence for a normal distribution. Those outcomes are also supported by a Shapiro-Wilk test (See Appendix – Figure 12). If the Shapiro-Wilk test shows a significance level that exceeds 0,05, the variable is normally distributed. In this case only intention to prescribe shows a lower significance value than 0,05 and is therefore not normally distributed and the Spearmans Rho is used to analyze the data (See Section 4.3). Another assumption tested is the normal distribution of the residuals which investigates if the model and the observed data are in line or if they differ from each other (Field, 2009). To analyze this assumption, a P-P plot of normally distributed residuals was created (See Appendix – Figure 13). Since all the dots, which represent the residuals, are close to the line of normal distribution, this assumption is met. Next to the normal distribution of the data and the residuals, it is important that the assumption of homoscedasticity is met. According to Field (2009) Figure 14 of the Appendix should "look like a random array of dots evenly dispersed around zero" (p.247). This can be observed and thus the assumption is met. An additional assumption that was tested is the one for multicollinearity, which describes if two or more independent variables are highly correlated and thus bias the outcome. By looking at the correlations in Table 2, it can be detected that none of the correlations between the independent variables is higher than 0,8; which is, according to Field (2009), where a high correlation starts. Therefore, this assumption is also met.

4.3 Correlation Analysis

Correlation describes the level of interdependence between attributes of two variables and is a condition for causality between independent and dependent variables; so without correlation a causal relation cannot be expected (Babbie, 2013).

To measure the strength of the relationships the Spearmans rank-order correlation was used via SPSS (See Table 2 and Appendix – Figure 7).

Table 2. Correlations and Descriptive Statistics

	Sample Size	Min.	Max.	Mean	SD	Intention to Prescribe	Optimism	Innovativeness	Mistrust	Age
Intention to Prescribe	99	1	7	5,43	1,17	1,000	0,282**	0,323**	-0,276**	-0,380
Optimism	104	2,13	6,75	4,61	0,89	0,23*	1,000	0,311**	-0,294**	-0,168*
Innovativeness	106	1	7	4,74	1,10	0,323**	0,398**	1,000	-0,216*	-0,022
Mistrust	104	1,38	5,25	3,32	0,77	-0,276**	-0,276**	-0,216*	1,000	0,074
Age	97	28	70	48,18	10,11	-0,380	-0,150	-0,022	0,074	1,000

The evaluation showed that all three categories of the technology readiness have a significant correlating effect on the intention to prescribe. While optimism and innovativeness are positively correlated towards intention to prescribe, mistrust is negatively correlated towards it. The correlations between the technology readiness dimensions and intention to prescribe are all significant at the 0,01 level, with innovativeness representing the highest correlation – 0,323. Additionally there are correlations among the three used technology readiness dimensions. Optimism has a significant positive relation towards innovativeness and significant negative relation with mistrust; both of these relations are significant on a 0,01 level. Mistrust as well as innovativeness are negatively correlated on a 0,05 level significance. Age is negatively correlated with intention to prescribe and both positive technology readiness dimensions – optimism and innovativeness. Furthermore there is a positive relationship between age and mistrust. None of the correlations with age are significant.

4.4 Regression Analysis

According to Field (2009), a regression analysis is a convenient statistical test which "allows us to go a step beyond the data" (p. 198). In this study the analysis is used in a way of determining possible relationships between the independent variables and the dependent variable. Furthermore the significance of those relationships is obtained. So in the context of this study the strength of the effect of technology readiness and age on the intention to use is analyzed.

The estimates from this examination can be seen in Table 3. Model 1 refers to the outcomes which can be observed when age is not used as a moderating variable and Model 2 shows the results if it is included. For model 1 the R^2 is 0,138 which indicates that 13,8% of the intention to prescribe can be explained by the chosen independent variables. Once age is used as a moderating variable, R^2 rises to 0,154. So the introduction of the moderator leads to a 1,6% increase in the explanation for varying levels of intention to prescribe (See Appendix – Figure 15). So, in other words, 84,6% of intention to prescribe are still unexplained and need to be discovered by analyzing the effect of other variables.

The standardized beta indicates the change in the dependent variable if the chosen independent variable is changed by one standard deviation. Before age is added as a moderating variable (model 1), optimism and innovativeness have a positive effect on intention to prescribe. The effect of age and mistrust on intention to prescribe is negative. However, the only significant relationship that can be noticed is between optimism and intention to prescribe. Projecting those results on the hypothesized outcomes, it can be seen that only hypothesis H1 was right and is therefore accepted: Optimism has a positive effect on intention to prescribe. Even though the results for the relationships between the other technology readiness dimensions and the intention to prescribe (H3, H5 and H6) do all show the expected direction, they all have to be rejected, as none of the relations is significant. For an overview of the evaluation of all hypotheses, a table was developed (See Table 4).

The introduction of the moderator age to the regression analysis leads to new beta values for each independent variable. While the already positive beta of optimism 0,206 increased to the higher positive value 0,895, the positive value of innovativeness decreased to a negative number, namely from 0,156 to -0,161. In case of mistrust, the negative value -0,148 moved further towards the null by increasing to -0,130. By comparing the results of the moderation effect with the hypothesized outcomes, it can be seen that all four hypotheses – H2, H4, H6 and H8 – can be rejected, since none of the results are significant. Except for the moderating effect of age on the relationship between optimism and intention to prescribe, all hypothesized moderation effects occurred in the expected direction. So while age does negatively affect the relationship between innovativeness and intention to prescribe, it does not negatively influence the relationship between optimism and intention to prescribe. For the latter one a non-expected insignificantly positive moderating effect was found. Moreover, the hypothesized positive moderation of age on the relationship between mistrust and intention to prescribe is supported by the outcomes, since the negative value got less negative. However, this outcome was not significant.

5. CONCLUSION

The goal of this study was to analyze the collected data to find an adequate answer to the research question and its accompanying sub-questions:

To what extend does the technological readiness and the age of a physician affect his intention to prescribe the artificial pancreas to patients?

1. *To what extent is a physician's intention to prescribe the AP influenced by his technological readiness and age?*
2. *Does the age of a physician moderate the relationship between technological readiness and intention to prescribe the AP?*

Table 3. Regression Analysis Results

Model		Beta	T-Value	Significance One-Tailed	R-Squared
1	**Constant**		3,361	0,0005	0,138
	Optimism	0,206	1,957	0,0265	
	Innovativeness	0,156	1,514	0,067	
	Mistrust	-0,148	-1,430	0,078	
	Age	-0,007	-0,071	0,4715	
2	**Age Moderating Optimism**	0,895	1,264	0,105	0,154
	Age Moderating Innovativeness	-0,161	-0,239	0,4055	
	Age Moderating Mistrust	-0,130	-0,173	0,4315	
	Age	-0,525	-0,621	0,268	

Table 4. Hypothesis Evaluation

Hypotheses	Beta	Sig.	Hypotheses Evaluation
H1: Optimism has a positive effect on intention to prescribe.	0,206	0,027	**Accepted ☑**
H2: Age negatively moderates the positive effect of optimism on intention to prescribe	0,895	0,105	**Rejected ☒**
H3: Innovativeness has a positive effect on intention to prescribe.	0,156	0,067	**Rejected ☒**
H4: Age negatively moderates the positive effect of innovativeness on intention to prescribe.	-0,161	0,406	**Rejected ☒**
H5: Discomfort has a negative effect on intention to prescribe.	-0,148	0,078	**Rejected ☒**
H6: Age positively moderates the negative effect of discomfort on intention to prescribe.	-0,130	0,432	**Rejected ☒**
H7: Insecurity has a negative effect on intention to prescribe.	-0,148	0,078	**Rejected ☒**
H8: Age positively moderates the negative effect of insecurity on intention to prescribe.	-0,130	0,432	**Rejected ☒**

It is intended to answer the research question by drawing conclusions from the tested hypotheses. As indicated in the results, only one hypothesis was confirmed. This confirmation shows that optimism has a significantly positive effect on the intention to prescribe the AP among the physicians who participated in the study. While this is a good indicator that technology readiness does have an influence on the intention to prescribe the AP, the rejected hypotheses are not pointing towards a significant relationship between technology readiness and intention to prescribe. Once age is added as a moderating variable, the effect of optimism on intention to prescribe is positively moderated. The effect of innovativeness and mistrust on intention to prescribe is negatively moderated by age. However, those moderating effects are not significant and are thus no indicators for an effect of age on the relationship. The significant positive relation between optimism and intention to prescribe shows that physicians with a thoroughly positive view on technology are likely to have such high trust in the AP that they are willing to recommend it to their patients. Innovativeness was found to have a not significant relationship with intention to prescribe. Even though this non-significance is with 0,067 not far away from the significance level 0,05, it still has to be explained why it is not as significant as optimism. One explanation can be found in the used questions for this technology readiness dimension. To determine the innovativeness level, physicians were asked to answer questions about the time when they purchase new technologic devices and their ability to handle them. Those questions can be seen as a reason for the difference to optimism, since physicians can have a positive view on technology even if they are not among the first people to try out new devices. The conclusion that the negative technology readiness dimensions discomfort and insecurity – in this study represented as mistrust – do not have a significant effect on the intention to prescribe the AP might be explained by looking at other studies. Son and Han (2011) also failed to find a significant relationship between insecurity and the usage of innovative functions. They explained this non-significance by referring to the study-background, which can also be done in this article. Even though physicians might have a negative opinion regarding technological medical devices, they can still have the intention to prescribe the AP, if they expect their patients to have a higher ability in handling those devices. So they do not base their prescriptions on their own technology aversion, but found it on the characteristics of their patients. On basis of all the collected data, it can be stated that the expected moderating influence of age can be rejected and that the influence of technology readiness on intention to prescribe the AP can just partially be accepted as only optimism was found to have a significant positive effect. To confirm or reject those outcomes, further research is needed. Methods of how those future studies could look like and what they could focus on, will be explained in Section 6.1.3.

6. DISCUSSION

6.1 Contributions

As indicated in the introduction, the intention of this paper is, on the one hand, to contribute to existing theories and, on the other hand, to give practical advice towards Inreda BV regarding possible market entry strategies. By stating theoretical and practical contributions, the results of this study will be summarized and discussed. Additionally some recommendations for further research will be given to cover the points which were not discussed within this paper.

6.1.1 Theoretical Contribution

By finding a significant relationship between optimism and intention to prescribe, a new component can be added to existing theories regarding the intention to prescribe a medical device. The observed positive effect of high levels of technology readiness on the intention to prescribe the AP can possibly be projected onto other medical devices, which might too have a higher likeliness of being prescribed by 'technological ready' physicians. However, the medical device should have technological features to be influenced by the technology readiness. It is important to note that this is only a theoretical possibility and that further research is needed to back this theory up or to reject it. As for the implication of age as a moderating variable, it was found that age had no significant moderating effect on the relationship between technology readiness and intention to prescribe the AP. Furthermore, as discovered in the factor analysis, the two technological readiness dimensions discomfort and insecurity were combined to form the new dimension mistrust. This shows that the used items, which ought to describe the two combined dimensions separately, were answered in such a similar way by the physicians, that they explain the same category. By naming it mistrust, it is intended to show the negative perception of technology. Another component that was changed on basis of the factor analysis was optimism, which now includes two reverse coded items which originally belonged to the discomfort dimension. The two items were represented by following statements in the questionnaire:

1. Many new technologies have health or safety risks that are not discovered until after people have used them.

2. There should be caution in replacing important people-tasks with technology because new technology can breakdown or get disconnected.

The reverse coding enabled the collective measurement of the optimism dimension. By adapting the factors, a more reliable outcome was possible.

6.1.2 Practical Implication

Inreda BV is planning on introducing the AP to the market once all the sufficient tests and certifications are completed (Inreda BV, 2015). For a successful market introduction of new products efficient research is required; in this case a primary research using original data was carried out (Blythe, 2009). Even though the regression analysis did not support most of the hypotheses, there are still outcomes that can be helpful for marketing activities. The correlation analysis showed that significant relationships between the technology readiness dimensions and the intention to prescribe the AP do exist. In fact they do not only exist, they also have the same direction as expected by the hypotheses. While innovativeness and optimism are positively related to the intention to prescribe, mistrust is negatively correlated towards it. This shows that a low level of technology readiness can lead to unwillingness in prescribing the AP to patients and that a high level of technology readiness possibly leads to a high intention to prescribe the device. The latter is also supported by the accepted hypotheses, that optimism has a significant positive effect on the intention to prescribe the AP. Based on those findings; Inreda should try to convince physicians with a low technology readiness that the AP is a helpful device for treating diabetes patients. Since it is hard to change the minds of people who have a naturally aversion against technological products, a creative way has to be found to encourage physicians to reconsider their opinions. One possible solution is the education of physicians with regard to the benefits an AP can give to patients. This is supported by Renard (2010) who suggests that the medical device industry should "dedicate more funds to support therapeutic education in the near future" (p. 31). By informing physicians about the employment of new medical devices like the AP, preconceptions can be prevented and benefits as well as drawbacks can be communicated. It should be the goal to not only praise the advantages of the device, but also to list the possible risks. Thus, physicians get a good basis of information to decide for themselves if they want to prescribe the AP or not. It is important that the education of the physicians with a low technology readiness is tailored to their needs. The communication, for instance, should not rely on incomprehensible technical terms. In addition to the technology readiness, age was analyzed as a possible moderating variable. However, none of the regarding hypotheses were significant and they all had to be rejected. Still it can be seen, that age can influence the technology readiness of physicians and also their intention to prescribe the AP. This is based on the outcomes of the correlation analysis. According to this analysis, age is positively correlated to mistrust. Moreover age is negatively correlated with optimism, innovativeness and intention to prescribe. Even if those results are not significant, they still show that age influences the technology readiness and the intention to prescribe in the expected way. This demonstrates that older physicians are more likely to have a low technology readiness level and also a lower willingness to prescribe the AP. For Inreda BV this means that it is harder to convince older physicians to prescribe the device. Again, a focus can be put on educating the older generations of physicians.

6.1.3 Recommendations for Further Research

As already stated in Section 6.1.1 further research is necessary in order to find more evidence for a relationship between the technology readiness of physicians and their intention to prescribe a medical device, which relies on some kind of technology. Since no significant effect of age on neither intention to prescribe nor on technology readiness was found within this study, future research could focus more extensively on this topic. However, further study should not only focus on the same relationships which were examined in this paper, but should add new dimension and thus explain the intention to prescribe a medical device with other independent variables like gender, social influences, technological complexity and other possible indicators. With regard to Inreda's AP and its planned introduction to the market, further studies about acceptance by possible users and intermediaries could significantly increase the efficiency with which the new product is launched. This does not only include further studies about physicians, but also the examination of patients, nurses and other groups of interest. To get a better understanding of how the AP will work in reality, clinical trials can be carried out.

6.2 Limitations

According to Babbie (2013), a scientific article should review its "particular shortcomings […] and suggest ways those shortcomings might be avoided" (p. 517). There are several shortcomings, or limitations, within this study. To obtain the data, a questionnaire was sent out to physicians. Data collection through a questionnaire has, next to some benefits like the quantifiable nature of the data, several flaws. Some of the information that is obtained through the fixed answer possibilities can be falsely interpreted by the researcher since there is no possibility for the physician to explain his answers or to ask questions about the survey. It cannot be seen how truthful a respondent answered the questions and how well he understood them. There is the possibility that a question is interpreted in different ways by different persons. Even if the usage of a questionnaire has several advantages for the data collection, it still has some limitations that have to be kept in mind. Future research can avoid such shortcomings by using both, quantitative data collection in form of a questionnaire and qualitative research in form of interviews or observations. Another possible limitation of this study is the hypothesized influence of physician's advice on a patient's intention to use a medical device. Even though some literature sources suggested the influencing nature of physician's recommendations on patient decisions (See Section 2.1.1), this should not be taken for granted as there are various studies which propose the opposite and claim that there is a decrease in a physician's influencing power (Goldman & Risica, 2004; Sharf, Stelljes & Gordon 2005; Friedrichsen & Milberg, 2006; Lasser, Ayanian, Fletcher & Good, 2008). Such ambivalent opinions can occur in many subjects and cannot be prevented. In this study it was decided to presume a trusting relationship between physicians and patients. To get a broader picture on the relationship between patients and medical advisors specific questions could be added to the survey. All in all, further research should try to critically evaluate this and other related sources and should focus on adding new aspects that were not considered in the existing research.

7. ACKNOWLEDGEMENTS

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9. APPENDIX

Figure 1. Why is age used as a moderator?

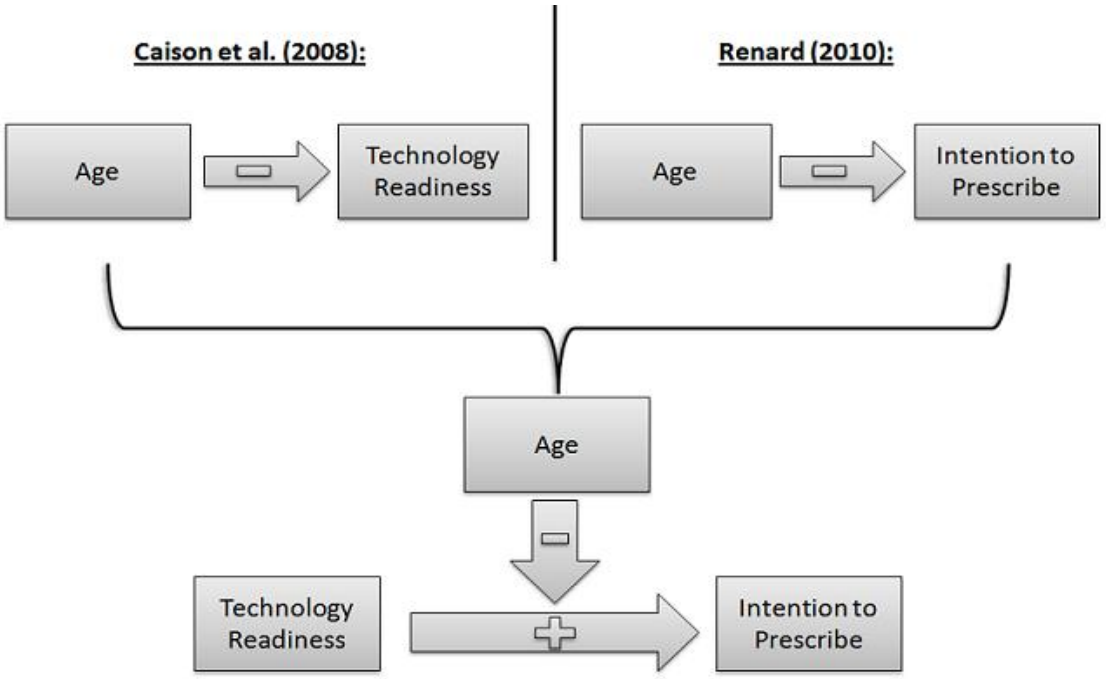

Figure 2. Scree Plot Showing the Eigenvalue

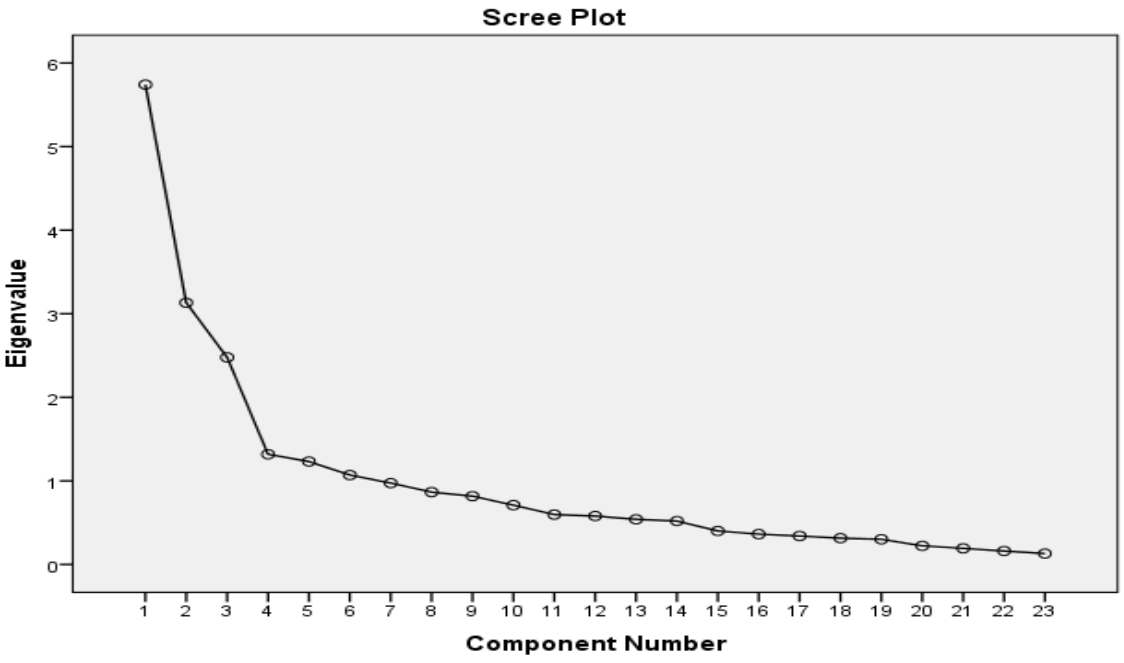

Figure 3. First Pattern Matrix

	Component					
	1	2	3	4	5	6
OPT_00_OPT_01	,566					,456
OPT_00_OPT_02	,697					
OPT_00_OPT_03	,733					
OPT_00_OPT_04	,826					
OPT_00_OPT_05	,883					
OPT_00_OPT_06	,667					
INN_00_INN_01						,615
INN_00_INN_02		,679				
INN_00_INN_03		,803				
INN_00_INN_04		,725				
INN_00_INN_05		,840				
ONG_00_ONG_01					-,746	
ONG_00_ONG_02					-,812	
ONG_00_ONG_03					-,681	
ONG_00_ONG_04		-,574				,455
ONG_00_ONG_05				,771		
ONG_00_ONG_06				,609		
ONG_00_ONG_07				,489		
ONZ_00_ONZ_01			,704			
ONZ_00_ONZ_02			,727			
ONZ_00_ONZ_03				,705		
ONZ_00_ONZ_04			,561			
ONZ_00_ONZ_05			,561			

Figure 4. New Pattern Matrix

	Component		
	1	2	3
OPT_01	**,569**		
OPT_02	**,834**		
OPT_03	**,828**		
OPT_04	**,673**		
OPT_05	**,789**		
OPT_06	**,685**		
INN_01		*,486*	
INN_02		**,724**	
INN_03		**,733**	
INN_04		**,769**	
INN_05		**,791**	
ONG_01			**,546**
ONG_02			**,546**
ONG_03			**,637**
ONG_04		*,492**	
ONG_05	***,517****		
ONG_06	***,592****		
ONG_07			**,647**
ONZ_01			**,509**
ONZ_02			**,611**
ONZ_03	*,452**		
ONZ_04			**,536**
ONZ_05			**,578**

* Reverse coding: Multiplication with -1

Figure 5. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,786
Bartlett's Test of Sphericity	*Approx. Chi-Square*	794,994
	Df	153
	Sig.	,000

Figure 6. Reliability Statistic – Cronbach's Alpha

	Cronbach's Alpha	N of Items
Intention to Use	,945	2
Optimism	,856	8
Innovativeness	,823	4

Mistrust	,745	8

Figure 7. Correlations

Spearman's Rho		Intention to Prescribe	Optimism	Innovativeness	Mistrust	Age
Intention to Prescribe	Correlation Coefficient	1,000	,282**	,323**	-,276**	-,038
	Sig. (1-tailed)	.	,002	,001	,003	,355
	N	99	99	99	99	97
Optimism	Correlation Coefficient	0,23*	1,000	0,311**	-0,294**	-0,168*
	Sig. (1-tailed)	0,11	-	0,001	0,001	0,050
	N	99	104	104	104	97
Innovativeness	Correlation Coefficient	,323**	,398**	1,000	-,216*	-,022
	Sig. (1-tailed)	,001	,000	.	,014	,416
	N	99	106	106	104	97
Mistrust	Correlation Coefficient	-,276**	-,276**	-,216*	1,000	,074
	Sig. (1-tailed)	,003	,002	,014	.	,236
	N	99	104	104	104	97
Age	Correlation Coefficient	-,038	-,150	-,022	,074	1,000
	Sig. (1-tailed)	,355	,071	,416	,236	.
	N	97	97	97	97	97

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Figure 8. Optimism Histogram

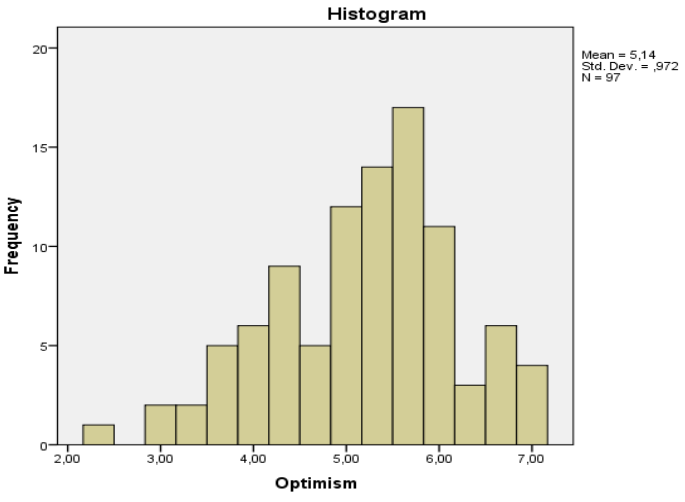

Figure 9. Innovativeness Histogram

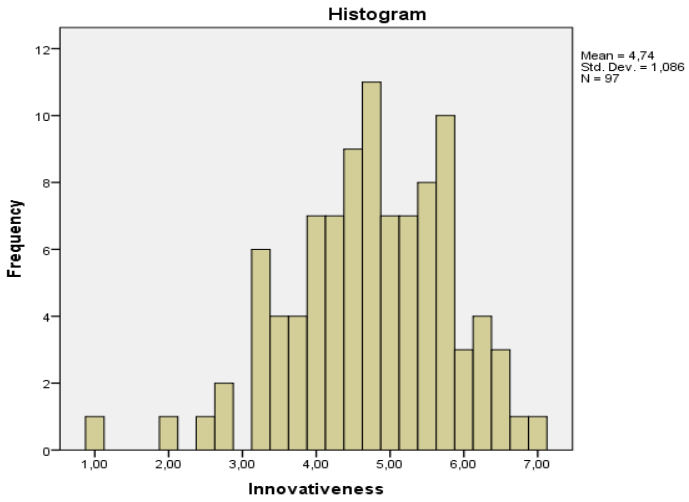

Figure 10. Mistrust Histogram

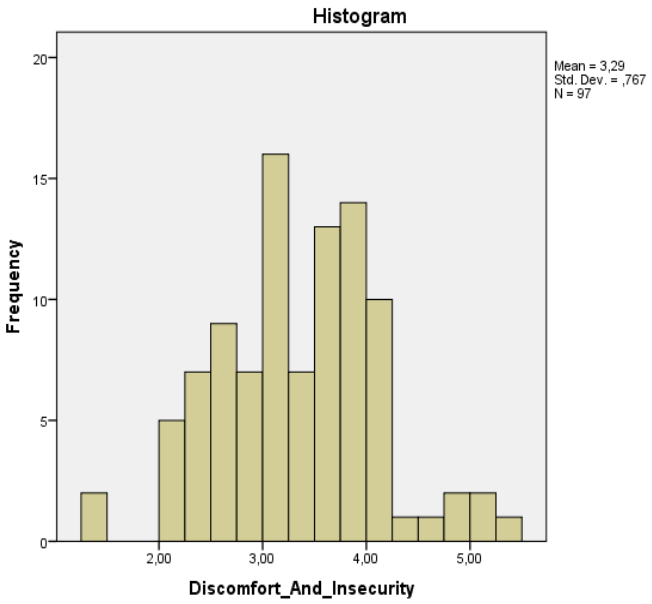

Figure 11. Intention to Prescribe Histogram

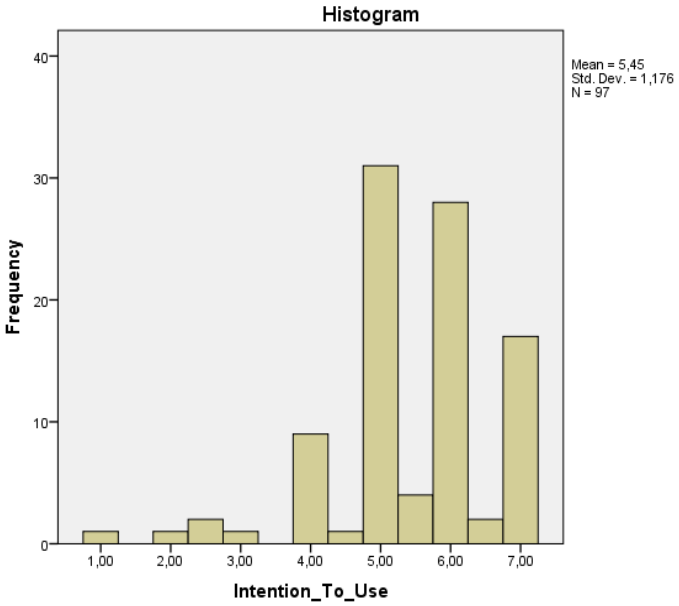

Figure 12. Shapiro-Wilk Test

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Optimism	,980	97	,140
Innovativeness	,978	97	,110
Mistrust	,984	97	,298
Intention to Use	,887	97	,000

Figure 13. P-P Plot of Normality

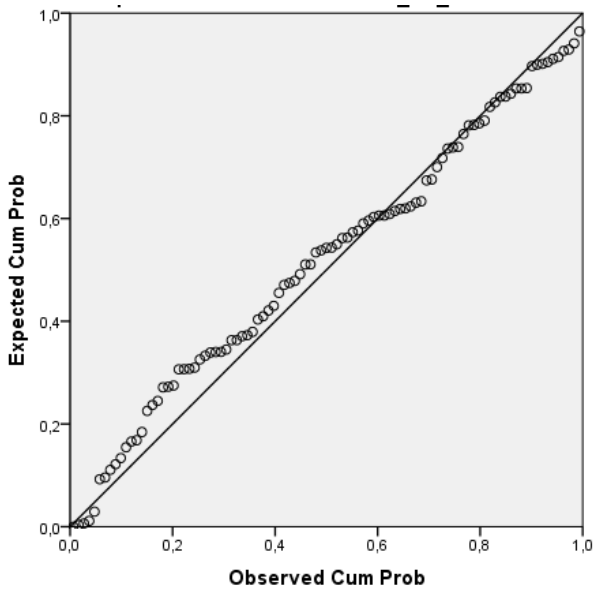

Figure 14. Scatterplot

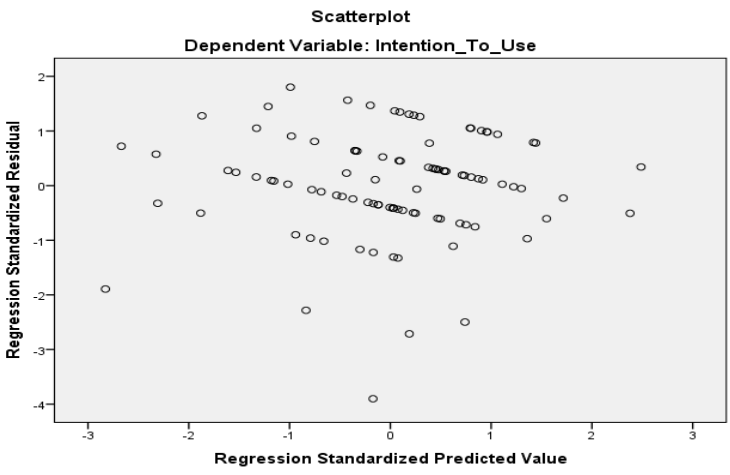

Figure 15. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,371[a]	,138	,100	1,11527
2	,392[b]	,154	,087	1,12355

a. Predictors: (Constant), AGE, Innovativeness, Mistrust, Optimism

b. Predictors: (Constant), AGE, Innovativeness, Mistrust, Optimism, Age_Moderating_Mistrust_Optimism, Age_Moderating_Mistrust

c. Dependent Variable: Intention_To_Use