The Influence of Nurses' Individual Characteristics on Their Intention to Advise an Artificial Pancreas

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ABSTRACT

Diabetes is a severe chronic illness with more than 387 million people worldwide suffering from it. The medical industry is fast changing and developing devices to treat diabetes. Currently the Dutch company Inreda Diabetic B.V. develops an artificial pancreas that could significantly change the treatment of diabetes patients. Since nurses play an important role between physicians and patients, it is important to research what drives their intention to advise usage of an artificial pancreas. This is done in this paper by focusing on the individual characteristics of nurses and their influence in the perceived usefulness of the device and the resulting intention to advise it.

The data revealed that not four characteristics, as proposed by the TRI, were valid, but only two: positivity and negativity. However, only positivity significantly influences perceived usefulness, negativity does not. Further, perceived usefulness has a significant positive impact on intention to advise. As the analysis revealed, there is a direct significant positive effect of positivity on intention to advise. This effect was not observed for the relationship between negativity and intention to advise.

This study provides important insights for marketing theory and Inreda, since it reveals that positive characteristics of nurses, who are essential stakeholders of the company, indeed influence their intention to advise the AP. Furthermore, the Technology Readiness Acceptance Model was used, whereby different influencing factors than the ones researched in earlier investigations were found. This change of the model requires further analysis by future research in order to control its integrity.

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Keywords

Artificial Pancreas, Diabetes, Technology Readiness, Technology Acceptance, Nurses, Individual Characteristics

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1. PROBLEM AND INTRODUCTION

In 2014, more than 387 million people worldwide suffered from diabetes (International Diabetes Federation, 2014), causing 1.5 million deaths (World Health Organization, 2015). Still, the number of diabetes patients is rising to an approximated amount of 592 million in 2035 (International Diabetes Federation, 2014). Diabetes is a chronic illness that requires regular and continuous medical treatment and can be classified into three different categories: Type 1 diabetes, Type 2 diabetes, and Gestational diabetes mellitus (American Diabetes Association, 2014). In every case, the pancreas is not able to produce insulin or the body cannot effectively use the insulin that has been produced (International Diabetes Federation, 2014). Insulin is the hormone that decreases the blood glucose level after food has been assimilated (Van den Berghe et al., 2006).

The diabetes device market can be segmented into two categories: glucose monitoring devices and insulin delivery devices (Business Insights, 2011). While glucose-monitoring devices simply measure the blood sugar of the patient, the insulin delivery devices give the body the necessary insulin. There is, however, a new product currently being developed that goes beyond this classification. The artificial pancreas continuously measures the glucose level and delivers, when necessary, insulin or glucagon (Peyser, Dassau, Breton, & Skyler, 2014). Glucagon is a hormone that is secreted from the pancreas, and is the counterpart to insulin as increases the glucose level in the blood (Hansen & Johansen, 1970; Castle et al., 2010). Maintaining a stable glucose level in the body is achieved through the artificial pancreas and is beneficial for the patient, since there are less rapid distortions from the desired level. This stable level also leads to less morbidity and mortality (van den Berghe et al., 2001; van den Berghe et al., 2003). But the artificial pancreas has more advantages: patients value that they do not have to measure their glucose level themselves and that they do not have to see the doctor as frequent as it is the case with other diabetes devices (van Bon, Kohinor, Hoekstra, von Basum, & DeVries, 2010).

The research conducted in this paper is in cooperation with Inreda Diabetic B.V. (in the remainder referred to as Inreda). Inreda is a Dutch company working in the field of the artificial pancreas. It developed multiple prototypes of a bi-hormonal device already, and is currently working on receiving certification for mass-market production. The final device is intended to be available firstly for adults and is expected to be ready for production in late 2016 (Inreda Diabetic, 2015). At a later point in time, a product specifically tailored for children is planned as well. Doyle, Huyett, Lee, Zisser, and Dassau (2014) state that an artificial pancreas can be of great benefit especially to children because they "do not have the capability to manage their own therapy" (p. 1192). The healthcare sector changes continuously (Cain & Mittman, 2002), meaning that Inreda engages in an environment that is rather unstable due to diverse innovations. Inreda's mission is to improve diabetes treatment and to enhance the quality of life of people suffering from diabetes (Inreda Diabetic, 2015).

Medical treatment in many sectors has undergone great advancement in the past years. It became more convenient, effective and less cost intensive for patients. Still, the innovations need to be accepted by doctors and recommended to others parties involved (Herzlinger, 2006). Next to patients, there are physicians who account for the usage of an artificial pancreas, and the nurses who are closer to the patients and handle routine activities. The nurses are also able to trigger the application of medical innovations (Huston, 2008). As Mibu, Yatabe, and Hanazaki (2012) found out, usage of artificial pancreas as diabetes treatment devices reduces workload of nurses related to blood glucose measurement, while simultaneously increasing their attention towards the glucose level. Nurses play an important role in the treatment of diabetes patients, since they are directly in contact with situations such as hypoglycemia and giving dietary advice (Kenealy et al., 2004).

As nurses are of high importance in the therapy of diabetes patients and are the intermediary between a physician and the patient, they might have an influence on the treatment of patients and the devices used for that. Still, only few studies focused on nurses in relation to technology acceptance (Chen, Yang, Tang, Huang, & Yu, 2008; Kowitlawakul, 2011). They found that technology acceptance is an important determinant for usage of a technology by nurses. Studying nurses' individual factors, like preferences and characteristics, enhances empirical knowledge and gives more insight into how technologies are accepted. Connecting this to the usage of an artificial pancreas, it is worth researching how the personal characteristics of nurses contribute to their position. Therefore the following research question arises:

To what extent do individual characteristics of nurses treating diabetes 1 patients influence their intention and readiness to advise an artificial pancreas?

Answering this research question can be of great help for Inreda as well as all parties involved in the business of treating diabetes. These are not only patients, nurses and physicians, but also researchers and marketers in general, since the extent of individual characteristics on decision making and intention is researched. The research is conducted within context of nurses in the Netherlands and Inreda can benefit from the results, since an adjustment of marketing efforts can be made towards promising customer segments. As Burton-Jones and Hubona (2006) describe, many technology systems never reach their potential. Bringing together the AP and well-established concepts like the Technology Readiness Index (Parasuraman, 2000) and the thereof developed Technology Readiness Acceptance Model (Godoe and Johansen, 2012) broadens the scope of academia and gives more insight into this field of practice in an environment where information systems play an increasing role (Venkatesh, Morris, G. B. Davis, & F. D. Davis, 2003). Further, knowing how individual characteristics influence nurses' intention to advise is useful, since it deepens knowledge of decision-making processes and the role a personal mindset plays.

2. LITERATURE REVIEW

The artificial pancreas is a rather new domain in the area of diabetes treatment. It is therefore valuable to consider how technologies in general are accepted and what factors influence a person's readiness to use them. A combination of technology acceptance and technology readiness shows how characteristics of individuals lead to the intention to use a technology. Additionally, consideration of how innovations diffuse through organizations is valuable as recommendations for marketing purposes can be derived from that.

After an innovation has been invented, it has to spread throughout the system in which it can be applied and has to be adopted by its members. This process is also defined as diffusion (Rogers, 2004). Especially the healthcare sector is

continuingly changing (Cain & Mittman, 2002) and new innovations are brought to the market regularly. This is why diffusion is important to understand in order to get the product to the intended customers. Rogers (1995) developed the Innovation Diffusion Theory (IDF) that addresses the rate of adoption of an innovation. This rate is determined by five attributes, which are: relative advantage, compatibility, triability, observability, and complexity. While the first four attributes are positively correlated with the rate of adoption, complexity negatively influences it.

The process of diffusion and the therewith-associated adoption of innovations is furthermore divided into five categories and follows a bell-curve shaped design. At the very beginning are the innovators which see the innovation's potential and are willing to take risks. After market share has increased the early adopters become interested in an innovation. These have financial possibilities but are less risk taking than innovators. As time goes by and market share increases the early majority adopts the innovation, followed by the late majority which is likely to be skeptical towards innovations and therefore accept the innovation after most of the individuals in the system has done so. The last category are the so-called laggards which are innovation averse and do not appreciate change (Rogers, 2010).

In the context of medical innovations, Melas et al. (2014) propose that the introduction of new technologies should be specifically targeted towards the first people to adopt a new technology, thus the innovators. The IDF (Rogers, 1995) is the foundation of understanding how technological innovations spread throughout a social system and its comprehension is therefore crucial for the further analysis regarding technology acceptance and technology readiness.

The theory of technology acceptance by Davis (1989) who developed the Technology Acceptance Model (TAM) belongs to one of the most prevailing concepts that explain what leads to acknowledgement of technologies. It states that technology acceptance of individuals is determined first and foremost by the ease of using a system and the perceived usefulness of it. These two factors drive an individual's decision about how and when to use a new technology. This model is based on the work of Fishbein and Ajzen (1975) who also focused on the acceptance of technology. The TAM was further developed by Venkatesh and Davis (2000) who give a more detailed description of which factors drive perceived usefulness by introducing *social forces* and *cognitive instrumental processes* to the model, resulting in the TAM2. In the context of this study, the selection of either TAM or TAM2 does not play a role, since the difference lies only in the predictors of perceived usefulness and ease of use.

In a study comparing technology acceptance among different cultures and genders, Alagöz, Ziefle, Wilkowska, and Valdez (2011) discovered that there are no big differences among cultures in regards to technology acceptance. However, women are less open to medical innovations when they are invasive or body near. Also age influences the technology acceptance for women but not for men. This study researched the cultural context of Germany, Poland and Turkey. Gefen and Straub (1997) also found differences between males and females with regards to technology acceptance. Still, more clarity can be brought to these issues by researching them in the field of diabetes nurses and controlling for an effect on technology acceptance. This is why this study uses both age and gender as control variables.

Accepting a technology is the first step in the process of making use of it. Thus, this model gives the basis of understanding how technology acceptance relates to actual usage of it. In the context of diabetes nurses, it enhances knowledge on how accepting the AP leads to the intention to advise it to patients and physicians. The TAM and TAM2 have been tested within different industries for various products or technologies. The studies focused e.g. on internet banking (Lai & Li, 2005; Vatnani & Verma, 2014), e-learning and e-HRM (Lee, 2010; Yusoff, Ramayah, & Ibrahim, 2010), and even on technologies in the healthcare and diabetes sector (van Bon, Brouwer, von Basum, Hoekstra, & DeVries, 2011; Daim, Basoglu, & Topacan, 2013; Bevier et al., 2014). In an extensive literature review Marangunić and Granić (2015) showed what work has been done on the TAM from 1986 until 2013 and propose four future research directions. First, moderating roles of individual variables should be researched. Second, additional variables could be added to the model. Third, the actual usage variable and its relation to objective measures need more elaboration. Lastly, focus should be given to older adults as a target group, since they are often neglected in extant research (Marangunić & Granić, 2015). The authors conclude that the TAM is an important model to understand human behavior and that it has been applied and developed a lot in the past decades. This study addresses the proposed research directions of Marangunić and Granić (2015) partially. It gives focus to other variables than the ones used before, by applying the TAM in the diabetes-nursing context. Also, external predictors of perceived usefulness are researched in the form of the Technology Readiness Index by Parasuraman (2000).

Even though studies confirm that the model is reliable and can be used in various contexts (King & He, 2006), other scholars advise caution when using the TAM outside already validated contexts (Turner, Kitchenham, Brereton, Charters, & Budgen, 2010). Also, Legris, Ingham, and Collerette (2003) state that research findings from the TAM are sometimes conflicting and that the model "hardly explains more than 40% of the variance in use" (p. 202).

This implicates for this study that caution should be given to research results, as they might not be generalizable. Also the strength of the relationships needs to be tested in order to check for the variance that is explained in this study's context.

Even more fundamental than the acceptance of a technology is whether or not a person is ready for technology in the first place. Parasuraman (2000) developed the Technology Readiness Index (TRI), which is a "multiple-item scale (...) that companies can use to gain an in depth understanding of the readiness of their customers" (p. 317) towards a technology. The index builds on four basic dimensions which are *optimism*, *innovativeness*, *discomfort*, and *insecurity*. The former two dimensions function as drivers of technology readiness whereas the latter two have a restraining role. Optimism has been described as "a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives" (Parasuraman, 2000, p. 311). Innovativeness is the "tendency to be a technology pioneer and thought leader" (Parasuraman, 2000, p. 311). Furthermore, discomfort is defined as a "perceived lack of control over technology and a feeling of being overwhelmed by it" (Parasuraman, 2000, p. 311), and insecurity is the "distrust of technology and skepticism about its ability to work properly" (Parasuraman, 2000, p. 311). The technology readiness should not be confused with technology competence as described by Parasuraman and Colby (2007). While technology readiness refers to one's propensity towards a technology, technology competence means the ability to actually use a technology.

Only after someone is ready to use a certain technology or to become more familiar with it, he is able to apply this knowledge. The concept is therefore highly valuable to understand what drives nurses regarding their intention to advise a new technology such as an artificial pancreas. As Meng, Elliott, and Hall (2010) found out, the TRI is also valid across different cultures like the US and China. Even though the sample of this study is based only on Dutch nurses, Inreda as a company is also interested in the German and Austrian market, thus highlighting the necessity of a research model that is applicable in a multinational context.

Since technology and its usage advanced a lot during the last decade, becoming especially evident considering that 6.8 billion subscriptions to mobile phones existed in 2013 (Sanou, 2013), Parasuraman and Colby (2015) developed the TRI further into the TRI 2.0. They describe a challenge for the TRI and TRI 2.0 as they measure technology attitudes and "the technologies themselves change over time" (p. 61). Since the original TRI was rather long, and has already been reduced by Lin and Hsieh (2012), Parasuraman and Colby (2015) shortened it while keeping validity and reliability. Also, the TRI 2.0 refers to more recent technologies, such as smartphones and social media, and brings more neutrality. The more recent TRI 2.0 has, however, not been used in the analysis of this paper, since measurement methods and the survey used were developed before Parasuraman and Colby (2015) published their work.

The extant literature already applied the TRI in multiple contexts and industries (e.g. Taylor, Celuch, & Goodwin, 2002; Massey, Khatri, & Ramesh, 2005; Jaafar, Aziz, Ramayah, & Saad, 2007; Summak, Bağlıbel, & Samancıoğlu, 2010). Also the connection from technology readiness to nurses in hospitals is drawn. However, no literature was found on technology readiness in the context of diabetes and nurses dealing with it. Instead, Kuo, Liu, and Ma (2013) researched how personality traits influenced perception of usefulness of mobile electronic medical record (MEMR) systems, and confirmed the TRI. Melas, Zampetakis, Dimopoulou, and Moustakis (2014) focused on medical staff in Greek hospitals and found that the majority was "sceptical about technology" (p. 683), particularly when it conflicts with their routine. They highlight the prerequisite to concentrate on researching technology readiness in the medical field. This is in line with Caison, Bulman, Pai, and Neville (2008) who found that male nursing students are more innovative and young students are more technology-ready.

This study aims to extend and develop knowledge in the area of technology readiness of nurses treating diabetes, and thus giving implications for not only further research but also firms and managers. Great attention is given to nurses, as they are the important link between patients and physicians.

In 2005, Lin, Shih, Sher, and Wang (2005) stated that the TAM and the TRI are interrelated, as they are system- and individual-specific, respectively. The authors hypothesized that technology readiness is an antecedent of perceived usefulness and perceived ease of use, the two determinants in the TAM. That causal model was tested and confirmed. Also Walczuch, Lemmink and Streukens (2007) combined the aspects of the TRI and TAM to test whether the individual characteristics indeed have an influence on the levels of the TAM. This model is called TRAM. As they found out, optimism has a positive influence on both perceived ease of use and perceived usefulness. Also innovativeness positively influences perceived ease of use but has a negative effect on perceived usefulness, which contradicts the hypothesis. Insecurity indeed negatively influences the two TAM levels, whereas discomfort only has a negative effect on the perceived ease of use and none on the perceived usefulness (Walczuch et al., 2007). These results show that the personal characteristics of an individual determine its position towards new technologies. Godoe and Johansen (2012) replicated this research and extended it by hypothesizing a positive relationship between both perceived ease of use and perceived usefulness, and a person's actual usage of the technology (see Appendix 10.1 for their research model). It was conducted with a sample of Norwegian employees that used instant messaging and electronic health record systems.

However, they found neither a significant relationship between insecurity and discomfort on perceived usefulness and perceived ease of use, nor a relationship between the perceived ease of use and the actual use. Nevertheless perceived usefulness does have an influence on actual use. Also the results regarding the effect of optimism and innovativeness follow the results of Walczuch et al. (2007).

Taking into account this integrated research model is highly valuable to test in how far the individual characteristics of nurses have an influence on their attitude towards an artificial pancreas and the final decision to advise usage of it.

3. RESEARCH MODEL

In this paper the relationship between individual characteristics of nurses and their intention to advise usage of an artificial pancreas is researched. This will be done by making use of an adapted version of the TRAM as it was developed by Godoe and Johansen (2012). It is based on the TAM (Davis, 1989) and TRI (Parasuraman, 2000). However, not the complete research model proposed by Godoe and Johansen (2012) will be used. This paper concentrates on the confirmed relationship of perceived usefulness on the intention to advise the product, and neglects the statistically insignificant effect of perceived ease of use on the intention. Following that, only the relationships of the four basic dimensions of TRI on the perceived usefulness are researched (see Figure 1).

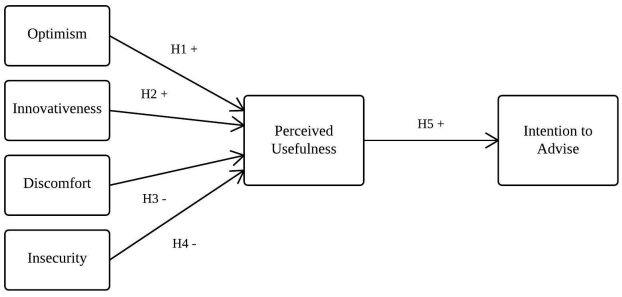

Figure 1: Research Model

3.1 The Effect of Optimism on Perceived Usefulness

Generally speaking, optimist people expect more good things rather than bad events in their life (Scheier & Carver, 1985; Carver, Scheier, & Segerstrom, 2010). As Costa-Font, Mossialos, and Rudisill (2009) state, the meaning of optimism can vary across different settings. They define it as "a specific form of cognitive bias capturing how individuals feel about the relative objective risk faced by themselves versus others" (p. 30). Bringing this to the context of technology, Parasuraman (2000) sees optimism as the "positive view of technology" (p.

311). Thus, it is a positive attitude towards technology as a way to improve life. In times of difficulty, optimism also leads to higher levels of subjective well-being (Carver et al., 2010), meaning that those individuals feel better than pessimistic ones.

The "positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives" (Parasuraman, 2000, p. 311) increases people's openness towards technology. Resulting from that optimist people are more likely to try and use new technologies (Scheier & Carver, 1987) such as the AP. Concluding, technology optimist people have a more open attitude towards technology and expect success instead of failure. Less thought is given to potential negative outcomes (Lu, Wang, & Hayes, 2012), thus, an individual sees a technology's usefulness. In the context of an AP, optimistic nurses expect the device to work and significantly increase a patient's quality of life. This study therefore hypothesizes:

H1: *Optimism among nurses positively influences their perception of the artificial pancreas' usefulness.*

3.2 The Effect of Innovativeness on Perceived Usefulness

Innovations and innovativeness are multidisciplinary efforts (Subramanian, 1996) that are part of areas such as strategic management, diffusion research, and marketing (Subramanian, 1996; Agarwal & Prasad, 1998). Garcia and Calantone (2002) think of innovativeness as a means of measuring the novelty of an innovation. They state that highly innovative products have a higher degree of novelty compared to low innovative ones. Innovativeness is an important concept for marketing, also because it has an immediate relevance for consumer behavior (Hirschman, 1980). The relationship between innovativeness and adoption of technologies is explained in the model of diffusion of innovations. As described by Rogers (2002), innovativeness is "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system" (p. 990), with a connection to subjective risk perception (Kummer, Schäfer, & Todorova, 2013). Thus, people having high innovativeness accept new technologies earlier and are the innovators in the diffusion model. Marketing efforts should therefore concentrate on these innovators first (Melas et al., 2014), since "earlier adopters are more technically competent than others" (Mun, Jackson, Park, & Probst, 2006, p. 356). Developing his TRI, Parasuraman (2000) defines innovativeness as the "tendency to be a technology pioneer and thought leader" (p. 311). This definition fits well with the statements of other researchers. Yet, it introduces the technology component of innovations and the leadership character of innovators. Leadership is a key component of organizational change, as leaders prepare the change and influence other staff (Clement-O'Brien, Polit, & Fitzpatrick, 2011).

In relation to medical research, Clement-O'Brien et al. (2011) found that chief nursing officers influence the adoption of innovations. Thereby the level of education and the experience are positively correlated with the number of innovation projects. Since leaders give the context for change and prepare the environment (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidouet, 2004; Clement-O'Brien et al., 2011), it is of high importance to find the influencing individuals in the organization to ensure diffusion of the innovation throughout the entire organization.

As Kummer et al. (2013) proved in their research on acceptance of sensor-based medication of nurses, the higher personal innovativeness of nurses is, the higher the perceived usefulness will be. Contrary to that Walczuch et al. (2007) found a negative relationship between innovativeness and perceived usefulness. This was not expected by the authors and they try to explain it with the assumption that innovative people are more critical and therefore expect technologies to fulfill all demands. The same negative relationship was found in a later study by Godoe and Johansen (2012). Still, this study hypothesizes a positive effect of innovativeness on perceived usefulness, due to the research outcomes that found this relationship or positive effects of innovativeness on technology adoption (Jong, Ruyter, & Lemmink, 2003; Kummer et al., 2013). The author therefore hypothesizes:

H2: *Innovativeness among nurses positively influences their perception of the artificial pancreas' usefulness.*

3.3 The Effect of Discomfort on Perceived Usefulness

Discomfort represents a paranoia of people towards technology, their belief that it does not include all people (Tsikriktsis, 2004), and the feeling that they cannot control it (Chen, Jong, & Lai, 2014). It is defined by Parasuraman (2000) as the "perceived lack of control over technology and a feeling of being overwhelmed by it" (p. 311). Resulting from this subjective lack of control, individuals with high discomfort rather use basic technologies instead of innovative ones (Son & Han, 2011). These basic functions require less knowledge and engagement with the technology. Mukherjee and Hoyer (2001) showed that customers evaluate costs and values of a complex innovation and that this can lead to a negative result for the customer. They see discomfort as a fear of technology-based products. The individual view of technology being complex can lead to many different, often negative, reactions of customers (Mick & Fournier, 1998). These findings suggest that discomfort has a negative impact on the perceived usefulness of a technology. However, Walczuch et al. (2007) and Godoe and Johansen (2012) did not find a, neither positive nor negative, relationship between discomfort and perceived usefulness. Still, these are only two findings so far which need further elaboration in order to confirm or reject the originally hypothesized relationship between discomfort and perceived usefulness. Following the initial TRAM and its expectations, this study hypothesizes:

H3: *Discomfort among nurses negatively influences their perception of the artificial pancreas' usefulness.*

3.4 The Effect of Insecurity on Perceived Usefulness

Son and Han (2011) view insecurity as an inhibitor of technology readiness. Parasuraman (2000) defines it as a "distrust of technology and skepticism about its ability to work properly" (p. 311). This means that the individual does not expect to get any valuable help from a specific technology and thus does not trust the development of that technology. Insecure customers are likely to be doubtful towards new feature and might not even want to try whether they would be beneficial for them. In their study Walczuch et al. (2007) found a negative influence of insecurity on perceived usefulness. This is confirmed by Godoe and Johansen (2012) who also did not find

a relationship. As for the relationship between discomfort and perceived usefulness, the findings of Walczuch et al. (2007) and Godoe and Johansen (2012) need further research. The results might be due to the studies' samples or a bias. In the context of diabetes nurses other findings might occur. In the original TRAM the expected relationship between insecurity and perceived usefulness is negative, therefore it is hypothesized:

H4: *Insecurity among nurses negatively influences their perception of the artificial pancreas' usefulness.*

3.5 The Effect of Perceived Usefulness on Intention to Advise

As Davis (1989) stated when developing the TAM, perceived usefulness has a positive effect on an individual's intention to use, since the technology contributes to a desired outcome of the user. Additionally, any system that does not lead to an increase in performance is not likely to be favored by users (Robey, 1979) and thus not likely to be accepted. The connection of perceived usefulness and the subsequent acceptance of a technology has already been tested extensively in academia (e.g. Mathieson, 1991; Thompson, Higgins, & Howell, 1991; Adams, Nelson, & Todd, 1992). Also the relationship between perceived usefulness and the intention to use a technology has received considerable attention in literature on TAM and TRAM (Lin et al., 2006; Godoe and Johansen, 2012). There, perceived usefulness had the role of a mediating variable, which will it also have in this study (see Figure 1).

Even though many earlier studies focus on the actual usage of a technology, this study relates to the intention to do. It is assumed that the intention to make use of a technology eventually leads to the decision to actually use it. Also, since the study is placed in the context of advising an AP that is not yet on the market, nurses cannot have actually advised the product. The author therefore hypothesizes:

H5: *Perceived usefulness of an artificial pancreas positively influences nurses' intention to advise the device.*

4. METHODOLOGY

In this research the relationship between the TRI and TAM is observed, adapting the work done by Godoe and Johansen (2012) with the TRAM, in the context of medical innovations and an artificial pancreas.

The purpose of this research is to show whether there is a relationship between the individual characteristics of nurses and their perceived usefulness of an artificial pancreas to treat diabetes 1. Consequently, the deriving relationship between the perceived usefulness and the nurses' intention to advise usage of the AP will be studied.

4.1 Study Context

This study is based in the healthcare sector and more specifically in the treatment of diabetes 1. In order to treat the disease, the Dutch company Inreda developed the artificial pancreas. Since the company intends to launch the device in 2016, the market acceptance of stakeholders is of great interest for the study. While there is already research conducted for patients and physicians, no information is gathered from nurses, yet. The study builds on the TRAM developed by Godoe and Johansen (2012), which is adjusted to this research's individual context. By looking at which individual characteristics of nurses influence their intention to advise the AP, Inreda can adjust its e.g. marketing efforts to achieve best results.

Even though the study is performed for the AP of Inreda, the results can be used by other companies active in the treatment of diabetes 1 and even other medical devices. Also literature can make use of this research, as the concept of accepting a product depending on personal characteristics does not change throughout different areas of application.

4.2 Subject Sampling

To test the nurses' acceptance of the AP as described in Figure 2, a questionnaire was constructed and sent to 188 Dutch diabetes nurses. This was done via the Dutch Association for Diabetes Care Professionals (EADV) with which all nurses in this sample are associated. It is also the vast majority of diabetes nurses in the Netherlands, as only few are not members of the association.

The sampling technique applied in this paper is convenient sampling (Babbie, 2013), since the data of the nurses was provided by the EADV and contains almost all Dutch diabetes nurses. This sampling method allows this study to examine the influence of individual characteristics on AP acceptance of diabetes nurses, who are an important stakeholder of Inreda's AP. Therefore it is assumed that taking data from the EADV does not pose any problem for the research.

4.3 Survey Construction and Operationalization

At the 8th of October 2014 the survey was sent via email to the participants, followed by a reminder email two weeks later. As literature states, reminder notifications can significantly increase return rates of surveys, and that this should occur two to three weeks after the initial invitation (Babbie, 2013). Even though the questionnaire is still available and can be answered, only responses received four weeks after the initial invitation are used for this study. It is assumed that at that point in time most of the respondents willing to participate did so and filled in the questionnaire.

To test for the intended variables, multiple measurement methods were used. The survey contained a question that asked about knowledge on different areas of the AP. Respondents could answer with "yes", "no", and "unsure". Furthermore, 7 point Likert scales, as used in similar research by Chismar and Wiley-Patton (2003), were mostly used throughout the survey. They give a spectrum from negative (1-3 e.g. "strongly disagree") to positive (5-7 e.g. "strongly agree"), with a neutral area in between (4). Lastly, general information of respondents was collected, such as sex, highest level of education, and time of employment in the current position. The survey sent to nurses contained also questions related to focus areas that go beyond this study, as there is more research conducted on diabetes nurses.

Please see to Table 1 for the variables used in this study and their definitions. The detailed operationalization of the research model can be found in Appendix 10.2. It shows the definitions of the variables used, the original items developed by the authors, and the adapted versions of the items in order to make them fit to this study's context.

This survey was developed in English language and translated into Dutch by native speakers. This allows a better measurement, since the respondents might have difficulties understanding complex English. Also surveys in the respondent's' native language help to obtain an unbiased sample (Wong & Wang, 2008). The survey questions can also be found in Appendix 10.2.

Table 1: Variable Definition

Variable	Definition
Optimism	a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives
Innovativeness	the tendency to be a technology pioneer and a thought leader
Discomfort	the perceived lack of control over echnology and a feeling of being overwhelmed by it
Insecurity	the distrust of technology and skepticism about ist ability to work properly
Perceived Usefulness	an individual's perception hat the application of a certain technology or innovation will outperform existing practices
Intention to Advise	an individual's intention intention to advise usage of a particular device or technology

It was designed in the program "IGS LimeSurvey", the survey construction program of the University of Twente. It also allowed distribution and monitoring. LimeSurvey was chosen because it is a tool broadly used in the University of Twente and in Inreda's research. To ensure that the survey is valid, applicable, and comprehensive, it was pre-tested by two diabetes nurses.

4.4 Control Variables

This study makes use of control variables in order to check the relationships and whether or not certain characteristics have an influence on them. As literature states, age has an impact on the innovativeness and technology readiness of individuals (Caison et al., 2008). Furthermore, Caison et al. (2008) found the gender to be influential, as male nursing students were found to be more innovative. Gender also had an influence in the work of Alagöz et al. (2011). An effect of age and gender on technology acceptance was also found in the study of Venkatesh and Morris (2000). Due to these results, this study controls for these two variables.

4.5 Data Collection

After the pre-test allowed further progress of the study, the survey was distributed via LimeSurvey to the 188 diabetes nurses whose email addresses were provided by the EADV. The invitation explained the purpose of the study and that it would be used for final thesis projects of students of the University of Twente. Furthermore, it stated that this research is done within the scope of the European project PCDIAB, which includes the companies Inreda Diabetic B.V., AMC Amsterdam, the University of Graz, the University of Twente, Profil Research, Full Group, and Novo Nordisk. Prior to the actual questions, a brief introduction about the AP was given. It explained the components, the functions of these, and how the AP helps patients to live with diabetes. For this purpose, pictures of the product were presented. This introduction gives respondents a better understanding of the AP before filling in the survey and corresponds to work of Taylor and Todd (1995). LimeSurvey, as the program used for data collection and monitoring, also records data during the process of filling in the survey. This gives the opportunity to use data even though the respondent disrupts the completion of the survey.

4.6 Analysis

To analyze the data gathered from the questionnaire conducted with the nurses, the relationships between the variables will be statistically investigated. This is done via SPSS, a statistics program that is regularly used for statistical analyses. The data gathered through the LimeSurvey questionnaire is easily transferrable into SPSS and data stays organized.

First, general descriptive information about the sample will be given, followed by the correlation table. After that, a regression analysis will be conducted. This will reveal to what extent the variables optimism, innovativeness, discomfort, and insecurity have an influence on the perceived usefulness of an artificial pancreas for nurses, and whether this influences their intention to advise the device to patients. The reliability for each of the relationships will be measured in Cronbach's Alpha.

5. RESULTS

5.1 Descriptive Statistics

Of the 188 diabetes nurses to whom the survey was sent, 94 replied and answered the questionnaire. This results in a response rate of 50%. However, since 17 surveys were not filled out completely, the sample size was reduced to 77 diabetes nurses. Response rates affect the data's quality and therefore high response rates are desirable. Babbie (2013) states that there is no completely acceptable response rate below 100% but also explains that this will hardly ever be the case. A more precise threshold is given by Cobanoglu and Cobanoglu (2003) who say that a response rate above 30% is extremely high. This being said, the survey's response rate of 50% seems appropriate for this study

The vast majority in the sample is female (87%), while there were only 10 males (13%). The respondents' age ranged between 36 and 63 years with a mean of 51.4 and a standard deviation of 5.9. Since the Netherlands have an almost even distribution of gender (Centraal Bureau voor de Statistiek, 2014), the clear overrepresentation of female respondents compared to males might lead to biased results and caution should be paid.

Regarding the respondent's educational level, 10.4% have a basic education (Dutch: voortgezet onderwijs; HAVO, VMBO, and VWO). 5.2% completed a medium educational training (Dutch: middelbaar beroepsonderwijs; MBO). Most respondents have a higher education (80.5%; Dutch: hoger beroepsonderwijs; HBO). Only 3.9 percent of all respondents have an academic or scientifictt educational background (Dutch: wetenschappelijk onderwijs; WO).

For the professional experience, six nurses (7.8%) work for 0-5 years in their recent job. 16 (20.8%) are already engaged for 6-10 years, and 18 nurses (23.4%) pursue their profession for 11-15 years. The majority of respondents, however, already worked for more than 15 years in their job as a diabetes nurse. These account for 37 nurses (48.1%). Of all respondents one nurse already participated in a clinical testing, meaning that the research setting was completely new to almost every respondent.

5.2 Validity

To test the validity an exploratory factor analysis with direct oblimin rotation was used. This is necessary in social sciences, since constructs cannot be measured directly (Field, 2009). According to Chismar and Wiley-Patton (2003), an item is valid when it loads high on the component. This is the case when loadings are above 0.7. A low validity is given for loadings lower than 0.4 (Field, 2009). Therefore they should be excluded from the further analysis.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.702 which is a good value according to Kaiser (1974). Also the Bartlett's test of sphericity shows a significant difference ($p<0.001$). The factor analysis revealed that the items load on three components. Thereby it became clear that the items of optimism and innovativeness load on one component, and the items of discomfort and security on a second. The third component is entirely composed of the items of perceived usefulness (see Table 2 for the components and loadings). Because some items did not load higher than 0.7, they were excluded from the analysis. For innovativeness, this was INN_00_INN_01. The items ONG_00_ONG_01 and ONG_00_ONG_04 were excluded for discomfort. Also two items did not load high enough for insecurity, namely ONZ_00_ONZ_02 and ONZ_00_ONZ_04. No items of optimism had to be excluded from the analysis. The exclusion is based on the low factor loadings (below 0.7) which indicate that the items are not valid and would therefore falsify results. It also means that questions with low loadings do not measure the intended element.

Contrary to what has been expected, the analysis revealed not five components but only three. The variables optimism and innovativeness are therefore combined in the variable positivity; discomfort and insecurity are combined in negativity. This mirrors the idea of Parasuraman (2000) who sees optimism and innovativeness as drivers of technology acceptance, and discomfort and insecurity as restraining it.

Table 2: Factor Structure Matrix of Loadings

	1	2	3
Positivity			
OPT_00_OPT_01	0,574		
OPT_00_OPT_02	0,582		
OPT_00_OPT_03	0,765		
OPT_00_OPT_04	0,623		
OPT_00_OPT_05	0,656		
OPT_00_OPT_06	0,549		
INN_00_INN_02	0,708		
INN_00_INN_03	0,681		
INN_00_INN_04	0,587		
INN_00_INN_05	0,679		
Negativity			
ONG_00_ONG_02		0,636	
ONG_00_ONG_03		0,58	
ONG_00_ONG_05		0,591	
ONG_00_ONG_06		0,776	
ONG_00_ONG_07		0,742	
ONZ_00_ONZ_01		0,777	
ONZ_00_ONZ_03		0,653	
ONZ_00_ONZ_05		0,58	
Perceived Usefulness			
VN_00_VN_01			-0,617
VN_00_VN_02			-0,798
VN_00_VN_03			-0,665
VN_00_VN_05			-0,807
VN_00_VN_06			-0,786

5.3 Reliabilities

Even though the scales in this research have been widely tested in earlier research, it is necessary to check for reliability, since adaptations were made. This is done by checking on Cronbach's Alpha, as it is a common measure for internal consistency (Cronbach, 1951). Table 4 gives an overview of the scores of the constructs.

As can be seen in Table 3, all values are above the proposed level of 0.7 (Nunally & Bernstein, 1994). This indicated that all constructs are sufficiently reliable. A deeper analysis showed that the reliability of each construct would not be increased if any item would be deleted.

Table 3: Model Reliability

Construct	Number of Items	Cronbach's Alpha
Positivity	10	0,848
Negativity	8	0,823
Perceived Usefulness	5	0,828
Intention to Advise	2	0,975

5.4 Correlation

Before the correlation analysis was carried out, several assumptions were tested. First, it was found that the variable intention to advise is not normally distributed. Therefore the Pearson coefficient cannot be used but the author will make use of Spearman's Rho as a measure of correlation. Second, it was checked whether the variables' residuals are normally distributed, which is the case. Lastly, no multicolinearity was found (according to the variance inflation factor). To see how the variables are connected, a summary is shown in Table 4. The correlation matrix shows the sample size and the Spearman's rho correlation coefficient (ρ) for the original variables and the control variables. It is striking that positivity is positively correlated with only intention to advise. Here the correlation is significant though only of moderate strength ($\rho=0.406$). In addition to the positive correlation, positivity is negatively correlated with negativity ($\rho=-0.195$), though the finding is not significant. This could indicate that people with a more positive character have less negative characteristics with regards to technology. The only other significant correlation exists between age and intention to advise ($\rho=-0.225$). This negative relationship shows that an increase in age leads to a decrease in the intention of a nurse to advise usage of the AP. However, the effect is rather weak so no final conclusions should be made from it.

Important to notice is that neither positivity nor negativity is significantly correlated with the perceived usefulness. Additionally, also perceived usefulness and intention to advise show no significant correlation. Lastly, gender as a control variable is not significantly correlated with the other variables.

5.5 Model Testing

In order to test **H1**, **H2**, **H3**, and **H4**, which were proposed before, the relationships between the two independent constructs, positivity and negativity, and perceived usefulness are tested using a regression analysis. Since the four original independent variables diverged into two constructs, only two simple linear regressions were conducted. The model accounts for only 9.6% of the total variation ($R^2=0.096$, with control variables), meaning that around 90% are still unknown and

Table 4: Correlation Matrix and Construct Level Statistics

Correlations	N	Positivity	Negativity	Perceived Usefulness	Intention to Advise	Age	Gender
Positivity	81	1					
Negativity	79	-0,159	1				
Perceived Usefulness	79	0,158	0,049	1			
Intention to Advise	77	0,406**	-0,135	0,173	1		
Age	77	-0,099	-0,175	0,123	-,225*	1	
Gender	77	0,005	-0,004	-0,041	-0,179	0,111	1

many other variables may have an influence on the perceived usefulness of the AP.

Table 5 shows the B, Standard Error, Beta (β), t-value, and significance of the control variables, the two constructs, and the constant. As can be seen, neither age nor gender, as control variables, are significant in the regression analysis. This changes after the introduction of the constructs to the regression analysis. The significance, and therefore importance, of age increases to 0.023 (one-tailed analysis) and thus it becomes a valuable part of the model. Its β-value lies at 0.236 so the observed effect is rather small. Additionally, positivity is significant with β=0.25. This shows that positivity indeed leads to an increase in the perceived usefulness of the AP. Still, this effect is rather small. Furthermore, negativity does not have a significant influence on perceived usefulness. For detailed model summaries, see Appendix 10.3.

In order to test **H5** and the relationship between perceived usefulness and the intention to advise, a second regression analysis was carried out. The model explains 2.5% of the total variance (R^2=0.025, with control variables) and thus does not contribute a lot to the clarification of what drives intention to advise. As Table 6 shows, both age and gender show no significant result. After inclusion of perceived usefulness to the model, age is at the boarder of being significant (p=0.053). The influence on intention to advise would have been negative (β=-0.187). More importantly, perceived usefulness has a significant influence on the intention to advise (p=0.049; β=0.191). This influence is positive and therefore goes into the intended direction.

To give a more holistic view and to investigate whether perceived usefulness acts as a mediating variable in the model, a third regression analysis was conducted. Here, the direct influence of positivity and negativity on intention to advise was measured. The model accounts for around 25% of the variance (R^2=0.256, with control variables). This is a great increase compared to the variance that the former two models explained. Looking at Table 7, it can be seen that again neither age nor gender plays a significant role in the model. Positivity, though, is significant and the effect is stronger (β=0.428). Based on the findings in the exploratory factor analysis, the hypotheses regarding optimism, innovativeness, discomfort, and insecurity could not have been tested as proposed by literature. Still, since the hypotheses were brought together in two concepts, the author makes the decision of confirmation/rejection under the assumption that the new concepts are sufficient substitutes of the original four hypotheses.

The conducted analysis shows that of the two proposed constructs, only one significantly influences nurses' perceived usefulness of an artificial pancreas. The effect is positive and thus **H1:** *Optimism among nurses positively influences their perception of the artificial pancreas' usefulness*, and **H2:** *Innovativeness among nurses positively influences their perception of the artificial pancreas' usefulness* are confirmed. Additionally, due to non-significance, **H3:** *Discomfort among nurses negatively influences their perception of the artificial pancreas' usefulness*, and **H4:** *Insecurity among nurses negatively influences their perception of the artificial pancreas' usefulness* are rejected. Regarding the proposed relationship between perceived usefulness and intention to advise, the effect goes in the suggested direction and is significant. Therefore **H5:** *Perceived usefulness of an artificial pancreas positively influences nurses' intention to advise the device* is confirmed.

Table 5: Results Independent Variables explaining Perceived Usefulness

Model 1	B	Std. Error	Beta	t-value	Significance
Constant	3,233	0,972		3,327	0,001
Age	0,03	0,018	0,189	1,653	0,051
Gender	-0,105	0,314	-0,038	-0,336	0,369
Model 2	**B**	**Std. Error**	**Beta**	**t-value**	**Significance**
Constant	1,013	1,473		0,688	0,247
Age	0,037	0,018	0,236	2,029	0,023*
Gender	-0,082	0,308	-0,03	-0,267	0,396
Positivity	0,291	0,135	0,25	2,148	0,018*
Negativity	0,11	0,126	0,103	0,874	0,193

Table 6: Results Perceived Usefulness explaining Intention to Advise

Model 1	B	Std. Error	Beta	t-value	Significance
Constant	7,571	1,062		7,131	0
Age	-0,026	0,02	-0,151	-1,331	0,094
Gender	-0,491	0,343	-0,163	-1,434	0,078
Model 2	**B**	**Std. Error**	**Beta**	**t-value**	**Significance**
Constant	6,891	1,125		6,127	0
Age	-0,033	0,02	-0,187	-1,64	0,053
Gender	-0,469	0,339	-0,155	-1,385	0,085
Perceived Usefulness	0,21	0,125	0,191	1,677	0,049*

Table 7: Positivity and Negativity explaining Intention to Advise

Model 1	B	Std. Error	Beta	t-value	Significance
Constant	7,571	1,062		7,131	0
Age	-0,026	0,02	-0,151	-1,331	0,094
Gender	-0,491	0,343	-0,163	-1,434	0,078
Model 2	**B**	**Std. Error**	**Beta**	**t-value**	**Significance**
Constant	4,935	1,473		3,349	0,001
Age	-0,022	0,018	-0,124	-1,175	0,122
Gender	-0,412	0,308	-0,137	-1,337	0,093
Positivity	0,549	0,135	0,428	4,05	0,000*
Negativity	-0,092	0,126	-0,079	-0,734	0,233

6. DISCUSSION

6.1 Summary of Findings

This study investigated the effects of nurses' individual characteristics on their perceived usefulness of an artificial pancreas and their intention to advise it to physicians and patients, and is mainly based on the work of Parasuraman (2000), and Godoe and Johansen (2012). The research question to be answered was: *To what extent do individual characteristics of nurses treating diabetes 1 patients influence their intention and readiness to advise an artificial pancreas?*

In order to investigate this, five hypotheses were developed and statistically tested based on a survey that was sent to 188

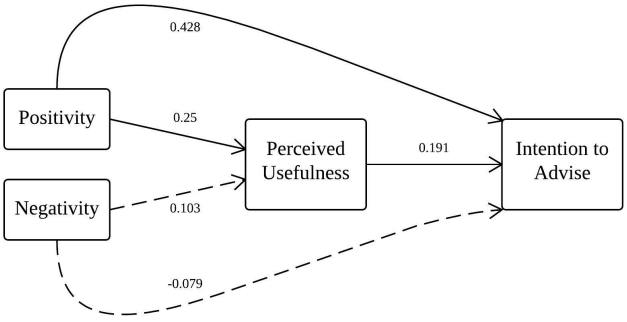

Figure 2: Revised Research Model with Regression Results

diabetes nurses throughout the Netherlands. This study also tested the proposed hypotheses with inclusion of the control variables age and gender. Furthermore, direct effects of the independent variables on intention to advise were investigated. Resulting from the factor analysis H1 and H2, as well as H3 and H4, were merged together and tested as two constructs. With two of the five hypotheses rejected, the model explains 9.6% of variation for the relationship between positivity and negativity, and perceived usefulness. The effect of perceived usefulness on the intention to advise explains only 2.5% of total variation. These results show that the model lacks important variables to explain both perceived usefulness and intention to advise. A direct relationship between positivity and negativity, and intention to advise explains 25.6% of the variance. This means that perceived usefulness is a partial mediator, which is also indicated using the four steps of Baron and Kenny (1986), where two of the steps are met. Please see Figure 2 for a graphical summary of the study's results. The low R^2 values prompt the conclusion that the variables used are not the most important ones for explaining the total variance. Future research should therefore focus on identifying more appropriate independent variables to find what drives the intention to advise an AP.

The significant positive influence of positivity on perceived usefulness is in accordance with the findings of Walczuch et al. (2007), and Godoe and Johansen (2012) regarding optimism and innovativeness. They found the same result in both of their analyses. The β-value of 0.25 lies a little bit below their results. Also the non-significant relationship between negativity, as discomfort and insecurity, and perceived usefulness follows Godoe and Johansen (2012). Therefore, these results are not really surprising, but support the findings of prior research. This applies also for the significant positive relationship between perceived usefulness and intention to advise. With regard to the control variables age and gender, only age influenced the relationships in a significant manner. As proposed by Parasuraman and Colby (2007), and Caison et al. (2008), age negatively affects the individual's perceived usefulness of the device. However, age did not affect the other relationships (perceived usefulness on intention to advise, and the direct effect of the independent variables on intention to advise). Also, it is noticeable that gender did not have any significant effect, contrasting findings in extant literature (Alagöz et al., 2011). A possible reason is that male nurses where underrepresented in the study sample, accounting for only 13% of respondents, and female answers thus biased the result. This could explain why no effect was found.

6.2 Limitations

This study is subject to several limitations that are important to be aware of when dealing with the results. First and foremost, this study is limited to the geographical context of diabetes nurses in the Netherlands. Although this is the main user group of Inreda and therefore practically relevant, the results might differ for nurses in other countries and cultural environments. One should therefore be cautious when applying the results to contexts beyond this research's scope. This implies for future research that the study should be repeated in other country contexts to validate the results. Second, the surveys are based on scales that were validated by research conducted in English and needed to be translated into Dutch. Even though this was done by a native speaker, translation errors might have occurred. Also differing interpretations of survey questions might have led to unintended answers. In future analyses these potential misunderstandings should be minimized. A third limitation is the very limited validity of the model in terms of the total variance it explains. With an R^2 of 0.096, 0.025, and 0.256, a large part of the variance remains unexplained. This means that even if the relationships were stronger, the reality they represent would still show just a small part of the big picture. More influencing variables need to be found to understand how the intention to advise is influenced. Fifth, the measures used in the survey are self-reported. Therefore they might not be objective and potentially less reliable (Legris et al., 2003). More extensive studies could make use of measurement methods that include personal interaction, even

though this is associated with more work. Additionally, the generalizability can be improved by including more respondents to the sample. The amount of 77 diabetes nurses is sufficient for this analysis but a larger sample could increase reliability and might lead to different results. Lastly, several items of the variables had to be removed within the scope of the external factor analysis. For insecurity, two of the five items were excluded, meaning that almost half the items intended to measure insecurity were not used in the analysis. This might have had an effect on the results in the correlation and regression analysis. Questions that measure the intended items better should be introduced.

6.3 Implications and Directions for Future Research

6.3.1 Managerial Implications

This study has essential implications for practical research directions. It provides Inreda with a basis for a better understanding of an important stakeholder group. These insights can be used to improve marketing efforts and tailor the presentation of the product to the conditions of the diabetes nurses. The results of this paper show that especially characteristics of positivity impact the perceived usefulness of an AP. A focus on nurses with these characteristics might result in greater benefits for Inreda than a general marketing approach. Furthermore, nurses that do not score high on positivity measures could get additional trainings and an introduction by Inreda to get to know the device and increase their perceived usefulness of it. This would support Davis (1989) who states that an individual needs to be convinced that a new product is better than the old one. In addition, Melas et al. (2014) state that it is important to initially target the people that adopt a technology early. Innovativeness is therefore an important attribute. Inreda intends to market the AP not only in the Netherlands, but also in Germany and Austria. Therefore it is important to expand the research and repeat it with diabetes nurses from these countries. This would again increase marketing knowledge for Inreda and specify where to focus marketing efforts on.

Since this study focuses on a medical device, the results might be generalizable to the field of other medical innovations. Marketers need to communicate the benefits of the products in a way that convinces the nurses and other stakeholder of their benefits and usefulness. As found out in this research, the perceived usefulness of a device positively influences an individual's intention to advise usage of it, even when its only a small effect.

6.3.2 Theoretical Implications and Research Directions

The analysis in this paper is based on prior research conducted in the field of the TRAM by e.g. Walczuch et al. (2007), and Godoe and Johansen (2012). Next to the possible practical directions, this study gives a leverage point for future research. Whilst satisfactory for the scope of this study, the sample size (N=77) is not the finest. Increasing the sample size in future analyses might increase validity, reliability, and lead to a change in the results.

Furthermore, the AP is a rather new device in the domain of diabetes treatment. For this reason, more research in this field is necessary to expand knowledge on how the device can be marketed to users and other stakeholders, such as physicians and insurance companies. Since Inreda also intends to develop a product specifically for children, research on technology readiness in this area can be valuable for both practice and academia.

The findings are partially in line with prior findings (Walczuch et al., 2007; Godoe & Johansen, 2012). They support the proposition that optimism and innovativeness have a positive influence on perceived usefulness. Also the positive effect of perceived usefulness on intention to advise has been proven in earlier work. However, focus should be given to discomfort and insecurity, as these variables did not show significant results in this analysis but in others (Walczuch et al., 2007).

An important finding in this paper is that not four independent variables were found after the exploratory factor analysis, but only two. The variables optimism, innovativeness, discomfort, and perceived usefulness could not be measured for themselves but were merged together into the two concepts positivity and negativity. This makes it impossible to conclude which factor had more influence on the perceived usefulness of the AP. Merging the four variables of the TRI into two new variables changes the way of analyzing the effect on perceived usefulness. In the past, research used the original variables (Parasuraman, 2000; Walczuch et al., 2007; Godoe and Johansen, 2012). However, taking into account the new findings, future research should try to find out whether the original four variables are still valid or whether positivity and negativity are suited better to explain perceived usefulness. This would broaden the knowledge on what influences the perceived usefulness of a technological device and give more opportunities to practical implementation.

7. CONCLUSION

To conclude this paper, it can be said that individual characteristics of nurses' influence the perceived usefulness of an AP only to a limited extend. Discomfort and insecurity were not found to have any influence on the perceived usefulness, whereas optimism and innovativeness have a small effect. However, perceived usefulness does not have a significant impact on the intention to advise an AP to patients and physicians. Therefore, it cannot be said that individual characteristics have a significant influence on the intention to advise, but only on the preceded stage of perceived usefulness. This paper can be of great value for Inreda, since it reveals essential insights into how nurses, as future stakeholders of the AP, are influenced in their individual views of the product's usefulness. Additionally, the paper supports Inreda in its process of developing, launching, and marketing the AP and the subsequent endeavor to improve peoples' lives.

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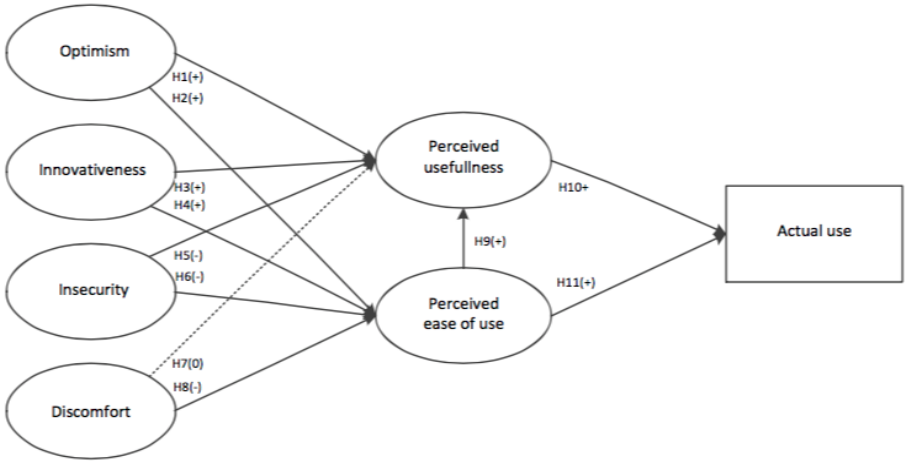
10. APPENDIX

10.1 Research Model of Godoe and Johansen (2012)



10.2 Research Model Operationalization

Construct	Definition	Original Item	Author and Cronbach's alpha	Adapted Item
Optimism	a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives	1. Technology gives people more control over their daily lifes 2. Products and services that use the newest technologies are much more convenient to use 3. You prefer to use the most advanced technology available 4. Technology makes you more efficient in your occupation 5. Technology gives you more freedom of mobility 6. You feel confident that machines will follow through with what you instructed them to do	Godoe and Johansen (2012), Parasuraman (2000), Lin & Hsieh (2005), Cronbach's alpha: ≥0.83	1. OPT_00_OPT_01: Technology gives people more control over their daily lives 2. OPT_00_OPT_02: Products and services that use the newest technologies are much more convenient to use 3. OPT_00_OPT_03: You prefer to use the most advanced technology available 4. OPT_00_OPT_04: Technology makes you more efficient in your occupation 5. OPT_00_OPT_05: Technology gives you more freedom of mobility 6. OPT_00_OPT_06: You feel confident that machines will follow through with what you instructed them to do
Innovativeness	The tendency to be a technology pioneer and thought leader	1. Other people come to you for advice on new technologies 2. In general, you are among the first in your circle of friends to acquire a new technology when it appears 3. You can usually figure out new high-tech products and services without help from others 4. You keep up with the latest technological developments in your areas of interest 5. You find you have fewer problems than other people in making technology work for you	Godoe and Johansen (2012), Parasuraman (2000), Lin & Hsieh (2005), Cronbach's alpha: ≥0.85	1. INN_00_INN_01: Other people come to you for advice on new technologies 2. INN_00_INN_02: In general, you are among the first in your circle of friends to acquire new technology when it appears. 3. INN_00_INN_03: You can usually figure out new high-tech products and services without help from others. 4. INN_00_INN_04: You keep up with the latest technological developments in your areas of interest. 5. INN_00_INN_05: You find you have fewer problems than other people in making technology work for you.
Insecurity	The distrust of technology and skepticism about its ability to work properly	1. Revolutionary new technology is usually a lot safer than critics lead people to believe [reverse scored] 2. A machine or computer isgoing to be a lot more reliable in doing a task than a person [reverse scored] 3. It can be risky to switch to a revolutionary new technology too quickly 4. If you buy products that are too high-tech, you may get stuck without replacement parts or service 5. Technological innovations always seem to hurt a lot of people by making their skills obsolete	Godoe and Johansen (2012), Parasuraman (2000), Lin & Hsieh (2005), Cronbach's alpha: ≥0.88	1. ONZ_00_ONZ_01: Critics lead people to believe that revolutionary new technologies are less safe than they usually are 2. ONZ_00_ONZ_02: A machine or computer is going to be less reliable in doing a task than a person 3. ONZ_00_ONZ_03: It can be risky to switch to a revolutionary new technology too quickly. 4. ONZ_00_ONZ_04: If you buy products that are too high-tech, you may get stuck without replacement parts or service. 5. ONZ_00_ONZ_05: Technological innovations always seem to hurt a lot of people by making their skills obsolete.

Discomfort	The perceived lack of control over technology and a feeling of being overwhelmed by it	1. Technical support lines are not helpful because they do not explain things in terms you understand 2. Sometimes, you think that technology systems are not designed for use by ordinary people 3. There is no such thing as a manual for a high-tech product or service that is written in plain language 4. If you buy a high-tech product or service, you prefer to have the basic model over one with a lot of extra features 5. There should be caution in replacing important people-tasks with technology because new technology can breakdown or get disconnected 6. Many new technologies have health or safety risks that are not discovered until after people have used them 7. Technology always seems to fail at the worst possible time	Godoe and Johansen (2012), Parasuraman (2000), Lin & Hsieh (2005), Cronbach's alpha: ≥0.74	1. ONG_00_ONG_01: Technical support lines are not helpful because they do not explain things in terms you understand 2. ONG_00_ONG_02: Sometimes, you think that technology systems are not designed for use by ordinary people 3. ONG_00_ONG_03: There is no such thing as a manual for a high-tech product or service that is written in plain language 4. ONG_00_ONG_04: If you buy a high-tech product or service, you prefer to have the basic model over one with a lot of extra features 5. ONG_00_ONG_05: There should be caution in replacing important people-tasks with technology because new technology can breakdown or get disconnected 6. ONG_00_ONG_06: Many new technologies have health or safety risks that are not discovered until after people have used them 7. ONG_00_ONG_07: Technology always seems to fail at the worst possible time
Perceived Usefulness	An individual's perception that the application of a certain technology or innovation will outperform existing practices	1. Using the system improves my performance in my job 2. Using the system in my job increases my productivity 3. Using the system enhances effectiveness in my job 4. I find the system useful in my job 5. Using the system enables me to accomplish my tasks more quickly 6. Using the system makes it easier to do my job	Venkatesh and Davis (2000), Cronbach's alpha: ≥0.87	1. VN_00_VN_01: I expect that using the artificial pancreas would enable me to accomplish tasks more quickly. 2. VN_00_VN_02: I expect that using the artificial pancreas improves my productivity in my job. 3. VN_00_VN_03: I expect that using the artificial pancreas will increase my effectiveness in my job. 4. VN_00_VN_04: I expect that using the artificial pancreas will be useful in my job. 5. VN_00_VN_05: I expect that using the artificial pancreas would make it easier for me to accomplish my daily tasks. 6. VN_00_VN_06: I expect that the artificial pancreas will make the execution of my work easier.
Intention to Use	An individuals intention to use a particular device or technology	1. Assuming I have access to the system, I intend to use it 2. Assuming I have access to the system, I predict that I would use it	Venkatesh and Davis (2000), Cronbach's alpha: ≥0.82	1. ITU_00_ITU_01: Assuming my organisation has access to an artificial pancreas, I intend to recommend it to the corresponding doctor. 2. ITU_00_ITU_02: Assuming my organisation has access to an artificial pancreas, I intend to recommend it to the corresponding doctor for the patient treatment.

10.3 Model Summaries

Model Summary of Table 5

Model	R	R Square	Adjusted R Square
1	0,19	0,036	0,01
2	0,309	0,096	0,045

Model Summary of Table 6

Model	R	R Square	Adjusted R Square
1	0,232	0,054	0,028
2	0,298	0,089	0,051

Model Summary of Table 7

Model	R	R Square	Adjusted R Square
1	0,232	0,054	0,028
2	0,506	0,256	0,215